DESIGN AND VALIDATION OF DIAGNOSIS TOOL OF INCLUSION OF CHILDREN WITH DISABILITIES IN PLAYGROUNDS

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Abstract

The last years in Medellin has been developed actions to create normative that promote the inclusion of people with disabilities in the different public spaces. Nevertheless even recreation is recognized as a fundamental right, it is needed to stablish guidelines for the design of inclusive playgrounds.
In this investigation were analysed 5 factors that are important for the design of inclusive playgrounds: surrounding environment, context, the user, activities and objects. When these factors were analysed, it was possible to identify the areas of a playground and its components that need to be evaluated, to design a diagnosis tool of the inclusion of children with reduced lower limb mobility in playgrounds. Then the diagnosis tool was evaluated in a series of validation cycles with different stakeholders to make an usable tool that takes into account the technical normative in the design of a playground. The diagnosis tool evaluates 3 areas (surrounding environment accessibility, play area accessibility and play area objects) and its components, to allow professionals to evaluate playgrounds in any stage of the design process to improve its accessibility and inclusion.

Keywords: Inclusive design, Design methods, Evaluation, Children with disabilities, Playgrounds

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1 INTRODUCTION

The disability concept and its approaches have been changed throughout the history. Generally it was seen as a disease and not as a human condition. Nowadays it has been adopted a totally different vision about disability, defining it as a term that covers the human condition, the activity limitations and participation restrictions, which is also influenced by a negative interaction between people and the characteristics of the environments that they interact with (World Health Organization, 2011) (Leonardi, Bickenbach, Bedirhan Ustun, Kostanjsek, & Chatterji, 2006).

In Medellin, Colombia, about 2.500 children between 0 and 9 years old have some form of disability (Secretaría de Salud de Medellín, 2010). In the last years the municipality has taken some actions with the attempt to create policies to promote the inclusion of people with disabilities in different social contexts, nevertheless, when the exploration of the policies and normative that regulate the playground's design took place, it was possible to confirm that in Medellin they have a full recognition of the recreation as a fundamental right that all children without any exception have; But when the playground design guides were searched, it was found that in the city they do not have any official guidelines to design regular playgrounds even less to design one that allow the inclusion of children with disabilities.

Taking into account that Medellin is making big transformations to be a more inclusive and intelligent city, it seems important to do an investigation to develop a diagnosis tool to evaluate the inclusion of children with reduced lower limb mobility in playgrounds. One of the goals of this research was to identify the design requirements of the urban context and play objects that need to be considered to achieve an inclusive design of playgrounds, therefore it was possible to design a diagnosis tool to evaluate the level of inclusion that a playground has based on the accomplishment of inclusive design requirements.

It is truth that to refer to a truly inclusion it has to be take into account the capabilities of the greatest number of people, it is also truth that disability is very complex and diverse, then it was decided to start the investigation just with reduced lower limb mobility, but with the attempt to replicate the methodology used, as a future work, to define the variables needed to take into account in the design for the inclusion of people with other types of disability.

2 METHODOLOGY

To develop the investigations it was used the action research (Koshy, 2005) (Reason & Bradbury, 2001). Taking into consideration that it looks for the learning and knowledge building through the action, it was proposed seven cycles to design and validate the inclusion diagnosis tool for playgrounds, as shown in figure 1:

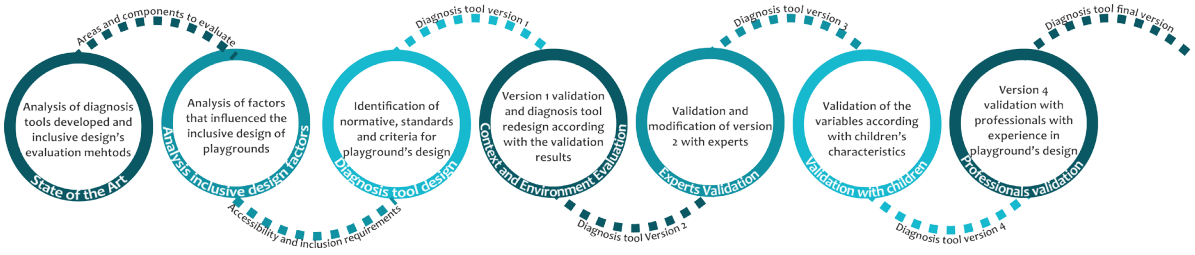

Figure 1. Research cycles defined

To start the designing of the diagnosis tool, it was consulted the companies mainly of countries like England, United States, Spain and The Netherlands, that have developed tools to evaluate the inclusion of children with disabilities in playgrounds, to determine the areas that the tool have to evaluate. Besides, it was checked the methods created in the academy field to assess the inclusive

design of a product, to identify the factors that had to be present in the inclusive design of playgrounds.

Afterwards, it was analysed the factors that influence the inclusive design of play spaces (the environment, the context, the user, the sequence of activities and the objects), to find the constraints for the inclusion of children with reduced lower limb mobility. These constraints were traduced into design requirements of the different components of a playground. The last ones constitute the starting point for the design of the diagnosis tool, but it had to be subject of a series of validations to evaluate its appropriateness and usability.

For the validation it was proposed four validation cycles. The first approach of the diagnosis tool was analysed in the context of a playground to determine if the variables were appropriate according with the design of a typical playground in the city, which generally has play objects as slides, swings, see-saws and monkey bars. After each validation stage, the diagnosis tool was redesigned, modifying its variables, structure or evaluation format accordingly with the results obtained.

Two architects who are experts on accessibility's assessment, were contacted to review the diagnosis tool and determine if they considered necessary to add or delete some of the variables. Moreover, their contributions were important to stablish indicators to give an accessibility and inclusion level as a result after applying the diagnosis tool. They were asked to define a score to each variable according with its relevance in the diagnosis tool and the value range defined for each one to accomplish with an accessible and inclusive design from their experience not only as professionals but as people with reduced lower limb mobility.

There was also necessary a validation with children with reduced lower limb mobility to make an anthropometry sounding because there is not available data about children with disabilities dimensions. The data collected from 9 children with reduced lower limb mobility were compared with the anthropometry tables of Colombian children without disabilities (Ruiz Ortiz, 2001), to determine if the value range of the variables related with the user had to be adjusted according with the results of this stage. Even when the number of children is not representative, it was taken just as a referent to define the higher or lower dimension that have to be taken into account in the design.

Ultimately, it took part a validation with four professionals (architects and engineers) with experience in design and construction of playgrounds. This cycle had the purpose to obtain a feedback about the usability of the diagnosis tool, to know if the professionals, as users, found it easy to use and understand.

3 RESULTS

3.1 State of the art

In this cycle it was possible to obtain a first definition of the areas and variables that have to be taken into account for the design of the diagnosis tool.

3.2 Inclusive design factors analysed

When the objects are designed taking into account the capabilities of people with disabilities, it could result in a very complex process because of the amount of variables that have to be considered when the designed objects have the intention to be used by the greatest number of people. For this reason, Sevilla (2011) in his master thesis proposed a model to analyse the interaction between people with disabilities and the building environment, with the attempt to simplify the process.

To complement the model posed by Sevilla and accordingly with the results of the review of the methods developed to evaluate the inclusive design of a product, when it is going to assess the inclusion of people with a determined disability in a product design, it is necessary to analyse five

factors to identify all the aspects that difficult the natural flow of the interaction between people and products:

- The user: in this case children with reduced lower limb mobility
- The context: playgrounds
- The environment: policies, normative and all the characteristics of the territory where the context is located (country and city)
- The sequence of activities: actions that the user must do when he/she is interacting with the context and the objects within
- The play objects: characteristics and demands

3.3 Diagnosis tool design

To make the design of the diagnosis tool, it was taken as reference the results of the two previous steps, as is explained in the next figure:

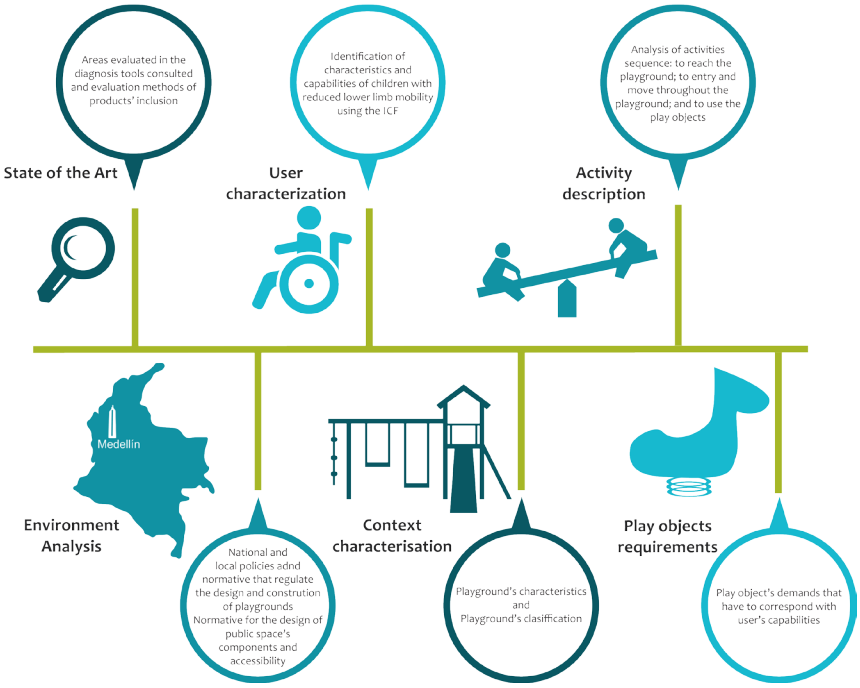

Figure 2. Diagnosis tool design process

To complement these results, it was also necessary to consult the accessibility normative in Colombia and the international standards for the design of inclusive playgrounds, as it appears in the figure 3.

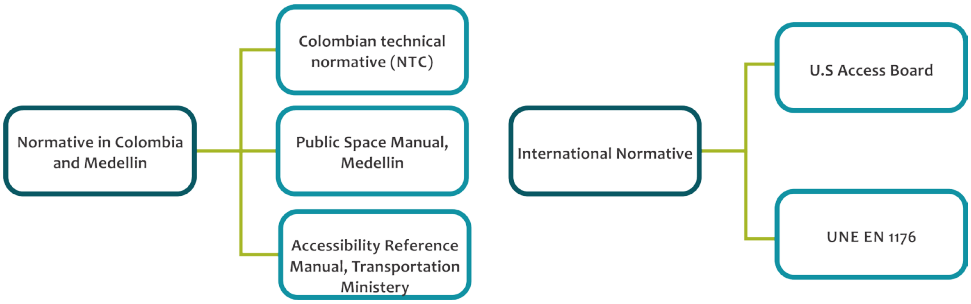

Figure 3. Playground and Accessibility normative

With the requirements stablished from the analysis of the inclusive design factors in a playground and the normativity consulted, it was defined the playground areas to be evaluated and the technical specifications that must be accomplish by each of the components of these areas, which were used to obtain the first version of the diagnosis tool.

3.3.1 First version design

In this version were defined 3 areas to be evaluated with their respective components and design requirements. The figure 4, shows the areas and components defined for the first version of the diagnosis tool.

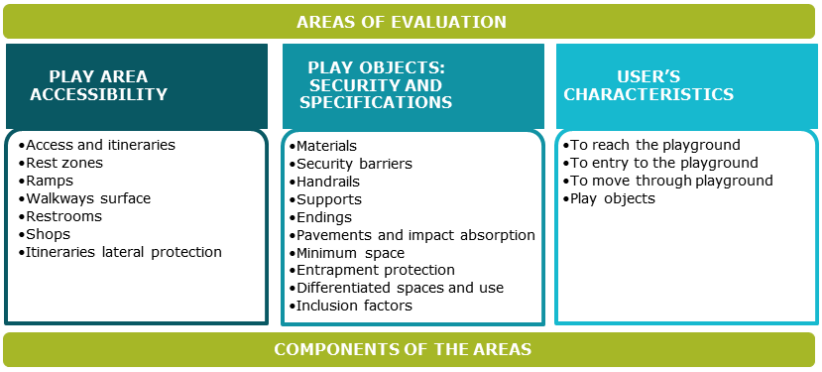

Figure 4. Diagnosis tool Structure version 1

This version consisted of tables for each component, structured as a check list with the design requirements for each one. It allowed to verify if every component accomplish or not with the necessary design requirements to afford the inclusion of children with reduced lower limb mobility. Below is presented an example of one of the tables of the diagnosis tool:

Table 1. Example of a table from the diagnosis tool version 1

PLAY AREA ACCESSIBILITY					
ACCESS AND ITINERARIES	**YES**	**NO**	**N.A**	**COMMENTS**	**PHOTOGRAPH**
The itinerary is flat					
If the itinerary is not flat, its slope is less than 5%					
The itinerary has rest areas					
The itinerary needs rest areas					
The rest areas in the itinerary are equidistant					
There is a main route traced					
There are other routes traced from the main route					
The itinerary has a minimum width of 90cm					
The itinerary has a differentiated route for bicycles, tricycle and other wheeled toys					
The itinerary has pedestrian walkways					
Pedestrian walkways are differentiated from the bicycles routes					
Longitudinal slopes are between 6% y 12%					
Perpendicular slopes are between 2% y 5%					

3.4 Validation cycles

3.4.1 First validation: context validation

The first version was applied to a playground from Medellin, to verify the appropriateness of variables according with the context. With this validation it was possible to determine:

- The required changes in the variables to make it more understandable
- Which variables need more information about the user to determine whether it meets or not the requirements
- Which variables were difficult to measure without the appropriate instruments
- The expertise level the evaluator need to use the diagnosis tool
- Which variables was not necessary to evaluate according with the typical playground design, for example in Medellín the public playgrounds are used by the people from the surrounding neighbourhoods, then it did not need restrooms or shops.

With these results, the diagnosis tool was adapted, but it still had the same check list structure. It was also deleted some of the components that were not necessary or were combined with others, changing from 21 to 14 components in total.

3.4.2 Second validation: experts on accessibility

The new version of the diagnosis tool was evaluated by two architects with expertise on accessibility assessment. With their help it was possible to determine that some components need to be more specific, for example it is needed to evaluate the accessibility of the itineraries to reach the playground apart from the accessibility of the internal itineraries of the playground (to allow children to move within the play area). It was also identified that some of the physical components of the urban and architectural environment were missing to evaluate in the diagnosis tool.

The diagnosis tool still had three areas to evaluate, but it was reorganized and renamed, and the components of each area also changed, resulting in 16 components to be evaluated, as it shows figure 5:

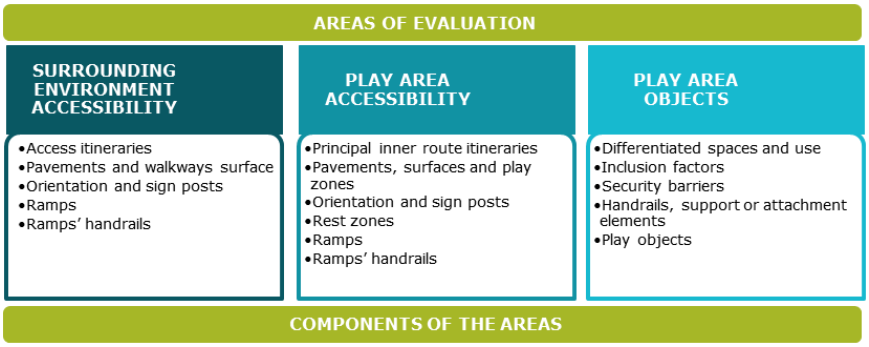

Figure 5. Diagnosis tool Structure version 3

It was also decided that the best structure of the evaluation tables for the professionals that will applied it, is with qualitative and quantitative variables. Then, when the evaluation is executed the users of the tool just need to fill in the numerical values when it is a quantitative data or specify if it accomplishes or not with a qualitative requirement.

In this stage, the two participants were asked to give a relevance weight to each variable and area evaluated in the diagnosis tool. This had the purpose to provide a level of accessibility and inclusion to the evaluated playground. It was determined that the 3 areas evaluated had the same relevance for the accessibility assessment due to the children need to approach the playground from its surroundings, to be able to enter and move throughout the playground, and to be capable to use the play objects within. Below is presented an example of an evaluation table designed in this stage:

Table 2. Example of a table from the diagnosis tool version 3

SURROUNDING ENVIRONMENT ACCESSIBILITY								
Route #:								
Route Identification:								
ACCESS ITINERARIES	**Unity**	**Value**			**0**	**1**	**2**	**Weight**
¿Has itineraries? (if its required an itinerary and it has not grade with NO, if it is not necessary grade N.A)	-	Yes	No	N.A	If the answer is NO, the whole component receives a grade of 0, if its YES make the evaluation			
Width (free from obstacles)	m				<1,20	1,20 - 1,60	≥1,60	0.245
It has a differentiated route for bicycles, tricycle and other wheeled toys	-	Yes	No	N.A	No		Si	0.164
Longitudinal slopes	%				>5	3 - 5	<2	0.273
Perpendicular slopes	%				>2		<2	0.273
Diameter area for turning the wheelchair	m				<1,50		≥1,50	0.273
Level difference between the pedestrian route and the road	m				>0,18	0,03 - 0,18	≤0,03	0.164
The itineraries with a gradient higher than 10 cm, have a protective curb with 5cm height	-	Yes	No	N.A	No		Yes/N.A	0.164
Level difference between the pedestrain walkway and the road in the pedestrian crosswalk	m				>0,03 No		>0,03 y <0,25 Yes/N.A	0.273
The crosswalks have a sloping pace	-	Yes	No	N.A				
Longitudinal slope in the sloping pace	%				>12	12	<12	0.273
Slopig pace width	m				<0,90	0,90	>0,90	0.218
Height of the vertical objects in the itineraries	m				<2,20		≥2,20/N.A	0.245
The entry and exit points of the playground are connected with the access itineraries	-	Yes	No	N.A	No		Yes	0.273

A variable is graded according with the value it has as:

- 0: when it does not accomplish with the accessibility/inclusion requirement
- 1: when it accomplishes the basic accessibility/inclusion requirement
- 2: When it accomplishes the adequate or optimal accessibility/inclusion requirement

3.4.3 Third validation: children with reduced lower limb mobility

It was necessary to make an anthropometry sound with children between 5 and 10 years old with reduced lower limb mobility, due to there is not an official study of their dimensions to determine the range values, that all the objects that children will interact with, must meet.

These dimensions were compared with an anthropometry study of Colombian children between 5 and 10 years old without disabilities (Ruiz Ortiz, 2001), to select the values of each variable to allow all children in that age range to use the objects and play spaces. With the identification of the dimensions, the tables of the diagnosis tool were adapted to accomplish it values.

3.4.4 Fourth validation: professionals with experience on playground's design and construction

At least, it was conducted a final validation with four professionals that work on the design and construction of playgrounds to evaluate the usability of the diagnosis tool and to determine if when it is applied to the same playground by different people, the same result was obtained or not, if so then it was important to identify the variables with incongruences to adjust it.

At the end of the evaluation each participant filled in a survey about their perception of the diagnosis tool, their knowledge to do the measures, the time required to complete it and the understanding of the variables.

All the participants agree with the number of variables, due to it is important to evaluate different components to make a complete accessibility and inclusion assessment of children with reduced lower limb mobility in playgrounds. The average time taken by the participants to fill in the diagnosis tool was about 1 hour and 20 minutes. They all coincide that the tool is easy to use and the variables are understandable, but there were a few exceptions. Those variables were adjusted to facilitate the comprehension and avoid to misinterpret it.

3.5 Final version design

Afterwards the validations cycles, the final version of the diagnosis tool were designed with all the changes that were made iteratively in each cycle. This version still has 3 areas but with 17 components to be evaluated, as it is shown in Figure 6:

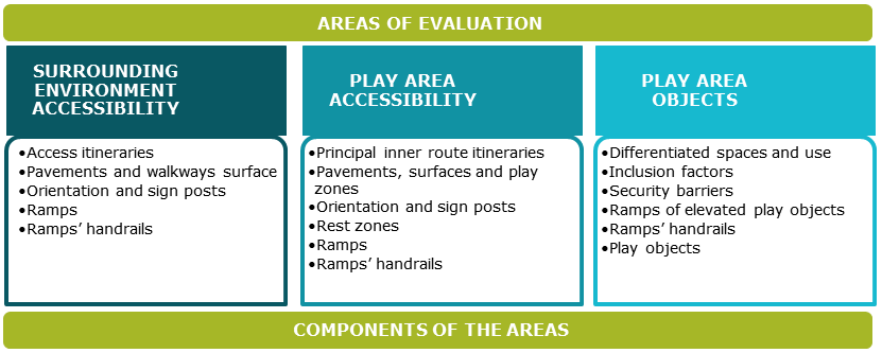

Figure 6. Diagnosis tool Structure final version

Table 3 is an example of the tables that professionals will use to carry out the evaluation. Each table has a column with the variables, one column with the unit of the variable, and one cell for the value measured and another one to write comments. When it is evaluating a component that could be more than one in the playground, the table has a space to name and identify the component.

Table 3. Example of a table from the diagnosis tool final version for the professionals

SURROUNDING ENVIRONMENT ACCESSIBILITY					
Route #:					
Route Identification:					
ACCESS ITINERARIES	**Unity**	**Value**			**Comments**
¿Has itineraries? (if its required an itinerary and it has not grade with NO, if it is not necessary grade N.A)	-	Yes	No	N.A	
Width (free from obstacles)	m				
It has a differentiated route for bicycles, tricycle and other wheeled toys	-	Yes	No	N.A	
Longitudinal slopes	%				
Perpendicular slopes	%				
Diameter area for turning the wheelchair	m				
Level difference between the pedestrian route and the road	m				
The itineraries with a gradient higher than 10 cm, have a protective curb with 5cm height	-	Yes	No	N.A	
Level difference between the pedestrain walkway and the road in the pedestrian crosswalk	m				
The crosswalks have a sloping pace	-	Yes	No	N.A	
Longitudinal slope in the sloping pace	%				
Slopig pace width	m				
Height of the vertical objects in the itineraries	m				
The entry and exit points of the playground are connected with the access itineraries	-	Yes	No	N.A	

4 CONCLUSIONS

- Medellin is a city that is making urban transformations to be a more innovative and intelligent city, to achieve this goal it is required to guarantee that all these transformations aim for a city that all its citizens could enjoy. Playgrounds, for example, that are places for the recreation of children, will be designed to allow all of them, despite their capabilities, access and participate in games. However in Medellin they do not have any design guidelines neither for regular nor inclusive playgrounds.

- Countries that have developed diagnosis tools for inclusion in playgrounds, are very aware about its importance because of the lack of a proper management and planning in the construction of playgrounds, and moreover about the poor sensitizing of the companies that execute those building projects around the inclusion of children with disabilities. In general, the public diagnosis tools are those intended for the community to evaluate playgrounds and to report those that do not accomplish with accessibility and inclusion requirements, so then the companies could offer their full diagnosis service to the owners of the playgrounds with an action plan to improve the play spaces.

- The opportunity mentioned above, in the playgrounds design, incentives this investigation to design and validate a diagnosis tool of the inclusion of children with reduced lower limb mobility in playgrounds. With the implementation of this tool, the professionals that work in the design process of playgrounds, could identify the design factors that creates an exclusion for children with the disability mentioned, to take actions to improve the accessibility and inclusion. To achieve this aim it was concluded that is needed to evaluate 3 areas:

  - The accessibility in the surrounding environment: this is needed to allow children to reach the entrance point to the playground
  - The accessibility in the play area: to assure the children could enter and move independently throughout the playground. Also, it is needed that the elements inside the play area, like the inner itineraries, rest zones, etc., are designed to let children use them.
  - Objects in the play areas: at least 50% of the play objects must be designed to be used independently by children with disabilities. Play objects must have variety in the experiences they give to children.

- The professionals who participated in the last validation, took 1 hour and 20 minutes to apply the diagnosis tool to a playground. It was found that the tool have an easy to understand and technical language. Some variables with unknown terms or a technical name of some play or urban elements, presented differences in the diagnosis tool grading due to a lack of consensus in the use of the terms, therefore it was needed to include a technical guide with the definitions of the terms.

- After performing the validation cycles and obtained the final version of the diagnosis tool, it could be concluded that to make an evaluation of the inclusion of children with reduced lower limb mobility in playgrounds, it is necessary to assess 3 areas with their respective components, which are 17 totally.

- The relevance of this diagnosis tool lies in the possibility that professionals, who design and build playgrounds, would have to evaluate playgrounds either in design phase or that are already build to modify it with the purpose to improve its accessibility and inclusion, focusing in the areas and components that really matter. The last part, could represent time and cost saving as they will evaluate and redesign the areas and components that are necessary.

- The poor familiarity with the accessibility guidelines and a lack of a playground design guide, could result in a misinterpretation of the normative and in objects designed without security and inclusion requirements. With the use of the diagnosis tool and the technical guide, it is expected that technical terms and requirements be clear for the professionals that use the diagnosis tool, and to detect easily in the very early stages, fails or mistakes that need to be corrected in a playground, to avoid reprocesses that could imply higher money and time expending.

- With the implementation of the tool and embracing professionals to design and build inclusive playgrounds, they are going to contribute to the elimination of physical and social barriers that people with disabilities have to face every day, allowing them to participate and enjoy public spaces. With the results of this investigation and the contributions of the inclusive design in the transformation of cities into societies without barriers in the use of products and urban spaces, it could motivate the engineering, design and architectural faculties, to develop inclusive design methodologies to apply them in the design process.

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