

Article

# Educational Systematized Design Thinking Platform—Case of Study: Bus Stop

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**Abstract:** Due to the pandemic caused by the SARSCoV-2 virus, higher education institutions need to develop innovations to accelerate change adaptation and give way to new teaching–learning processes. Since design thinking is currently used in an inspirational way to find solutions to problems, this work presents the design of an Educational Systematized Design Thinking (ESDT) methodology based on a hybrid approach of Kano’s model and the minimum value product creation. Moreover, its implementation is carried out to generate the so-called ESDT platform, which is a tool that students, teachers, and educational researchers can use to work remotely. A case study to respond to a fundamental design problem in the community of a group of architecture students is presented to demonstrate the effectiveness of the proposed work.

**Keywords:** design thinking; Kano’s model; digital platform; systematized methodology



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## 1. Introduction

The pandemic caused by the SARSCoV-2 virus, which began in 2020, has drastically changed our daily lives around the planet. Higher education was not far behind, and an agile transfer from face-to-face activities to online activities was necessary to continue with lectures and classes. Digital platforms used for meeting purposes were adapted or created for educational goals; some examples are Teams, Zoom, Google Classroom, Moodle, Verbling, GoToWebinar, and Blackboard Collaborate. Teachers saw the need to familiarize themselves with these platforms and adapt the content of their material to a digital environment. In particular, subjects related to design were particularly problematized when transferring topics and activities that are regularly face-to-face to a digital environment due to the nature of their actions involving direct contact or manual practice. Changing those educational strategies from face-to-face education to complete online education required considerable effort and adaptation to change by teachers and students [1].

Many tools exist to help in the development of new projects. Industries, government, engineers, and entrepreneurs become familiar with rapid prototype development. For these rapid developments, well-known agile methodologies, such as the SCRUM methodology [2] allow client interaction but do not allow changes until the end of each iteration. The development team and clients meet at the end of each iteration to discuss the subsequent attributes. Other agile methodologies include XP [3] and Kanban [4]. However, entrepreneurs and companies do not know technical terms, and performing these methodologies can sometimes become complicated.

The Design Thinking (DT) methodology emerged as a need to find alternative strategies with a multidisciplinary team, where the whole team understand the project and collaborate to find a creative solution that best fits. Whether working alone or collaboratively, presenting a project's solutions is challenging. Many platforms exist that integrate the DT methodology. For instance, MURAL [5] is a visual workspace to exchange ideas and promote creativity based on agile and DT methodology. It has a free version that can register an unlimited number of people but only allows the user to work on three projects simultaneously. After these, the projects are impossible to follow up without paying; additionally, the platform only allows a whiteboard to share ideas without tracing any project's development. Another platform is Batterii [6], which gives access to hundreds of unique creator communities to understand the possible users and build a custom community that shares ideas stored in a central place. This platform creates a community to share brainstorming ideas but does not provide timely follow-ups on projects or record the development of any project; it also is difficult to follow the site's navigation. This platform charges a monthly fee for a single person to continue having the projects visible and does not have a free version.

Unfortunately, while there is no complete DT platform or integral tool that contains all the stages of this methodology, the working team implementing the DT methodology must be responsible for finding tools or other complementary platforms that help them to have a general panorama of their project that best suit each project's ideation, design, development, prototyping, and testing stages. Although post-it notes, whiteboards, and notebooks are simple, none provide full tracking from the ideation of a project until it is released. DT platforms are becoming a powerful tool to work collaboratively on, iterate, and control a process, but users still have to complete the project without tracing.

This work presents an Educational Systematized Design Thinking (ESDT) platform composed of a finite number of defined activities distributed along the five stages of the DT methodology. It is based on the mixed approach of Kano's model and the minimum value product creation. The first is the framework presented in [7], where the attributes of a project are categorized according to Kano's model, which was chosen because it takes into account the perceptions of users to make this classification (see [8,9]). The second is the proposal for evaluation of a Minimum viable product [10], where the authors describe the necessary steps to release a product with the minimum essential metrics considered for people. Moreover, it includes an agile methodology to ensure complete and rapid development.

The deficiencies of the other platforms are covered in the present work, allowing users to have a step guide in each of the stages of DT methodology and follow up on a project from the users' perception of the problems and challenges facing the deployment of the solution on the market. It is essential to mention that the platform is intuitive and allows users with no experience in the area to use it.

The need for innovative research is increasingly vital, since we can know aspects of consumption, habits, and improvement of products within an industry through it. These characteristics are sought to be brought to educational classrooms, mainly in higher education. However, didactic techniques are sometimes incompatible with innovation research, which directs the learning process in a direction oriented by methods focused on educational research.

The main objectives pursued with this work are listed below.

1. Designing a systematized methodology that allows users not only to generate solutions, but also to identify problems and challenges in a community remotely.
2. Designing and implementing the ESDT platform.
3. Applying the ESD methodology through the ESDT platform to a group of architecture students to respond to a real design problem in their community.
4. Validating the reliability of the use of the developed ESDT platform in a distance education model.

The main contribution of this work is to fill part of the enormous gap between educational research and research on innovation by providing a tool that students, teachers, and academic researchers can use to work remotely. This tool is the developed ESDT platform, which is an online platform that allows us to respond to the needs detected through a clear and structured process to yield the creation of a new product or improvement of an existing one in a systematized way.

The case study addresses an urban issue within the Universidad del Valle de México, Guadalajara Sur campus community: the bus stop. The application of the ESDT methodology through the use of the ESDT platform is carried out by architecture students with the subject 'Bus Stop Architectural Project 1'. It is crucial to respond to real design problems within the student community.

The paper is organized as follows. Section 2 presents the background and related Works, and Section 3 describes the materials and methods. Section 4 presents the novel ESDT Methodology, while Section 5 describes the developed ESDT platform. Then, Section 6 presents the case study in the mobility sector of a smart city project from an architecture point of view developed using the ESDT methodology. Finally, the paper is closed with some relevant discussions in Section 7 and conclusions in Section 8.

## 2. Background and Related Works

### 2.1. Design Thinking Methodology

DT can be defined as an analytical and creative process that involves a person in opportunities to experiment, create, and prototype, as well as gain feedback and redesign [11]. The DT methodology as a solution-based framework consists of five components: empathize, define, ideate, prototype, and test [12]. DT methodology has to struggle twofold: (a) firstly, users must depict context-sensitivity and situational adaptability of workflows without losing conceptual clarity, (b) secondly, when they propose instructions for real-life projects, they have to clarify that they offer 'only' guidance and no definite means for design problem-solving. In sum, DT methodology has to deal with the fact that DT is originally no process, but that it shapes processes [13].

### 2.2. Kano's Model

Kano's Model is also known as the attractive quality theory, proposed in 1984 by the quality expert Noriaki Kano. This model recognized two important characteristics concerning quality: the physical fulfillment of the specifications of a product and the generated final user satisfaction.

Kano makes a distinction between various quality elements that translates them into attributes of a product or service, which influence customer satisfaction:

- Obligatory attributes (M)—These are those that, if not satisfied, will produce dissatisfaction to the client.
- One-dimensional attributes (O)—These are those in which the satisfaction of the client is proportional to the level of compliance with them.
- Attractive attributes (A)—Product elements that have the greatest influence on how satisfied the customer is.
- Indifferent attributes (I)—These are those that do not increase customer satisfaction.
- Reverse attributes (R)—Elements that result in dissatisfaction when fulfilled and satisfaction when not fulfilled.
- Questionable attributes (Q).—These indicate that the question is misspelled or has been answered illogically.

A questionnaire format is used to determine the classification of the attributes of the product or service. For each attribute, a pair of questions is formulated: the functional question and the dysfunctional such as the following, respectively.

- How does it feel if the attribute is present in the product?
- How does it feel if the attribute is NOT present in the product?

Each question has five response options: ‘like’, ‘must be’, ‘neutral’, ‘acceptable’, and ‘dislike’. Then, the results are evaluated according to each attribute associated with the answers to the functional and dysfunctional parts of the question, as in Table 1 [14].

**Table 1.** Table Kano Categories.

Customer Requirements		Dysfunctional (Negative Question)				
		Like	Must be	Neutral	Acceptable	Dislike
Functional (Positive Question)	Like	Q	A	A	A	O
	Must be	R	I	I	I	M
	Neutral	R	I	I	I	M
	Acceptable	R	I	I	I	M
	Dislike	R	R	R	R	Q

In addition, SCRUM is a process that applies a set of rules or a group of good practices to work collaboratively to ensure fast development. Moreover, it is responsible for rapid iterations called sprints; each sprint lasts one to four weeks. This agile methodology provides flexibility, dynamism, and fast communication with clients, among other properties, and was introduced in 1986 by Takeuchi and Nonaka [2].

### 2.3. Agile Method: SCRUM

SCRUM has roles that must be covered by the people involved in the process. These roles are Scrum Master, Product Owner, and Development team to ensure that the activities are fulfilled in the established time. SCRUM is divided into the following six stages: (1) Backlog planning; (2) Sprint backlog; (3) Spring planning; (4) Iteration (Sprint); (5) Revision of the iteration; and (6) Retrospection. When the iteration is finalized, there will be a Minimum Viable Product (MVP) to test and receive feedback; the team is responsible for starting the next iteration and defining the requirements until the project or product is concluded.

### 2.4. Existing DT Platforms

Some tools and platforms are oriented to developing some activities of the DT methodology; some examples are described. For instance, Google keep [15] is a tool of Google and allows users to add, eliminate and move notes; create a list; and share photos within a group. This platform helps to share information, and storage relies on the user. On the other hand, Ideaflip [16] makes it easy to share ideas and turn thoughts into arguments based on a brainstorming strategy. Concept Inbox [17] is a platform that allows the control and tracking of changes using a version controller and collaborates with the team in real time.

These are some of the most used platforms during the development of a process. However, as you can see, none of them contain all the tools to create a complete project. Tools and platforms compatible with the project specifications are required and known by the entire development team. The following section presents the concepts relevant for our proposal.

## 3. Materials and Methods

This section will describe the strategies used to implement Systematized Design Thinking Methodology within a group of architecture students of the Universidad del Valle de México, campus Guadalajara Sur.

### 3.1. Participant Recruitment

The study was carried out from February to May 2022. Five students were invited for their level of studies since they already have theoretical–practical tools to work on a project of a certain degree of architectural complexity. At the same time, they are in a position of

openness to experiment with new design methodologies. It is worthwhile to mention that students formed their teams internally. They chose with whom to work on this project; in this way, their communication and dynamics were benefited during the process.

Participants were informed that their participation in the current study was voluntary. Informed consent was obtained from all individual participants included in this study.

### 3.2. Study Design

At the beginning of the process, the students have an online session with a professor who is an expert in the ESDT methodology and knows the ESDT platform. This professor describes to the students the big picture and the basics of the design methodology, its possibilities, benefits, stages, and expected results to be applied systematically. Some successful users' stories are shared, and this professor answers several questions and concerns. Moreover, interaction exercises are performed with the group to generate trust among the students. This activity drives the students to the closer communication that is necessary throughout the process. Now, the students are ready to manage and start working with the ESDT platform.

In the second phase, there is another online session with another expert professor in data collection, who explains to the students different ways to collect data and how the ESDT perform this task. Then, the students are presented with how this data will be processed to obtain the attributes within Kano's Model Categorization. In the same way, all the necessary doubts are clarified to begin to put this knowledge into practice.

Finally, once the surveys are generated, applied, and processed, the students have six online follow-up sessions with an expert professor in the area of architectural design, who, from his experience, guided the students through a process of ideation, recommending the use of various techniques. The professor delves into issues of sketching ideas; the implementation of technical, structural, and formal solutions to give an adequate response to the attributes obtained; and techniques to generate a three-dimensional model that could be used as a final prototype as part of the ESDT methodology. The total number of required experts are three professors from the UVM Guadalajara Sur campus, who were at their homes during the online sessions.

### 3.3. Tools

As we were working on this process within the pandemic caused by COVID-19, it was necessary to adapt the workflow to a completely digital and online environment. The sessions were remote, using software to make live video calls, digital platforms were used to support the ESDT, and, during the ideation stage, specialized software and electronic drawing tablets were used for the work of drawing and sketching ideas and prototypes. The students made use of online platforms for the application of surveys, both the surveys during the empathy stage and in the testing stage.

## 4. Educational Systematized Design Thinking Methodology

This work presents a novel methodology based on the refined Kano's model, the importance-satisfaction model, the minimum value product creation, and the components that comprise it: empathize, define, ideate, prototype, and test with SCRUM; all shaped by DT, the ESDT methodology (See Figure 1).

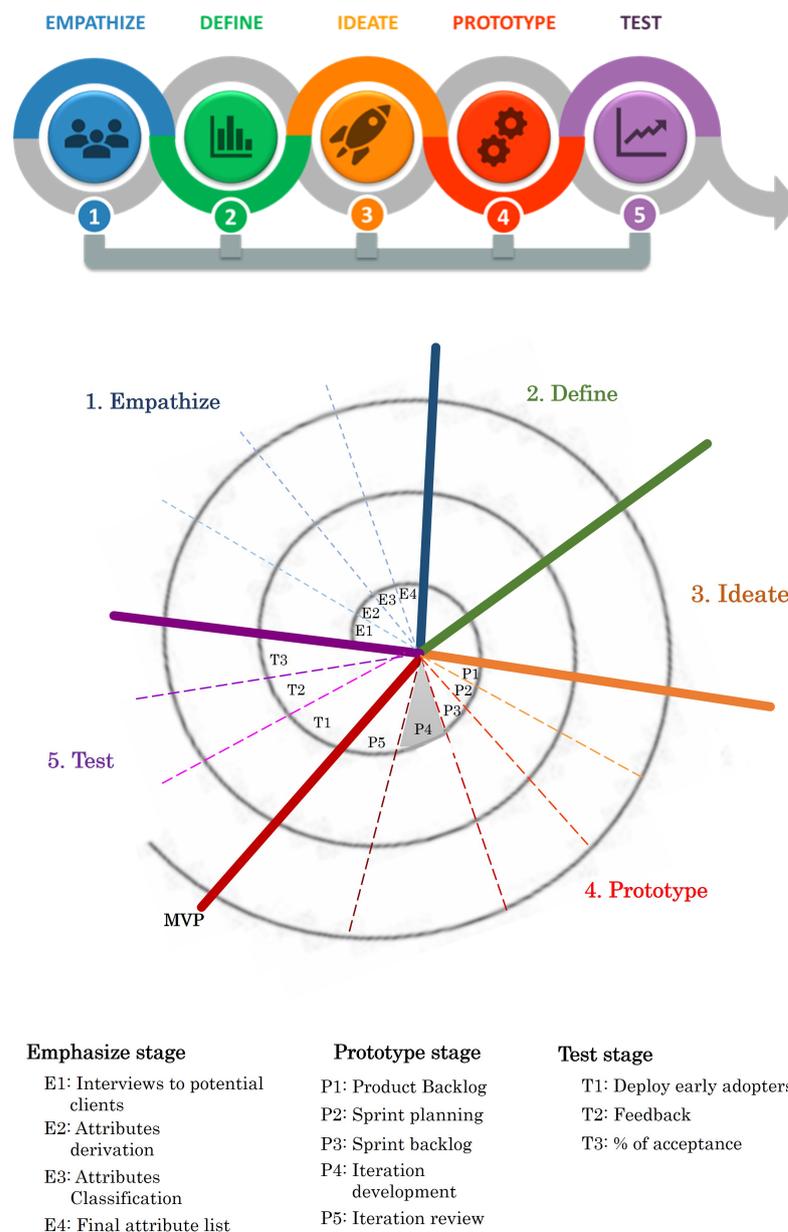


Figure 1. Proposed methodology using SCRUM agile method and Design Thinking.

Each component is defined as a stage, subdivided into tasks to be performed, allowing for the simple and easy monitoring of the milestones. The description of each stage of the ESDT methodology is given below.

1. Empathize. In this stage, there is an understanding of the needs of a target market, and the product owner (design thinker) has to create strategies to mix between potential customers and listen to, identify, and know their needs regarding the product or service they want to offer. The proposal in this action follows four tasks to make this process simple and easy to follow; they are listed below.
  - E1: Interview with potential users—In this task, the product owner is responsible for conducting interviews with potential users to collect the attributes that users seek regarding their needs for the search for products or services offered. The product or service can be a new or existing one.
  - E2: Attribute derivation—The product owner and the scrum master analyze the information obtained from the interviews to obtain a first list of attributes L1 requested by potential users.

- E3: Attributes classification—With the list of attributes obtained, L1, engineers, sales agents, accountants, supervisors, product owners, marketing people, and those involved in the project meet to determine the final attributes list L1'. They can also add some unmentioned important attributes. From this meeting, there will be a final list of attributes that the product or service will have throughout the development.
  - E4: Final attribute list—The final attribute list, L1', is presented to the whole team to ensure there will be no changes.
2. Define. The list, L1', containing the final attributes is used as the input for the generation of the survey posed by the Kano model (see Section 2.2). The survey is generated online and sent to the target market, then is collected and analyzed to categorize the attributes to characterize them by the degree of importance in the process.
  3. Ideate. The results of categorizing of the attributes (could be M, O, A, I, R, Q) according to the Kano model will be presented to designers. In this stage, it is desirable to generate countless ideas to create multiple possibilities of solutions to problems raised, so it is important to include the developers, scrum master, and the product owner to boost the creative potential of the people working in a work team. Several techniques and tools that promote creative thinking (see [18]) in order to generate ideas, such as:
    - the art of asking;
    - forced relations;
    - the five whys;
    - a creative meeting;
    - SCAMPER (Substitute, Combine, Adapt, Modify/Magnify, Eliminate, and Rearrange/Reverse);
    - storytelling; and
    - brainstorm.
  4. Prototype. The design and development team will produce a scaled-down number of iterations (sprints) of the product in this stage. It is an experimental phase in which the development team will obtain a Minimum Viable Product (MVP) to test. In this stage, our proposal involves prototyping based on the SCRUM agile methodology. All steps are explained in the previous section, this methodology allows the development of a functional version of the product in a short time, in which each iteration will have one or more functional requirements. The development team decides at the beginning of the stage how many sprints are required before the product can be released and implemented according to the number of attributes, functionalities, and features.
  5. Test. Designers evaluate the product to discard possible process failures and refine the prototype if necessary. The evaluation of the prototype is based on the type of product; if it is a new product, the validation must be completed using the refined model of Yang categorization [19]. Instead, if it is a known product with new features, the product owner will decide between two available models, Yang or Tontini categories [20]. This stage is divided into three steps.
    - T1: Deploy early adopters. In this step, the product or service is released to early adopters in order to obtain feedback on its use and functionality, among other attributes.
    - T2: Feedback. The feedback obtained from early adopters is stored and used to perform an analysis of the result and experiences of the product or service.
    - T3: Percentage of acceptance. The percentage of endorsement of a product is defined by the market size, expected adoption speed, the existence of substitute products, competition, marketing, and adaptability. According to these metrics, the proposal will provide a percentage of acceptance, which will indicate whether

the product is ready to be released or at what stage of DT it has to be returned to ensure greater acceptance.

After the prototyping stage, the process delivers a project with the MVP, and the description of the process that considers the perception and action areas for the development of a product is presented in Figure 2.

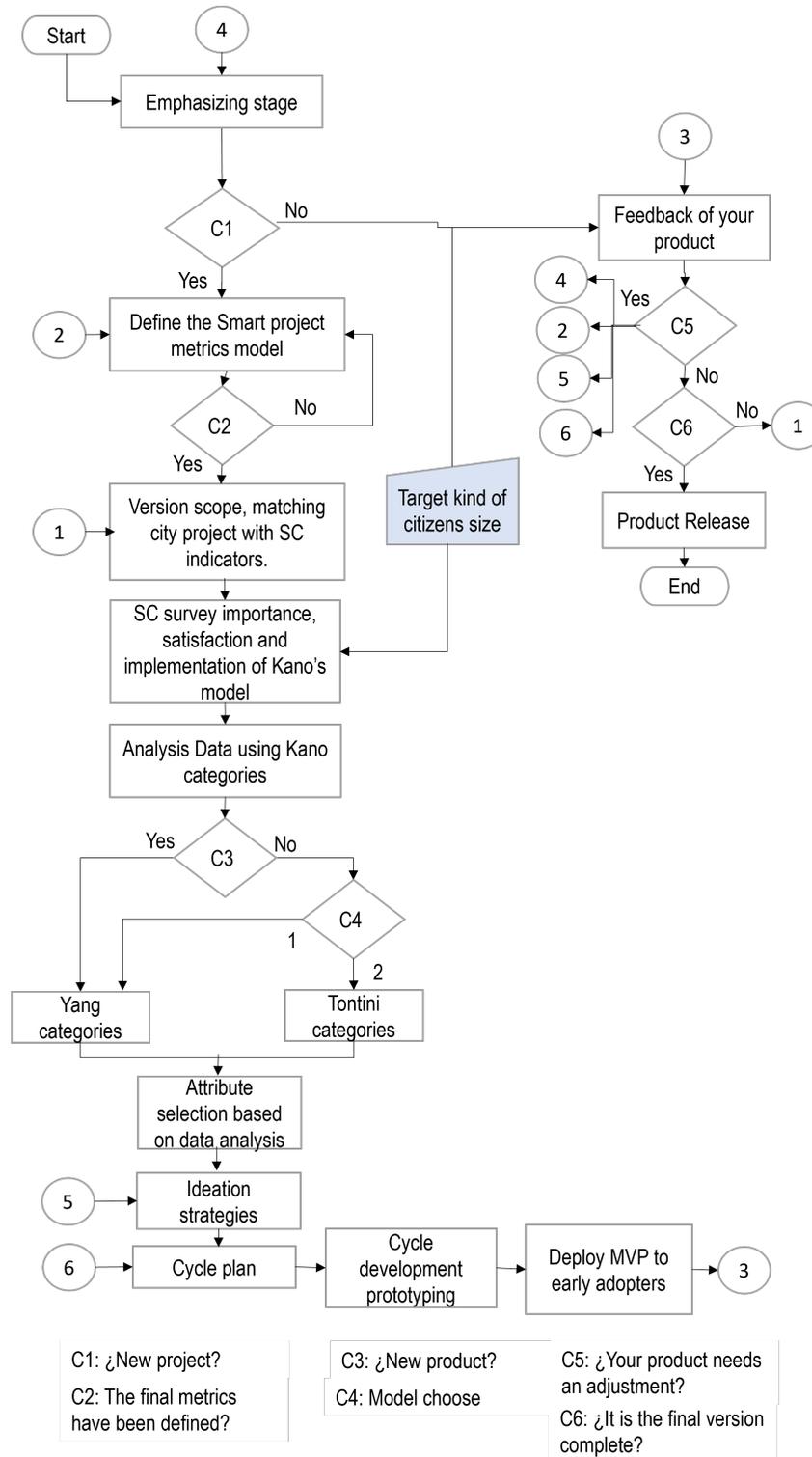


Figure 2. Propose methodology for a MVP and smart metrics to release a project.

The methodology differentiates between a new project or an improvement of a previous one. For either option, the methodology starts with the emphasize stage, where the development team defines the project's scope. If it is a new project, the metrics for the smart model are defined, and make sure there won't be changes or additions on the version. After this, the version requirements are defined; otherwise, if it is not a new project, there will be a survey in order to receive feedback about the product. According to the results, the development team can start its process from any of the five stages of the DT methodology. If it is the final version, the project is now ready to be released.

After defining the metrics of the project, a step to match metrics and indicators using the Boyd Cohen Wheel (refer to [21]) is used to verify the correspondence with the Smart City (SC) project, a survey based on Kano's model is applied to defined the number and type of users in order to collect information about the satisfaction metrics. Once the survey information is collected, analysis data is performed based on Kano categories. If it is a new product, Yang categories are used; otherwise, the user can decide between using Yang or Tontini categories. The ideate stage starts to determine the actions to be executed in the project.

The prototype stage, as explained previously, is responsible for making a cycle plan; once the plan is concreted, there is a product-development cycle. The result of the prototype stage is the MVP, which is deployed to early adopters, or, if it is a new version of a project, there is a step for feedback, version adjustment, and release. Suppose the version is not ready and the acceptance percentage is insufficient to release the project. In that case, the process can start again according to the results in the empathizing, define, ideate, prototype, or test stages as many times as the product and the development team decides.

The proposed methodology is based on the information from two previous works. The first one is the framework presented in [7], where a project's information is classified based on the perception of the people in front of specific smart city projects based on Kano's model results. The second is the proposal for evaluation of a MVP [10], where authors describe the necessary steps to release a product with the minimum required metrics considered for people.

## 5. Educational Systematized Design Thinking Platform

The platform as the design process is subdivided into five stages and implementation. For the Front end implementation, JavaScript language, ReactJs library, and Redux are used. Redux manages the state of the application and the data connection. The databases used by the application and data storage are based on NoSQL and MongoDB [22]. On the other hand, for the implementation of the Back end, the Python language and Micro-framework flask [23] are used. Finally, the architecture of the platform uses the API rest.

In the first stage, the "Emphasizing stage", four activities are proposed.

- E1. Interviews of potential users, for this activity, an interview is conducted to know the opinion of the project to potential users. These interviews can be performed personally or virtually according to the project, scope, objectives, and participants' decisions.
- E2. Attribute derivation, an analysis of the results obtained from the interviews is carried out to obtain a first list of possible attributes.
- E3. Attribute classification, in a meeting between project participants, the relevant attributes are decided. They also can add or remove convenient attributes.
- E4. Final attribute list, the list of attributes that will be worked on throughout the project's development, is reviewed.

Once the first stage ends, the methodology distinguishes between a new project or the improvement of a previous one (known). The second "*Define stage*" starts. This stage follows a process based on the Kano methodology for classifying the project attributes. The Algorithm 1 expresses Kano's model categorization procedure and the results.

**Algorithm 1** Kano's Model Categorization.**Input:** *A survey***Output:** *Categorized attributes*

- 1: Categorization
  1. Attributes are classified according to Kano's model into:
    - Attractive attributes (A)
    - One-dimensional attributes (O)
    - Reverse attributes (R)
    - Obligatory attributes (M)
    - Indifferent attributes (I)
    - Questionable attributes (Q)
  2. The final attributes categorization is defined
- 2: Refining
  1. Calculate the level of importance for each attribute
  2. Refined attributes and its level are obtained
- 3: I-S Model
  1. Attributes are categorized according to the I-S Model
  2. The level of satisfaction of each attribute are calculated
  3. the attributes are positioned in the corresponding quadrants
  4. Results are analyzed

After receiving the survey results, a categorization is performed using the Kano's model [14]. Finally, the I-S model [19] provides a list of attributes that are highly recommended in the model and which can be added later .

In the "Ideate stage", there are some strategies to facilitate the creation of a solution. In the proposal, only some of the main strategies are considered, which are Brainstorming [24], six thinking hats [25], and SCAMPER [26]. Brainstorming attempts to solve specific problems by generating new ideas from the team. A leader is responsible for controlling every team member's participation time and evaluating the ideas. Six hats of thinking is a technique in which participants put on hats in turn, every hat has a color related to its function emotions, objective decisions, and difficulties, among other functionalities that are considered. S.C.A.M.P.E.R is the acronym of the Substitute, Combine, Adapt, Modify/Magnify, Put to other users, Eliminate/Minify, and Rearrange/Reverse actions.

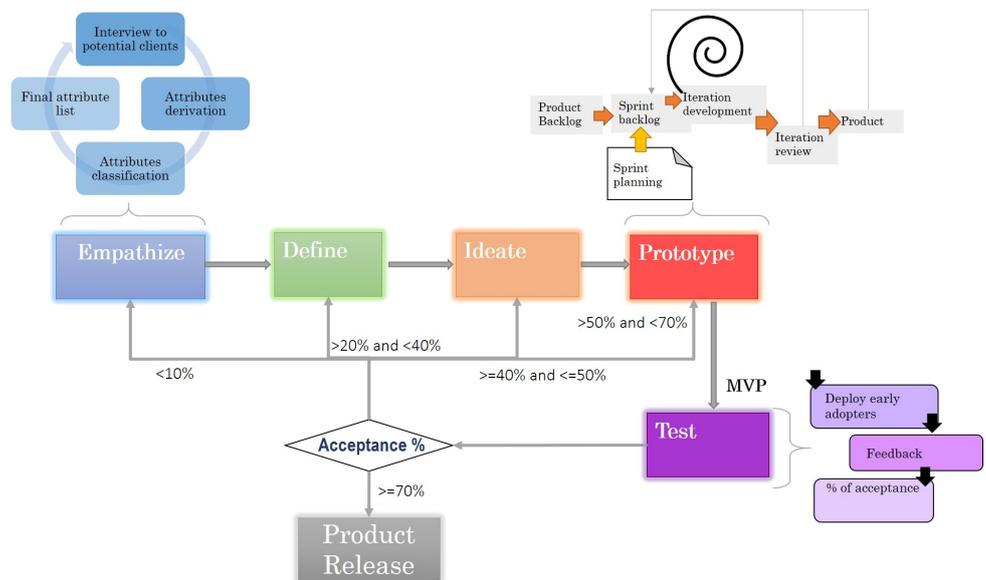
During the "Prototype stage", adopt the SCRUM agile methodology. This methodology, as mentioned in a previous section, allows the fast development of products considering high communication with clients. SCRUM is flexible, easy to understand, and composed of the next steps.

- Product backlog. This step is responsible for defining requirements according to priorities, the scope and objective of the project are stated.
- Sprint planning. The output of this step is a list with attributes ordered from highest to lowest priority. A cycle plan is defined.
- Sprint backlog. The personal staff defines a set of activities to be carried out in the implementation of the prototype. The iteration can contain all the attributes mentioned in the previous step or just a set of them. The iteration can last a maximum of four weeks; each person in the development team has responsibilities and duties to fulfill.
- Cycle-development prototype. This is an iterative process where the Scrum Master meets with the development team for about 15 minutes daily to eliminate obstacles and prevent delays. The development team participates in describing the activities that has to be 'done' and 'doing'.
- Iteration review. The development team presents the deliverables to determine if changes are required or if the objective was met. Feedback is received in this step. At the end of the prototyping stage, the result is an MVP.

Finally, the "Test stage" guarantees the result of acceptance by the users. This stage is divided into three parts. In the first, the project team decides when to deploy the version to

early adopters. In the second, the team determines whether the product is new or known; there should be feedback from potential users. The third works as follows, to give the percentage of acceptance according to the entire previous procedure are considered metrics such as type of target market, cost of the product, marketing, and means of access to the product, among others. In the end, a percentage will be obtained that determines at what stage the project should follow. The following percentages of acceptance are proposed and shown in Figure 3.

- Minor or equal to 10%: the project should return to the empathize stage.
- Between 20% and 39%: the project should continue to Define stage and rephrase the procedure.
- Between 40% and 50%: it is recommended to return to the ideation stage to find new solutions based on some of the ideation strategies.
- Between 51% and 69%: it is proposed to return to the prototype stage and make only adjustments to the current version.
- At least 70%: the percentage was left with a wide range of acceptances by developers, and the product owner decides whether to release the project or the version.



**Figure 3.** Systematized methodology with percentage of acceptance.

These percentages are recommendations proposed within the methodology and can be adapted according to the specific needs of the product or service being developed. Finally, if the version is not ready, the process starts again as many times as the project personnel decides.

In summary, the proposed ESDT methodology is described in Algorithm 2.

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**Algorithm 2** ESDT Methodology.

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**Input:** *A survey***Output:** *Percentage of acceptance*

## 1: EMPATHIZE STAGE

1. Interview to potential clients
2. Attributes derivation
3. Attributes classification
4. Define final attribute list

## 2: DEFINE STAGE

1. **if** it is a new project **then**
2.     Define the smart project metrics model
3.     **if** all metrics are defined **then**
4.         Version scope are matched with SC indicators
5.     **else**
6.         return to step 2-1 if it is a new project
7.     **end if**
8. **end if**
9. SC survey importance satisfaction and the implementation of the Kano's model are made
10. Analysis of the data using Kano categories is perform
11. **if** It is a new product **then**
12.     Yang categories is required
13. **else if** Users can choose between Yanf or Tontini categorization **then**
14.     Attribute selection is made base on the data analysis
15. **else**
16.     go to step 5-2 Feedback of the product
17. **end if**

## 3: IDEATE STAGE

1. User select an ideation strategy

## 4: PROTOTYPE STAGE

1. Start the cycle plan
2. Create the product backlog
3. Create spring planning
4. Create spring backlog
5. Define the cycle development strategy
6. Iteration review

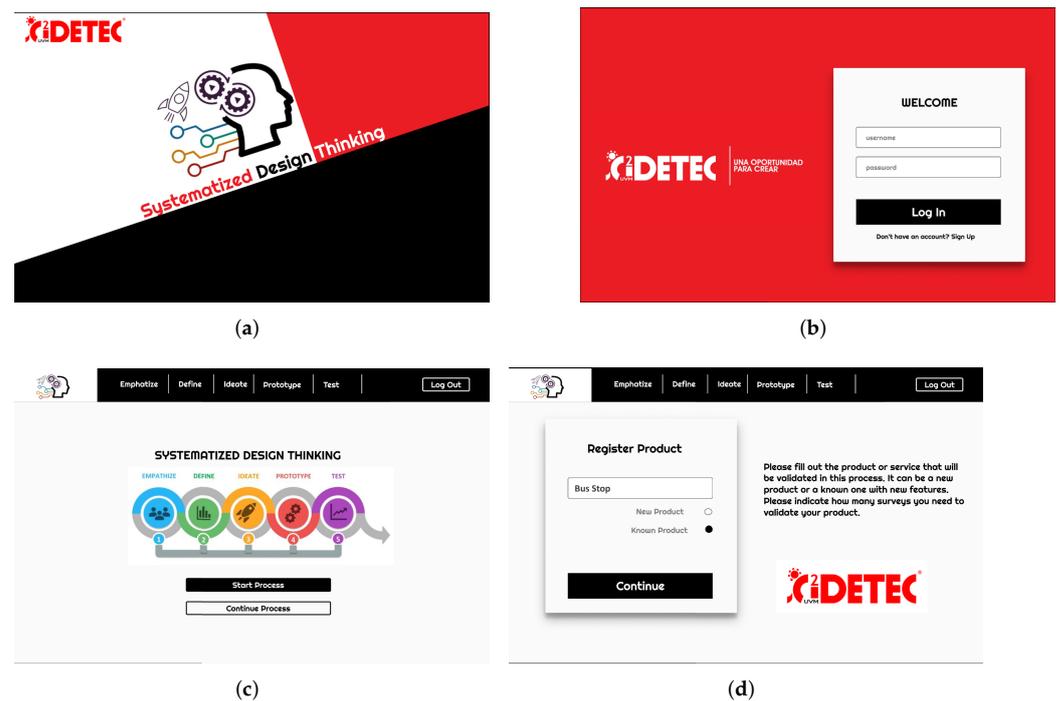
## 5: TEST STAGE

1. Deploy MVP to early adopters
  2. Feedback of the product
  3. Analyse the result of percentage of acceptance
  4. **if** The product needs any adjustment **then**
  5.     return to any of the stages, step 1. EMPHASIZE, step 2. DEFINE, step 3. IDEATE, or step 4. PROTOTYPING
  6. **else**
  7.     The final version is release
  8. **end if**
- 

**6. Application of the Educational Systematized Design Thinking Methodology to the Case of Study: Bus Stop**

Five students in their third semester of architecture were invited to take part in this study case since they are students who have completed one year within the Program in which they have learned the basics of the architectural design course. They have tested some design methodologies in Architectural Representation. On the other hand, these students already have theoretical and constructive bases to generate a proposal with certain solid bases in practical and aesthetic terms. Finally, another important factor is that they are just starting with architectural design subjects. They will work with other methodologies in the future, making them more open to testing alternative methodologies.

First, Figure 4 presents the screens of the platform for a student who is going to start any project process: (a) when students enter the platform, they will see the main image and wait a few seconds before the platform continues; (b) if students are not registered, they will have to register and log in with their username and password; (c) Once the students have entered, they will see the stages that the process will go through, and they will be able to choose one of the following options, start a new process, or continue with an already started one; this paper's product is a Stop bus and a known product; and finally (d) if they choose a new process, they have to specify the name of the project (Product name), and if it is an entirely unknown product (New product) or a product similar to an existing one but with new features to improve (Known product).



**Figure 4.** Platform entry process. (a) Platform splash. (b) Registration and sign-up view for users. (c) Select between starting a new process or continuing with another one. (d) Select between a new or a known product.

1. Empathize. In a class session, students have explained what this stage consists of and what kinds of tools could be used to complete it depending on the importance of achieving empathy with users to know the real opinions and needs of the target population. Figure 5 describes all students' processes during the empathizing stage. (a) The empathize stage comprises four main activities, E1 is the interview, E2 is the Derivation of attributes, E3 is the attributes classification, and E4 is the final list of attributes. (b) E1: Presents the description of the required characteristics according to potential clients or possible interested parties, considering the profession, age, gender, and product description. The interviews were conducted with people who currently use public transport. The interviews were conducted via Zoom with students and teachers of the Universidad del Valle de México. For the participants' safety and due to the context of the pandemic, we performed 15 interviews. (c) Once each activity is completed, a screen such as this is presented with the activity marked as complete. (d) E2 is where each student enters all the attributes they want to work on in their projects. In this case, 12 attributes were defined: AT1) comfortable infrastructure; AT2) roof to cover you from the sun; AT3) roof to cover you from the rain; AT4) stopgap bus for ascent/descent; AT5) structure design that allows road visibility; AT6) spacious seats; AT7) ergonomic seat form; AT8) assistance device; AT9) trash container; AT10)

luminary; AT11) seats with backrest, and AT12) necessary amount of seats. (e) E3: Once all the attributes have been entered, the user selects the main ones with which you want to test the model. In this case, all attributes were selected as final attributes. (f) Once selected, press the arrow to pass them as final. (g) E: Presents the entire list of attributes with which it will work to make its evaluation. (h) Finally, once all the activities have been completed, they are marked as final, and the empathizing stage is completed.

At the end of the empathize stage, the Define stage begins; the platform indicates the beginning and end of each of the stages.

2. Define. Once the final attributes contained in the L1' are defined as a result of the previous stage, they serve as the input for the generation of the survey based on Kano's model (see Figure 6). (a) In this project, a total of 12 attributes were selected. Once it is verified that all the attributes are found, the user clicks the button "Generate survey". (b) The platform will automatically convert the questions into the Kano format, which divides each attribute's AT<sub>i</sub> into two categories: (1) How would the user feel if the product/service had the attribute AT<sub>i</sub>? and (2) How would the user feel if the product/service did NOT have the AT<sub>i</sub> attribute? A total of 24 questions were generated in this proposal. (c) Once the quiz is ready, it will be deployed on the ESDT platform. Some of the questions are very long, so the platform presents a brief description of each one, and if the student hovers over the mouse, the user can see the complete question. At this time, the user on the ESDT platform can make a profile selection. In this profile button, each user decides which market segment the survey is aimed at. This segment includes a range of people's ages, professions, genders, and other characteristics that the user may wish to specify. The survey is sent online to people who meet the defined profile and are registered on the platform, and a link is also provided to users so they can share the survey with external tools. Students conducted surveys of 46 public transport users who make daily use of this type of equipment. Users were asked about 12 different possible attributes that students thought could be important for the project development. (d) Between the previous screen and the current screen described in this point, there is a marker that indicates the progress of the surveys and finalizes when the platform reaches a defined number of responses. Finally, the platform categorizes the results (see Table 2).

Once these results are presented, the ESDT platform allows the user to generate a report with the results in a .pdf file. This report includes the results from applying Kano's model in two ways: a table, similar to Table 3, that considers the satisfaction index (SI) and dissatisfaction index (DI), and a Figure 7 that depicts the SI vs. DI in the so-called SI/DI plot (see [9]).

From Figure 7, it can be noted that AT12 (necessary amount of seats) can be seen as one attribute, the fulfillment of which causes a high rate of user satisfaction; while AT3 (Roof to cover you from the rain) can be most adequately seen as the attribute whose non-fulfillment causes a high rate of user dissatisfaction. In addition, attributes AT1, AT4, AT5, AT6, AT7, AT8, AT9, AT10, and AT11 are close to each other above the middle part of the satisfaction index, while AT2 cannot cause satisfaction in the user; on the contrary, it can cause dissatisfaction.

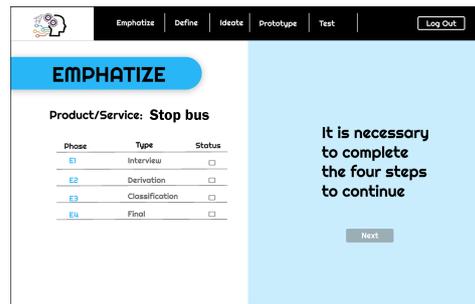
Now, according to the report, the students chose the attributes they will consider as an input for the next stage. After a team meeting, the students decided to choose the following attributes.

- One attractive attribute:
  - AT12. Necessary amount of seats.
- Four one-dimensional attributes ordered by score as:
  - AT3. Roof to cover you from the rain;
  - AT4. Stopgap bus for ascend/descent;
  - AT5. Structure design that allows road visibility; and

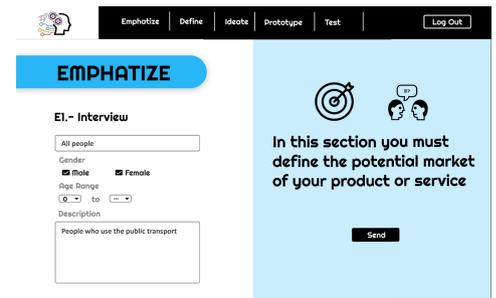
- AT11. Seats with backrest.
3. **Ideate.** Once the list of attributes and characteristics has been completed, students begin this ideation stage in the platform; several strategies, such as brainstorming and six thinking hats, are described. Each of these strategies contains a set of steps that students can follow (see Figure 8).  
Figure 9 presents the result of the ideate stage. The students developed sketches, diagrams, and schemes where attributes were implemented within the design of the bus stop. The course professor participated as a guide through this stage, supporting technical and functional suggestions to achieve a better product. At the end of this stage, the students delivered the plans and graphic elements necessary to explain the result in detail.
  4. **Prototype.** Once finished with the ideation process and the plans of the proposal, the platform allows us to keep track of the final attributes delivered in a prototype, presenting the final attributes to work (See Figure 10). (a) It presents the final attributes and allows the students to select them, to decide how many sprints they want to perform using the SCRUM methodology. (b) All the attributes are selected in this case since they will be worked on in one iteration. (c) During the sprint construction, the requirements (attributes) and the tasks associated with each of them are requested. (d) The platform keeps the tasks on the track that the prototype already carried out, those that are being worked on, and those that have been completed by a defined date classified as To do, Doing and Done activities.  
In the prototype result of this stage, the students generated a digital model and a scale model of it, in which all the attributes of a three-dimensional form could be observed, having the possibility of transporting and exposing the prototype to the public (Figure 11).
  5. **Test.** Finally, the testing stage allows the validation of the final acceptance of the prototype and gives an acceptable percentage. It is recommended to be released if it is greater than 70 percent. Figure 12a shows an acceptance of 80 percent and (b) presents the final classification of the worked attributes in this project.  
Six weeks after the ESDT methodology application, students were enthusiastic and pleased by having this experience since they were able to verify its effectiveness. At this stage, students once again conducted surveys among public transport users, this time showing their images and the scale model in order to find out the opinions of and possible acceptance of the prototype by the public. These surveys yielded positive results from users (see Figure 11).

**Table 2.** Bus stop quality attributes

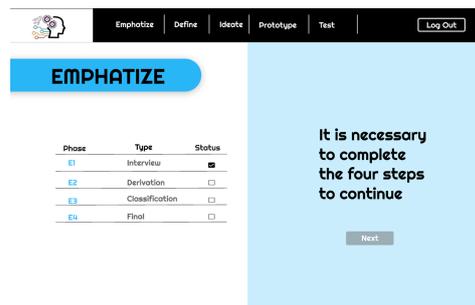
ID	Quality Attribute	Category in Kano's Model
AT1	Comfortable infrastructure	Indifferent
AT2	Roof to cover you from the sun	Reversible
AT3	Roof to cover you from the rain	One-dimensional
AT4	Stopgap bus for ascent/descent	One-dimensional
AT5	Structure design that allows road visibility	One-dimensional
AT6	Spacious seats	One-dimensional
AT7	Ergonomic seat form	Indifferent
AT8	Assistance device	One-dimensional
AT9	Trash container	One-dimensional
AT10	Luminary	One-dimensional
AT11	Seats with backrest	One-dimensional
AT12	Necessary amount of seats	Attractive



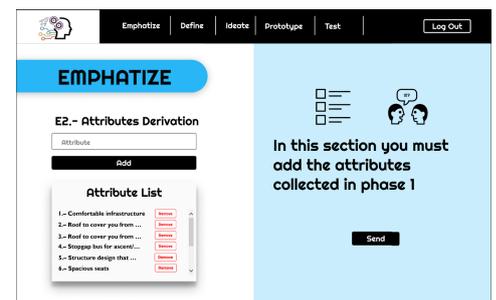
(a) Empathize stages



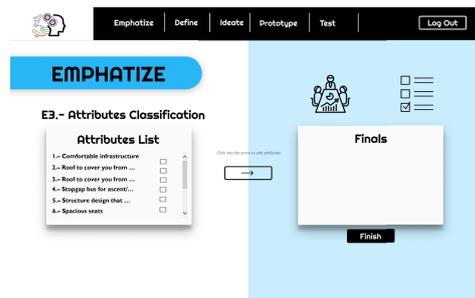
(b) E1.Definition of people to conduct interviews (potential market)



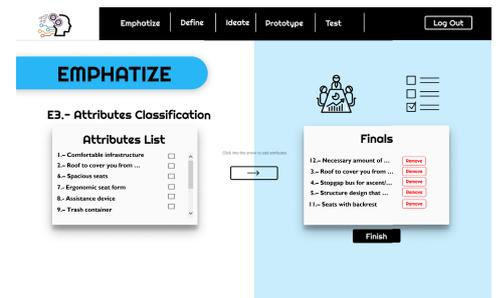
(c) Emphasize stage 1 complete



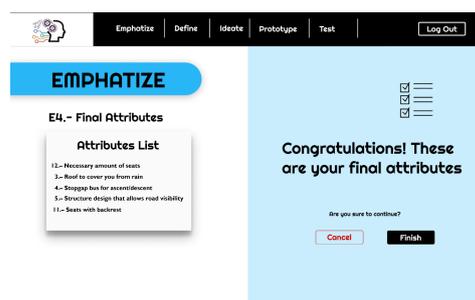
(d) E2.Derivation is the attribute list



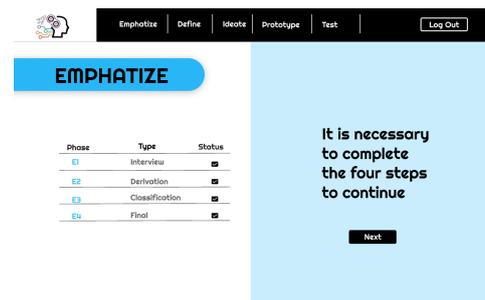
(e) E3.Attributes final classification.



(f) E3.Selection of the final attributes list



(g) E4.Final Attribute list classification.



(h) Complete emphasize stages

Figure 5. Emphasizing stage.

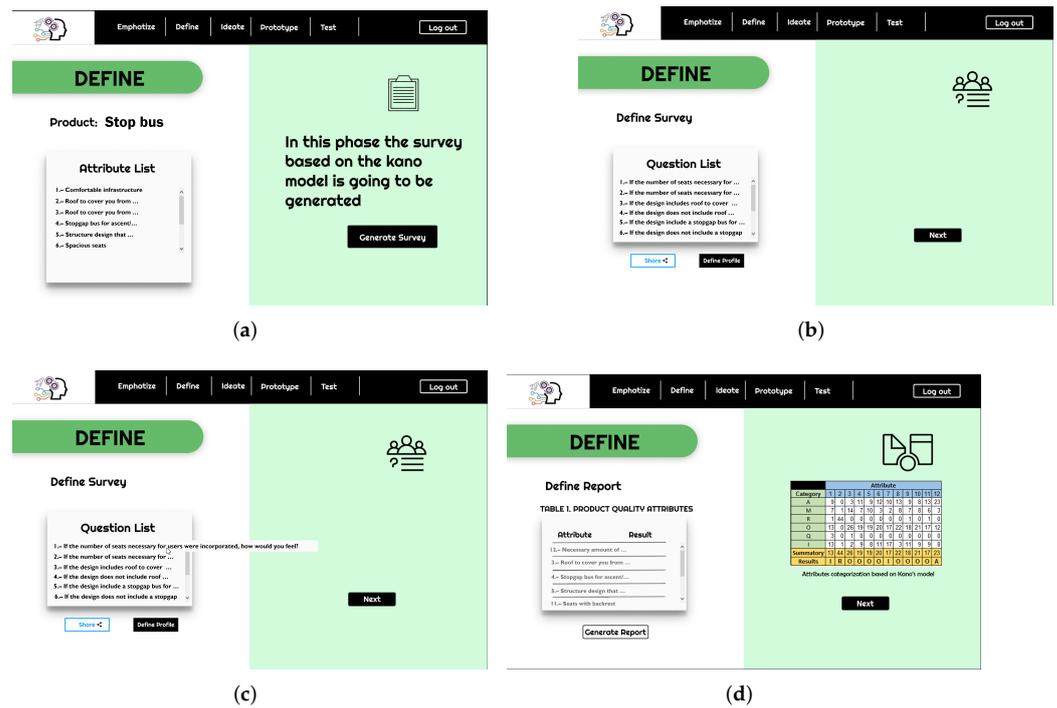


Figure 6. Define stage. (a) Final attribute list. (b) List of final questions in Kano model. (c) Questions in the modality, with the attribute and without the attribute. (d) Final classification results.

Table 3. Overall results of requirement categorization based on Kano model.

	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12
A	9	0	3	11	9	12	10	13	9	8	13	23
M	7	1	14	7	10	3	2	8	7	8	6	3
R	1	44	0	0	0	0	0	0	1	0	1	0
O	13	0	26	19	19	20	17	22	18	21	17	12
Q	3	0	1	0	0	0	0	0	0	0	0	0
I	13	1	2	9	8	11	17	3	11	9	9	8
DI	0.47	0.50	0.89	0.57	0.63	0.50	0.41	0.65	0.56	0.63	0.51	0.33
SI	0.52	0	0.64	0.65	0.61	0.70	0.59	0.76	0.60	0.63	0.67	0.76

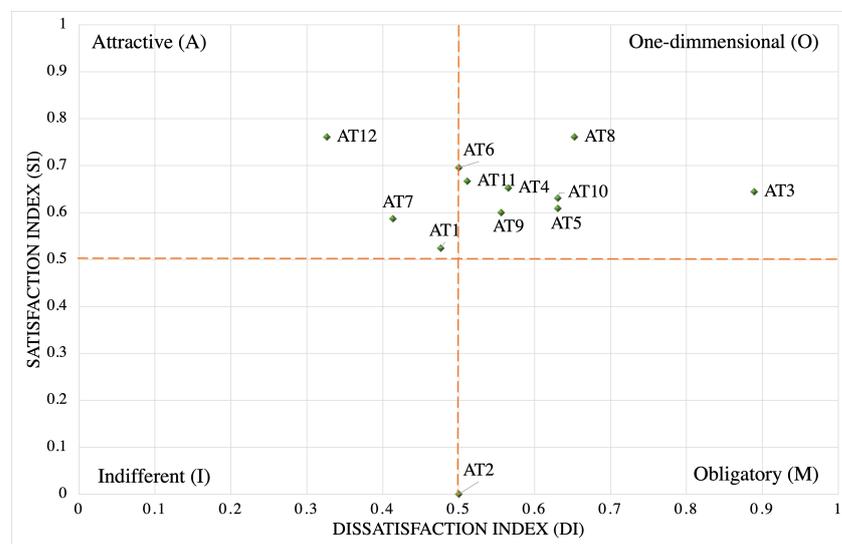


Figure 7. Overall results of attributes' categorization based on Kano model.

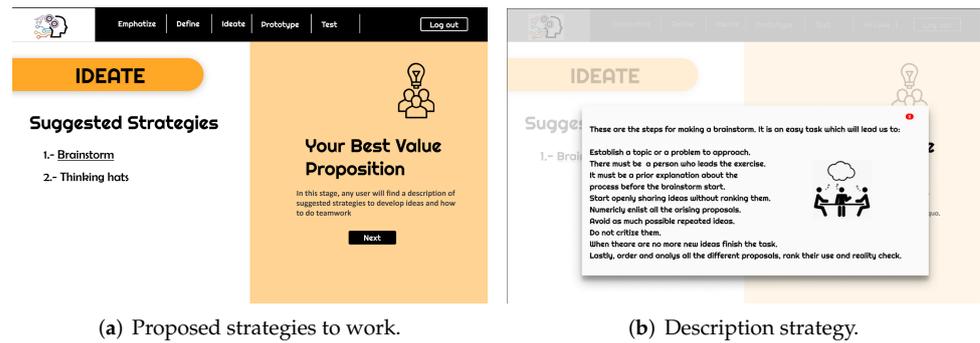


Figure 8. Ideate stage.



Figure 9. Firsts student's sketches during the ideate process.

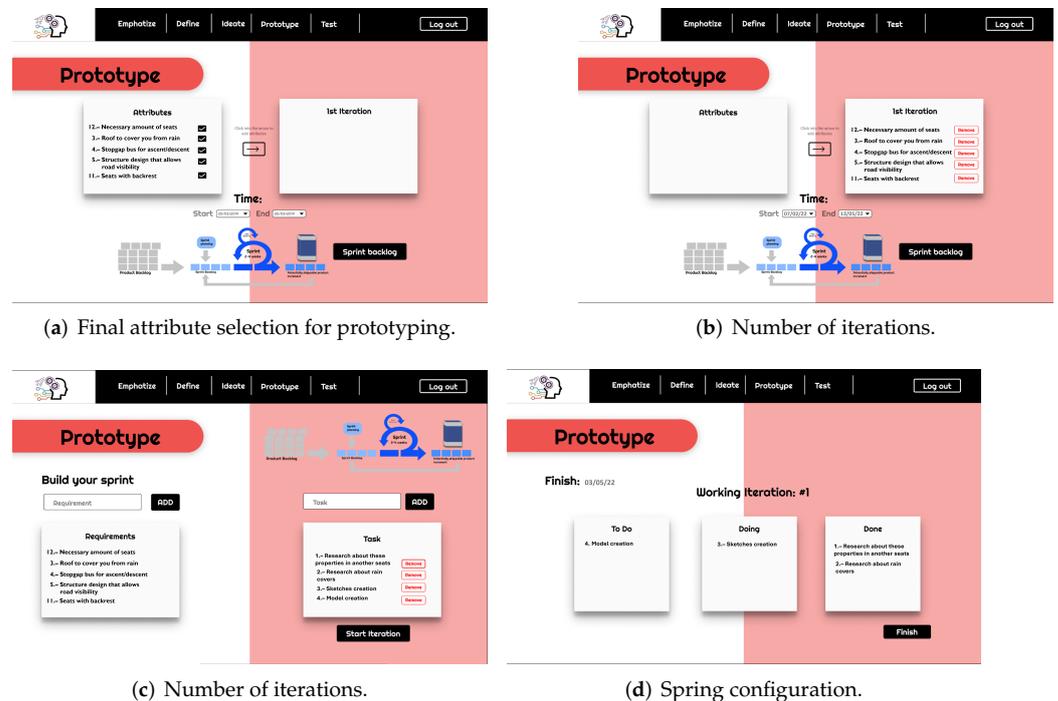
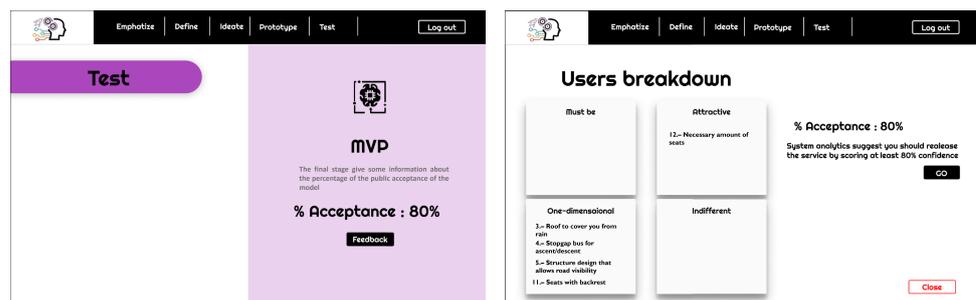


Figure 10. Prototype stage.



Figure 11. Physical model developed in the prototype stage.



(a) Acceptance percentage.

(b) Classification final attributes.

Figure 12. Test stage.

## 7. Discussion

The migration from a face-to-face learning system to an online system was a challenge that both students and teachers were forced to overcome in recent years due to the COVID-19 pandemic. This paradigm shift brought about several discoveries about the method of working in the university by using tools and platforms that had been available for a long time that we had not been forced to use. During these last months, we have verified the versatility of these platforms and several benefits they bring, such as remote work and the speed of transmission of information related to the projects being worked on.

An exciting aspect gathered from this exercise carried out through the ESDT Platform was the participatory design that the students could put into practice. Participatory design is a practice that has become important in recent years by taking into consideration the ideas, opinions, and needs of people directly from them, without having to be interpreted by the designer. Although the students had already studied this design methodology, it had never been put into practice by them during their university studies. On the other hand, we looked for a critical problem in the city to which students could contribute something using this methodology, which was very interesting. Students were surprised with the survey results, and the way the same attributes were already generated provided a practical, even formal, response to the design of the elements. Throughout the process, it was essential always to remember that the prototyping stage would be reached, which motivated the

students to generate a conceptual search as wholly as possible with the aim of not leaving aside any attribute, a result of the empathy stage.

The result satisfied the students, who were enthusiastic about the methodology and the task of having generated a proposal to solve a real problem in the city, taking into account the opinions of real people. This achievement was performed in the testing stage, where the results of the survey were positive in terms of functionality and aesthetics. This methodology allowed students to focus on solving a design problem instead of using the time to deduce or interpret users' needs through means that might not be as reliable as surveys.

This positive result can, therefore, open a way for students to use this methodology recurrently in architecture and other disciplines that seek to generate prototypes to test design efficiency, such as industrial design, mechanical engineering, and interior design, among others. This exercise leaves this possibility open since, from what could be verified with this exercise, the results can be positive and help the design process differently, looking for the best possible outcome.

It is worth mentioning that, taking into account essential aspects in the implementation of a methodology within an educational experience, it is clear to see that the use of a new tool is generally a cause of optimism on the part of students due to the novelty that it represents, as commented by Leoste et al. [27] in their article, in which they sought to implement emerging technologies used in higher education. They used technologies such as artificial intelligence, big data, simulations, and robots in a large study with students and professors from 18 universities. Still, we can finally speak of a new way to approach the teaching and learning system using technology to achieve better results. In addition, the process discussed in this article leaves the field open for new possibilities of integration between technology and teaching, taking advantage of the mechanisms and platforms that online education has brought with it.

The next step to improve this methodology is using the presented platform to generate a tool that allows the uploading of information, whether this is documents or images, to the platform. The aim here was to concentrate on the entire process using a platform to achieve a follow-up and to be clear about the steps that have been taken during the detection stages or milestones in the process that are important for the whole project's development.

## 8. Conclusions

We can conclude several points by following the ESDT methodology in a case study. (1) On one hand, it is clear that the pandemic caused by SARSCoV-2 came to radically change the methods of learning and teaching in all areas. (2) In this particular instance, at the higher education level, (3) institutions were forced to generate virtual spaces and platforms where they could continue with the training of the students. (4) This migration permeated the various areas of education, looking for options, platforms, and applications that would help to correctly monitor the courses and the preparation of the students. An example of this is the ESDT platform, which was, without a doubt, of high value in this process.

It was possible to confirm the benefits of this design methodology as an integral design tool, which is well worth analyzing and proposed as an alternative to the traditional methods of any design process. These benefits were tangible since the stage of the users' empathy during the formulation of surveys based on the information defined at the beginning, in agile and very accurate circumstances, attributes the obtention of the expected product to the results of the analysis of the surveys carried out. This process helped students focus on the issues that directly concern them without being forced to return or re-raise the project requirements.

The practical results obtained based on this methodology were satisfactory, verified with exit surveys at the test stage. At this point, one can check the application's efficiency, the methodology's ability, and the platform to work in an online environment. Although the results were very encouraging, some limitations could be found in the process that could be considered for future methodological applications of the system. For instance,

it is difficult for the students to load the surveys and their interpretations without expert intervention. On the other hand, the online work system, whatever its nature, involves challenges in terms of human relationships and direct communication between the parts of the team working on the same project.

As the next steps in the future, the application of this systematized methodology by students of other professions and advancement levels is contemplated to evaluate the grade of the platform's acceptance. Moreover, to look for increasingly complex projects that represent a more significant challenge in each stage is a goal, so that both the platform and the people involved (teachers and students) can acquire more experience and skills to achieve more and better practical results.

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## Abbreviations

The following abbreviations are used in this manuscript:

DT	Design Thinking
ESDT	Educational Systematized Design Thinking
SCRUM	Systematic Customer Resolution Unraveling Meeting
SCAMPER	Substitute, Combine, Adapt, Modify, Put to another use, Eliminate and Reverse.
MVP	Minimum Viable Product
SI	Satisfaction Index
DI	Dissatisfaction Index

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