

**Hwa Chong Institution**  
**Project Work**  
**Category 3**  
**Inventions Log Book**  
**(Revised for 2020)**

Title of Project: **Efficient Whiteboard Cleaner (Wipe-Board)**

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## 1. Problem Finding

### 1A Problems Identification

Team has first defined the objective of the project to be - “**An invention that will improve the students' well-being in HCI**”. With that in mind, we observed and brainstormed on problems which HCI students may have encountered daily, and eventually nailed down two common problems for consideration:

**1) Students' concentration was disrupted by the whiteboards cleaning process during lessons.**

We observed that on average, teachers had to temporarily pause the lesson every fifteen to twenty minutes, in order to erase the whiteboard. Such disruptions often result in students losing their train of thoughts, or becoming distracted by talking to their seatmates. It is difficult to shift the students' attention back after that and they might lose the concepts discussed easily. Over time, the intermittent disruptions are likely to affect the effectiveness of their learning.

**2) As a result of failure to drink sufficient water, students may often become dehydrated.**

We observed that this is a recurring problem for students in primary and secondary school. Given the sheer workload and hecticness of their schedules, students often end up forgetting to drink enough water, which may cause health issue to the students in the long run

### 1B Evaluation Criteria

We evaluated the options with three considerations to help us decide on the problem to work on:

- 1) **Feasibility of solution** - Is the problem, given our capabilities, able to be solved?
- 2) **Impact of the solution** - which problem has a greater impact to the target audience?
- 3) **Existence of alternative solutions** - are there existing/alternative solutions to the problem?

### 1C Evaluation Matrix

We scored the considerations, against the problems and accorded points 1 (least significant) to 4 (most significant) for each consideration. The results of our scoring is as shown in Table 1 below.

*Table 1: Problem Evaluation Grid*

Considerations for Selection	Problems	
	<i>#1: Disruption and hampering of the effectiveness of students' learning due to cleaning the whiteboards</i>	<i>#2: Students may become dehydrated as a result of drinking insufficient water</i>
Feasibility of the solution	4	1
Impact/Usefulness of the solution	3	3
Lack of existing/alternative solutions	2	1
<b>Total Score</b>	<b>9</b>	<b>5</b>

Conclusion: Based on the score of our evaluation, we have chosen **Problem 1** as the invention to solve the problem will be more feasible in construction and more impactful to our target audience.

## 2. Define the Problem

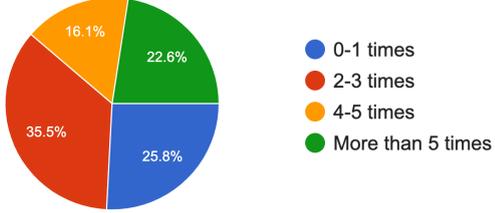
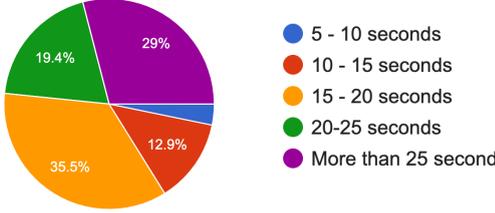
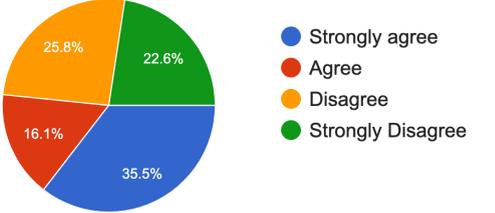
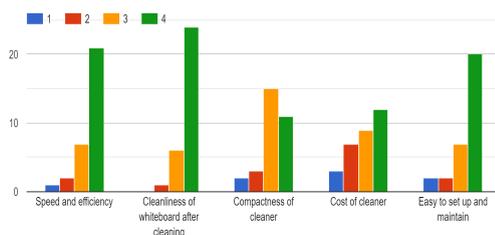
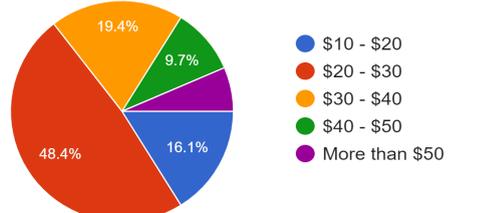
### 2A Problem Statement and Survey Conducted

We defined our problem statement as: To create a more efficient yet affordable whiteboard cleaning solution to reduce the disruption to teachers and students during lessons. We conducted a survey in March 2020, on 31 secondary 1 students to find out:

- If there was a **need and demand** for an efficient whiteboard cleaner
- The **most important features** our target audience were looking for

- What **price** they were willing to pay for a more efficient whiteboard cleaner  
 The key survey results are summarised in the Table 2 below:

*Table 2: Key Survey Results*

	Survey Questions	Survey Results	Conclusion
1	<b>Frequency of cleaning</b> On average, how many times does the whiteboard need to be cleaned during each lesson?	 <ul style="list-style-type: none"> <li>● 0-1 times</li> <li>● 2-3 times</li> <li>● 4-5 times</li> <li>● More than 5 times</li> </ul>	About <b>75%</b> of the respondents reported having to clean the whiteboard <b>at least 2 times</b> per lesson, which shows that this disruption is commonplace in each classroom setting.
2	<b>Time spent on cleaning</b> On average, how long does it take for you or your friends to clean the white board?	 <ul style="list-style-type: none"> <li>● 5 - 10 seconds</li> <li>● 10 - 15 seconds</li> <li>● 15 - 20 seconds</li> <li>● 20-25 seconds</li> <li>● More than 25 seconds</li> </ul>	About <b>84%</b> of the respondents took at least <b>15 seconds</b> to clean the whiteboard, while almost <b>30%</b> of them took more than <b>25 seconds</b> to do so.
3	<b>Was cleaning disruptive?</b> I think that cleaning of whiteboard during and in between lessons is disruptive as it breaks my focus	 <ul style="list-style-type: none"> <li>● Strongly agree</li> <li>● Agree</li> <li>● Disagree</li> <li>● Strongly Disagree</li> </ul>	More than <b>50%</b> of respondents either strongly agree or agree that cleaning the whiteboard is disruptive as it breaks their focus. This shows that the need to clean whiteboard indeed disrupts students' learning momentum and is likely to affect the overall effectiveness of the lessons.
4	<b>Most desired features</b> Rank the features of the whiteboard cleaner according to importance (1 being the least important and 4 being the most important.)		The top 2 most desired features are: 1. Effectiveness of cleaning 2. Speed and efficiency 3. Simplicity of setting up
5	<b>Ideal cost of invention</b> What do you think is a reasonable price range for a more efficient whiteboard cleaner?	 <ul style="list-style-type: none"> <li>● \$10 - \$20</li> <li>● \$20 - \$30</li> <li>● \$30 - \$40</li> <li>● \$40 - \$50</li> <li>● More than \$50</li> </ul>	About <b>65%</b> of respondents are willing to pay <b>\$30</b> or below for the more efficient whiteboard cleaner

**Conclusion:** A more effective and efficient whiteboard cleaner is desired to help improve quality of lessons in HCI.

**2B Compare and Contrast**

We conducted research to find existing or alternative solutions to our proposed invention. We were unable to find an existing solution similar to our proposed invention. However we found automated whiteboards that come with automated cleaning functions as an alternative solution. Refer to Table 3 for the comparison between our proposed invention and the automated whiteboard.

*Table 3: Analysis of proposed solution vs alternative solution*

Criteria	<p><b>Our proposed invention</b></p> 	 <p><b>PLUS N-20 Series Copyboard</b></p>
Cost	- Low cost: Very affordable Estimated cost: \$20	- High cost: Not affordable Selling price: ~\$3000
Implementation	- Easy to fit on whiteboard, portable and stand-alone product, customisable.	- Bulky, comes together with the whiteboard - Requires a big space in the classroom
Functions	- Single function: cleaning of whiteboard	- More functions (eg: printing or saving of images)
Energy consumption	- Does not require any electricity	- Requires electricity this power points to operate

**Conclusion:** Our proposed invention is significantly cheaper and easier and more practical to implement in schools with many classrooms, as compared to the alternative solution in the market.

**3. Our BIG IDEA**

**3A Description of Proposed Invention**

Our proposed whiteboard cleaner is made up of three key components:

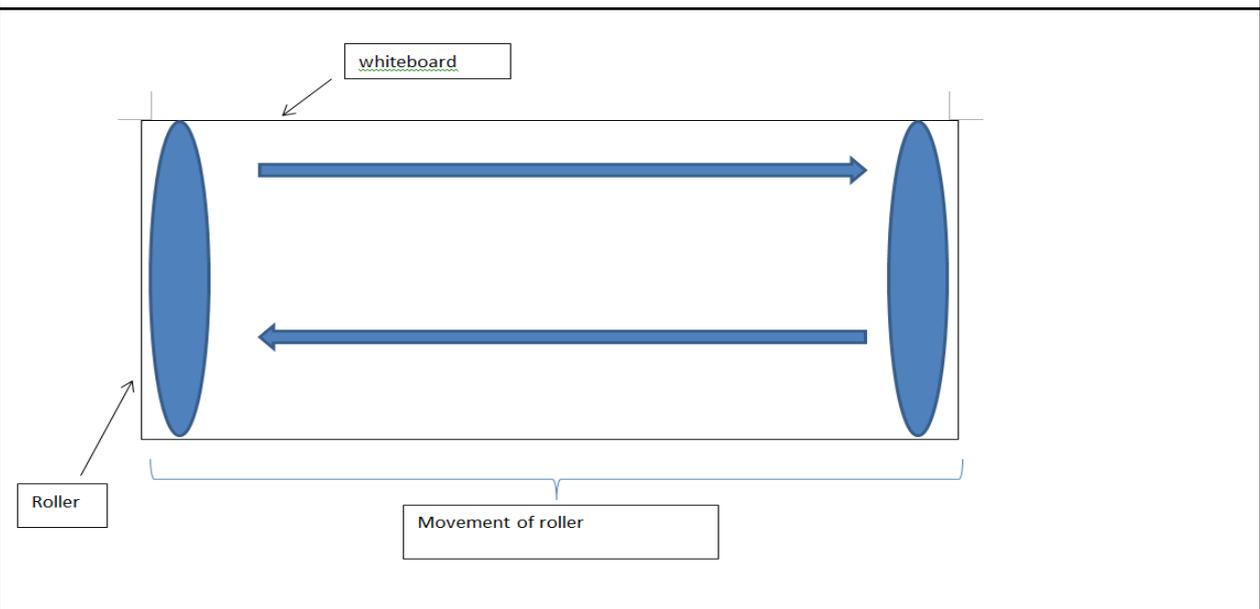
- 1) **Cleaning structure** - same vertical height as the white board, with a cloth wrapped around it
- 2) **Water tube** - fitted inside the cleaning cloth, to discharge water onto the cloth automatically
- 3) **Mode of transport** - supporting the cleaning structure, moving horizontally across the whiteboard

Refer to Table 4 for our design ideas:

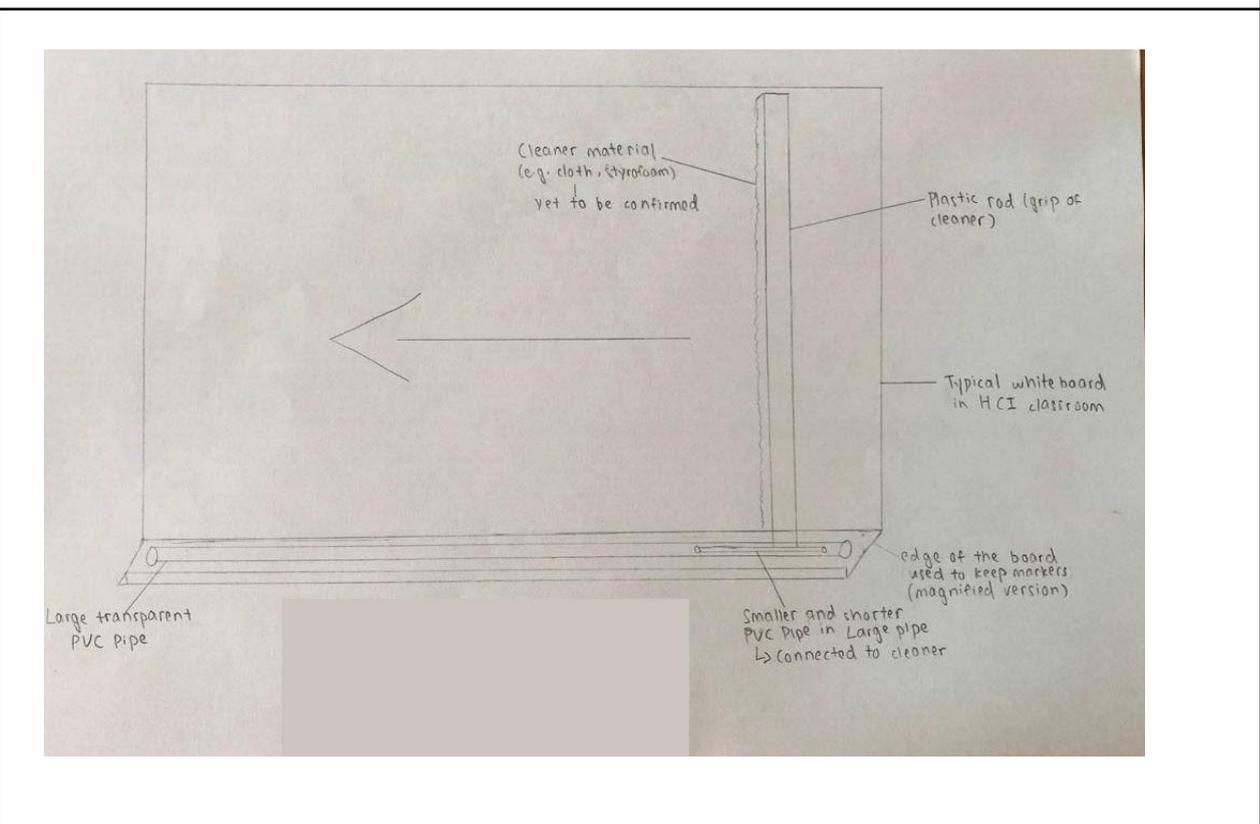
*Table 4: Design ideas*

<p><b>Proposed Workflow Design:</b></p>
<ol style="list-style-type: none"> <li>1. Grip the plastic rod (handle) behind the cleaner.</li> <li>2. Pull it across from right to the left.</li> <li>3. The smaller PVC pipe moves inside the larger PVC pipe, allowing the cleaner to move across.</li> <li>4. Hence, the writings on the whiteboard are cleaned.</li> </ol>

**Diagram 1: Proposed Working Principles:**



**Diagram 2: Initial Blueprint:**



**3B Differentiating factor of our invention**

When designing our proposed invention, we have considered and included several key features to differentiate and to address the issues arising from the conventional duster or automated whiteboard. Refer to Table 5 for the summary of our design consideration.

**Table 5: Key features and differentiating factors of our proposed invention**

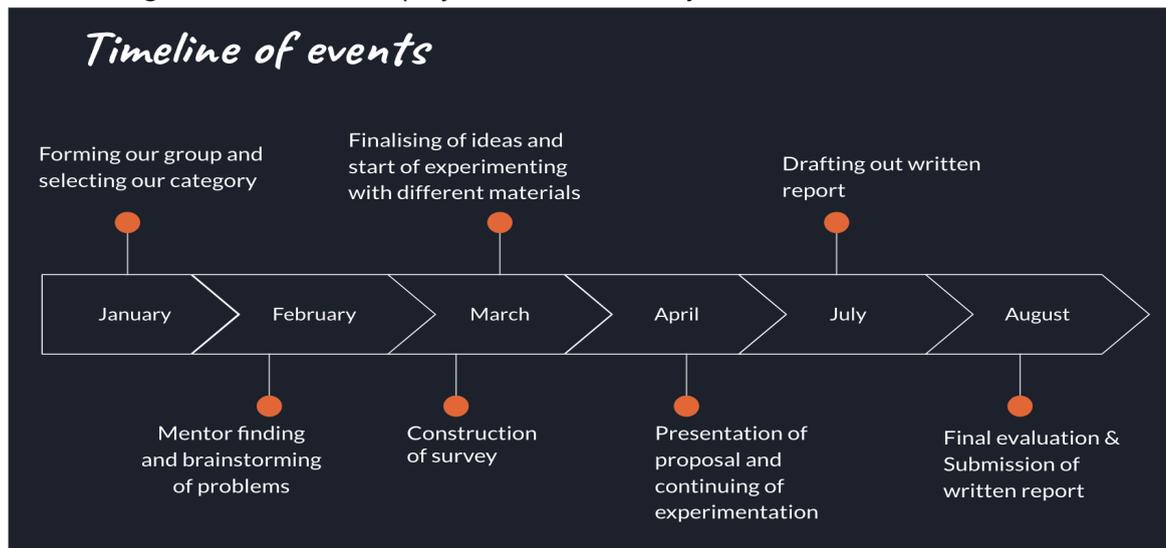
Design consideration	Key features of our proposed invention	Differentiating Factors from other solutions
Speed and efficiency	- Length matches width of whiteboard, can clean whiteboard in a single swipe	- Much more efficient than the conventional whiteboard duster
Effectiveness of cleaning action	- Very clean - Little to none residue left behind	- Relatively cleaner than the conventional duster, which still leaves behind some residue
Compactness of cleaner	- Compact - Minimal obstruction to the whiteboard	- Much more compact than the bulky automated whiteboards
Easy to set up and maintain	- Very easy to assemble and set-up - Requires regular maintenance, but just replacing the cleaning material (low cost)	- Automated whiteboard needs to have space and power cable, not easy to set-up - Requires high cost maintenance
Affordable for multiple installation	- Low cost product with easy installation - Estimated cost: \$20	- Automated whiteboards are expensive, not practical to install in all classrooms - Selling price: \$3000

**3C Expected Problem**

The main problem that we foresee for our proposed design was that our cleaning solution is meant for one swipe clean of the entire whiteboard. It is not useful when the user wants to only clean a small part of the whiteboard, for example to remove a formula written in the middle of the board. In the case of partial cleaning, a conventional duster will be more useful.

**3E Project Timeline and Major Milestones**

Refer to Diagram 3 below for our project timeline and major milestones:



**3G Analysis of Pros and Cons of Design Idea**

In addition to identifying the expected problems, we have also analysed the pros and cons of our design ideas. Refer to Table 6 for our analysis.

Table 6: Pros and Cons of Design Idea

<b>Pros</b>	<ul style="list-style-type: none"> <li>- Simple design with only mechanical movement, no electronic parts or programming required</li> <li>- Does not require expensive materials to construct (production cost is low)</li> <li>- Feasible solution which is easy to construct (using simple tools) and achieve the objective of cleaning efficiency and being cost-friendly</li> </ul>
<b>Cons</b>	<ul style="list-style-type: none"> <li>- Users cannot do partial cleaning</li> <li>- Only can clean in horizontal direction (cannot move horizontally)</li> <li>- Requires regular maintenance</li> </ul>

## 4. Proposed Construction Process

### 4A Choice of Materials and Rationale

Table 6 captures the materials chosen to build the prototype, and the rationale of our choices.

Table 6:

Key structure	Material Used	Rationale
Cleaning structure	Microfibre cloth	We tested the cleaning properties of a whiteboard duster, a microfibre cloth and a microfiber cloth with water, based on two criteria: How quickly it cleans the whiteboard, and the "Cleanliness level of the whiteboard". We concluded that microfibre cloth with the help of water would give the best cleaning solution, as it cleaned the fastest while leaving no residue. <b>(Refer to result in Graph 1, Annex A)</b>
Support structure (to hold the cleaning structure and connect to the transport structure)	Plastic	We considered three materials for the support structure: metal, plastic and wood. We assessed that plastic provides the best grip, as it does not drop splinters like wooden materials. It is also lightweight and more durable than metal which rusts easily. <b>(Refer to result in Graph 2, Annex A)</b>
Transport structure (to support mo structure across the board)	PVC rods	We considered using rollers or ball bearings to facilitate the cleaning process, but it was difficult to construct. We brainstormed further and decided to replace it with two PVC Pipes. A slit would be cut on top of the larger PVC Pipe, revealing the smaller PVC Pipe. Through that, the cleaner would be connected to the smaller PVC Pipe. Hence, when the cleaner is pulled across the whiteboard, the smaller PVC Pipe would move in the larger one, allowing the cleaner to move and clean the whiteboard. It is much more feasible to construct yet equally effective. <b>(Refer to result in Graph 3, Annex A)</b>
Water container (to be connected to the microfibre cloth)	Plastic tube	The test result in Annex A showed that having water on microfibre cloth improved the effectiveness of cleaning the whiteboard. Hence, we decided to add a water tube to discharge discharge water onto the cloth when pressed against the whiteboard

Other materials	Hot glue, tape	An invention cannot be made without these basic materials to put it together, hence we have taken into account the cost of these tools and added them into our estimated price range of our product.
Picture of actual materials used		

**4B Considerations for Prototype Construction**

As mentioned in question 4A, we have made considerations for the materials we were going to use for our invention by thinking about what would be easy to implement, and what would be better for the user. For example, we used a rectangular plastic rod as it is the material with the best grip for the user. We also used PVC pipes as the mode of transport for the cleaner as rollers were difficult to be implemented. Furthermore, we did not want the users to apply their own force to clean the whiteboard, hence we added water so that cleaning of the whiteboard would be easier. Our prototype will be constructed based on our considerations for the user’s ease in using it.

**4 C Prototype Construction Process.**

Refer to Table 7 for our prototype construction process.

*Table 6: Construction Process*

Step	Description
1	With a metre rule, measure the dimensions (i.e. the length and the breadth) of the face of the rectangular plastic rod which the cleaning material would be attached to and record them as Set A.
2	Using a permanent marker and a metre rule, measure the lengths recorded in Set A on the cleaning material and draw an outline.
3	Use a scissors to cut the cleaning material along the outline drawn.
4	Using a hot glue gun, apply hot glue onto the surface of one side of the rectangular plastic rod.

	
5	Then, paste the prepared fabric onto that surface to attach it to the plastic rod.
6	Measure the height of the plastic rod using a standard ruler, recording it as Set B.
7	Measure the length in Set B on the side across the width of the smaller PVC pipe, marking it with a permanent marker.
8	Cut the part out from the smaller PVC pipe for the entire pipe.
9	Add 4 centimetres to the breadth of the rod measured in Set A.
10	With the calculated value, measure it on the longer side of the smaller PVC pipe with a metre rule, and mark the ends with a permanent marker.
11	Cut the extra ends of the smaller PVC pipe until only the part within the markings remain.
12	<p>Then, use the plastic rod and insert the shorter side of the rod into the slit made on the smaller PVC pipe, fixing them together.</p> 
13	Based on the length in Set B, measure it on the side across the width of the larger PVC pipe, marking it with a permanent marker.
14	Cut that part out from the larger PVC pipe across the entire pipe.
15	Shorten the larger PVC pipe to fit the length of the slit meant for storing materials of the whiteboard.

16	Slot the smaller PVC pipe with the plastic rod inserted through the hole on one side of the larger PVC pipe.
17	Add the water container and tube to the top of the plastic rod and secure with tape and hot glue.
18	<p>Place the set-up in the slit meant for storing whiteboard markers in the whiteboard.</p> 

#### **4D Working Principles**

In a typical whiteboard in Hwa Chong Institution, there is an edge of the whiteboard where markers are kept. The whiteboard cleaner will be installed into the sides of the whiteboard. The cleaner will take up the entire width of the board if installed correctly. Then, it is ready for use. The cleaner will be pushed along the length of the board, and with just a little bit of pressure, the microfibre would be able to clean the board, leaving no residue. If and when the microfibre is too dirty, you can either wash it or replace it with another microfibre cloth, as installation is easy.

Please click on the video link to see how our prototype works:

*Efficient Whiteboard Cleaner (Demonstration of working principles):*

<https://youtu.be/6RLoZYpjaLE>

## **5. References**

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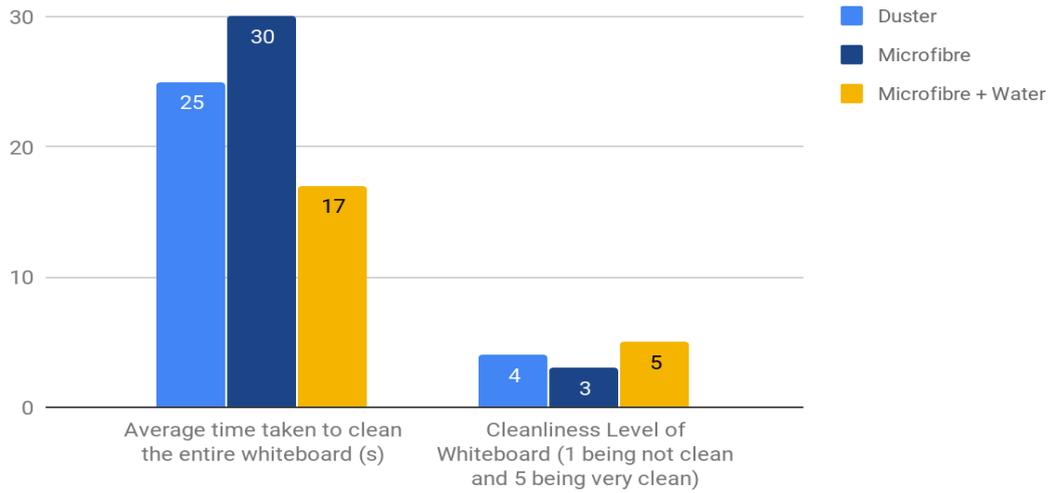
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**Annex A**

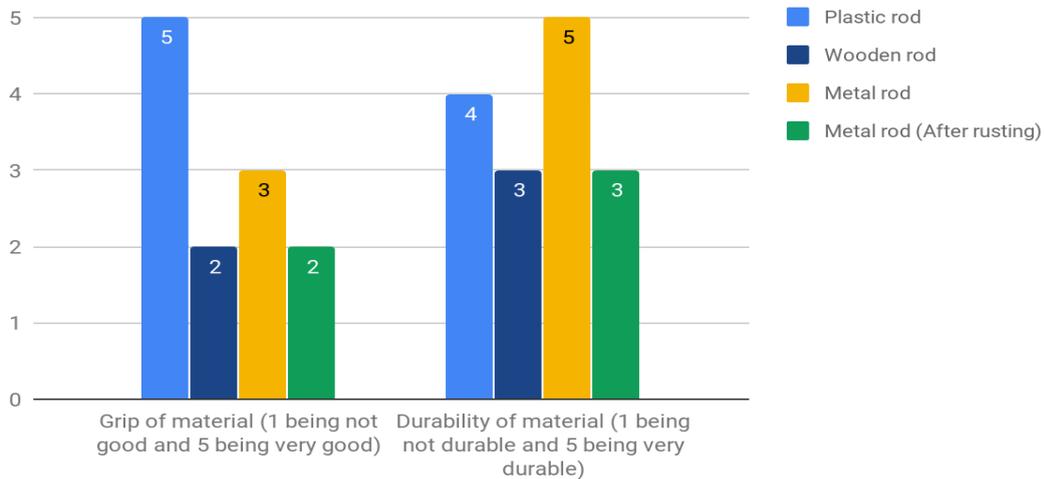
**Graph 1:**

Relative effectiveness of materials to become cleaner



**Graph 2:**

Relative effectiveness of materials to become the handle



**Graph 3:**

### Comparing modes of transport

