"CLEANUP" Challenge Solution Submission Example

This "Cleanup" Challenge Solution Submission Example was constructed to provide additional insight into CASE Challenge submission expectations. Please note that actual CASE Challenge submissions should be more detailed than the following simplistic example.

Solver Names

Team: Super Clean

Members: Jane Smith (POC), John Doe, and Dr. ABC XYZ

Solution Identifier/Name

MAVERICK - **M**ethods **A**ssessing **V**acuum **E**fficiency and **R**obustness **I**n **C**reative **K**onditions

I. Solution Overview

In the below lettered subsections, provide support for your solution concept, design, and the procedures to be employed within. Describe why your solution will work and how it will measure the effectiveness of vacuum cleaners.

a. Solution Summary

Provide a short summary of your proposed solution.

The testing of consumer appliances is not novel in the world of electronics, and vacuum cleaners are no exception. However, there presently exists no standard metric or methodology to compare abilities across vacuum cleaners in a way that supports the needs of both consumer and commercial scenarios. Our solution aims to identify a simple, repeatable methodology for testing the robustness and efficiency of different commercially available vacuums to assist in establishing a benchmark procedure that can be used for various vacuum applications. Our solution defines efficiency as the number of passes the vacuum cleaner takes to achieve a passing score on the International Sanitary Supply Association (ISSA) Clean Standards Assessment (CSA) and on a gravimetric dust assessment. Robustness is defined as the range of particle sizes the vacuum is able to pick-up in a single pass over smooth, textured, and sticky terrain.

b. Solution Validity [*Scientific Support 2. Validity*]

Our solution defines efficiency and robustness in the following ways:

Efficiency – Efficiency is defined as the number of passes the vacuum cleaner needs to make over the pre-defined particulate patterns to achieve a passing score on the ISSA Clean Standards Assessment and on a gravimetric dust assessment. The first assessment will measure how many passes the vacuum takes to achieve a passing score on the ISSA CSA, whereas the gravimetric dust assessment will take place in a separate test series which measures the overall weight of particulates left behind after each vacuum pass.

Robustness – Robustness is defined as the range of particle sizes the vacuum can pick up in a single pass over different surface types. Our main three surfaces of choice are smooth (laminate tile floor), textured (40oz carpet weight carpet patch), and sticky (concrete floor coated in mouse-trap glue).

c. Solution Background [*Scientific Support 1. Background*]

The ISSA CSA and gravimetric dust assessments we have selected are utilized in schools, office places and large businesses to ensure that clean standards are met. Our goal is to adapt these well-established practices into a simple test which can be conducted both in commercial and consumer environments. This will allow us to collect both objective and subjective data on each vacuum, resulting in the assignment of a relative score based on the testing scenario.

II. Solution Design and Methodology

Our design will include four (4) vacuum cleaner types within three (3) price ranges. We define our vacuum cleaner types as upright bagless, upright bagged, two piece, and handheld cordless. Our price ranges are low ($30-$70), medium ($70-$200) and high ($200+). We intend to test four (4) vacuum cleaners of each type in each price range to assist in the validation of our test methods (n = 48 total vacuums tested).

Efficiency Testing:

ISSA CSA - Each vacuum will be passed over a 1ft patch of laminate flooring under four (4) particle conditions of powder, dirt, cereal and pet hair. The particle conditions will be applied such that the same net weight of particles is evenly distributed on the 1ft patch of flooring. A robotic arm will move each vacuum head over the surface under each of the particle conditions, in a fixed back and forth swipe pattern, for a time of 10 seconds. The patch will be evaluated and ranked on the ISSA CSA after each 10 second trial until a passing score is obtained, with the total number of trials being recorded.

Each evaluator of the ISSA CSA will be pre-screened to ensure they do not have a conflict of interest.

Gravimetric Dust – Each vacuum, under each particle condition, will complete up to ten passes over the laminate surface patch. The total remaining dust after each pass will be measured using a gravimetric dust measurement machine and then reapplied to the patch. This process will be repeated for all four types of particulates.

Robustness Testing:

All 48 vacuums will be tested on their ability to pick up fine dirt on each of the three surface types (smooth surface, textured carpet and sticky floor) in a single pass. Remaining particles will be collected and measured to evaluate how much the vacuum was able to pick up. This test will be repeated five (5) times for each vacuum cleaner to allow for an accurate representation of the vacuum's performance.

Subjective Data Collection:

In an effort to collect a subjective ease-of-use score, several participants will use the vacuums and record their opinions on self-report behavioral assessments of product usability. While not previously defined, this measure gives context to the overall performance scores (derived from efficiency and robustness testing) of the vacuums and helps to validate that our findings are in line with consumer opinions. Several participants will be recruited and assigned to different vacuum use cases in order to test a broad spectrum of user needs across both home consumer and commercial environments. Subjective vacuum usability scores will be reported separately from objective vacuum performance scores.

III. Solution Self-Assessment

Reflect in the below sections on your solution, with respect to its relevance to key CLEANUP Challenge evaluation criteria. Identify and describe the broader implications of your solution via the following prompts.

a. Scientific Support

In the below numbered subsections, discuss why your solution is replicable and generalizable. Describe how it will objectively measure the effectiveness of vacuum cleaners.

1. *Replicability [Scientific Support 3. Replicability]*

   Our methods are designed to be easily replicable in a home environment by a consumer or in a commercial setting. While it is true that most home consumers do not have access to a gravimetric dust measuring device, semi-accurate measurements can be taken at home using a dust pan and broom to evaluate vacuum performance standards.

2. *Generalization [Scientific Support 4. Generalization]*

   Our methodology is applicable to any existing or future vacuum cleaner or related suction cleaning product, and focuses on evaluating the device's ability to efficiently clean a surface.

3. *Ground Truth [Scientific Support 5. Ground Truth]*

   Vacuum cleaner performance is evaluated via efficiency and robustness testing based on grounded, non-subjective measurements of surface cleanliness.

b. Realism

In the below numbered subsections, discuss how your solution reflects the real-world situations, circumstances and conditions to which it will ultimately apply. Describe the ease with which your solution could be transitioned to real-world applications.

1. *Psychological Realism [Realism 1. Psychological Realism]*

   Participants in our vacuum study are able to see, feel and use the cleaners firsthand, allowing for true psychological realism. The use of different types of surfaces and particles that are found in many home and commercial settings also increases the psychological realism of this study.

2. *Physical Realism [Realism 2. Physical Realism]*
   The different types of surfaces and particles used in our study also provide a true sense of physical realism for participants as they closely mimic real-world vacuum cleaner use scenarios and circumstances.

3. *Practicality [Realism 3. Practicality]*
   The most difficult part of our data collection, if implemented, will be acquiring the set of 48 vacuums and ensuring that the data collected across the test series is done in a repeatable manner. As a result, implementing a simple robotic lever arm to pass the vacuums over the surfaces is likely to be the best option. Due to the large quantity of data that would be collected, an analysis pipeline and statistical plan will need to be made in advance to understand data outcomes. The test in its full form should occur in a somewhat large facility, in order to house all of the vacuums used in the study.

c. Novelty

In the below numbered subsections, discuss how your solution is unique and describe what is creative/clever about your ideas. Indicate how your solution is sufficiently different from the pre-existing class of standard consumer vacuum tests. It is only necessary to provide information for the subsections you feel are relevant to your solution.

1. *Procedure [Novelty 1. Procedure]*
   The most innovative portion of our solution is in the way we measure surface cleanliness rather than vacuum suction or strength. In this way we create a basis for testing new systems as they are invented.

2. *Motivation [Novelty 2. Motivation]*
   Related to motivation novelty, we ensure that all study participants do not have conflicts of interest. As such, motivations are aligned with establishing the true performance of each vacuum rather than with trying to ensure a specific make/model of vacuum is evaluated favorably. In addition, advertising by vacuum manufactures will not be allowed on the study site and all brand markings will be covered on vacuum cleaners prior to the study.

3. *Enhanced Realism [Novelty 3. Enhanced Realism]*
   The use of pet hair, cereal and dirt on various surfaces allows for a realistic evaluation of the vacuum cleaners' capabilities.

4. *Technology [Novelty 4. Technology]*
   The use of a robot arm to repeatedly move the vacuum cleaner in a set motion is a creative use of technology.

5. *Objective Measurement [Novelty 5. Objective Measurement]*
   Ground truth novelty is represented by the use of a gravimetric dust measuring device to accurately generate a metric for surface cleanliness.

d. Participant Considerations

In the below numbered subsections, discuss how your solution ensures the safety of the human participants and adheres to ethical principles and guidelines. Provide enough detail to illustrate that the experiment is safe and ethical for human subjects.

1. *Beneficence [Participant Considerations 1. Beneficence]*
   Earplugs will be provided for all observers, participants and experimenters to shield them from the risk of loud vacuum noises throughout the experiment. We will ensure that electrical plugs and wiring are maintained for both electrical and tripping hazard safety.

2. *Respect for Persons [Participant Considerations 2. Respect for Persons]*
   Participants are free to leave our study at any time, for any reason, without penalty.

3. *Justice [Participant Considerations 3. Justice]*
   The study is open to recruitment of all participants over the age of 18 who do not self-report a conflict of interest with the particular brands of vacuum cleaners being tested. Participant subjective measurements will be de-identified prior to evaluation by the analysis team such that an individual's opinions are not colored by the experimenter's opinion of those individuals.

4. *Investment [Participant Considerations 4. Investment]*
   Participation in this experiment will require up to one full day of a participant's time.

IV. Supplementary Information

[Optional] In this section, provide any supplementary information related to your solution that was not covered in the previous sections.

V. References

[Optional] In this section, provide citations of any references you utilized in generating your solution.

Consumer Reports, "Testing Vacuums Video," https://www.consumerreports.org/video/view/appliances/laundry/1253206297001/testing-vacuums/.