# EMPIRICAL RESEARCH REPORT
# on
## DEAL FINDER APPLICATION

Group 4:

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# <u>INTRODUCTION</u>

**What is Empirical Research?**
Empirical research is defined as any study whose conclusions are exclusively derived from concrete, verifiable evidence. The term empirical means that it is guided by scientific experimentation and evidence. Likewise, an analysis is empirical when it uses real-world evidence in investigating its assertions.

**Purpose:**
After completing the interface design for our application, it was necessary to learn about how various factors affect the overall user experience with regards to our website. Empirical research fulfils this purpose with the primary aim of gathering concrete evidence based on thorough user research and then statistical analysis to come up with the appropriate hypothesis.

**Outline:**
To obtain reliable data that lead us to a reliable conclusion, we follow a systematic process consisting of the following series of stages in sequence:
- Identification of research questions
- Determination of variables
- Design of experiment
- Analysis of empirical data
- Building a mathematical model that can explain and support the hypothesis.

In this document, we detail the step-by-step procedure we have implemented in our empirical research process.

# RESEARCH QUESTIONS

After several iterations, we have come up with the following research questions that could influence the design of our system and the corresponding implementation. We have specified the variables determining the relationships in the questions, thus removing ambiguity. We have also used measurable quantities to develop a mathematical relationship instead of just a qualitative one. Following the above procedure, we have ensured that the questions we have are "Testable Research Questions".

**Research Query 1:**
> How does the aesthetic score (on a scale of 1-10) of an interface depend on the number of objects, object types and the layout of the objects it has?

**Research Query 2:**
> How does the system's efficiency (rated on a scale of 1-5) depend on the number of objects and the type of objects it has?

**Research Query 3:**
> How does the accessibility of features of the system (rated on a scale of 1-5) depend on the percentage of the screen occupied by the objects and type of objects?

The corresponding hypotheses of the above queries are:
- **RQ1:**
  - $H_0$ : The aesthetic score (on a scale of 1-10) of an interface does not depend on the number of objects, object types and the layout of the objects it has.
  - $H_1$: The aesthetic score (on a scale of 1-10) of an interface depends on the number of objects, object types and the layout of the objects it has.
- **RQ2:**
  - $H_0$: The efficiency of the system (rated on a scale of 1-5) does not depend on the number of objects and the type of objects it has.
  - $H_1$: The efficiency of the system (rated on a scale of 1-5) depends on the number of objects and the type of objects it has.
- **RQ3:**
  - $H_0$: The accessibility of features of the system (rated on a scale of 1-5) does not depend on the percentage of the screen occupied by the objects and the type of objects.
  - $H_1$: The accessibility of features of the system (rated on a scale of 1-5) depends on the percentage of the screen occupied by the objects and the type of objects.

# VARIABLE DETERMINATION

After the research hypotheses are framed, we identify the variables for each of the hypotheses. These variables will be used to observe and record quantitative data. The corresponding variables for each query are:

- ❖ **RQ1:**
  - ➢ **Dependent variable** (The one users will rate)**:** Aesthetic score can take values between 1-10.
  - ➢ **Independent variables:**
    - ■ **The number of objects:** We have two possible values - less than 24 and greater than 24.
    - ■ **Type of objects:** Three possible values - text only, image only, text and image.
    - ■ **Layout:** Two possible values - symmetric and asymmetric.
- ❖ **RQ2:**
  - ➢ **Dependent variable:** Efficiency score, can take values between 1-5.
  - ➢ **Independent variables:**
    - ■ **The number of objects:** We have two possible values - less than 26 and greater than 26.
    - ■ **Type of objects:** Three possible values - text only, image only, text and image.
- ❖ **RQ3:**
  - ➢ **Dependent variable:** Accessibility score, can take values between 1-5.
  - ➢ **Independent variables:**
    - ■ **Type of objects:** Three possible values - text only, image only, text and image.
    - ■ **Percentage of the screen occupied:** Three possible values - Low, medium, high.

Once we have determined the variables and their possible values, we can set up the experiment.

# EXPERIMENT DESIGN

In our experiment, we are **Manually Recording** the data received from the test users.

**Scale used :**
1.  **Study 1:** We are using an **ordinal scale** for recording and measuring the data since we are giving the interfaces scores on a scale of 1-10 where there is a definite ordering in the rating scale.
2. **Study 2:** We are using an **ordinal scale** for recording and measuring the data since we are giving the interfaces scores on a scale of 1-5 where there is a definite ordering in the rating scale.
3. **Study 3:** We are using an **ordinal scale** for recording and measuring the data since we are giving the interfaces scores on a scale of 1-5 where there is a definite ordering in the rating scale.

**Recruiting participants:**
We asked 12 college students to participate in the study, knowing that they fulfil the conditions of the intended user base we are trying to cater to. Participants were selected from different disciplines, thus ensuring a heterogeneous group.

**Tasks:**
1. **Research Question 1 Task:** Participants were asked to rate a given interface based on its aesthetics on a rating scale of 1-10.
2. **Research Question 2 Task:** Participants were asked to apply the sortBy filter on a given interface and to rate the experience on a scale of 1-5.
3. **Research Question 3 Task:** Participants were asked to wishlist a particular product on a given interface and rate the experience on a scale of 1-5.

**Assignment of tasks:**
1. **Research Question 1:** Each participant in the study performed tasks corresponding to all test conditions. All 12 participants were asked to rate all 12 interfaces. Hence this was a repeated measure of within-subject study design.
2. **Research Question 2:** Each participant in the study performed tasks corresponding to all test conditions. All 12 participants were asked to rate

all six interfaces. Hence this was a repeated measure of within-subject study design.

3. **Research Question 3:** Each participant in the study performed tasks corresponding to all test conditions. All 12 participants were asked to rate all six interfaces. Hence this was a repeated measure of within-subject study design.

*N.B.: To remove the practice effect, we have used the **Latin Square Method** to collect the experimental data so that there is no bias in the ordering of the interfaces in which we sent to the participants.*

**The experiment's procedure:** All the participants were contacted ahead of time to schedule a meeting for the experiments. The experiment was conducted in an online fashion where the participants were asked to share their screen. Systematically, they were provided with the interfaces and asked to perform their tasks. Our team members were simultaneously writing down the data. At the end of the experiments, all participants were thanked enough for their time and cooperation. All experiments were concluded successfully.

# DATA COLLECTION

Data was collected during the online conduct of the experiments and were simultaneously noted down in an excel sheet. Screenshots are attached below, and the excel sheet can be found in the below link:

https://docs.google.com/spreadsheets/d/1hUW3TzvAxmfDOroi1gQUVo2m98NVKJCICTDWILU-QdM/edit#gid=938531009

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | RESEARCH QUESTION 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | Names | Interface 1 | Interface 2 | Interface 3 | Interface 4 | Interface 5 | Interface 6 | Interface 7 | Interface 8 | Interface 9 | Interface 10 | Interface 11 | Interface 12 |
| 4 | Vaibhav | 7 | 7 | 8 | 6 | 5 | 6 | 4 | 8 | 7 | 8 | 6 | 6 |
| 5 | Venkatesh | 8 | 9 | 7 | 6 | 6 | 9 | 5 | 7 | 7 | 8 | 9 | 8 |
| 6 | Debapriya | 6 | 8 | 7 | 9 | 7 | 8 | 7 | 8 | 7 | 6 | 9 | 7 |
| 7 | Nikita | 5 | 7 | 7 | 7 | 8 | 7 | 8 | 6 | 8 | 7 | 7 | 7 |
| 8 | Pranav | 7 | 7 | 9 | 8 | 8 | 9 | 6 | 9 | 9 | 8 | 8 | 10 |
| 9 | Rahul | 7 | 6 | 5 | 7 | 6 | 7 | 4 | 6 | 8 | 6 | 7 | 6 |
| 10 | Anushka | 5 | 6 | 4 | 6 | 6 | 5 | 4 | 7 | 7 | 3 | 7 | 4 |
| 11 | Nishank | 9 | 10 | 9 | 8 | 8 | 10 | 8 | 9 | 10 | 10 | 9 | 10 |
| 12 | Ansh | 7 | 6 | 6 | 8 | 6 | 7 | 6 | 7 | 7 | 6 | 7 | 7 |
| 13 | Smita | 4 | 4 | 5 | 5 | 6 | 5 | 3 | 5 | 7 | 7 | 5 | 3 |
| 14 | Venkateshwaran | 6 | 5 | 7 | 7 | 5 | 7 | 8 | 7 | 8 | 7 | 7 | 6 |
| 15 | Pritam | 5 | 5 | 5 | 7 | 7 | 7 | 6 | 8 | 7 | 6 | 8 | 7 |
| 16 | | | | | | | | | | | | | |
| 17 | No. Of Objects | >24 | <24 | <24 | >24 | <24 | >24 | >24 | <24 | <24 | >24 | >24 | <24 |
| 18 | Types Of Objets | 3 | 1 | 3 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 3 |
| 19 | Layout | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 2 |

Convention for types of objects:
1. Text is represented by 1
2. Image is represented by 2
3. Text and Image is represented by 3

Convention for Layout:
1. Symmetrical is represented by 1
2. Asymmetrical is represented by 2

**RESEARCH QUESTION 2**

| NAME | Interface 1 | | Interface 2 | | Interface 3 | | Interface 4 | | Interface 5 | | Interface 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) |
| Pranav | 58 | 3 | 6 | 5 | 6 | 5 | 5 | 5 | 8 | 5 | 9 | 5 |
| Ritwik | 15 | 3 | 10 | 4 | 7 | 5 | 9 | 3 | 5 | 5 | 16 | 5 |
| Vaibhav | 40 | 3 | 5 | 5 | 4 | 4 | 5 | 4 | 3 | 5 | 15 | 4 |
| Rahul | 50 | 2 | 26 | 3 | 5 | 3 | 35 | 2 | 4 | 5 | 11 | 5 |
| Nikita | 25 | 3 | 6 | 4 | 4 | 3 | 4 | 3 | 9 | 4 | 20 | 2 |
| Anket | 21 | 3 | 15 | 4 | 5 | 5 | 10 | 3 | 8 | 5 | 14 | 4 |
| Venkatesh | 48 | 3 | 10 | 4 | 6 | 4 | 8 | 5 | 7 | 4 | 12 | 4 |
| Niharika | 28 | 2 | 6 | 3 | 9 | 3 | 4 | 3 | 6 | 4 | 8 | 4 |
| Harsh | 55 | 2 | 8 | 5 | 4 | 5 | 14 | 4 | 5 | 5 | 16 | 3 |
| Utkarsh | 43 | 2 | 5 | 4 | 5 | 5 | 5 | 5 | 9 | 5 | 12 | 4 |
| Himanshu | 53 | 3 | 14 | 4 | 7 | 4 | 12 | 3 | 10 | 4 | 13 | 4 |
| Shriram | 58 | 2 | 8 | 4 | 5 | 5 | 16 | 4 | 8 | 5 | 9 | 5 |
| No. of Objects | >26 | | >26 | | <26 | | <26 | | <26 | | >26 | |
| Types of Objects | | 1 | | 3 | | 2 | | 1 | | 3 | | 2 |

Convention for types of objects:
1. Text is represented by 1
2. Image is represented by 2
3. Text and Image is represented by 3

**RESEARCH QUESTION 3**

| NAME | Interface 1 | | Interface 2 | | Interface 3 | | Interface 4 | | Interface 5 | | Interface 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TASK 2 | | TASK 2 | | TASK 2 | | TASK 2 | | TASK 2 | | TASK 2 | |
| | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) | Time(in sec) | Rating(1-5) |
| Pranav | 10 | 4 | 31 | 3 | 6 | 4 | 166 | 1 | 30 | 4 | 3 | 5 |
| Ritwik | 8 | 4 | 4 | 5 | 5 | 5 | 24 | 1 | 5 | 4 | 3 | 5 |
| Vaibhav | 20 | 4 | 4 | 5 | 1 | 5 | 40 | 1 | 32 | 4 | 2 | 4 |
| Rahul | 10 | 4 | 20 | 3 | 2 | 5 | 35 | 1 | 14 | 4 | 1 | 5 |
| Nikita | 7 | 3 | 3 | 4 | 5 | 4 | 17 | 1 | 13 | 3 | 3 | 4 |
| Anket | 12 | 5 | 6 | 5 | 5 | 5 | 43 | 1 | 9 | 5 | 6 | 5 |
| Venkatesh | 13 | 4 | 5 | 5 | 4 | 5 | 58 | 1 | 14 | 4 | 3 | 5 |
| Niharika | 15 | 2 | 3 | 5 | 4 | 4 | 30 | 1 | 13 | 3 | 2 | 5 |
| Harsh | 14 | 3 | 7 | 4 | 3 | 5 | 69 | 1 | 18 | 3 | 4 | 5 |
| Utkarsh | 20 | 3 | 8 | 5 | 2 | 5 | 42 | 1 | 17 | 4 | 2 | 5 |
| Himanshu | 13 | 4 | 9 | 4 | 4 | 5 | 46 | 1 | 12 | 3 | 3 | 5 |
| Shriram | 18 | 3 | 7 | 5 | 7 | 4 | 56 | 1 | 15 | 4 | 4 | 5 |
| No. of Objects | >26 | | >26 | | <26 | | <26 | | <26 | | >26 | |
| Types of Objects | | 3 | | 3 | | 2 | | 1 | | 2 | | 2 |
| % Screen Cover | | 3 | | 3 | | 3 | | 2 | | 1 | | 1 |

Convention for types of objects:
4. Text is represented by 1
5. Image is represented by 2
6. Text and Image is represented by 3

Convention for % screen covered :
1. Low is represented by 1
2. Medium is represented by 2
3. High is represented by 3.

# DATA ANALYSIS

In the context of the three research queries and the compiled data, we performed the non-parametric test: **Friedman Test**. Our factors in consideration for the interfaces were either two or more, and there was at least one factor with three or more levels.

We performed the data analysis using the Friedman Test on an online platform https://astatsa.com/FriedmanTest/. The data used for the calculation is in the sheet https://docs.google.com/spreadsheets/d/1hUW3TzvAxmfDOroi1gQUVo2m98NV KJCICTDWILU-QdM/edit#gid=938531009. Results for the corresponding research queries are as below:

**Research Query 1:**

Friedman chi-square statistic for the corresponding data: **28.285203**

Number of degrees of freedom: **11**
The number of degrees of freedom can be found by the number of correlated groups or interfaces in the context of query minus 1.

P-value for the data: **0.002927**

Significance level considered: **0.05**

As the p-value < 0.05, we can say that the **null hypothesis is rejected**. Thus the hypothesis that 'The aesthetic score (on a scale of 1-10) of an interface does not depend on the number of objects, object types and the layout of the objects it has' proves to be false. This proves the alternate hypothesis. Thus we can conclude that **the aesthetic score of an interface depends on the number of objects, object types and the layout of the objects it has**.

**Research Query 2:**

Friedman chi-square statistic for the corresponding data: **32.846608**

Number of degrees of freedom: **5**

The number of degrees of freedom can be found by the number of correlated groups or interfaces in the context of query minus 1.

The P-value for the data: **0.000004**

Significance level considered: 0.05

As the p-value < 0.05, we can say that the **null hypothesis is rejected**. Thus the hypothesis that 'The efficiency of the system (rated on a scale of 1-5) does not depend on the number of objects and type of objects it has' proves to be false. This proves the alternate hypothesis. Thus we can conclude that **the efficiency of the system depends on the number of objects and the type of objects it has**.

**Research Query 3:**

Friedman chi-square statistic for the corresponding data: **46.349862**

Number of degrees of freedom: **5**
The number of degrees of freedom can be found by the number of correlated groups or interfaces in the context of query minus 1.

P-value for the data: **7.708004e-09**

Significance level considered: **0.05**

As the p-value < 0.05, we can say that the **null hypothesis is rejected**. Thus the hypothesis that 'The accessibility of features of the system (rated on a scale of 1-5) does not depend on the percentage of the screen occupied by objects and the type of objects it has' proves to be false. This proves the alternate hypothesis. Thus we can conclude that the **accessibility of the system depends on the percentage of the screen occupied by objects and the type of objects it has.**

# CONCLUSION

From the data collected and the subsequent Friedman's chi-square analysis, we can safely prove the alternative hypothesis of each research query correct since in all the cases, the p-scare came considerably lower than the arbitrary threshold of 0.05. This signifies that the data collected by us were not entirely due to chance, and there is a significant correlation between the independent and dependent variables.

From the results of the experiments, it is also clear to us that in designing the interfaces, more number of objects actually negatively contributes to the aesthetics and overall usability of the system. Too many objects make the website too cluttered, thus making it difficult for users to use the website efficiently.

We also deduce that the percentage of the screen occupied by objects also contributes to the efficiency of usage of the application, and close to 100% occupancy is detrimental to the user experience for the same reasons as mentioned above. We also notice that very little occupancy of the screen is also not desirable since it doesn't provide enough information to the users to use the website properly, and also too much white space isn't visually appealing either.

Keeping in mind all the above inferences of the experiment, we will forward the results to the design team for implementation and making the system easy to use, visually pleasing and provide an appealing user experience in general.

# REFERENCES

To calculate the Friedman Test online: https://astatsa.com/FriedmanTest/.

Youtube lectures for reference:

https://www.youtube.com/watch?v=ep64qdISQAU&list=PLwdnzlV3ogoX3iArOKR q4RHSPrZyxhkrI&index=27

https://www.youtube.com/watch?v=fD-wAmhhd6A&list=PLwdnzlV3ogoX3iArOKR q4RHSPrZyxhkrI&index=28

https://www.youtube.com/watch?v=v-zB0XPv76I&list=PLwdnzlV3ogoX3iArOKRq 4RHSPrZyxhkrI&index=29