EMPIRICAL STUDY

INTERACTIVE HUMAN DIGESTIVE SYSTEM VR TOUR

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Empirical Research is a controlled experiment to collect and analyze data on user behaviour. To perform this research on our project "Human Digestive System VR Experience", we will collect data from various users of the VR application and that data is called *Empirical Data* and will sequentially follow the 4 stages:

1) Identification of research question(s)
2) Determination of variables
3) Design of experiment
4) Analysis of "Empirical data"

These stages will help us to build a computational model for judging the "*aesthetics*" of our VR application since aesthetics of an application directly relates to the *user's satisfaction*. We will begin our empirical study by framing research questions (hypothesis).

RESEARCH QUESTIONS

For our VR project, we have framed 1 research question and for that 2 hypothesis which will help us to obtain a meaningful conclusion after the analysis of empirical data.

1) **RQ1:** How does the "Aesthetic Score" on a scale of (1-10) depends of the number of objects, object types and the layout of the objects an interface has?
   a) **H_0:** The "Aesthetic Score" on a scale of (1-10) does not depend on the number of objects, object types and the layout of the objects an interface has.
   b) **H_1:** The "Aesthetic Score" on a scale of (1-10) depends on the number of objects, object types and the layout of the objects an interface has.

Now we will identify the variables to observe and record quantitative data.

DETERMINATION OF VARIABLES

Since in our hypothesis, we have 4 variables:- Number of Objects (N), Object Types (T), Object Layout (L) and Aesthetic Score (AS), we will categorise them into 2 categories: *Independent* and *Dependent*

1. *INDEPENDENT VARIABLES*
   a. *Number of Objects (N)*
      i. It is an **integer** value.
      ii. It corresponds to the total number of objects in the UI (texts, sliders, buttons, images etc).
   b. *Type of Object (T)*
      i. It takes any combination of **[Text, Image]** as its value.
      ii. It corresponds to the object's type whether the object is text, image etc.
   c. *Layout of Objects (L)*
      i. It takes **(Asymmetric/Symmetric)** as its value.
      ii. It corresponds to the design's layout whether it is symmetric or asymmetric.

2. *DEPENDENT VARIABLES*
   a. *Aesthetic Score/Rating (AS)*
      i. It takes an **integer** value in the **interval [0-10]**.
      ii. It corresponds to the user's rating about the aesthetics of the UI and is dependent on the **factors** (independent variables) of the interface.

3. **CONTROL VARIABLE**

   As a control variable, we set the **Age factor** as a control variable and limit it to the student's (age group) since our VR Application is designed for that particular Age-Group

After identifying the variables, we do a pilot study to find the values of the independent variables and dependent variables.

DESIGN OF EXPERIMENT

For the **Pilot-Study**, we asked 6 of our friends to test the below mentioned User Interfaces and rate them on a scale of [1-10] and these ratings are referred to as the "empirical data". Since we have 6 participants and each participant will test 3 interfaces (subset of interfaces), our test type is **Between-Subject**.

Participant (PX)	Name
1	Amrit
2	Aayush
3	Jayati
4	Amit
5	Manav
6	Sparsh

INTERFACES

1) **Interface-1 (I_1)**
   a) Number of Objects (N) = 53
   b) Type of Objects (T) = Text & Image
   c) Layout of Objects (L) = Asymmetric
   d) *Link*
      https://www.figma.com/proto/lx58yKq5K4EOqViVFDIb5x/COMPARE-1?page-id=0%3A1&node-id=2%3A2&viewport=-18%2C943%2C1&scaling=contain

2) **Interface-2 (I_2)**
   a) Number of Objects (N) = 95
   b) Type of Objects (T) = Text & Image
   c) Layout of Objects (L) = Asymmetric
   d) *Link*
      https://www.figma.com/proto/yjQXQVW9rGTynjOphAFLff/MAIN?page-id=0%3A1&node-id=5%3A15&viewport=1167%2C769%2C0.03125&scaling=scale-down

3) Interface-3 (I_3)

   a) Number of Objects (N) = 60

   b) Type of Objects (T) = Text

   c) Layout of Objects (L) = Symmetric

   d) *Link*

   https://www.figma.com/proto/IYPaFc72KSxnQ2S1YyKNZg/COMPARE-2?page-id=0%3A1&node-id=1%3A2&viewport=638%2C218%2C0.25&scaling=contain

We ask the participants to perform the below **Tasks** (primary task is to rate the User Interface)

1) Login into the VR Application.

2) Sign-up as a New User.

3) Recover a Forgotten Password.

4) View Organ Information

5) Test VR Alternate Controls

6) Test VR Environment User Interface

7) Exit out of the VR Application

COLLECTED EMPIRICAL DATA

	I1	I2	I3
P1	9	7	5
P2	8	6	4
P3	8	7	2
P4	10	8	5
P5	9	7	3
P6	8.5	8	5

ANALYSIS OF THE COLLECTED DATA

As the project is between-subject design which includes 3 factors(each having level >2) which are also independent of each other, it satisfies the assumptions of **KRUSKAL WALLIS TEST.**

- The critical chi-square value, with c-1 degrees of freedom i.e for $3 - 1$ degrees of freedom and an alpha level of .05, the critical chi square value is 5.9915.
- Since the critical chi-square value obtained above is 5.9915:
  - If $\chi^2 > 5.99$ then we will reject H_0 and accept H_1 and vice versa.
- Statistics of the test :-

I_1	I_2	I_3
9	7	5
8	6	4
8	7	2
10	8	5
9	7	3
8.5	8	5

Sorting all the values present in the above table in ascending order and then put them in new table with rank specified for each value :

Original Score	Rank
2	1
3	2
4	3
5	4
5	5

5	6
6	7
7	8
7	9
7	10
8	11
8	12
8	13
8	14
8.5	15
9	16
9	17
10	18

	I1	I2	I3
RANK	16	8	4
RANK	11	7	3
RANK	12	9	1
RANK	18	13	5
RANK	16	10	2
RANK	15	14	6
T(sum)	88	61	21
n	6	6	6

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)$$

H= 12.6257 (n=18, all n_j=6, T_1=88, T_2=61, T_3=21)

<u>CONCLUSION</u>

We got the statistical value of H = 12.6257 which is quite larger than the threshold i.e. 5.9915 and therefore we can easily **reject the null hypothesis** and say that the alternate hypothesis is valid i.e. **H_1 is valid** which says the the "Aesthetic Score" **depends** on factors like Number of Objects (N), Type of Objects (T) and Layout of Objects (L)