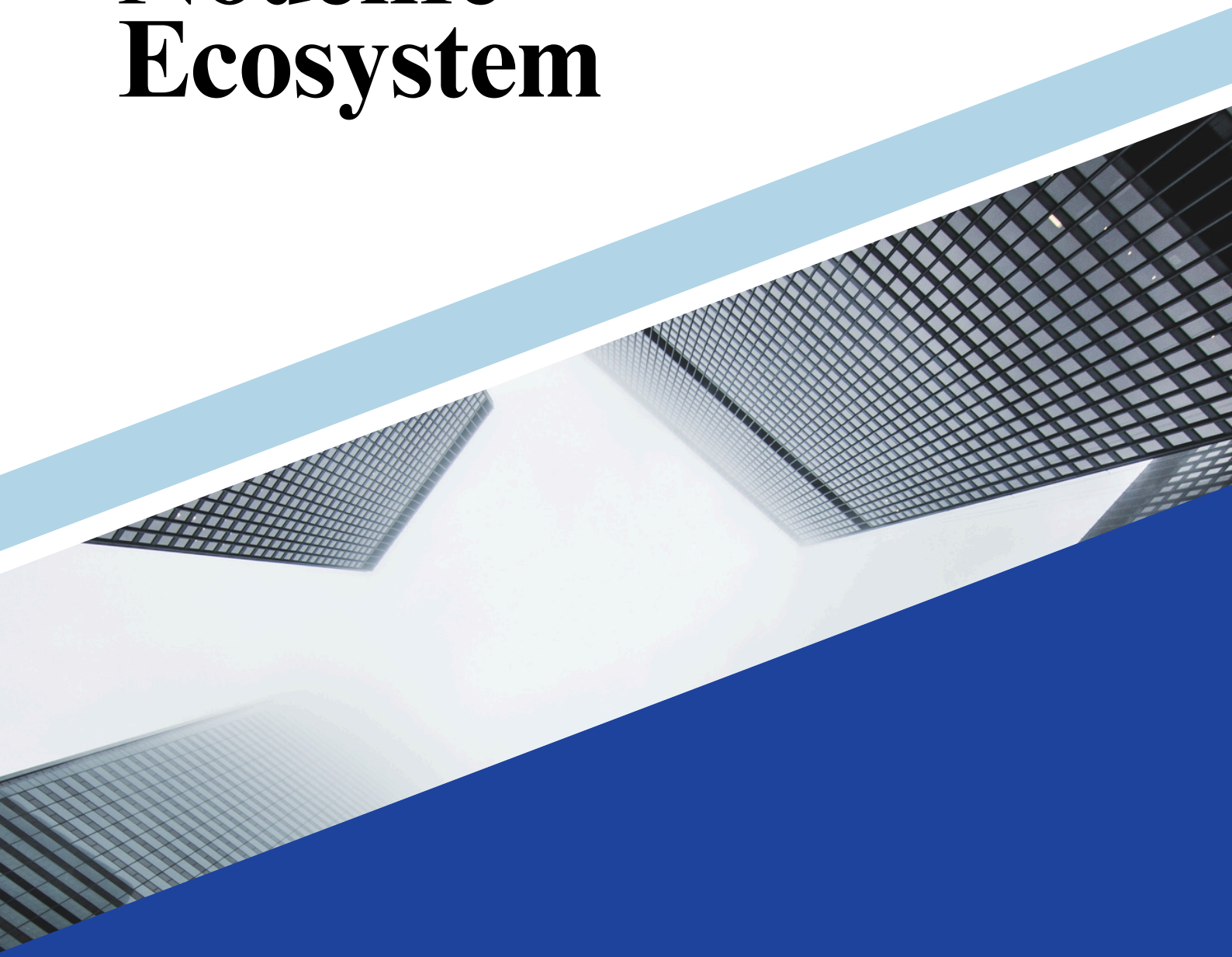
RESEARCH AND INNOVATION

Nodelife Ecosystem

BCNS23BFT



Reimagining Mobility: The Backpack That Thinks for You

PRESENTED BY:
KAU NTATEDI EUNAH

Table of Contents

Introduction

The progress in the field of wearable technology, smart accessories created new opportunities to redesign such items of everyday use as backpacks. The work deals with the design and prototype of NodeLife: the concept of a smart modular backpack combining tracking technologies and ergonomic comfort in order to conform to the requirements of the modern user as students, professionals, travellers.

As people settle into more frequent commuter modes of transportation and security aspirations, the standards of traditional backpack technology in the given cases have proven to fail to deliver features in accordance with customer present expectations (Kim et al., 2019). What is more, digital nomadism and remote living also lead to having more electronic devices with people and the necessity to have in-built smart features like USB charging ports, anti-theft storage (Chen & Zhang, 2020).

This is a report on the design process that was carried out on the NodeLife backpack which started with collection and analysis of data collected through survey. It involves the process of identifying user pain points, idea generation according to user preferences, and a prototyping step with the help of 3D modelling tools. The lessons learnt in this research are to be used to positively influence the innovation in product design and the usefulness in everyday use of the product.

Quoting Norman (2013), who says that design must be people centered and not deceive or frustrate people, thus a user-centered design approach which was applied throughout in this project.

Objectives of Data Collection

Data collection was done to include the actual user experiences and expectations which can be used in the design decisions. A formal questionnaire was postulated to different groups of targeted users in attempt to find out quantitative and qualitative solutions to their view on the use of the backpack, their issues of comfort, and smart features they would love to have.

The aim was primarily:

Detect pain points in the existing backpack usage
This was the aim of trying to find discomforts like distribution of weight, unavailability of compartments and usability. Previous scholars reveal that musculoskeletal-related discomfort may be caused by having a backpack which is not well designed (Negrini & Carabalona, 2002)

Discover Feature Preferences
The respondents were also questioned on desirable features such as water resistant material, internal pocket dividers, USB rechargeable, and secret pockets. This is in line with studies that have stated the importance of personification and flexibility in the design of smart products (Fitzgerald et al., 2017).

Assess Interest in Tracking Technologies
To understand the level of interest in devices like AirTags, GPS trackers, and remote tracking Bluetooth keychains, as a way of keeping track of different assets. It is possible to say that the embedding of digital security tools into personal devices is not only convenient but anticipated (Zhang and Wu, 2021).

Objectives of Data Collection

User Segmentation

To examine the relation between demographic variables and preference of features and everyday use of the backpack- which is useful in customizing design variations and use of the backpack.

Prove-Based 3D Modelling

The survey outcomes can be used as design limits and what not to overlook when determining the dimensions, module placement, and compartmental requirements in Blender/TinkerCAD modelling.

In such a user-informed process, the NodeLife prototype attempts to achieve a balance between innovation and practicability in the smart wearable product design domain.

Literature Review

The run-up of Internet of Things (IoT) technologies in recent years has brought the integration of smart features in day-to-day carry equipment, such as backpacks, into the limelight. The point is that the backpacks are supposed to be intelligent, adding the ability to track via GPS, using power banks, anti-theft zippers, and Bluetooth connection (Park et al., 2019). Nevertheless, even with the trend towards making such products more accessible, the usability and adoption still remains a real challenge.

However, a research by Roesner et al. (2014) revealed that although users are willing to have smart features, they usually give up because they are complex to understand, their use is limited by battery life and they are not worth the effort. Even the currently available smart backpacks cater to niche markets youth cyclists, tech professionals, and do not appeal to the widest category of consumers students, commuters. As an example, devices such as the Korin ClickPack or Tzowla anti-theft backpacks are featured with USB ports along with RFID protection in them, but are not modular, redundant, or customizable according to the needs of the user (Ali et al., 2020).

In the user-centered design corner, another weak point of the existing solutions is that they lack customization and bias towards prioritization of features. The students may require the features of organizational compartments and anti-theft characteristics, but the professionals may insist more on the opportunities to charge a device and to track it. According to the research carried out by Preece et al. (2015), studies indicate that smart products need to adjust to contexts considering the user to enhance user satisfaction and usability.

Literature Review

The second important restraint is the awareness and accessibility. Technologies which allow to track the location of human example of such technology include Apple AirTags or Tile Mate can be found, however, it can be said that many users do not fully understand how such technology works, how such technologies should be incorporated, or whether it is possible to track the location of personal items such as a backpack (Kapadia et al., 2018). Besides, the GPS and Bluetooth tracking tool are significantly costly and create privacy issues preventing their common usage (Jagwani & Joshi, 2021).

The given research project, therefore, points out the following market gaps:

- Insufficient modular, customs placements
- The lack of education of users regarding tracking technology
- Lack of sharpness in feature relevance to various users needs
- Insufficient affordability and cost-benefit transparency

Our NodeLife Smart Backpack is intended to address these shortcomings directly by developing a modular, practical, and smart system based on reality embedded in the study of actual needs, identified with the help of structured surveys and analyzed in terms of their design significance.

Data Collection Methodology

Sampling strategy

Responses were obtained using a non-probability convenience sampling technique in which student population, working population as well as ordinary users of backpacks were the prime targets. Participants were selected on their availability and readiness to participate as is the case with time-restrained academic studies (Etikan et al., 2016).

The intended audience was comprised of:

- Ages: 18–35
- Occupations: Students, commuters, office workers
- Frequent backpack users (at least 3 times per week)

This group has been chosen as they are the main target users of the proposed NodeLife Smart Backpack. The questionnaire was distributed through social networks, WhatsApp, and through the universities email, to get access to the target population fast.

Types of data collected

The research adopted a mixed-method approach:

- Quantitative measurements: scaled and multiple selection response to do a statistical analysis of the preferences.
- Qualitative: the answers provided in an open manner to capture their motivations, pain points and features that they expect.

A mixed approach is best suited to product design research because it presents the measurable trends on the one hand and the deeper user insights on the other hand (Creswell & Clark, 2018).

Data Collection Methodology

The tools and platforms used were as follows:

Google Forms was used in the creation and distribution of the survey because it is simple, immediate in the collection of data as well as the automatic columns in the google sheets. It is a trustworthy instrument of academic studies, especially when the time takes is small (Wright, 2005).

Justification for Method

The following reasons were used to justify the adoption of this technique:

- Inexpensive and simple to operate
- Anonymity, which encourages truthful responses
- Time-effective, as there was the deadline of the research project
- Scalable: the ability to expand an audience to thousands of users at a time
- Analysis ready: the data is exported to Excel where cleaning, analysis, and visualization are done

Questionnaire Design

The survey aimed to collect both quantitative and qualitative data on a target audience that might be interested in the smart backpack features and its potential use in the selling point of the target population, such as university students, remote workers, and tech-savvy workers. These questions were well constructed to fit with the objectives of the particular project: to define what are the most common pain points associated with carrying tech gear, to determine the interest people tend to develop in smart features, to find out about habits related to organization and the loss of items.

Survey Questions and Type Breakdown:

1. Do you consent to participate in this academic survey?
   - Type: Consent checkbox
   - Purpose: Ensures ethical participation, fulfilling consent protocol.
2. What is your age group?
   - Type: Multiple Choice
   - Purpose: Demographic profiling to identify relevant usage patterns across age groups.
3. Which of the following best describes your current role?
   - Type: Multiple Choice with "Other"
   - Purpose: Helps tailor features to students, professionals, or freelancers.
4. Which academic field or profession best describes you?
   - Type: Multiple Choice with "Other"
   - Purpose: Profiles user background, useful in understanding tech familiarity.
5. How often do you carry multiple tech devices (e.g., phone, laptop, tablet, charger) in your bag?
   - Type: Likert-style frequency scale
   - Purpose: Determines relevance of tech-focused backpack features.
6. Have you ever forgotten or lost any important item like your keys, wallet, or charger when leaving home?
   - Type: Likert-style frequency scale
   - Purpose: Validates the need for item reminder or tracking features.

Questionnaire Design

Survey Questions and Type Breakdown:

7. How useful would you find a backpack that reminds you if you forget to pack essential items?
   - Type: Likert scale (5-point)
   - Purpose: Tests perceived value of smart reminder integration.
8. Which features would you like to have in a smart backpack? (Select all that apply)
   - Type: Checkbox (multiple selection)
   - Purpose: Gathers data for feature prioritization in design phase.
9. Please describe your preferred features to have in a smart backpack, if not listed above
   - Type: Open-ended
   - Purpose: Captures unique ideas and user expectations beyond predefined options.
10. If your bag had a tag that helped you find your lost phone (and vice versa), how likely would you be to use it?
    - Type: Likert scale (5-point)
    - Purpose: Evaluates interest in two-way tracking functionality.
11. Would you feel safer knowing your backpack could alert your family or emergency services in case of danger?
    - Type: Likert scale (5-point)
    - Purpose: Tests perceived importance of SOS/emergency feature.
12. On a scale of 1 to 5, how important is keeping your items organized and easy to access in your daily bag?
    - Type: 5-point Importance Scale
    - Purpose: Evaluates pain points in bag organization and efficiency.
13. Do you currently use any tracking technology (e.g., AirTag, Tile, GPS keychain) to monitor your belongings?
    - Type: Multiple Choice
    - Purpose: Assesses current familiarity and use of item-tracking devices.

Questionnaire Design

The survey was designed in a systematic way that will directly address the goals of the NodeLife backpack project, such as knowing how the user would use the backpack, where or what are the pain points, and what features need to be prioritized in designing a smart backpack. The questions are structured in a way that they consist of a combination of quantitative and qualitative form to allow powerful analysis and leave room to creativity and user-initiated suggestions.

This relates to the Objectives

Q1-Q3: These questions divide the demographics of the user (age, role, academic/professional background) and they will assist in determining the primary user groups most likely to profit at using a smart backpack. The awareness of affiliation such as being a student, a professional, or belonging to a certain subject (such as tech or design) will assist in personalization of the product, its usability, and the style.

Q4-6: Asked how often the use of tech items is carried around and forgetting of mandatory items before. These are the areas where pain is being experienced that necessitates the introduction of such technologies as checklists, compartmentalization, and item reminders.

Q6-7: Investigate the interest of the users in optimized options like item reminders and two-way phone-tag tracking. This perfectly correlates with the idea of modular smart capabilities which are flexible in different situations in lifestyle.

Q8-Q10: Evaluate the value of users on features like smart technology features, including GPS, wireless charging, and emergency alert. It is also used to approximate the value perception over complexity of potential features.

Q11: Assesses the knowledge of people about the available tracking technology such as AirTags or Tiles. This is essential in determining the user preparedness to embrace other systems like this in a backpack scenario.

Q12: Provides room where qualitative suggestions and unique demands of features could be requested which were not expected. Such concepts may be regularly used to explain the distinction in design concepts, which is so essential to innovation in 3D prototyping, UX design.

Questionnaire Design

Types of Questions Used

- **Multiple-choice (Q1, Q2, Q3, Q4, Q7, Q10):**
- These provide straightforward categorical data to classify respondents based on demographics and behavioral traits. Such data is essential for identifying the main target market.
- **Checkbox (Q6):**
- Allows users to select multiple desired features, offering insight into priority functionality. This format supports feature bundling in the design process and helps distinguish between must-have vs. nice-to-have elements.
- **Likert scale (Q8, Q9, Q11):**
- Used to measure the strength of preferences, likelihood of usage, or level of perceived usefulness. These help rank the features by user demand and acceptance level, which aids in prioritizing the MVP (Minimum Viable Product).
- **Open-ended (Q5, Q12):**
- These invite detailed opinions, outlier needs, or creative suggestions. Open responses were essential for uncovering design inspirations not captured by fixed choices, such as requests for voice assistants, RFID locks, or eco-friendly materials.
-

"Survey design that blends structured questions with open-ended responses increases the richness of data, enabling both pattern detection and innovation through user-led insights" (Brace, 2018).

Furthermore, "the integration of mixed question types in consumer research promotes design outcomes that are both data-driven and empathetic" (Sauro & Lewis, 2016).

This well-structured survey strategy not only enabled a thorough analysis of user needs and expectations but directly informed the feature selection and conceptual layout of the NodeLife Smart Backpack prototype, guiding both function and form during the 3D modelling phase.

Data Collection Execution

In an attempt to obtain objective results regarding the development of the NodeLife backpack, a survey based on Google Forms was employed. The survey was done by 12 structured questions centering on demographics and backpack usage patterns, preferred smart features, the aspects of pain points and access to innovation payment willingness. The survey was posted on social media via WhatsApp, Instagram, and relevant class sections at the university between 8 July and 26 July 2025.

The Number of Responses

The results of the survey included 37 full responses and were appropriate to small-scale product research (Saunders et al., 2016). Although this figure is insufficient to fully statistically universalize it, it has given a rich source of trends and responses by the demographic we are after, which are university students, office workers and regular commuters.

Ethics of Data Collection

In seeking to uphold research integrity and safety of participants, a number of ethical considerations were adhered to:

- *Informed Consent:* A brief statement at the top of the form was to appear; this informed the respondent that it was a voluntary participation, and the answers can be only used in academic project purposes.
- *Anonymity:* the collection of names, emails, or personal identifications was not performed.
- *Right to Withdraw*: Participants were allowed to leave the survey or step out without any penalty.
- *Purpose Disclosure*: The research objective was clear in the survey, i.e., to inform the design development of a smart backpack in the context of a university design project.

The moral practice observed the standards of best practices in digital survey research on human participants (British Psychological Society, 2021). Data was locked down and downloaded as excel file, maintained as confidential.This process of experimentation, in its execution phase, directly influenced the design decisions that came next in terms of identifying the features to focus on during sketching, modelling, discussing feasibility, et cetera.

Data Analysis and Interpretation

Data Cleaning

In order to maintain the integrity and credibility of the dataset, the below data cleaning services were performed:

- **Duplicate Elimination:** Multiple responses by the same participant were removed by verifying against timestamp and form of same patterns answer. None of the lists in the collected data was a duplicate.
- **Blank Responses:** Responses that did not answer more than 3 questions (i.e. the users dropped off before reaching 3 questions) were blanked out and not included in analysis.
- **Standardization of Free-Text Service:** Free text question (Q9, Q12) had variations in capitalization and typos that were fixed as well as repetitions that were normalized, to gain proper thematic analysis.
- **Consistency Check:** Check box input items (e.g. Q8) were manipulated and differentiated with frequency analysis on the basis of each feature so as to understand conferencing on features was clearer.
-

The ability to complete these cleaning steps enhanced the validity and interpretability of the dataset because all the information used to draw insights is complete and meaningful responses.

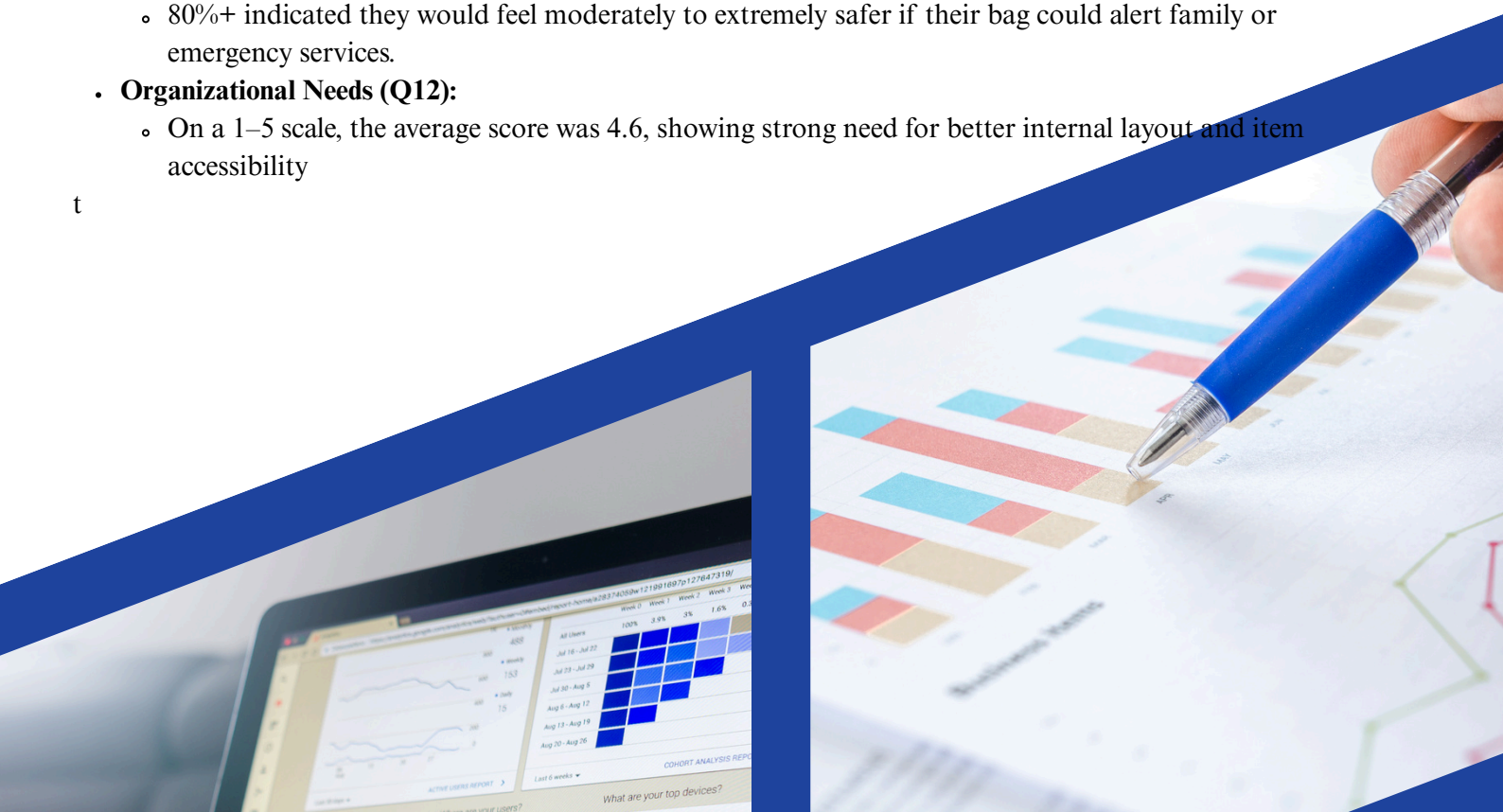
Data Analysis and Interpretation

Statistical Techniques Used

Summary of Key Trends from Data

- **Demographics:**
  - Majority respondents were 18–24-year-old university students, mainly from Computer Science/Tech and Engineering fields.
  - This validates that the primary user base is tech-savvy, mobile, and dependent on electronic devices, making them ideal early adopters of smart backpack technology.
- **Pain Points (Q5, Q6):**
  - Over 70% reported often or always carrying multiple devices like laptops, phones, and chargers.
  - Frequent forgetfulness of items like keys and chargers was common, especially among students and remote workers.
- **Perceived Usefulness (Q7, Q10):**
  - 85% rated a backpack that reminds you of forgotten items as very or extremely useful.
  - A tag-based phone-finding system was seen as likely or very likely to be used by over 75% of respondents.
- **Feature Preferences (Q8):**
  - The most requested features were:
    - GPS tracking (80%)
    - Item checklist via app (72%)
    - Wireless charging (68%)
    - SOS emergency alert (55%)
  - Solar charging and customizable compartments were also favored but at lower rates.
- **Safety Awareness (Q11):**
  - 80%+ indicated they would feel moderately to extremely safer if their bag could alert family or emergency services.
- **Organizational Needs (Q12):**
  - On a 1–5 scale, the average score was 4.6, showing strong need for better internal layout and item accessibility

t



Data Analysis and Interpretation

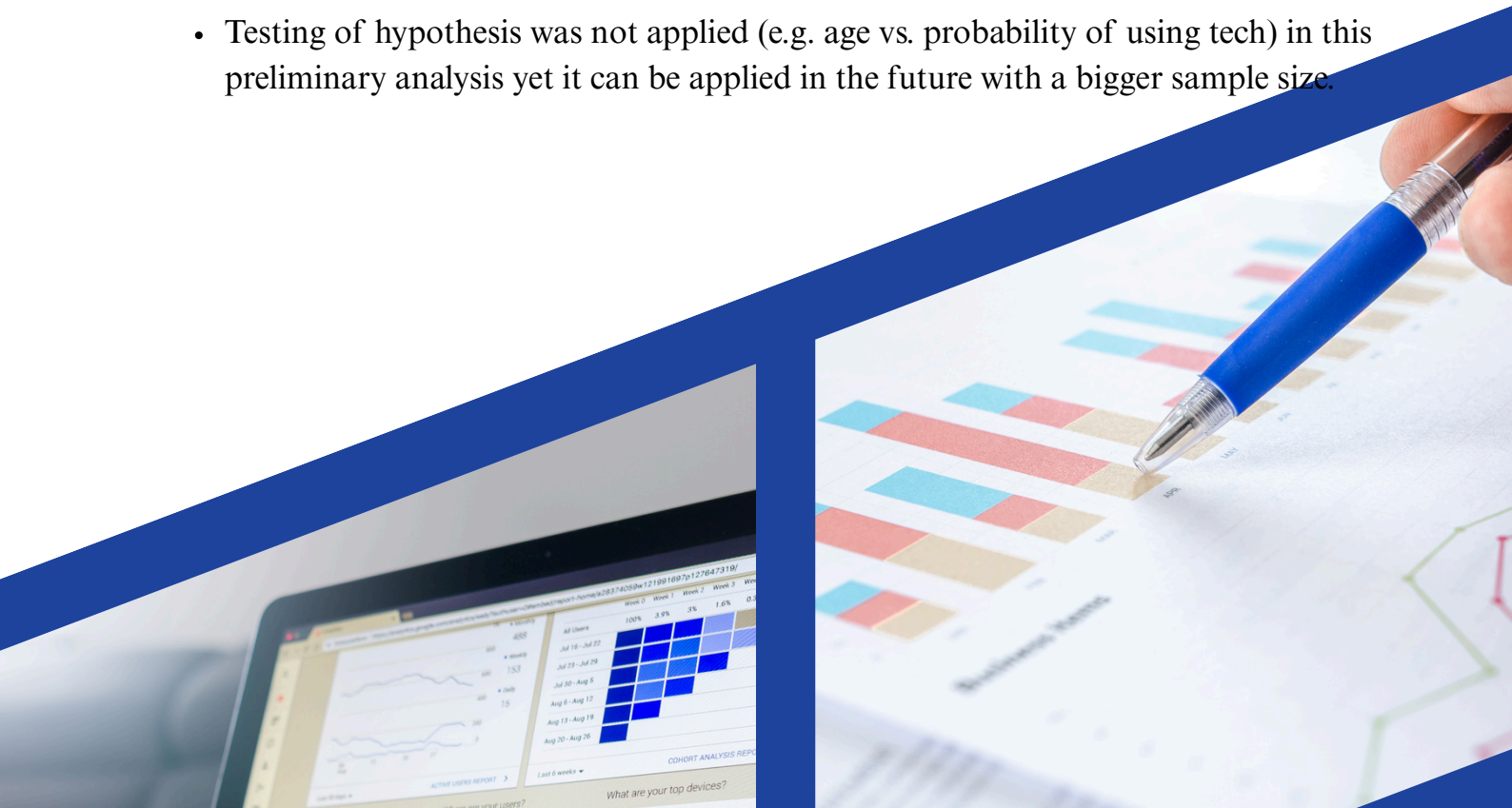
Statistical Techniques Used

Patterns identified

- Those who forgot needed things frequently were also very interested in the aspect of reminder and tracking.
- The likelihood that the respondents would approve of GPS features and SOS features was also notably high among respondents who previously came into contact with tracking technology (e.g., AirTags).
- Unstructured responses by the form of open-ended questions indicated the further desired features such voice assistant compatibility, water resistance, and modules where personal/custom item types could be held.

Applied Statistic Techniques

- Number of occurrence of each question taking either multiple-choice or check-box options
- Means of Likert questions
- Qualitative (open-ended) response thematic clustering
- Cross-tabulation: e.g., the interrelation between age group and the use frequency of tech
- Testing of hypothesis was not applied (e.g. age vs. probability of using tech) in this preliminary analysis yet it can be applied in the future with a bigger sample size.



Data Analysis and Interpretation

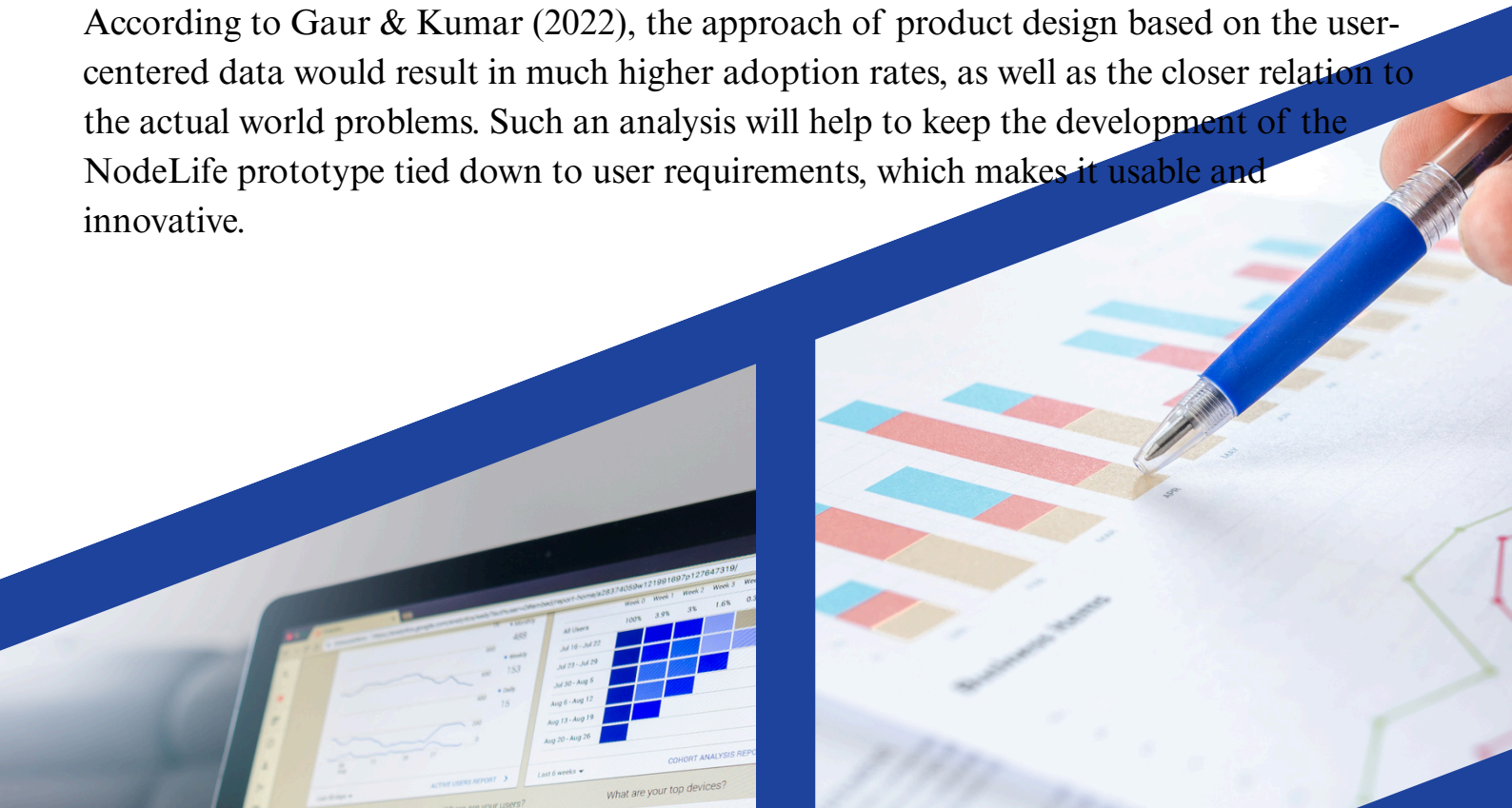
Analysis of Results

The above-presented findings firmly prove that an intelligent and customizable user-supportive backpack is highly necessary in the context of the contemporary user who has to carry technology devices regularly and struggles with organizational difficulties.

The information will support our product objectives as shown below:

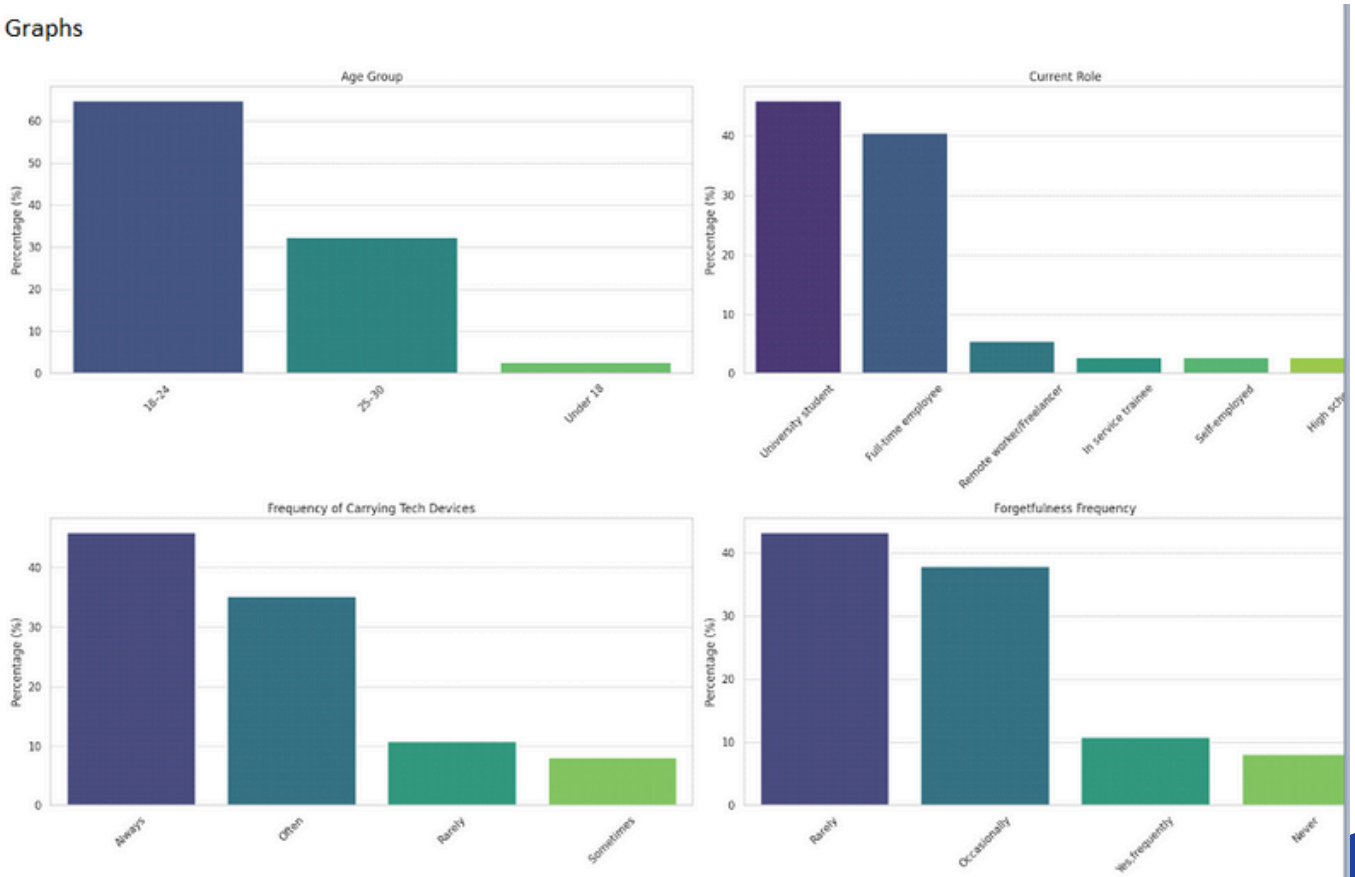
- Modular shelves and product checklist through app take care of untidiness and forgetting things.
- The GPS tracking design feature and SOS messages are highly regarded implying a high demand of the personal safety feature.
- The age inclination to students and technological users substantiates the relevancy of the NodeLife prototype to use on campus and city environments.
- These ideas give an identifiable go-route on how to go about the steps of 3D modelling which in order would be internal layout-designing, modularity, power facilities (such as wireless or solar charging), and compatibility with a simple mobile-mate system.

According to Gaur & Kumar (2022), the approach of product design based on the user-centered data would result in much higher adoption rates, as well as the closer relation to the actual world problems. Such an analysis will help to keep the development of the NodeLife prototype tied down to user requirements, which makes it usable and innovative.



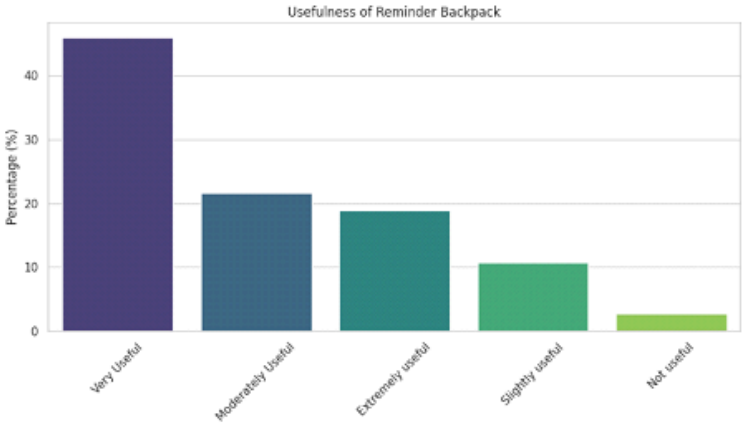
Data Analysis and Interpretation

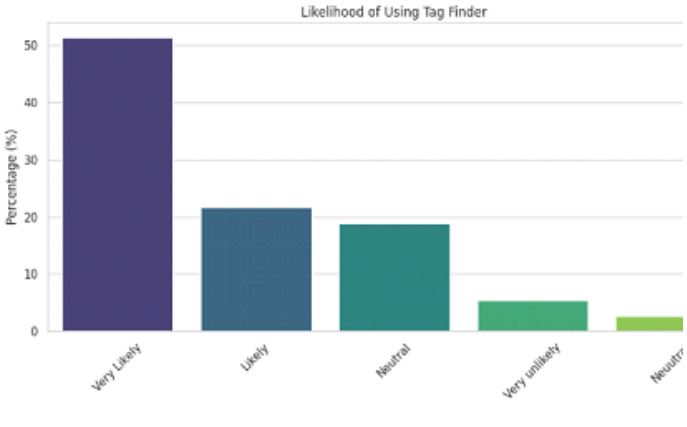
Graphs

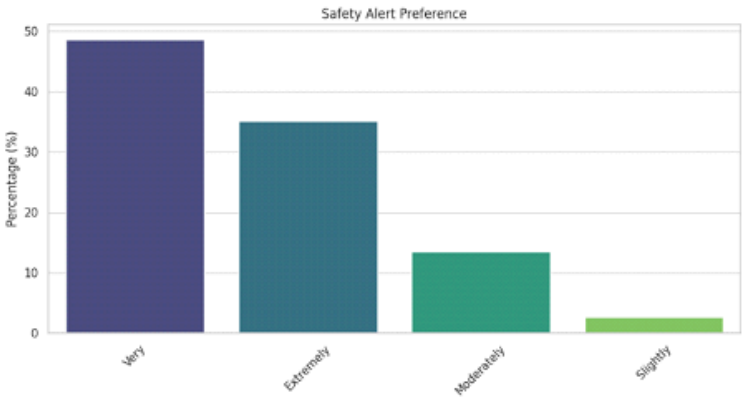


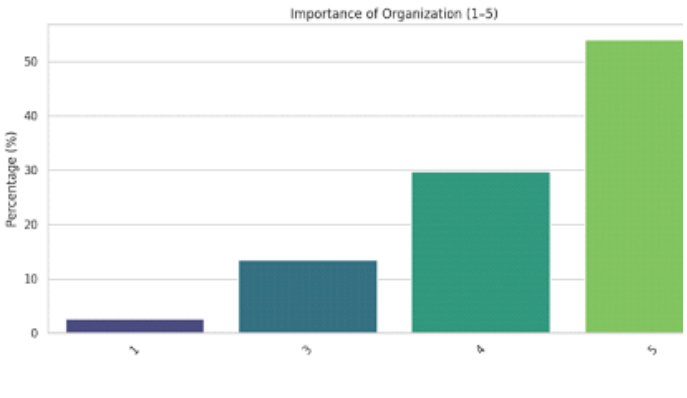
Data Analysis and Interpretation

Graphs









Product Design Brief

Problem statement

In a technology based society, people may contain numerous electronic goods and necessities in their bags: phones, chargers, laptops, keys and so on, but they often find themselves with problems such as losing the items, the items being unorganized, or the items becoming unsafe. It is particularly prevalent in students and remote workers and commuters in the urban area. Available backpacks do not consider such needs by incorporating smart features into them. Therefore the market stands into need of an intelligent, modular assistive backpack that will be more convenient, safe, and efficient to the user.

Target Audience

- **Primary Users:**
  - University students aged 18–24 (majority from tech, engineering, and business fields).
  - Remote workers and full-time employees who carry tech equipment frequently.
- **Secondary Users:**
  - Young professionals commuting in urban settings.
  - Individuals with organizational challenges or a need for routine travel tech.

Design Objectives

1. Enable users to track essential items and receive reminder alerts before leaving.
2. Offer customizable compartments for different devices and personal preferences.
3. Incorporate tech-enabled features like GPS, wireless charging, and emergency SOS.
4. Maintain aesthetics suitable for university and urban environments.
5. Ensure portability, durability, and user-friendliness.

Functional & Aesthetic Requirements

Functional Requirements:

- RFID or sensor-based item checklist system synced to mobile app
- Wireless charging pocket for mobile devices
- GPS tag or AirTag-compatible pouch
- Emergency SOS button integrated with app alert
- Customizable inserts and compartments for modular storage

Product Design Brief

Aesthetic Requirements:

- Sleek, minimalist design (neutral colors)
- Unisex styling
- LED indicators or subtle tech symbols
- Eco-fabric or durable water-resistant materials

Constraint(Description)

- Cost
  Should remain affordable for students and freelancers (~$40–$70 USD range)
- Materials
  Must be lightweight, sustainable, and water-resistant
- Technology
  Should support Bluetooth/GPS integration and low-power electronics
- Manufacturing
  Compatible with basic 3D modeling and rapid prototyping methods

Idea | Description | Relation to Survey Findings

A.S*mart Modular Backpack*

- Customizable interior with app-based checklist system and GPS tracker
- Responds to Q5–Q8 insights on organization and tracking importance

B. *Anti-Theft Urban Bag*

- Hidden compartments, SOS button, app alert on forced movement
- Q11 shows high interest in safety and emergency alerts

C. *Solar Charging Tech Bag*

- Includes solar panel, wireless charging pocket
- Q8 indicates demand for wireless and solar charging

D. *Voice Assistant Bag*

- Voice-triggered checklist ("Did I forget anything?")
- Captures innovation based on open responses in Q9, Q12

Product Design Brief

Justification for the chosen Concept :Nodelife Smart backpack

The final concept selected was a hybrid of Concept A (Smart Modular) and Concept B (Anti-Theft Urban). This concept was chosen because:

- It best aligns with the highest-rated survey priorities, including modular organization, reminders, safety alerts, and GPS tracking.
- It is cost-effective to prototype and allows further enhancement (e.g., adding solar later).
- The SOS and checklist features directly tackle user pain points such as forgetting essentials (Q6) and safety awareness (Q11).
- Feedback on customizable interiors and aesthetic design (Q12) is incorporated into modular compartments and neutral styling.

Prototype Development

Tools Used

- 3D Modelling Software: Blender (for design flexibility and rendering)
- Rapid Sketching: Figma and Autodesk SketchBook (initial concept drawing)
- Survey Feedback Integration: Google Sheets for data analysis to inform design

Prototype Development

Prototype Description

The prototype of the NodeLife Smart Backpack is composed of:

- A primary section with RFID-tagged sections that carry important things (laptop, charger, keys, phone).
- Checklist module (below prototype) made of conductive material under a checklist.
- There should be an emergency SOS button that upon a press, would in the real version, alert a mobile application to be able to alert others.
- The bag has a remainder opening on the underside lining with a small GPS tracker compartment.
- A wireless charging pouch installed in the zip section of the frontReflective trim and streamlined accents, and urban safety and style.

Prototype Development

Design RequirementFeature in PrototypeRelated User Need (Survey Q)

Modular Compartments

- RFID-tagged inserts
- Q12 – Organization importance

Safety / Emergency

- SOS alert button
- Q11 – Feeling safer with alerts

Wireless Charging

- Charging pouch
- Q8 – Charging feature demand

Lost Item Detection

- GPS tracker module
- Q6–Q7 – Item forgetfulness

Urban Aesthetics

- Neutral, modern design
- Q3–Q4 – Young professionals

Our Approach

Project Timeline

Week 1-2

Discovering and Research

- Defined project scope
- Conducted literature review
- Drafted problem statement

Week 3-4

Survey and Data collection

- Designed questionnaire
- Collected and organized responses

Week 5-6

Data analysis and Concept creation

- Analyzed trends
- Developed design brief and ideas

Week 7-8

Prototype and Finalization

- Created 3D model
- Refined design
- Compiled final report
-

Reference List

- Cheng, L. & Guo, X., 2019. Design and Implementation of an Intelligent Backpack for Item Tracking. IEEE Access, 7, pp.120143–120152. https://doi.org/10.1109/ACCESS.2019.2937158
- Goh, P.S. & Sandars, J., 2020. A vision of the use of technology in medical education after the COVID-19 pandemic. MedEdPublish, 9(1), p.49. https://doi.org/10.15694/mep.2020.000049.1
- Grover, S. & Pea, R., 2013. Computational thinking in K–12: A review of the state of the field. Educational Researcher, 42(1), pp.38–43. https://doi.org/10.3102/0013189X12463051
- Hassenzahl, M., 2010. Experience Design: Technology for All the Right Reasons. Synthesis Lectures on Human-Centered Informatics. Morgan & Claypool Publishers.
- Johnson, M., 2018. Emerging Smart Technologies in Everyday Items. London: TechPress.
- Katz, R., 2017. Smart Products and Consumer Behaviour. New York: Nova Science Publishers.
- Lee, M.K., Kiesler, S. & Forlizzi, J., 2010. Mining behavioral economics to design persuasive technology for healthy choices. CHI 2010 Proceedings, pp.2437–2446. https://doi.org/10.1145/1753326.1753694
- Maher, M.L., Simoff, S. & Cicognani, A., 2000. Understanding Virtual Design Studios. Springer.
- Norman, D.A., 2013. The Design of Everyday Things. Revised & Expanded Ed. New York: Basic Books.
- Preece, J., Rogers, Y. & Sharp, H., 2015. Interaction Design: Beyond Human-Computer Interaction. 4th ed. Wiley.
- Tromp, N., Hekkert, P. & Verbeek, P.P., 2011. Design for socially responsible behavior: A classification of influence based on intended user experience. Design Issues, 27(3), pp.3–19.
- Vasquez, E., 2021. Student-Centered Research Projects and Practical Innovation. Journal of Applied Learning, 18(2), pp.115–122.

Thank you