Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 6
Open Access

Design of Advanced Technologies for Performance Tracking and Analysis in Fitness and Nutrition

Kevin Rene Baque Obando[1],Bryan Santiago Villacis Navarrete[2],Jaime Mesias Cajas[3],Johnny Xavier Bajaña Zajia[4]

[1]Universidad Técnica de Cotopaxi Extensión La Maná
[2]Universidad Técnica de Cotopaxi Extensión La Maná
[3]Universidad Técnica de Cotopaxi Extensión La Maná
[4]Universidad Técnica de Cotopaxi Extensión La Maná

Cite this paper as: Kevin Rene Baque Obando,Bryan Santiago Villacis Navarrete,Jaime Mesias Cajas,Johnny Xavier Bajaña Zajia (2024) Design of Advanced Technologies for Performance Tracking and Analysis in Fitness and Nutrition. Frontiers in Health *Informatics*, *13(6) 295-303*

Abstract

The article's focus was on evaluating the design of a mobile platform using the Mobile-D methodology, which uses machine learning to enhance users' physical performance and well-being by analyzing data from their devices and providing personalized recommendations. The main objective of the application is to improve health and well-being by offering personalized exercise plans and nutritional recommendations, reducing diseases related to lifestyle choices. Regarding the methodological aspects, a preliminary evaluation was conducted of a weight prediction algorithm, a collaborative filtering algorithm, and an assessment of the training level for new users. In terms of the findings, these have been significant regarding the algorithm designed to predict weight and recommend appropriate exercise and nutrition plans according to the user's experience, successfully evaluating the algorithm's ability to adjust the distribution based on the user's experience levels. Additionally, the ability to assess the satisfaction of gym clients and workers (n =225) who use a mobile application for tracking physical and nutritional performance. The results showed that 88% of users were satisfied or very satisfied with the application, indicating its relevance, ease of use, and effectiveness in meeting users' needs. The majority of users considered that the application was in line with their fitness goals, and a small percentage expressed dissatisfaction or negative aspects. The study concludes that the application is a valuable tool for improving health outcomes**.**

Keywords: mobile platform, Mobile-D, machine learning, physical performance, lifestyle.

1. Introduction

The development of a mobile application designed to monitor and analyze performance in fitness and nutrition utilizes advanced technology to provide a safe, interactive, and personalized experience (Reshma Raj K et al., 2020). This development involves the use of Gemini AI to provide real-time suggestions based on physical activity, fitness goals, and nutritional preferences (Rane, Nitin & Choudhary, Saurabh & Rane, Jayesh, 2024). The application also tracks daily food intake and uses Firebase to efficiently store and manage information, ensuring a scalable and secure solution that delivers a seamless and consistent user experience (Angosto, S., García-Fernández, J. & Grimaldi-Puyana, M., 2023).

Fitness enthusiasts increasingly rely on mobile technology to follow exercise and nutrition routines, driving the development of advanced applications that track physical activity and provide personalized nutritional advice (Jiang Hu, Wei He, Jie Zhang, Jaeki Song, 2023). Studies have shown that these applications improve health self-management and physical activity, promoting a healthy lifestyle (Bruno F. Tavares et al., 2020; Yunwen Wang, William B. Collins, 2021). They have also fostered a global community of fitness enthusiasts, creating social networks where users can share

achievements, challenges, and tips (Fernando García-Pascual, Manel Valcarce-Torrente, Ferran Calabuig & Jerónimo García-Fernández, 2023). Increased engagement in these online communities boosts motivation and adherence to exercise and nutrition programs, providing support and accountability. These contributions and findings underscore the growing importance of mobile technology in fitness and nutrition.

The development of a mobile application for physical and nutritional tracking responds to the global concern for health and wellness. The rise of lifestyle-related diseases and obesity has created a demand for accessible tools to promote healthy habits (Fruh et al., 2021). This project aligns with contemporary trends, where mobile technology plays a crucial role in health management (Porri et al., 2024). The application aims to provide a comprehensive tool for users to monitor their physical activities and eating habits in a personalized way. It is designed to offer a centralized, user-friendly platform that allows users to set personalized goals, receive reminders, and access analytical data. This will contribute not only to individual well-being but also to broader communities by promoting healthy habits and preventing lifestyle-related diseases.

Additionally, the application offers features such as detailed tracking of physical activity, calorie intake, personalized meal plans, and progress monitoring. The intuitive interface and personalized notifications enhance user engagement. By providing specific and customized tools, the application becomes an indispensable companion in the journey toward a healthier and more balanced lifestyle.

This application leverages user profiles to create personalized exercise and nutrition recommendations. These data are collected through biometric measurements such as body mass index (BMI), body fat percentage, and anthropometric measures. Predictive algorithms process these data to suggest suitable exercises and nutritional values, incorporating nutritional analysis systems to assess individual needs for recommendations. Exercise recommendation systems will use machine learning algorithms and predictive analysis, utilizing libraries like TensorFlow and Scikit-learn. These will be implemented with real-time data processing systems for nutritional values and food suggestions, combining user profile information with nutritional data. This system ensures an appropriate response with a balanced and personalized diet for each user.

2. Methodology

Agile methodologies for mobile devices are an iterative, incremental, and collaborative approach to mobile application development, emphasizing flexibility, adaptability, and rapid delivery of high-quality software products. Agile divides the development process into smaller, manageable iterations or sprints, creating a dynamic environment that encourages feedback, testing, and quick adjustments (Hazem Abdelkarim Alrabaiah and Nuria Medina-Medina, 2021). These methodologies can be adapted to mobile service timeframes, such as the Mobile-D methodology. Agile methodologies emphasize four values (Castilla, Pacheco & Franco, 2023):

- Building a strong team and ensuring their environment meets their needs.
- Prioritizing functional software development over comprehensive documentation.
- Focusing on client feedback rather than contract negotiation.
- Being flexible and open to change, as the ability to respond to change determines project success or failure.

The Mobile-D methodology is an agile, user-focused approach suitable for the development of fitness and nutrition mobile applications (Chandarana et al., 2024). This methodology involves two phases: exploration and initiation. The exploration phase aims to define project requirements and understand client needs, ensuring a shared vision. The initiation phase involves setting up the development environment, preparing resources, and establishing coding standards. The team is formed, and specific roles are assigned, ensuring alignment and project readiness. This methodology ensures the rapid and high-quality delivery of a product that meets client and end-user needs (Castillo et al., 2023).

The Mobile-D methodology is a fast and flexible approach for developing a fitness and nutrition mobile application for the “JC” Gym. It involves an iterative production process, where the application is developed in manageable sprints,

each focusing on developing and testing priority features. In this scenario, the software is tested and stabilized to ensure quality before the final release. This involves thorough testing, optimization, and a final product review with stakeholders (n=225 clients and employees). The final version is characterized as stable, high-quality, and free of critical errors, providing a smooth user experience. The application is then ready for market launch, including initial monitoring and user feedback to plan future improvements. The agile, user-focused approach of the methodology ensures high-quality delivery that meets client and user needs, providing a solid foundation for the product's growth and continuous improvement.

3. Results

3.1. Weight Progress Testing.

The image shows data prediction results for a user's weight over a period of time. The graph displays weight changes over four months, with data points at the beginning and mid-month.

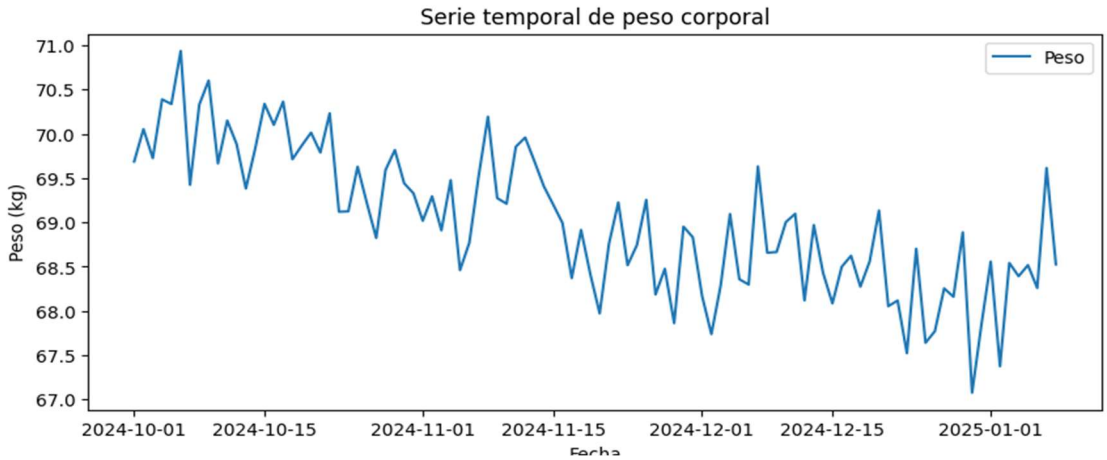


Figure 1. Time Series for Body Weight

3.2. Evaluation of the Algorithm's Suitability in Predicting Body Weight

This graph presents the same data as the previous one but emphasizes the algorithm's predictive outcomes. It demonstrates the algorithm's capacity for future predictive analysis of body weight trends.

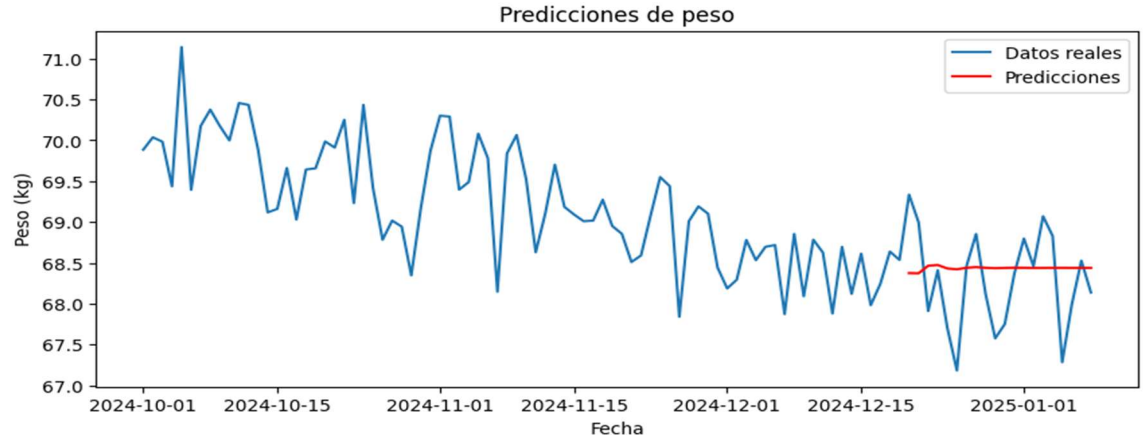


Figura 2. Adjustment of Predictions for Body Weight

3.2. Design and Testing of the k-NN Collaborative Filtering Algorithm

3.3.

In this case, a distinctive algorithm is developed focusing on filtering suggestions for both exercises and nutrition. It

leverages a data matrix (arrays), where each row represents a user, and each column characterizes a user following a specific plan (from 1 to 5). In this scenario, the columns are composed of Exercise A, Exercise B, Nutrition A, and Nutrition B (Figure 3).

```python
# Importar librerías necesarias
import numpy as np
from sklearn.neighbors import NearestNeighbors

# Datos simulados de preferencias de usuarios para planes de ejercicio y nutrición
# Filas = Usuarios, Columnas = Planes (Ejercicio A, Ejercicio B, Nutrición A, Nutrición B)
user_preferences = np.array([
    [5, 3, 0, 1],
    [4, 0, 3, 1],
    [1, 1, 0, 5],
    [1, 0, 4, 4],
    [0, 1, 5, 4],
    [3, 3, 3, 3]
])

# Nuevo usuario (usuario objetivo) para el que queremos recomendaciones
new_user = np.array([[4, 0, 1, 2]])
```

Figure 3. Import of Libraries and Evaluation of a New Object (User)

Next, the necessary functions and indices are defined to enable the algorithm to execute the respective associations and determine the most accurate recommendations based on the user's inherent conditions (Figure 4).

```python
# Crear el modelo de k-NN
k = 2  # Número de vecinos más cercanos
knn_model = NearestNeighbors(n_neighbors=k, metric='cosine')
knn_model.fit(user_preferences)

# Encontrar los k vecinos más cercanos
distances, indices = knn_model.kneighbors(new_user)

# Mostrar los vecinos más cercanos
print(f"Índices de los usuarios más similares: {indices.flatten()}")
print(f"Distancias a los vecinos más cercanos: {distances.flatten()}")

# Calcular las recomendaciones basadas en los vecinos cercanos
# Promediar las preferencias de los vecinos en cada plan para recomendar al nuevo usuario
similar_users = user_preferences[indices.flatten()]
recommended_preferences = similar_users.mean(axis=0)
print(f"Preferencias recomendadas para el nuevo usuario: {recommended_preferences}")
```

```
Índices de los usuarios más similares: [1 0]
Distancias a los vecinos más cercanos: [0.10128297 0.18851778]
Preferencias recomendadas para el nuevo usuario: [4.5 1.5 1.5 1. ]
```

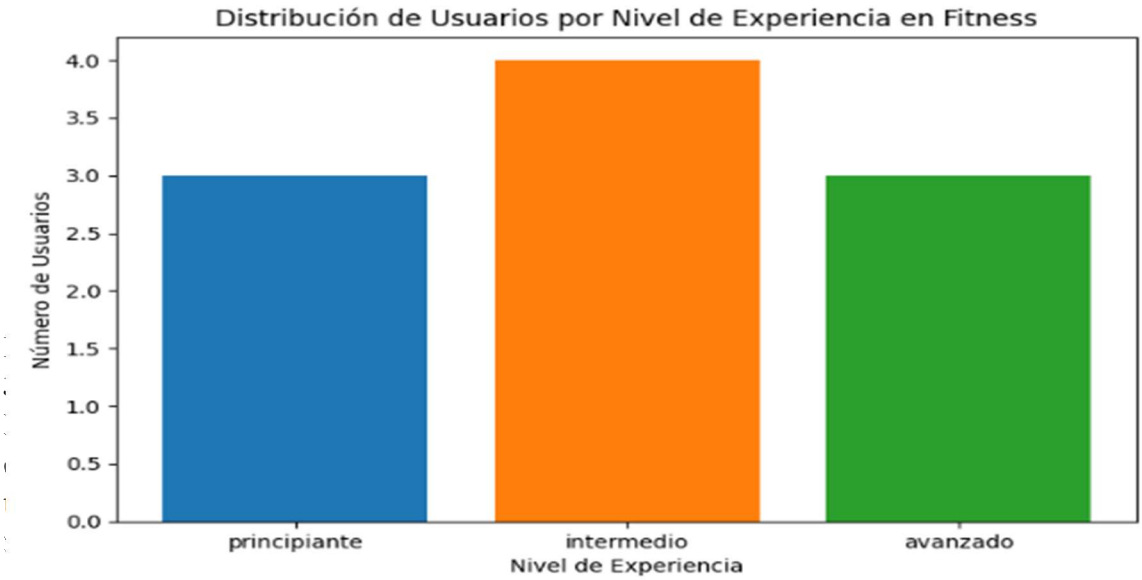
Figure 4. Construction of the K-NN Model and Performance Evaluation

3.4. Evaluation of Training Levels for New Users Using the K-NN Collaborative Filtering Algorithm

In this second test, the algorithm determined which type of exercise to recommend to new users based on their experience level (Beginner, Intermediate, and Advanced). Using these parameters, responses were programmed to align with exercise recommendations for new users (Figure 5). This aims to visually display, through graphs, the calculation and measurement of the existing experience levels among users (Figure 6).

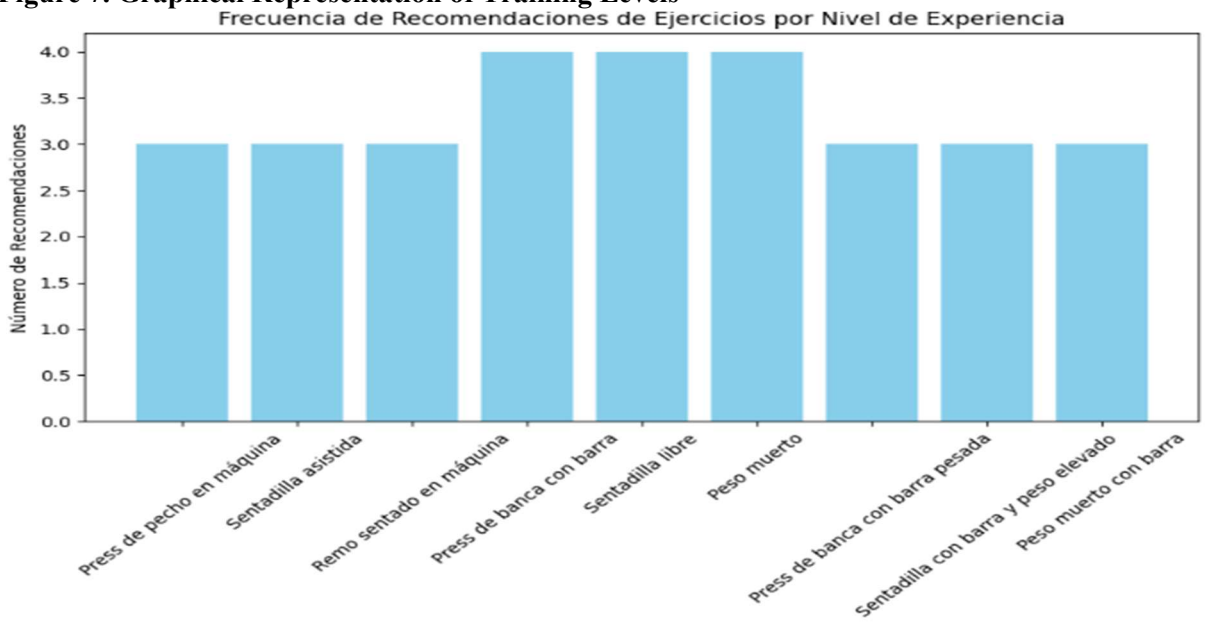
```python
users = [
    {"nombre": "Usuario 1", "nivel": "principiante"},
    {"nombre": "Usuario 2", "nivel": "intermedio"},
    {"nombre": "Usuario 3", "nivel": "avanzado"},
    {"nombre": "Usuario 4", "nivel": "principiante"},
    {"nombre": "Usuario 5", "nivel": "intermedio"},
    {"nombre": "Usuario 6", "nivel": "avanzado"},
    {"nombre": "Usuario 7", "nivel": "principiante"},
    {"nombre": "Usuario 8", "nivel": "intermedio"},
    {"nombre": "Usuario 9", "nivel": "intermedio"},
    {"nombre": "Usuario 10", "nivel": "avanzado"},
]

# Contar el número de usuarios en cada nivel
user_levels = [user["nivel"] for user in users]
level_counts = Counter(user_levels)

# Preparar datos para el gráfico
levels = list(level_counts.keys())
```

Figure 5. Code for Defining Training Level Categories.



se Suggestions
pecific food and
xperience level;
nutrition plan to

Figure 7. Graphical Representation of Training Levels



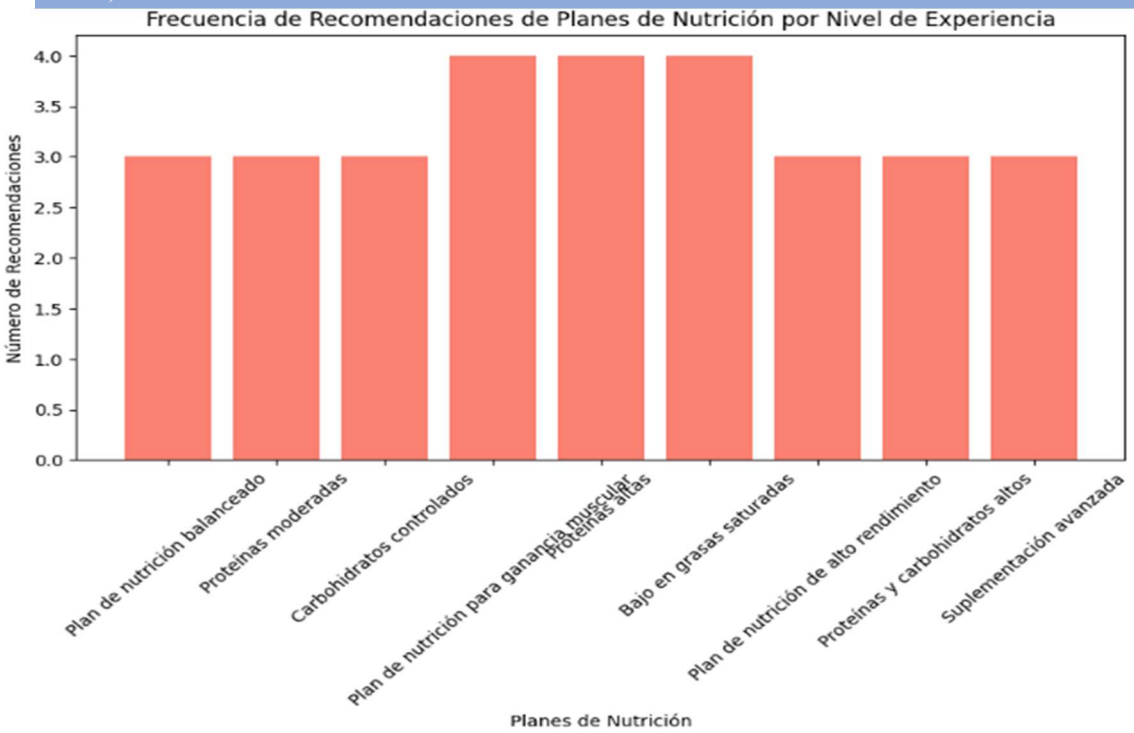


Figure 8. Graphical representation of the training level.

3.6. Customer Perception Evaluation

This section reflects the results of the application of a survey as a crucial tool to understand and improve the satisfaction of customers and employees at the "JC" gym, regarding the management of the mobile application designed to monitor performance and analysis in fitness and nutrition, providing valuable information about their preferences and experiences (Table 1).

Table 1. Perceptions of the application

Questions	Categorization	Frequency
How satisfied are you with the overall experience of the application?	Dissatisfied	0
	Very dissatisfied	0
	Neutral	25
	Satisfied	101
	Very satisfied	99
How useful did you find the food and exercise recommendations?	Not useful	0
	Slightly useful	19
	Neutral	13
	Useful	94
	Very useful	99
Do you feel you have made progress toward your fitness goals with the application?	No progress	0
	Little progress	15
	Neutral	11
	Some progress	89
	A lot of progress	110
How easy was it to navigate the application?	Very difficult	0

	Difficult	1
	Neutral	29
	Easy	100
	Very easy	95
Would you recommend this application to others?	Definitely not	0
	Probably not	5
	Neutral	27
	Probably yes	97
	Definitely yes	96

3.6. Customer Perception Evaluation

This section reflects the results of a survey conducted as a crucial tool to understand and improve the satisfaction of both customers and employees at the "JC" gym, regarding the management of the mobile application designed to monitor performance and analysis in fitness and nutrition, providing valuable information about their preferences and experiences (Table 1).

According to the data presented in Table 1, the findings to be presented are based on the perceptions shared by the employees and clients of the local gym “JC” with the aim of evaluating the reception and feedback regarding the use of the application. The surveys revealed that 88.89% of users were satisfied or very satisfied with the application, indicating that it meets or exceeds most of the expectations. However, 8.89% of respondents were neutral, suggesting they may not have experienced a significant impact or need more time to fully assess their experience. Only 2.22% expressed dissatisfaction or were very dissatisfied, which indicates minimal perceived problems or negative aspects.

The users' perception of the application’s features and results was mostly positive, with 88.89% rating them as "Useful" or "Very useful," indicating the relevance of the application, its ease of use, and its effectiveness in meeting users' needs. However, 6.67% of users gave a "Neutral" response, suggesting they haven’t fully explored the app's features or that they haven't had a significant impact. Only 4.44% rated the features as "Slightly useful" or "Not useful."

Most respondents felt that they had made progress toward their fitness goals with the application, and the categories "Some progress" and "A lot of progress" show that the application is meeting users' expectations. The "No progress" and "Little progress" categories had minimal impact, indicating that almost all users perceive positive results from using the tool.

Regarding the navigation of the application, the results were also largely positive: 45.71% of respondents stated that the interface was "Easy" to use, and 42.86% rated the experience as "Very easy." However, only 8.57% of respondents had a neutral perception, suggesting that some users did not have a clear impression or needed more time to fully explore the application.

Ultimately, 91.43% of respondents would recommend the application, with a majority (50-60%) choosing "Definitely yes" and 30-40% choosing "Probably yes." This indicates high satisfaction and acceptance of the application. However, 8.57% of users were "Neutral," suggesting room for improvement or lack of conviction in certain aspects. Negative responses were minimal, emphasizing the preference for favorable opinions. This indicates a high level of satisfaction with the application.

4.Discussion

The application aims to improve health and well-being by offering personalized exercise plans and nutritional recommendations, reducing lifestyle-related diseases such as obesity and diabetes. It optimizes fitness and nutrition results by offering personalized recommendations based on individual data, increasing the efficiency of training programs and diets (Al Naabi Y, Ibrahim N, Dhillon JS., 2024; Ulfa et al., 2022). The application also provides detailed information on nutrition and exercise, enabling users to make informed decisions about their health. It also includes

community and support features, fostering motivation and adherence to fitness and nutrition programs (Alessio et al., 2024). Continuous monitoring and real-time data tracking, adjusted with machine learning algorithms (Madhushika et al., 2023), include automatic notifications and reminders that help users stay focused on their goals. The convenience and accessibility, which allow users to access their fitness and nutrition plans anytime and anywhere, make it easier to integrate healthy habits into daily life.

5.Conclusions

The analysis phase represents a crucial requirement in creating a mobile platform that meets users' needs and addresses real problems, optimizing functionality and effectiveness. On the other hand, the intuitive user interface improves navigation and user experience, increasing satisfaction. In a broader context, advanced fitness tracking technologies allow for the creation of personalized training and nutrition plans, improving well-being and performance. Considering a data-driven approach, the application becomes a valuable tool for achieving health goals, making it an indispensable tool for users.

The recommendation lies in refining the requirements analysis process, conducting usability testing, and gathering user feedback to adapt the platform to the changing needs of users. Ongoing evaluations and updates of fitness tracking technologies are also essential to maintain the alignment of the application with market expectations and to improve the user experience.

6. References

- Al Naabi Y, Ibrahim N, Dhillon JS. (16 de Julio de 2024). Designing sustainable mobile weight management applications: information technology (IT) experts perspectives. *Mhealth, 10*(25), 1-21. doi:10.21037/mhealth-24-4
- Alessio et al. (09 de Mayo de 2024). Digital applications for diet monitoring, planning, and precision nutrition for citizens and professionals: a state of the art. *Nutrition Reviews*, 1-15. doi:https://doi.org/10.1093/nutrit/nuae035
- Angosto, S., García-Fernández, J. & Grimaldi-Puyana, M. (17 de Agosto de 2023). A systematic review of intention to use fitness apps (2020–2023). *Humanities and Social Sciences Communications, 10*(512), 1-11. doi:https://doi.org/10.1057/s41599-023-02011-3
- Bruno F. Tavares et al. (2020). Mobile Applications for Training Plan Using Android Devices: A Systematic Review and a Taxonomy Proposal. . *Information, 11*(7), 1-20. doi:https://doi.org/10.3390/info11070343
- Castilla, Pacheco & Franco. (Mayo de 2023). Digital government: Mobile applications and their impact on access to public information. *SoftwareX, 22*, 1-10. doi:https://doi.org/10.1016/j.softx.2023.101382
- Castillo et al. (Septiembre de 2023). Agile, user-centered design and quality in software processes for mobile application development teaching. *International Journal of Software Engineering & Applications (IJSEA), 14*(5), 1-17. doi:10.5121/ijsea.2023.14501 1
- Chandarana et al. . (Agosto de 2024). A comprehensive review of agile methodologies in mobile app development. *International Research Journal of Modernization in Engineering Technology and Science, 06*(08), 1931-1937. doi:10.56726/IRJMETS61006
- Fernando García-Pascual, Manel Valcarce-Torrente, Ferran Calabuig & Jerónimo García-Fernández. (2023). The use of a fitness app for customer recommendation: linear models and qualitative comparative analysis. *Humanities and Social Sciences Communications, 10*(811), 1-8. doi:https://doi.org/10.1057/s41599-023-02330-5
- Fruh, et al. . (27 de Enero de 2021). A practical approach to obesity prevention: Healthy home habits. *J Am Assoc Nurse Pract., 33*(11), 1055-1065. doi:10.1097/JXX.0000000000000556

- Hazem Abdelkarim Alrabaiah and Nuria Medina-Medina. (2021). Agile Beeswax: Mobile App Development Process and Empirical. *Sustainability: Study in Real Environment, 13*(4), 1-33. doi:https://doi.org/10.3390/su1304
- Jiang Hu, Wei He, Jie Zhang, Jaeki Song. (Julio de 2023). Examining the impacts of fitness app features on user well-being. *Information & Management., 60*(5), 1-6. doi:https://doi.org/10.1016/j.im.2023.103796
- Madhushika et al. (Mayo de 2023). SMART - Machine Learning Based Fitness Mobile Application. *International Journal of Advanced Research and Publications, 6*(5), 1-6. Recuperado el 17 de Noviembre de 2024, de https://www.ijarp.org/published-research-papers/may2023/Smart-Machine-Learning-Based-Fitness-Mobile-Application.pdf
- Porri et al. (15 de Febrero de 2024). Time to act on childhood obesity: the use of technology. *Front. Pediatr.Sec. Pediatric Obesity, 12*, 1-11. doi:https://doi.org/10.3389/fped.2024.1359484
- Rane, Nitin & Choudhary, Saurabh & Rane, Jayesh. (2024). Gemini or ChatGPT? Capability, Performance, and Selection of Cutting-edge Generative Artificial Intelligence (AI) in Business Management. *Studies in Economics and Business Relations, 5*(1), 40-50. doi:10.48185/sebr.v5i1.1051
- Reshma Raj K et al. (Marzo de 2020). User's Perspective about Mobile Fitness Applications. *International Journal of Recent Technology and Engineering (IJRTE), 8*(6), 3368-3373. doi:10.35940/ijrte.F8760.038620.
- Ulfa et al. (Agosto de 2022). Nutrition-Related Mobile Application for Daily Dietary Self-Monitoring. *Wiley: Journal of Nutrition and Metabolism*, 1-11. doi:DOI:10.1155/2022/2476367
- Yunwen Wang, William B. Collins. (Junio de 2021). Systematic evaluation of mobile fitness apps: Apps as the Tutor, Recorder, Game Companion, and Cheerleader. *Telematics and Informatics, 59*, 1-47. doi:https://doi.org/10.1016/j.tele.2020.101552