doi.org/10.54141/psbd.1182006

PAMUKKALE JOURNAL OF SPORT SCIENCES
ISSN: 1309-0356
dergipark.org.tr/en/pub/psbd

Pamukkale J Sport Sci, 14(1), 43-62, 2023

Research Article

Multi-Criteria Evaluation of Mobile Fitness Applications During COVID-19 Pandemic Based on AHP

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Keywords
Analytic Hierarchy Process (AHP), Fitness applications, Mobile fitness applications

Article History
Received 29 September 2022
Revised 06 March 2023
Accepted 23 March 2023
Available Online 27 April 2023

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ABSTRACT

Fitness centres have been among the first businesses affected by the COVID-19 pandemic. It is clear that with the pandemic, users' choices for sports services and selection criteria for them have changed. During the pandemic, there has been a transition from traditional gym classes to virtual fitness classes. People have started to rapidly adopt these technology-based alternatives worldwide, and there has been an increase in the download and use of these mobile fitness applications. However, there are many alternatives to fitness applications for users. In this study, making the most effective selection among the alternatives in mobile applications where there are conflicting user criteria and identifying customer-oriented platform development proposals in terms of service providers are aimed to contribute to the relevant literature. The study has proposed an Analytic Hierarchy Process (AHP) model, one of the Multi-criteria Decision-Making approaches, for selecting the best choice among mobile fitness application alternatives where there is more than one alternative with more than one criterion and these criteria conflict with each other. The proposed AHP solution has a modular structure that can be easily adapted in case user preferences (criteria) changes and can flexibly be updated when the alternatives change.

INTRODUCTION

The COVID-19 pandemic has drastically changed the consumption habits of people around the world. The pandemic has caused radical social and economic changes all over the world (Bounie et al., 2020; Knotek II et al., 2020; Roggeveen & Sethuraman, 2020). The use of smartphones and smart devices has increased worldwide; mobile applications have made our lives easier at many points and have replaced face-to-face products and services (Devezas, 2020). While the rapid rise of developments in information and communication technologies has led to an increase in the diversity of mobile applications, COVID-19 has also been effective in increasing the use of mobile applications (Heidenreich & Talke, 2020; McLean et al., 2020; Moon, et al., 2021). It is a fact that COVID-19 has made mobile applications more valuable. Therefore, mobile applications now constitute the future of every sector, including health, food and beverage, education, banking, and games (Carlo et al., 2019; Galindo et al., 2020; Jones and Nikolaeva, 2020; Li and Lalani, 2020; Ramdhan & Hamdani, 2021; Stauffer, 2020). The mobile application ecosystem also includes fitness industry (Angosto et al., 2020; Lee & Trimi, 2021). Fitness centres were among the first businesses to close after the outbreak of the COVID-19 pandemic. Although technology has made its presence felt in the fitness industry since 2016, the pandemic has triggered this growth sharply (Ananthakrishnan et al., 2020).

During the pandemic, there has been a transition from the traditional gym to virtual fitness classes. In this process, fitness entrepreneurs have started to identify the demand for virtual training and realize the potential of online services. On the other hand, the growing trend of protecting physical health with COVID-19 has provided technology investors with enormous opportunities to develop fitness applications where users can be more socially isolated and protect their physical health, which has increased the number of fitness applications. During COVID-19, when mobile devices are used extensively, mobile fitness applications are seen by customers as a new marketing channel and an alternative to fitness businesses (Parker et al., 2021). Experts predict that gyms serving before COVID-19 will adopt a unique concept, such as boutiques or high-tech gyms after COVID-19 (Moustakas et al., 2020). There are many fitness applications (free or in-app purchases) on smart devices (Bondaronek et al., 2018). However, there is uncertainty as to whether some applications meet users' expectations. For this reason, fitness applications should be developed with a good user interface, well-designed exercise and nutrition programs that will attract users, cooperation with well-known fitness professionals and health experts, video applications, and providing feedback. Therefore, what needs to be done for fitness applications is to evaluate this process and the factors that are effective in the process and to follow appropriate strategies.

Users' choices in the purchasing process are essential for both applications and users. The purchasing process includes the emergence of a need, the determination and evaluation of product or service alternatives that will meet this need, the decision to purchase, the purchase, and all actions after the purchase (Schiffman & Kanuk, 2009). Therefore, users' being in the proper purchasing decision process depends on knowing the relative position of these applications in fitness technology.

The healthiest method of determining the strengths and weaknesses of fitness applications, how well they have achieved their goals, and their relative position in the industry is to compare the practices in the fitness industry with each other. Performance measurement serves the purpose of seeing the current status of these applications, providing competitive advantage and differentiation (Alfaro et al., 2007). “The Diffusion of Innovations” model provides benefits for adapting and using rapidly changing technology. This model is an approach that Everett M. Rogers introduced in 1995 to implement the steps and processes involved in the diffusion of new telecommunications technologies (Kavak et al., 2016). The diffusion of innovations model is frequently used by marketers to influence the behavior of large groups of people. This paper provides the effects of the COVID-19 pandemic on the fitness industry, the perspectives of previous research on the subject, and proposes an Analytic Hierarchy Process solution to select among mobile applications by considering the selection as a decision problem.

Literature Survey

Technology is an indispensable part of innovation. In addition, when technology gains the quality of the economy and is transferred to practice, it also gains an innovation dimension (Güneş, 2010). Therefore, the fitness industry must keep up with the times and show an innovative approach through technology. "Rogers' Diffusion of Innovation Theory" focuses on gathering information about the innovation adoption process and reducing uncertainty (Agarwal et al., 1998). The model classifies people according to the criteria of adopting innovations about innovations over a particular time series (Berger, 2005; Park et al., 2004). Therefore, the diffusion of innovations model is an essential tool in interpreting the decisions of users to turn to fitness applications and buy the right one among these applications during the COVID-19 quarantine period. For an innovation to be genuinely new, the information it contains need not be truly new. Therefore, the concept of innovation should be expressed in terms of acquiring knowledge, persuading, or deciding to adopt (Rogers, 1995). In this respect, the diffusion of innovation provides benefits in adapting and using the model to the ever-changing and evolving fitness technology. Hence, reported information about the fitness applications, such as new installs, average daily active users, and in-app purchase revenue data, are objects considered as the criteria of the problem. There are many factors in choosing a fitness app by user (Cho & Kim, 2020; Rohm et al., 2012; Thompson, 2014). Users prefer a fitness application primarily based on criteria such as ease of use, the usefulness of the application, or personal interests (Grundy et al., 2016; Hermsen et al., 2017). However, health concerns caused by the COVID-19 pandemic have taken priority among the reasons for the preference of these applications (Nyenhuis et al., 2020; Parker et al., 2021; Yang & Koenigstorfer, 2020). The difference between the applications chosen by users during the pandemic period and the applications that are not preferred is related to the innovations used in fitness technology and the trust is given to users (Ueafuea et al., 2020). Lee and Walsh (2011) have concluded sports marketing has become a popular business decision with the possibility of becoming more popular in the future. They have studied sports marketing outsourcing decision-making factors using the Analytic Hierarchy Process (AHP) model. Nisel and Özdemir (2016) have presented a comprehensive literature review of AHP applications in sports. 62 sports-related AHP articles have been selected, categorized, and analyzed in their study. The findings show that the AHP model has successfully been used in the field of sport for variable aims. Lee (2008) has aimed to identify factors affecting sports sponsorship decision-making and develop a sports sponsorship model using AHP. Mirkazemi et al. (2009) have applied the analytic hierarchy process for the performance evaluation criteria of university sports offices. Zadeh et al. (2012) have studied the proper locations of sports spaces using a geographic information system (GIS) and AHP to locate these places in Kahnouj city. Lee and Ross (2012) have identified the decision-making factors of sport sponsorship in the global market context using AHP. Marjani et al. (2013) have studied the selection of the most appropriate sports shoes using the AHP. Nezad and Damaneh (2014) have used AHP to identify the performance evaluation and criteria of the Iranian sports federation. Ebrahimi et al. (2015) have applied AHP to find a suitable location for Ahvaz Sport. Ludi and Yao (2015) have used AHP in the Selection of the Leading Sport Industry in Shanxi Province.

Based on the aforementioned studies, the authors have concluded that with the COVID-19 pandemic, both users' choices for sports services and selection criteria for them have changed. For this reason, it can be assumed that they have developed some reaction situations for preference, download, and purchase of fitness applications. In this context, the aim of the study is to provide decision support not only for the users of the applications but also for the customer-oriented platform developers.

During and after COVID-19, customers who find it dangerous to go to fitness centers have turned to technological alternatives. This situation has increased the diversity of mobile applications within the scope of fitness applications and increased the usage rates of these mobile applications. In this process, in which mobile devices are used intensively, determining which users should choose mobile applications and the features that should be developed in mobile applications by service providers are discussed in this study as a decision problem. This study suggests a solution based on the Analytic Hierarchy Process. In this study, making the most effective selection among the alternatives in mobile applications where there are conflicting user criteria and identifying customer-oriented platform development proposals in terms of service providers are aimed to contribute to the relevant literature.

METHODS

Research Model

In the study, the Analytic Hierarchy Process model, one of the Multi-criteria Decision Making (MCDM) approaches, has been used for the selection of mobile fitness application alternatives where there is more than one alternative with more than one criterion and these criteria conflict with each other. AHP allows complex problems in a hierarchical structure and in a logical and structural way.

Data Collection Tools

Mobile fitness applications and Multi-Criteria Decision Making (MCDM) Approach

The increasing complexity of the pandemic has multiplied the decision complexity (Ceballos et al., 2016). Marketing can be a general discipline that can provide solutions here (Liu et al., 2019). Decision-making with many criteria is important (Ishizaka & Nemery, 2013). To respond to these needs, multi-criteria decision analysis methods are widely used (Greco, 1997). However, the selection of the proper type of MCDM methods has the utmost importance (Roy & Słowiński, 2013). Wątróbski et al. (2019) have presented a methodological and practical framework for selecting suitable MCDM methods for a particular decision. They present a general framework for selecting an appropriate MCDM method for a given area of decision support, even in cases of data gaps in the decision-making problem description. The proposed framework has been implemented within a web platform available for public use at www.mcda.it. The proposed framework and the web platform by Wątróbski et al. (2019) have been used to decide which MCDM method is proper for our problem. The application gives the result that AHP is suitable for the selection of mobile fitness application problems.

In MCDM decision problems, goals and criteria leading to these goals are important. Decision criteria play an important role in choosing between alternatives. In mobile fitness applications, six of the top-ranked applications in the USA have been determined as alternatives to the decision problem. In decision problems where there is only one criterion since the selection is made for this purpose, the decision can be easily determined in which the alternative containing the best criterion is selected for the decision problem. However, in mobile fitness applications with many alternatives, there are many conflicting criteria in determining the best alternative for the users. These criteria include;

1. New Installs (M) (often referred to as "downloads," this is the number of new users who are downloading the app for the first time)
2. Average daily active users (K) (the number of users who opened the app at least once in the last 24 hours)
3. In-app Purchase Revenue (M) (the amount of revenue generated by users making purchases within the app)
4. IOS-Samsung applicability
5. User-Friendly/Users can go at their own pace
6. Flexibility with their schedule (Video Downloadable, Online-Offline, etc.).

In determining the values of the first four of these criteria, the numbers in the related report (Apptopia, 2023) have been used, and in the last two, the evaluations have been made in the interviews with users and information systems experts about the applications in question. In MCDM, the final decision is made according to comparisons both between criteria and within criteria. While the aim of the comparison between criteria is to place the criteria in priority order according to the evaluations of the decision maker (DM), the aim of the benchmarking is to determine which of the alternatives is more attractive in the relevant criterion. The final decision is made after the synthesis of these two comparisons. It is necessary to emphasize that the selected alternative will be the most preferred option according to the priority given by the decision maker.

Data Collection Procedure

Multi-Criteria Decision-Making Approach Steps

Firstly, the goals of the users have been determined. For this, both quantitative and qualitative targets have been determined. These also express the expectations of a user from the mobile Fitness applications used in the Covid pandemic. All six criteria mentioned earlier are 'utility' goals the users want to maximize. However, when the alternatives are examined, it is seen that no alternative is superior to the other alternatives in all criteria. In other words, when switching from one alternative to another, some criteria improve while others worsen. In this case, there can be no talk of the optimal solution for selection. AHP is one of the most widely used methods among MCDM methods. Along with the weighting of the decision-based criteria, the AHP process is also used to choose between alternatives depending on the criteria weights (Aktaş et al., 2015). AHP was developed by Saaty (1980) and can measure the perceptions of users/experts by making use of pairwise comparisons. In AHP, the 1-9 scale is used for pairwise comparisons (Saaty, 1980; 2000). In this study, AHP has been applied since it has been assumed that there is no dependency between the criteria; in other words, there is no mutual interaction between the criteria.

AHP Model Steps

There are four stages in the AHP model; 1) Displaying the criteria in a hierarchical structure. 2) Making pairwise comparisons between Criteria and Alternatives. 3) As a result of pairwise comparisons, determining the priorities of the criteria and the degree of preference of the alternatives according to each criterion. 4) Determination of the order of alternatives as a result of criteria priorities and preference degrees (Aktaş et al., 2015; Saaty, 1994). These four AHP stages are discussed in detail below.

Step 1 (Displaying the criteria in a hierarchical structure)

In this study, all criteria determined have been created as single-level criteria. In order to reach the final goal, six benefit criteria (n=6), whose details are given below, have been determined.

Step 2 (Making pairwise comparisons between Criteria and Alternatives)

In the second step, pairwise comparisons were made. A square matrix represents pairwise comparisons. The following standard AHP scale (Table 1) has been used for pairwise comparison. In our six-element (n=6) problem, n.(n-1)/2=15 pairwise comparisons have been made. These comparisons are shown in Table 2.

The w1/w2 value shows which of the first or second criteria is more important than the other and what the degree of importance is, according to an upper purpose that is the basis for the user's decision. Values on the diagonal are one since each element has a comparison with itself. On the other hand, half of the matrix is the inverse of the other elements. For example, if w3/w2=5 (the first element is more important than the second element), it is clear that w2/w3 =1/5. Since pairwise comparisons should be consistent, consistency analyses of all comparisons have been performed, and it has been shown in the result tables that they are consistent (Consistency Ratio CR≤0.1).

Table 1
AHP Standard Scale

Scale	Definition	Description
1	Of equal importance	The contribution of both elements to a higher level criterion/purpose is equal.
3	Less important	One element is slightly more important than the other element.
5	Quite important	One element is quietly more important than the other element.
7	Very important	One element is more important than the other element.
9	Absolutely important	One element has absolute superiority over the other element in terms of importance.
2,4,6,8	Intermediate values	It is used as an intermediate value when the above scales do not fully reflect the degree of importance between the two elements.
Inverse Values	1/3, 1/5, 1/7 etc.	These are the values that will be obtained when the order of the elements is changed.

Table 2
AHP Pairwise Comparison Matrix

Criteria	X_1	X_2	X_3	X_4	X_5	X_6
X_1	w_1/w_1	w_1/w_2	w_1/w_3	w_1/w_4	w_1/w_5	w_1/w_6
X_2	w_2/w_1	w_2/w_2	w_2/w_3	w_2/w_4	w_2/w_5	w_2/w_6
X_3	w_3/w_1	w_3/w_2	w_3/w_3	w_3/w_4	w_3/w_5	w_3/w_6
X_4	w_4/w_1	w_4/w_2	w_4/w_3	w_4/w_4	w_4/w_5	w_4/w_6
X_5	w_5/w_1	w_5/w_2	w_5/w_3	w_5/w_4	w_5/w_5	w_5/w_6
X_6	w_6/w_1	w_6/w_2	w_6/w_3	w_6/w_4	w_6/w_5	w_6/w_6

The method of Saaty has been used in determining the values of the weights under error due to its advantages, such as detecting the degree of inconsistency in the evaluations. It is assumed that the decision-makers are completely consistent in their preferences and do not make mistakes.

Step 3 (Determining the priorities of the criteria and the degree of preference of the alternatives according to each criterion)

In determining the criteria prioritization and the preference values of the alternatives, the values in the matrix have been found by normalizing (Baird, 1989). The following expression is used in the normalization:

$$w_i = \frac{a_{ij}}{\sum_{j=1}^{n} a_{ij}} \qquad i=1,2,3,\ldots n \qquad (1)$$

In the formula a_{ij} is any value in the matrix in binary comparison and $a_{ij} = 1/a_{ji}$, $\forall_{ij} \in$ A and $a_{ij} \neq \infty$.

Step 4 (Determination of the order of alternatives as a result of criteria priorities and preference degrees)

At the last stage in AHP, the ranking of the alternatives has been determined by synthesizing the criteria priorities and preference values. The following formula is used for the ranking value of the first alternative (P: Global priorities of the criterion, A: Alternatives, a: Preference values of the alternatives according to the criteria):

$$\sum_{i=1}^{n} a_{1i} * P_i \qquad (2)$$

The following Table 3 has been used to quantify the qualitative values.

Table 3
Quantification of Qualitative Values

Scale	Utility	Cost
9	Very High	Very low
7	High	Low
5	Middle	Middle
3	Low	High
1	Very low	Very High

AHP Model Solution Proposal

Six of the mobile fitness applications which are at the top of the list in the USA in 2020 and whose numerical criterion values are given below have been determined as alternatives to the decision problem and have been coded and included in the problem as A1, A2, A3, A4, A5, and A6.

As the criteria of the decision problem, six criteria for mobile fitness applications are determined below. Since there is only one level in the problem, the local and global weights of the criteria are the same. Criteria;

X_1: New Installs (M) (often referred to as "downloads," this is the number of new users who are downloading the app for the first time).

X_2: Average daily active users (K) (the number of users who opened the app at least once in the last 24 hours).

X_3: In-app Purchase Revenue (M) (the amount of revenue generated by users making purchases within the app).

X_4: IOS-Samsung compatible.

X_5: User-Friendly/Users can go at their own pace.

X_6: Flexibility with their schedule (Video Downloadable, Online-Offline).

While the first three criteria contain quantitative values, the last three include qualitative values according to the decision makers' evaluations. The "Qualitative Values

Converted Decision Matrix" obtained after digitizing the qualitative values is given below in Table 4.

Table 4
Decision Matrix with Converted Qualitative Values

Criteria/ Alternatives	X_1	X_2	X_3	X_4	X_5	X_6
A_1	4.80	1500	4.4	7	7	7
A_2	3.40	500	5.8	7	9	7
A_3	3.40	520	4.5	7	9	9
A_4	2.90	290	4.4	5	7	7
A_5	2.80	650	4.5	7	7	7
A_6	2.70	410	4.2	7	5	5

After the qualitative values have been converted to numerical values, all numerical values have been converted to a standard scale. In determining the criteria priorities and alternative preference values in AHP, the opinions of the experts who made the examination have been taken as a basis.

In Table 5, column totals are presented for calculating the binary criteria weights by using the pairwise comparison of the criteria and the pairwise comparison matrix of the criteria.

Table 5
Binary Comparison of Criteria and Column Totals

Criteria	X_1	X_2	X_3	X_4	X_5	X_6
X_1	1	3	1/2	1/3	2	1/5
X_2	1/3	1	1/4	1/5	1/2	1/9
X_3	2	1/4	1	1/2	3	1/3
X_4	3	5	2	1	4	1/4
X_5	1/2	2	1/3	1/4	1	1/7
X_6	5	9	3	4	7	1
Total	11.833	20.250	7.083	6.283	17.500	2.037

The A_{norm} matrix found by dividing each element by the column sum is presented in Table 6.

Table 6
A_{norm} Matrix

Criteria	X_1	X_2	X_3	X_4	X_5	X_6
X_1	0.085	0.148	0.071	0.053	0.114	0.098
X_2	0.028	0.049	0.035	0.032	0.029	0.055
X_3	0.169	0.012	0.141	0.080	0.171	0.164
X_4	0.254	0.247	0.282	0.159	0.229	0.123
X_5	0.042	0.099	0.047	0.040	0.057	0.070
X_6	0.423	0.444	0.424	0.637	0.400	0.491

After the A_{norm} matrix, the weight matrix has obtained with the formula $w^{(6)} = \lim_{k\to\infty} \frac{A^6 e}{e^T A^6 e}$ for six criteria (k=6). In order for the weights of the binary comparison matrix with n=6 to be consistent, at least the nth power of the A_{norm} matrix must be taken. The A^6e matrix is calculated and presented below:

$$A^6e=\begin{bmatrix} 0.088359 & 0.088361 & 0.088359 & 0.088363 & 0.088359 & 0.088362 \\ 0.04377 & 0.043771 & 0.04377 & 0.043772 & 0.043769 & 0.04377 \\ 0.140104 & 0.140107 & 0.140104 & 0.14011 & 0.140104 & 0.140107 \\ 0.17475 & 0.174747 & 0.174748 & 0.174743 & 0.174753 & 0.174755 \\ 0.059605 & 0.059607 & 0.059605 & 0.059609 & 0.059605 & 0.059607 \\ 0.493411 & 0.493409 & 0.493414 & 0.493402 & 0.493408 & 0.493399 \end{bmatrix}\begin{bmatrix}1\\1\\1\\1\\1\\1\end{bmatrix}=\begin{bmatrix}0.530163\\0.262622\\0.840637\\1.048496\\0.357638\\2.960443\end{bmatrix}$$

Since $e^T.A^6e = 6$;

It is obtained that $w^{(6)}$=[0.08836 0.04377 0.14011 0.17475 0.05961 0.49341].

Consistency Test:

A consistency test is performed to understand whether the w weight matrix is consistent. The Consistency Ratio (CR) is the ratio of the inconsistency index value (CI) to the random index value (RI).

$$CR=\frac{CI\ (Inconsistency\ Index)}{RI\ (Random\ Index)} \quad (3)$$

A value of CR≤0.1 is considered acceptable for the validity of the consistency test (Harker, 1987).

Firstly, the Inconsistency Index (CI) must be calculated to calculate the CR. The CI defined by Satty (1977) by normalizing is calculated as follows:

$$CI=\frac{\lambda maks-n}{(n-1)} \quad (4)$$

In order to be able to calculate CI, λ_{maks} is calculated with the help of the following formula.

$$\lambda_{maks}=\frac{1}{n}\sum_{i=1}^{n}\left(\sum_{j=1}^{n} a_{ij}w_j/w_i\right) \quad (5)$$

First, the AwT matrix is calculated.

$$Aw^T=\begin{bmatrix}0.56586\\0.22782\\0.75843\\1.30066\\0.3522\\2.86569\end{bmatrix}$$

Then, λ_{maks} can be obtained as:

$$\lambda_{maks} = \left(\frac{1}{6}\right)\left\{\frac{0.56586}{0.08836} + \frac{0.22782}{0.04377} + \frac{0.75843}{0.14011} + \frac{1.30066}{0.17475} + \frac{0.3522}{0.05961} + \frac{2.86569}{0.49341}\right\}=6.030376$$

$$CI=\frac{\lambda maks-n}{(n-1)}=\frac{6.030376-6}{5} = 0.006075$$

$$CR=\frac{CI\ (Inconsistency\ Index)}{RI\ (Random\ Index)}=\frac{0.006075}{1.24} = 0.004899 \quad \text{(for n=6, RI=1.24).}$$

Since CR≤0.1 is required to say that the matrix is consistent, our matrix can be said to be highly consistent. The criteria weights are shown in Table 7 below.

Table 7
Criterion Weights

Criteria	Weights (w_i)
X_1	0.08836
X_2	0.04377
X_3	0.14011
X_4	0.17475
X_5	0.05961
X_6	0.49341

After this stage, pairwise comparison matrixes showing the degree of preference for each criterion are given in Table 8. In addition, the consistency ratios of the comparison made according to each criterion are also given below the Table 8.

Table 8
Preference Values of Alternatives According to Each Criterion (X_1, X_2, X_3, X_4, X_5 and X_6)

CRITERION		A1	A2	A3	A4	A5	A6	PREFERENCE VALUE
CRITERION-1	A_1	1	2	2	3	4	5	0.36035
	A_2	1/2	1	1	2	3	4	0.19668
	A_3	1/2	1	1	2	3	4	0.19668
	A_4	1/3	1/2	1/2	1	2	3	0.11486
	A_5	1/4	1/3	1/3	1/2	1	2	0.07612
	A_6	1/5	1/4	1/4	1/3	1/2	1	0.05530
	CI:	0.01983			**CR:**	0.01599		
CRITERION-2	A_1	1	3	3	6	2	5	0.39258
	A_2	1/3	1	1	3	1/2	2	0.12904
	A_3	1/3	1	1	3	1/2	2	0.12904
	A_4	1/6	1/3	1/3	1	1/3	1/2	0.05775
	A_5	1/2	2	2	3	1	2	0.20948
	A_6	1/5	1/2	1/2	2	1/2	1	0.08212
	CI:	0.02049			**CR:**	0.01652		
CRITERION-3	A_1	1	1/4	1/2	1	1/2	3	0.10018
	A_2	4	1	3	4	3	6	0.42559
	A_3	2	1/3	1	2	1	2	0.15479
	A_4	1	1/4	1/2	1	1/2	3	0.10018
	A_5	2	1/3	1	2	1	2	0.15479
	A_6	1/3	1/6	1/2	1/3	1/2	1	0.06447
	CI:	0.04212			**CR:**	0.03397		

Table 8 (Continued)

CRITERION		A1	A2	A3	A4	A5	A6	PREFERENCE VALUE
CRITERION-4	A_1	1	1	1	2	1	1	0.18182
	A_2	1	1	1	2	1	1	0.18182
	A_3	1	1	1	2	1	1	0.18182
	A_4	1/2	1/2	1/2	1	1/2	1/2	0.09091
	A_5	1	1	1	2	1	1	0.18182
	A_6	1	1	1	2	1	1	0.18182
	CI:		0.00000		**CR:**		0.00000	
CRITERION-5	A_1	1	1/2	1/2	1	1	2	0.13342
	A_2	2	1	1	2	2	3	0.26084
	A_3	2	1	1	2	2	3	0.26084
	A_4	1	1/2	1/2	1	1	2	0.13342
	A_5	1	1/2	1/2	1	1	2	0.13342
	A_6	1/2	1/3	1/3	1/2	1/2	1	0.07805
	CI:		0.00335		**CR:**		0.00270	
CRITERION-6	A_1	1	1	1/2	1	1	2	0.15385
	A_2	1	1	1/2	1	1	2	0.15385
	A_3	2	2	1	2	2	4	0.30769
	A_4	1	1	1/2	1	1	2	0.15385
	A_5	1	1	1/2	1	1	2	0.15385
	A_6	1/2	1/2	1/4	1/2	1/2	1	0.07692
	CI:		0.00000		**CR:**		0.00000	

As seen from the binary comparison matrices above, the consistency ratios of the six matrices ($CR_{X_1} = 0.01599$, $CR_{X_2} = 0.01652$, $CR_{X_3} = 0.03397$, $CR_{X_4} = 0.00000$, $CR_5 = 0.00270$, $CR_{X_6} = 0.00000$) are all below CR≤0.1 and it can be said that the comparisons are extremely consistent.

After the consistency analysis of the pairwise comparisons, in the final stage, the 'combined decision matrix' used to synthesize the criteria priorities and the preference value of the alternatives according to each criterion is presented in Table 9.

Table 9
Combined Decision Matrix

Criteria/ Alternatives	X_1	X_2	X_3	X_4	X_5	X_6
Criterion Weight (w_j)	0.08836	0.04377	0.14011	0.17475	0.05961	0.49341
A_1	0.36035	0.39258	0.10018	0.18182	0.13342	0.15385
A_2	0.19668	0.12904	0.42559	0.18182	0.26084	0.15385
A_3	0.19668	0.12904	0.15479	0.18182	0.26084	0.30769
A_4	0.11486	0.05775	0.10018	0.09091	0.13342	0.15385
A_5	0.07612	0.20948	0.15479	0.18182	0.13342	0.15385
A_6	0.05530	0.08212	0.06447	0.18182	0.07805	0.07692

The criteria weights (w_j) in the decisionta matrix are taken from Table 7, and the preference values of the alternatives according to each criterion (a_{ij}: the value of the i^{th} alternative according to the j^{th} criterion) are taken from the values in Table 8.

The total weight value (A_i) of each alternative equals the sum of the product of the preference value a_{ij} of that alternative for the relevant criteria and the weight of the relevant criteria (w_j) as given in the following formula.

$$A_i=\sum_{j=1}^{6} a_{ij} * w_j \quad \forall_i=1,2,3,\ldots 6 \qquad (6)$$

In this context, the decision matrix prepared for the decision maker is presented in Table 10 below.

Table 10
Decision Matrix

Criteria/ Alternatives	X_1	X_2	X_3	X_4	X_5	X_6	Total Weight	Rank
A_1	0.03184	0.01718	0.01404	0.03177	0.00795	0.07591	0.17869	3
A_2	0.01738	0.00565	0.05963	0.03177	0.01555	0.07591	0.20588	2
A_3	**0.01738**	**0.00565**	**0.02169**	**0.03177**	**0.01555**	**0.15182**	**0.24385**	**1**
A_4	0.01015	0.00253	0.01404	0.01589	0.00795	0.07591	0.12646	5
A_5	0.00673	0.00917	0.02169	0.03177	0.00795	0.07591	0.15322	4
A_6	0.00489	0.00359	0.00903	0.03177	0.00465	0.03795	0.09189	6

RESULTS

The decision matrix, as a result of the comparisons that are considered to be consistent as a result of the consistency analysis, is presented in Table 10. When the results are examined, it is recommended that the user should choose the application coded with A_3 according to the determined criteria and weights. According to the exact comparisons, it is seen that the A_2 application is the second, the A_1 application is the third, the A_5 application is the fourth, the A_4 application is the fifth, and the A_6 application is the sixth. In this model, the user can quickly analyze the changes in the decision matrix by changing the weights of the criteria.

DISCUSSION

The COVID-19 pandemic is rapidly changing consumer habits and reshaping the sports industry. While gyms are negatively affected by the pandemic due to the measures taken and customer preferences, marketers offering virtual application services constantly gain customers by increasing their sales volume. With unexpected situations like the Covid pandemic and ever-changing technology, the fitness industry is expected to keep up with the times and provide a more personalized approach to health. During and after the COVID-19 period, customers who find it dangerous to go to fitness centers have turned to virtual alternatives to applications. This situation has increased the diversity and use of mobile applications within the scope of fitness applications. In this study, determining which mobile applications should be chosen by the users and the features that should be developed in the mobile application by the service providers have been considered a decision problem and modeled with AHP, which is one of the Multi-criteria Decision-Making approaches. AHP analyzes complex problems in a hierarchical system. In order to enable the experts on the subject to participate effectively in decision problems, expert opinions have been taken as the basis for determining the preference values of the AHP criteria priorities and alternatives. One of the strengths of AHP is that it allows the conversion of qualitative variables into quantitative ones.

CONCLUSION

This study has converted qualitative variables into quantitative ones, apart from previous studies. In mobile fitness applications, six top-ranked applications in the USA have been coded and determined as alternatives to the decision problem. As the criteria of the problem, six criteria, three quantitative and three qualitative, have been taken as basis in line with the expert opinions. The proposed solution, modeled with AHP, has a modular structure that can be easily adapted in case of user preferences (criteria) changes and can flexibly update the model in case of an increase or decrease in alternatives. It has also been considered that the proposed model could provide users with quick decision support, as potential users to rarely can focus on the best results and seldom thoroughly examine the search results. In this context, it is evaluated which design features of mobile exercise development applications can affect the quality perception of the users and whether modelled the alternatives in the application stores match the criteria presented will affect the quality perception of the users. To survive in a competitive market, applications must dynamically adapt to needs. This will maintain existing customers, increase its popularity, and not only maintain existing customers, but also increase its popularity and bring in new customers. In this regard, the decision matrix made with AHP also contains important essential data in terms of regarding marketing strategies for marketers who develop mobile applications.

The application developers can gain knowledge on the subject from the table presented, such as where they are in the market, how much importance the users give to any criteria, what criteria they should focus on in order to reach more customers in the market, etc. For example, although the pandemic is predicted to decrease in the following years, increasing the offline features of the applications may be an essential strategy. Similarly, it is seen that among the important criteria for fitness enthusiasts are the ability to plan and monitor training programs through mobile applications and even to receive services at their own pace and a lower cost. Additionally, it will contribute to the marketing strategies by informing about the preference situations in case the criteria weights change dynamically or if new criteria are added.

Although the effect of the pandemic decreased in 2021 and beyond, it is expected that most people will not return to their old habits in gyms, and it is evaluated that they will continue their mobile fitness and wellness applications. Mobile applications will also minimize the hygiene problems caused by the pandemic and ensure that users stay in shape with the movements they make at home. For this reason, there will inevitably be a significant change in the fitness industry, especially in mobile applications and their content.

Acknowledgments

No funding was received for the preparation of the submitted manuscript.

Authors' contributions

Not applicable.

Declaration of conflict interest

The author has no conflicts of interest to declare.

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