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A Proposed Approach to Evaluate Digital Business Model Selection for SuperApps using Interval Valued Spherical Fuzzy AHP

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Abstract

Various users have used SuperApps due to the rapid development of digital platforms. Due to their fast market entry by technical rivals and significant growth potential, SuperApps have become enterprises' preferred business method. SuperApps are the correct business, but senior managers must be careful when choosing which digital business models to employ. By classifying the digital management elements of SuperApps and comparing them to potential alternatives based on the preferences of eight digital leaders, we aimed to propose a method for choosing a suitable digital business model. Interval Valued Spherical Fuzzy Analytic Hierarchy Process (IVSF AHP) helps by giving decision-makers access to a broad range of preference domains. According to the rule, Spherical Fuzzy Sets adhere to the squared sum of the membership, non-membership, and hesitation degrees should fall within the range [0, 1]. Each element is distinct since it has an independent assignment within the same range. The IVSF AHP approach favored due to the complexity of the features of the digital business model and their transitional structure, is applied. The chosen digital business model may alter not only the managerial dynamics but also the revenue model of SuperApps depending on the sort of structural interaction of their platform network, according to the numerical application's results.

Keywords: Analytic Hierarchy Process; Digital Business Model; Multi-criteria Decision Making; Interval-valued Spherical Fuzzy Sets; SuperApps

1. INTRODUCTION

Business professionals have used the term SuperApp frequently for the last 5-6 years. WeChat, AliPay, GoJek, Grab, Momo, ZaloPay, and many other SuperApps, which the features and strategies they implement will be detailed in the following sections, are extensively discussed in the current digital economy world, thanks to the considerable volume of their massive digital network and the incredible size of their turnover and income. It attracted the attention of not only chronic enthusiasts, entrepreneurs, senior professionals, and investors but also an extensive user network.

The term SuperApp, which has been discussed frequently recently, and the problems it brings are among the problems faced by the current digital business ecosystem. In today's digital business ecosystem, where more than 90 percent of the projects and applications offered in digital economies fail, choosing and implementing an adequate business model in digital investments is of vital importance for managers and investors. This study evaluated how to choose a business model in SuperApp applications by a decision-maker team consisting of a digital leader staff of eight people using IVSF AHP.

In the literature and methodology section of the study, the aim of the study and references related to the subject are given. The following part presents detailed information about what SuperApps are and their elements. In the next chapter, the features of SuperApps were evaluated, and the structure design that will form the basis for the AHP method was designed. In the methodology section, the steps of the IVSF AHP methodology are presented, and in the last part, the results are presented by discussion and wishes for future studies in the same field are mentioned.

2. LITERATURE

As it is known, the AHP methodology is created by weighing the importance of specific alternatives, certain criteria, and sub-criteria with respect to each other. The alternatives, criteria, and sub-criteria addressed in business problems where the classical AHP methodology is applied consist of more specific and defined options. This situation causes the problem of decision-makers needing to be able to decide certain levels of importance or be able to choose between levels of importance. This problem is overcome with fuzzy decision-making. However, AHP methodologies that use fuzzy logic, which is used in the classical sense, are primarily focused on decision-makers' indecisiveness and the problem of being stuck between choices. Another critical problem encountered is the types and diversity of alternatives. Business problems trying to be solved; The results of traditional fuzzy logic AHP methods satisfy researchers and decision-makers when it consists of a problem such as choosing a warehouse location, an investment decision, a technical equipment purchase problem, etc.

However, the problems encountered in today's digital business world are far beyond the traditional and fundamental problems mentioned above, intangible, far from being defined and specific, and variable from the customer's point of view, such as experiences and expectations. The choice of business model to be preferred and to be implemented in digital platforms and SuperApp strategies creates an undefined set of alternatives based on user experience and expectations. To overcome this problem, it is the IVSF AHP method, uses fuzzy; however, it differs from traditional fuzzy AHP methods while evaluating the alternatives among each other in terms of criteria and sub-criteria, which creates a broader and more possible decision set.

A powerful idea for dealing with uncertainty is the spherical fuzzy sets (SFs), which present a larger region for making decisions and can detect hesitation. SFs, one of these recent advancements, help achieve this goal by providing decision-makers with a wide range of preference domains. The rule SFs follow states that the squared total of membership, non-membership and hesitation degrees should be within [0, 1]. At the same time, each element is independently assigned within the same range, which makes it unique.

SFs and IVSF AHP methods are vastly used in the fuzzy decision-making domain: To manage both types of problems concurrently, Szabolcs et al. introduce IVSF AHP, which considers hesitant scoring and uses mathematics to synthesize the views of various stakeholder groups. Interval-valued spherical fuzzy sets outperform the previous extensions because their membership function can be characterized in a wider range of ways. For adding decision makers' opinions about the membership functions of a fuzzy set into the model with an interval rather than a single point, interval-valued spherical fuzzy sets are used. Their paper uses the IVSF AHP approach to address the issue of public transportation [1].

Dogan's work proposes a fuzzy MDCM technique to handle the problem of process mining technology selection under uncertain and ambiguous settings. Their approach is based on spherical fuzzy AHP. Then, one-at-a-time sensitivity analysis is used to lessen the subjectivity of the decision-makers [2].

The AHP is expanded in Sharaf's study by SFSs. SFSs are employed in the suggested method to build the pairwise comparison matrices. A spherical fuzzy preference scale is therefore presented. To guarantee that a reasonable solution is obtained, the consistency of the spherical fuzzy pairwise comparison matrices is then verified. To do this, the spherical fuzzy pairwise comparison matrices are transformed into crisp matrices, and the consistency is then checked using Saaty's eigenvalue approach [3].

Under the SFSs' dimensions, Sangwan has presented a comprehensive framework that combines the AHP and TOPSIS methodologies. SF AHP is used to determine the criteria weights, which are subsequently utilized in IVSF TOPSIS to determine where the cloud service providers rank. The study considers six contradictory benchmarks set by three decision-makers and five possible solutions. A sensitivity analysis is also carried out to show how trustworthy the suggested method is [4].
Tepe's research focused on the issue of choosing an electric vehicle and included a case study with six criteria and 10 possibilities. The suggested decision model combines interval-valued spherical fuzzy sets with the AHP and ELECTRE methodologies. This study is interesting since it is the first to assess the performance of electric vehicles using IVSF, AHP, ELECTRE and make appropriate choices [5].

To assess farmers' perceptions of Agriculture 4.0 technologies and conduct a prioritization research based on how these technologies are perceived to be used, Erdogan suggests a decision-making framework. To address all qualitative and quantitative decision-making elements, multicriteria decision analysis is also used. Interval-valued spherical fuzzy numbers are utilized in the context of this study to best model the ambiguity in the process and to be able to reflect the uncertainty caused by the use of linguistic variables in the decision process [6].

The goal of Gundogdu and Kahraman is to extend the traditional AHP to the SF AHP approach and to demonstrate its application and validity through a case study involving the selection of a renewable energy source and a comparison of neutrosophic AHP and SF AHP [7].

Gundogdu and Kahraman utilized their proposed method to compare the service performances of various hospitals, and their study expands upon the IVSF AHP method. The approach has been created with this objective in mind, and it analyzes service quality in the healthcare sector using SERVQUAL dimensions [8].

Although there are various articles in the literature about SuperApps and their economic effects, this article on the choice of business model to be applied in SuperApps will be the first article in the literature.

3. SUPERAPPS AND THEIR FEATURES

This imposing and inaccessible SuperApp business model raises many questions, such as: Is the concept of "SuperApp" the strategy we should implement, or is the "SuperApp Strategy" a phenomenon that needs to be worked on at a focused level? To answer the questions that arise the definition of SuperApps and their features should be outlined.

SuperApps are digital platforms that offer services and applications to users at the same time, such as food ordering and delivery, taxi calling, shared driving services, digital payment, sales of bus, plane, or movie tickets, car rental, courier services, insurance services, social networking applications, essential health services, repair, and concierge services. The two main results can be deducted from this definition: SuperApps have a broad user network and business relationships with business partners that provide their services. (If a SuperApp does not carry out all the business processes, it provides other services and applications by establishing cooperations, except for the services that almost all are experts and debut) [9]. The definition outlined above may be biased if we perceive SuperApps as Double-Sided Online Marketplaces. While the supplier cluster has the same characteristics in applications such as AppStore, OpenSea, AliBaba, Delivery Hero that work with the Double or Multi-Sided Online Marketplace business model, the suppliers differ in every aspect.

For example, in Delivery Hero, all suppliers are only food suppliers such as restaurants, buffets, and fast-food restaurants, while in SuperApps, those who are positioned on the supplier side, for instance, the characteristics of the car rental business partner and the movie theater operator business partner are entirely different from each other. For this reason, in marketplaces such as Delivery Hero, it is possible to reach a high number of business partners due to the specific and rapid operation of the management processes on the business partner's side, as well as creating a competitive environment between the marketplace business partners, additional income models can be created through business partners, or the service offered by the business partner below a certain quality. The relevant business partner can be quickly dismissed or sanctioned when detected. On the contrary, the situation is quite different with SuperApps. SuperApps select their business partners through a much more rigorous process (refer to Table 1).

As mentioned above, SuperApps have an extensive user network, and the business partner is expected to have the capacity and service management ability to serve this vast user network. If SuperApp includes limited-service management capability business partners serving at a local level (geographically) among the services it offers, in this case, it will make its users dissatisfied.

Table 1. Characteristics of the SuperApp partner candidate

	SuperApp	**Online Marketplace**
Size of Partner:	Corporate	SME
Management Process:	Common Agreement	Central
Partner Competition:	Non	Extensive and promoted
Human Resources:	Expertise	Best practice based
Number and Variety:	Less	Huge
Relevance and Weight:	Very	Negligeable

Since SuperApps need to cooperate with large corporate structures as business partners, they face negotiating with the same business partner it deals with. In this case, it would be challenging to conclude the negotiation terms with satisfying results for both sides. However, if the size of the user network owned by SuperApp appeals to the business partner, the parties can conclude the terms by a successful agreement. If the business partner is already a sub-company of a large "conglomerate," the possibility of forming a basis for a deal is very slim. In such a case, the candidate partner company would see that most of the user network they discuss intersects with the leading "conglomerate" company and would think such a business partnership would be meaningless [10]. The strategically suitable partner candidate for a SuperApp should have the following three characteristics:

- Specializing in a specific vertical business area,
- Not belonging to a large conglomerate or not having access to a network where it can coincide with the network of the relevant SuperApp,
- To provide active services in a wide area geographically (or preferably digitally).

Finding business partner candidate(s) with these background features may also vary for SuperApps depending on the economies in which they operate. To contribute to this perspective mentioned above, the effect of the economic size of the region or country where the SuperApp operates should be elaborated: As an example, we can compare the economies of the United States and Turkey from a valuation perspective: While the total value of NYSE and Nasdaq was approximately 45 Trillion USD in May 2022, we know that the total value of BIST in the same period was about 170 Billion USD. In large economies, SuperApps would have the opportunity to find business partner candidates or even candidates with ease. This opportunity would be slim in shallow economies. The economy in which SuperApp operates and wants to grow may also lead to changes in the SuperApp strategy. So, what should be the partner acquisition strategy of SuperApps operating in narrower and limited economies?

To overcome this deadlock, SuperApps should focus on early startups which provide services with digital business models in vertical markets. Early startups should deliberately be chosen because they still have time to reach their maturity period. Since an early startup has yet to prove itself, it will likely be overwhelmed by the demands flowing to it from the SuperApp. On the other hand, a startup that has already entered the maturity period would lead to "refine stage" in its internal organization (investors want to maximize the valuation for a possible exit). However, SuperApp would not want to feel the pressure of the "refine stage" strategies the mature startup applies regarding the service it will commission with the business partnership.

3.1. SuperApp Business Model Alignment

We also mentioned above that the type of startup that SuperApp should focus on should have a digital business model. This feature is essential in meeting the cascading demands of the SuperApp user base (and naturally, we are referring to the scaling of the partner). Otherwise, it would be an unnecessary managerial risk for SuperApp to bear the potential burden of the startup trying to open a playground for itself in the physical world. If we exemplify this situation with the mobility industry, the most suitable partner candidate for a SuperApp will not be a startup that puts its vehicle fleet into service with an innovative business model but a startup that markets the uses of other people's vehicles without having a physical vehicle fleet [11].

Although this business partnership strategy is compatible, another critical point to be considered is what the investors of both parties expect from the future of the business partnership. Although the collaborative profile built continues in harmony, the SuperApp has a high probability of acquiring and completely swallowing the small startup in this symbiotic collaboration. For this reason, the fact that the parties clearly state their expectations of each other and the cooperation they established at the very beginning of the road eliminates many potential problems before they arise.

3.2. Network Interaction

The importance of the user base of SuperApp was mentioned earlier. The network is essential because the digital platform income arises from the interaction of the network's sides. Thus, it is concluded that in digital platforms and naturally in SuperApps, the network, and interaction are as meaningful as the network. What should be expressed about interaction is the characteristics of interactions. These interactions are not sourced from a single interaction type; instead, they form a set of interactions. It is recommended for SuperApps that the user harmoniously perceives these interactions and that they are "complementary" and "integrated" interactions as much as possible. To exemplify this situation, we can focus on shared driving experiences in the mobility sector: It is expected that the first steps in the journey of an application that started with a shared driving experience service to evolve into a SuperApp will be services that complement this initial point of departure—for example, enriching the application with examples from the mobility sector, such as selling plane, train and bus tickets. Suppose this example of the SuperApp candidate is to provide digital payment systems service in the following steps. In that case, it should do so in an integrated manner, integrate this digital payment service with the sales of plane, train, and bus tickets it offers, and let its users experience it.

The main reason for this binding is the value proposition we deliver to our user network at the beginning of our journey. However, it would be fitting to diversify the services after commissioning several complementary services. We can exemplify this case for an online food ordering service: Providing grocery, water orders, or similar cargo delivery services for users does not cause a jolt in the perceived value proposition from the customer's point of view. On the contrary, it would be welcomed positively. However, suppose an application that started by offering a food order service that suddenly tries to sell insurance to its users. In that case, it may seriously damage the perception of the user base. SuperApps can benefit from "industry similarity indexes" while deciding which service they will deploy next and being inspired by their experiences and opinions. It may also be a very realistic approach to conduct analytical studies that predict which additional services users can request after performing machine learning studies with the "big data" held by SuperApps that have reached maturity [12].

3.3. User Audience

Thanks to a single application, the comfort and pleasure of accessing dozens of services the user may need within seconds seem very attractive. SuperApps are expected to require fewer clicks than the "standalone app"; this provides serious comfort to the user. Thus, the user cannot download separate applications for daily activities. Users who can access many services together will keep the SuperApp application on their mobile phones and use it whenever needed.

However, another area that needs to be managed against SuperApps arises in this case. The essential feature of SuperApps, called "Process Excellence" or "flawless," is a concept with an inter-service binding for SuperApps. The fact that a SuperApp serving in, e.g., ten main business lines include nine perfectly functioning business lines and one service line that creates dissatisfaction, unfortunately, binds SuperApp itself due to all its other services. Entire customer processes should be digitally delivered to avoid this disadvantage.

3.4. Building the Strategy

Considering the factors mentioned earlier, it is easy to conclude that the SuperApp business model itself is not a strategy. Still, different methods should be implemented considering the relationships with business partners, the depth of the economy in which it operates, and the internal dynamics and maturity level of the SuperApp.

However, it is reasonable to divide the strategies that would be implemented for the SuperApp into phases according to the lifecycle phases of the platform and to establish different but mutually supportive strategies in each phase.

To elaborate on this issue, the life cycle of a SuperApp platform can be evaluated into three periods: development, growth, and maturity (see Figure 1).

The development period is an expansion or a network building for SuperApps. This period is where managers set out with the business line they know best, not potential collaborations, strengthen their value proposition, expand the user pool as much as possible, listen to the customer, and revise the value proposition frequently with feedback. During this period, managers are still determining if they have solved the user base's basic needs and problems. No platform sells products or services. The meta they sell needs to include the missing item of the user vast. The user needs meta, emotion, or experience they are missing. If managers cannot accurately define what they are selling, they will have difficulty establishing and reinforcing the value proposition, thus building collaborations in the later stages of the SuperApp. What are they selling? Time? Comfort? Accessibility?

Figure 1. Phases of a SuperApp digital platform

3.5. Aligning Value Proposition with Business Processes

It is just as essential to embed the value proposition into business processes as it is to identify it. The value proposition should be embedded in an almost corporate DNA format, not only in end-user processes but also in other internal organizational processes. Users interact with the platform not just as a customer but often as an employee, suppliers, or in different forms. The user who takes on these roles should also feel and experience the traces of the value proposition in business processes that touch these roles.

At this stage, the SuperApp candidate will risk significant losses (promotion and marketing budget, i.e., customer acquisition cost "CAC") to grow its network audience. Although this first period is the phase of reaching the user base, which may create a total loss at the bottom line, the application must generate revenue to prove itself. Interaction channels will naturally be established to generate income at this establishment stage. At this point, digital leaders should think and design the interaction channels multidimensionally, not one-dimensional.

3.6. Income and Loyalty-Building Interactions

As stated earlier, the interaction between the parties would create revenue. However, more than this one-dimensional interaction is needed. To build user loyalty, i.e., commitment, interaction should be established between and within the parties. Loyalty only depends on the user's interaction with himself and another user. In Table 2, examples of interactions that generate revenue and commitment by the platform in different business lines are listed.

SuperApp candidates, who have passed the infancy stages and reached the growth stage, will find new management areas such as contract management, integration, and data consolidation under the title of collaborations in this stage. Companies that will take part in the SuperApp will have the opportunity to reach a ready and wide network, as well as get rid of software development costs with a technological effort only at the level of integration with the relevant SuperApp and find the opportunity to focus on their own business and service excellence. Although this is a significant gain for the business partner, it also requires pre-calculation of what steps to take if the SuperApp it works with is in any problematic situation.

Table 2. Revenue and loyalty creating interactions based on different sectors

Business Line	Revenue based Interactions	Loyalty based Interactions
Career:	Placement	Training Tools, Search and Filter Options
Food Order:	Online Order	Gamification
Online Marketplace:	Product Order	Price Comparison, Comments and Scoring
Messaging:	Online Payment, Money Transfer	Messaging, Facetime Calls

As well as the value proposition of being a solution to the user problems raised earlier, SuperApps should also answer the following question: "Can the problems of collaborating partners be solved?". The response of business partners to finding solutions to each other's needs and problems is the first step in making progress in the "digital innovation" approach.

The platform, which has passed the growth phase, is now taking firm steps towards becoming a great SuperApp. Its partnership structure has changed with the investments and funds it has received until this maturity period. New faces from different backgrounds and experiences have taken their place in senior management. In parallel with the changing partnership structure, the partners will press the top management about the company's valuation to create new funding or different financial opportunities and expect profitability from the company. The SuperApp, which has entered the maturity period, should carry out efficiency studies to reduce costs in the face of these demands and produce diversified and customized offers according to customer segments with analytical studies based on big data.

The possibility of encountering the need to make some arrangements or revisions about the business partners may come to the fore, according to the functional harmony of the business partners in the SuperApp and the users' feedback. Since the harmony with business partners should become more automatic and robotic during the maturity period, it becomes necessary to focus on technical integration studies at this level, in other words, to create a "toolbox effect." The SuperApp may stop working with some partners during this period [13, 14].

At this point, an interesting question may arise: Although standalone apps such as YouTube, Instagram, and Google Maps have more users than SuperApps, why don't they turn their business model into a SuperApp business model and use this massive network in their hands? The answer to this question lies in the business model difference between standalone apps and SuperApps.

In SuperApps, the product is the value arising from interaction; In individual applications such as YouTube and Instagram, the product is the interaction itself.

4. DIGITAL PLATFORM FEATURES

4.1. SuperApp Platform Building Features

Successful digital platforms have similar features (refer to Figure 2). Almost all of them are built on the model of bringing together buyer and seller groups. Apart from this model, there are, of course, other business models that have been and can be successful. Skype and PayPal cases may be exemplified: Why do users utilize these apps? Would a user utilize Skype if there was no other user to talk to? If a user cannot find a business that accepts PayPal payments, is there any point in using it? The same is true for the online marketplace model, which set out to bring together a massive group of buyers and sellers. The challenge is not just about the number of networks targeted to be managed but also about their diversity. If a marketplace has only one product line range, its usage frequency would drop dramatically. So, not only the amount but also the diversity of the network is significant [15].

What should managers pay attention to when setting up a digital platform? What should be the strategy that they need to construct and operate? A structural framework can be presented by asking five questions regarding the following digital platform strategy features:

4.1.1. Network Building

The first of five basic questions: Can a user base be attracted to the digital platform? Entering a large user base on a digital platform and being able to register, log in, and use the platform is the first essential step to digitally scaling the platform. To create this, managers must meet the requirements of at least 1 of the 2 cases: The first one is that the business already has a ready-made user base that it addresses and can direct to the platform. The Google AdSense case may exemplify this situation: Google AdSense first opened its service to already existing Google AdWords users. The second case is the strategy of making available data that already exists. Zillow, a real estate search website, used this strategy. First, it collected all the data about the real estate sector, which it could obtain free of charge over the net or from government institutions, and converted this data mass into a format that users could search, list, and turn into a benefit with easy use. In short, it packaged the data it had beautifully and presented it to the users. New data was added to the existing data by the users' use of this data. Zillow presented this new data back to its users. This strategy consists of 3 steps: (1) Organize and pack the existing data and present it as usable, (2) import users and create new data or transaction data, and (3) sell users' data back. This strategy must have brought Google to mind immediately. Did Google follow the Zillow Steps too? In the simplest sense, Google uses web crawlers to reach servers worldwide and store publicly available data. It presents this data as usable with the sorting algorithm it has developed. This time, it sells the search and click data created by the users to those who want to advertise. In other words, the Zillow steps mentioned are also valid for Google. This strategy is used successfully by Google and many digital platforms, even if users do not feel it. This is the first point that online marketplaces use and start for their exit strategy [16, 17].

4.1.2. Value Proposition Building

If managers cannot reach large user groups, they should answer the second question: Can they offer a value proposition if the platform cannot get mass users? This case may be exemplified by a historical videotape boom of the 1980s illustration: Video players are devices that allow users to watch tapes on television. Consider the time when video players and video cassettes first hit the market. Since there needed to be more video players, the movie industry naturally wanted to avoid printing and reproducing their films on videotape. Likewise, end users did not buy video players because they needed more movie cassettes to watch, like the Skype and PayPal example given earlier. Cinema producers do not produce tapes because there is not enough audience potential, and the potential audience does not buy video players because there need to be more film tapes. This is a very frustrating paradox for video producers. Manufacturers circumvent this dilemma by introducing a new value proposition, adding a "record feature" to video players. End users quickly accepted this value proposition, and with the increasing use of video players, the motion picture industry acted immediately to print their films on videocassettes.

There are two basic strategies managers can implement to offer users value propositions: The first is to focus on a narrow niche market early. Yelp, the city guide that shares information and reviews about hundreds of thousands of places worldwide, was a website that listed only Far Eastern cuisine restaurants in a single city, San Francisco, and shared information and comments about products and user experiences. It took a little while for Yelp to add other towns and places to its portfolio, along with the potential for use.

The other strategy is to make the digital platform available to a limited social group or create an environment where users can socialize. For example, in the past, Zynga company gave an excellent example of a social game design by allowing users to help each other in Farmville. At the time Farmville was popular, the number of daily active users was 35 million unique users. The Clubhouse application, available only to iPhone users, also successfully implements this strategy at an early stage [18].

4.1.3. Trust-based Relationship Building

Another question that should be answered is how to gain users' trust—creating champions for the best experience platform that managers would get on this topic and see the results quickly. Managers can think of the champions of the platform as their paid users. Whatever the platform's subject, promoting and advertising should be considered with well-known champions in the relevant industry, having a high number of followers on social media channels, and will drag other potential users behind them. Managers may have heard that most of the "Gamers" with a high number of followers on social media channels share their gaming experiences with their followers as part of a promotional campaign [19].

1. Platform Building Features
1. Network Building
2. Value Proposition Building
3. Trust based Relationship Building
4. Revenue Model Building
5. Legacy Advantage

2. Interaction Effect Features
1. Matchmaking Effect
2. Magnet Effect
3. Toolbox Effect

3. Network Features
1. Network Effect
2. Cluster Effect
3. Risk of Disintermediation
4. Multi-homing
5. Multiple Network Access

Figure 2. Criteria and Sub-criteria

4.1.4. Revenue Model Building

The fourth question is how and how much users should pay for the digital platform. The digital platform needs users, so managers must keep users in the network as much as possible. Users should be reassured about the financial aspect of the business model. Since products and services are in a digital environment, managers can apply many different and creative offers and pricing strategies that they cannot offer offline. They can try various models, such as:

- Pay-as-you-go
- Different payment options according to different feature packs
- Creation of user-specific offers

If the platform has a two-sided marketplace model, managers must offer these applications to the end user, the buyer, and the service provider, the seller. They should develop multiple pricing and revenue turnstile models that will put the network stakeholders at ease and stay on the digital platform, no matter which side they are on. For instance, Uber provides additional rewards to drivers who respond positively to five consecutive calls to avoid the "risk of multi-homing." Thus, it both increases the loyalty of the drivers and offers passengers more driver options when they enter the application [20].

4.1.5. Legacy Advantage

The last question is more relevant for businesses that are already running but want to present their existing customers with a new digital model. One of the fastest and most robust ways to create users for the digital platform is to target current customers. As mentioned earlier, if investors still have an ongoing business, attracting their existing customers to the digital platform will be a fast and very low-cost solution.

4.2. Interaction Characteristics

Today, business professionals can count the most important reasons why digital platforms come to the fore intensively as (1) the transformation of competition as the commercial competition starts to take place over platforms rather than products, and (2) the process of creating shared value that allows interaction to increase in line with end-user expectations [21]. With the shift of competition and customer interaction onto digital platforms, it has become crucial for businesses to recognize and understand the platform features. A digital platform builds on three primary features: (1) Cloud, (2) Mobile, and (3) Social.

The Cloud feature qualifies for the platform's time independence, while the Mobile feature qualifies for the platform's spatial autonomy. The third feature, the social feature, qualifies the human dimension of the platform, that is, the end user dimension, i.e., the customer. With the change of generations, the demand for end users to interact with digital systems is increasing. Responding to this demand on the business side requires a bold and highly motivated management approach as well as technological and organizational means and capacity. Because the interaction with the end users takes place in social media and similar public environments, or even if this is not the case, this interaction may be made public by the end user positively or negatively. Business processes and policies that support this commercial courage and motivation can be put forward through strategic management. Strategic management also requires visionary leadership. It would not be wrong to describe the digital platforms that we give the basic features of as Cloud, Mobile, and Social as the "Globally Accessible Networks," that is, networks that can be accessed globally, with network management independent of time and location [22].

When digital platforms are defined as networks that can be accessed globally, three essential business elements sustain and feed this structure. These, respectively, are "Connection," which can be understood as the ease of integrating and transacting for users, "Attraction" which can be described as the attractiveness of including users and stakeholders; and "Flow," which can be defined as the convenience of the steps followed in creating interaction and shared value. Business professionals can support these three essential business elements with business elements only after they complete the processes of transforming the big data they have into information and then into managerial decisions. Before moving on to the business elements that support these business elements, the importance of Big Data should be emphasized. The journey of data science, which ends with the transformation of raw data into manageable data, the analysis and modeling of this data using suitable analysis methods, and the entry of the analyzed and modeled data into decision-making processes, is a business layer that is an inseparable part of the items mentioned earlier [23].

4.2.1. The Matchmaking Effect

Managers can supplement the first item of work, "Connection," with Matchmaking, the "Matchmaker Effect." In the digital platform, managers will use data, which is the essential element for the correct matching of the parties. Set up advanced search options on the platform so parties can find their counterparty. Encourage the support of content with data and images.

4.2.2. The Magnet Effect

Managers will use the Magnet, the "Magnet Effect," to support the "Attraction" element. For users to transact, shop, swap, and interact on the digital platform, they need to be able to find parties. Promotions, campaigns, and revenue models should be designed to attract every user group to interact.

4.2.3. The Toolbox Effect

"Tool Effect" is the last element to support the "Flow" item. Managers can create a tool effect only with the technological opportunities and resources they will provide to users. To give an example of the tool effect created by digital platforms, we can cite the following examples: The code libraries provided by Apple to programmers, the hosting opportunities offered by YouTube to content creators, and the collaborative content creation feature provided by

Wikipedia to authors. If other global examples are observed, Amazon gives more importance to Toolbox when we look at the AWS platform. Digital platforms such as eBay and Airbnb have strengthened the influence elements of Matchmaker and Magnet to increase their network interaction. On the other hand, what can managers say about the Facebook platform if they evaluate it in terms of corporate users? Corporate companies that consider Facebook and its group companies as promotional channels are in constant promotional activity on Facebook. While doing this, they use the promotion management interfaces designed in detail. Looking at these comments, Facebook uses Magnet and Tool Effects quite well.

4.3. Network Features

In this section, we will focus on five basic platform features that are interesting and that managers should know when operating their digital platforms [24]. Managers who evaluate these five essential features may make pivotal moves to change their digital platform's business model. To better understand the effects and dynamics of these features on digital platforms, the Didi case may be an adequate example.

Didi is the world's largest ride-hailing service company, with 30 million daily transactions. It was established in 2012 in China. It has surpassed Uber in many ways. Didi acquired local competitor Kuaidi in 2015 and Uber China in 2016. In 2016, it reached a daily transaction volume of 25 million. In 2018, Meituan, in the online and offline food market industry, started its ride-sharing service in Shanghai. Meituan began by taking 8% commission from the drivers instead of Didi's 20% commission, and thus thousands of cars were registered to Meituan from Didi. Didi got into the food delivery business in response to Meituan. Companies lost money with mutual promotions and free campaigns, and their profitability decreased considerably. In March 2018, Alibaba's online map service, Gaode Map, started to provide a shared-driving service and accepted other players to its platform using the "opening the doors to others" scenario. On the other hand, Ctrip, an Online Travel Agency, an online tourism agency, also entered the same sector.

As can be seen, the technological possibilities available to digital players have seriously reduced the barriers to entry into different sectors [25]. Based on the size of the market, it is inevitable that the competition will shift from products to digital platforms, as pointed out earlier. So, what is Didi doing now in an intense digital competition environment? Didi continues its operations in China. It started operations in Russia in 2020. However, it still needed to eliminate AliBaba and other competitors from the Chinese market. In short, it continues its activities by expanding and losing a significant market share. So why does this occur? Why are digital platforms subject to such intense competition? What should a digital platform do when faced with such open competition? To answer these questions, it is necessary to understand the Network on which the digital platform runs.

The success factors of traditional and digital companies are different; for this reason, who manages the digital operational processes implemented on digital platforms and who provides the product and service is crucial. Competitive advantage is not created at the product, service, or company level but during the interaction of the Network and the platform. The success of a platform, that is, the success of digital network management, is possible if a healthy, robust, and dominant ecosystem is established. The soundness of a digital platform means its scalability potential; its robustness means its profitability, and its dominance means its sustainability.

If we pay attention to the example of Didi, we see that it is much easier to scale the platform than to maintain it. Didi needs help becoming a market dominator due to the intense competition environment. Here are the five crucial digital network features to understand why such situations occur:

4.3.1. Network Effect

The first feature is the Network Effect. The network effect brings many advantages to the digital platform; It includes existing users to get more users to the platform, and the growing user presence attracts suppliers; on the contrary, the increasing diversity with the number of suppliers attracts more users, the decrease in promotion, marketing, and sales costs with the content creation of the stakeholders on the platform, and the increased interaction with the shared value creation factor [26].

4.3.2. Clustering Effect

The network's structure is the most significant factor in maintaining the platform's scale. The more types and features of the network structure in small sections, the more fragile and competitive the platform is. For instance, taxi drivers in Istanbul are looking for passengers in Istanbul. Likewise, the passengers need to look for cabs in Istanbul as well. A person who wants to go home after work in Istanbul does not call a taxi from Antalya. In this case, competing with an application like BiTaksi in İzmir, Ankara, or any other geography is straightforward, with the precondition of a definite commercial focus on the relevant region. In the example of Didi, for the same reason, Didi had to compete with dozens of digital players in different cities, despite being the first in the market due to the large geographical structure and large population of China. This effect is called the Clustering Effect. At this point, we can cite Airbnb next to the Didi case. How many ways can we cluster customers when we think about Airbnb? Or conversely, how many other groups can a customer divide the houses in the city he or she will be traveling to? In this case, Airbnb's network cluster is almost homogeneous, i.e., very similar. Therefore, emerging as a competitor to Airbnb requires global competitiveness. However, competing in a narrow area with platforms with a business model open to clustering effects like Didi is possible [27, 28].

4.3.3. Risk of Disintermediation

Another network feature managers may encounter in digital platform management is the Risk of Disintermediation. This feature arises because the parties can continue their commercial relations and interactions without the platform's services after they find their counterpart using the digital platform. Consider a platform that provides an "Armut" like service and meets users who want to receive assistance. If a user is satisfied with a cleaning worker, he or she met through such a digital platform, would he or she reach that person later on the same platform? Or does the same cleaner use the same platform again when he or she gets enough customers through the platform? Digital platforms with business models at risk of disintermediation can be likened to leaky buckets. Still, they continue to exist and grow due to the tremendous and continuous mutual demand between the network parties.

4.3.4. Multi-Homing

The multi-homing vulnerability occurs when users are simultaneously on multiple competing platforms. To reduce the risk of multi-homing exposure, solutions such as target number of transactions, rewards for turnover, or loyalty systems can be implemented on the platform. Uber rewarding drivers who accept requests five times in a row can be an example. However, the prevention of this risk may vary from business to business. We can give campaign-based platform examples such as "Grupon" or "Şehir Fırsatı." Some of them had prevented their merchants from being on another platform, but customers started using more than one website in this case. In other words, even if multi-homing was blocked on one side of the network, it could occur on another platform [29, 30].

4.3.5. Multiple Network Access Effect

The final network feature is the "multiple network access effect." AliBaba; provides access to different networks with its AliPay application. The strategy of reaching various networks lies behind the fact that digital ecosystems such as Amazon offer multiple services simultaneously [31, 32]. Recall the Didi case. Unfortunately, in the example of Didi, this can only be possible through purchases or differentiation of services.

Many digital platform features should be considered by managers when designing a SuperApp business model. Since these features are transitive both within and between each other, a bundle of strategies that are difficult to manage for managers in different fields and specialties occurs. To manage this complexity and variability, each of the senior executives from different fields, such as marketing, sales, information technologies, finance, and human resources, must evaluate the digital business model to be selected from their perspective. However, a decision that this senior executive team will make jointly, and a digital vision digital platform business model should be chosen. One of the most suitable methodologies for this decision-making process is the "Fuzzy AHP" methodology. "Fuzzy AHP," which enables decision makers to evaluate alternatives from different perspectives and look at the selection problem with a holistic approach, will be used to evaluate all these criteria and sub-criteria mentioned above. Spherical Fuzzy Sets (SFSs), which offer a wider preference domain to decision-makers, would be the right choice when using the fuzzy AHP method.

5. METHODOLOGY

5.1. Interval-Valued Spherical Fuzzy Sets (IVSFSs): Preliminaries

SFSs are used by decision makers to determine membership degrees within the ranges determined for criteria and sub-criteria. SFSs can have a maximum square sum of 1.0. Thus, decision makers' "hesitancy" can be easily identified in an SFS domain. For example, let the fuzzy numerical value of a verbal preference be (0.6, 0.4, 0.5). The sums are greater than 1, but the sum of the squares is less than 1. SFSs were developed by Gündoğdu and Kahraman [33, 7, 34, 35] based on Pythagorean Fuzzy Sets. The definition of SFSs is given as follows:

Definition a. In a universal set of U, a single-valued SFS A_G is described as,

$$\tilde{A}_G = \{\langle u, (\mu_{\tilde{A}_G}(u), \nu_{\tilde{A}_G}(u), \pi_{\tilde{A}_G}(u)) | u \in U\rangle\} \tag{1}$$

where

$$\mu_{\tilde{A}_G}: U \to [0,1],$$
$$\nu_{\tilde{A}_G}: U \to [0,1],$$
$$\pi_{\tilde{A}_G}: U \to [0,1],$$
$$0 \leq \mu^2_{\tilde{A}_G}(u) + \upsilon^2_{\tilde{A}_G}(u) + \pi^2_{\tilde{A}_G}(u) \leq 1 \ \forall u \in U.$$

For each , the numbers $\mu_{\tilde{A}_G}(u)$ is degree of membership and $\nu_{\tilde{A}_G}(u)$ is non-membership. Finally, $\pi_{\tilde{A}_G}(u)$ is the hesitancy of u to $\bar{A}_G$.

Gundogdu and Kahraman [8] describe the arithmetic calculation of IVSFSs. They also present the formulas to defuzzify and aggregate IVSFSs.

Definition b. An IVSFS $\tilde{A}_G$ of the universal set U is defined as in Eq. (2).

$$\tilde{A}_G = \left\{ u, \begin{pmatrix} [\mu^L_{\tilde{A}_G}(u), \mu^U_{\tilde{A}_G}(u)], \\ [\upsilon^L_{\tilde{A}_G}(u), \upsilon^U_{\tilde{A}_G}(u)], \\ [\pi^L_{\tilde{A}_G}(u), \pi^U_{\tilde{A}_G}(u)] \end{pmatrix} | u \in U \right\} \tag{2}$$

where

$$0 \leq \mu^L_{\tilde{A}_G}(u) \leq \mu^U_{\tilde{A}_G}(u) \leq 1,$$
$$0 \leq \upsilon^L_{\tilde{A}_G}(u) \leq \upsilon^U_{\tilde{A}_G}(u) \leq 1,$$
$$0 \leq \left(\mu^U_{\tilde{A}_G}(u)\right)^2 + \left(\upsilon^U_{\tilde{A}_G}(u)\right)^2 + \left(\pi^U_{\tilde{A}_G}(u)\right)^2 \leq 1.$$

For each $u \in U$, $\mu^U_{\tilde{A}_G}(u)$ is the upper degrees of membership and $\upsilon^U_{\tilde{A}_G}(u)$ is non-membership. Finally, $\pi^U_{\tilde{A}_G}(u)$ is the hesitancy of u to $\tilde{A}_G$. For an IVSFS $\tilde{A}_G$, an interval-valued spherical fuzzy number is defined as;

$$\langle [\mu^L_{\tilde{A}_G}(u), \mu^U_{\tilde{A}_G}(u)], [\upsilon^L_{\tilde{A}_G}(u), \upsilon^U_{\tilde{A}_G}(u)], [\pi^L_{\tilde{A}_G}(u), \pi^U_{\tilde{A}_G}(u)]\rangle$$

For convenience, the pair;

$\langle [\mu_{\tilde{A}_G}^{L}(u), \mu_{\tilde{A}_G}^{U}(u)], [\upsilon_{\tilde{A}_G}^{L}(u), \upsilon_{\tilde{A}_G}^{U}(u)], [\pi_{\tilde{A}_G}^{L}(u), \pi_{\tilde{A}_G}^{U}(u)] \rangle$

is denoted by

$\tilde{\alpha} = \langle [a,b],[c,d],[e,f] \rangle$

where

$[a,b] \subset [0,1]$,
$[c,d] \subset [0,1]$,
$[e,f] \subset [0,1]$,
$b^2 + d^2 + f^2 \leq 1$.

5.2. Extension of Spherical Fuzzy AHP (SFAHP)

SFAHP comprises the phases below;

Level 1. First, we develop a 3-layer model for use within AHP. These model layers are alternatives, main criteria and sub-criteria, respectively.

Table 3. Linguistic expressions for SFSs [8]

Linguistic terms $\tilde{\alpha} = \langle [a,b],[c,d],[e,f] \rangle$	**Score Index**
Definitely Extreme Relevance (DER) ([0.85,0.95], [0.10,0.15], [0.05,0.15])	9
High Extreme Relevance (HER) ([0.75,0.85], [0.15,0.20], [0.15,0.20])	7
Extreme Relevance (EXR) ([0.65,0.75], [0.20,0.25], [0.20,0.25])	5
Slightly More Relevance (SMR) ([0.55,0.65], [0.25,0.30], [0.25,0.30])	3
Equally Relevance (ER) ([0.50,0.55], [0.45,0.55], [0.30,0.40])	1
Slightly Small Relevance (SSR) ([0.25,0.30], [0.55,0.65], [0.25,0.30])	1/3
Small Relevance (SR) ([0.20,0.25],[0.65,0.75], [0.20,0.25])	1/5
Very Small Relevance (VSR) ([0.15,0.20], [0.75,0.85], [0.15,0.20])	1/7
Definitely Small Relevance (DSR) ([0.10,0.15], [0.85,0.95], [0.05,0.15])	1/9

Level 2. In this step, we will use Table 3 to reduce the verbal preferences of decision makers to numerical expressions. We will use this measurement reference to compare criteria and sub-criteria pairs when evaluating alternatives.

Level 3. We are at the step where we will measure whether the decision makers' comparisons are consistent. For this we must ensure that the CR levels we will measure for each assessment are below 10%. If we do not reach the desired numbers of CR levels, we will revise the consistency of the evaluations of the decision makers.

For instance, the dual-cross comparison matrix

$$J = \begin{matrix} C_1 \\ C_2 \\ C_3 \end{matrix} \begin{vmatrix} ER & SSR & ER \\ SMRI & ER & HER \\ SR & VSR & ER \end{vmatrix}$$

is converted to

$$J = \begin{matrix} C_1 \\ C_2 \\ C_3 \end{matrix} \begin{vmatrix} 1 & 1/3 & 5 \\ 3 & 1 & 7 \\ 1/5 & 1/7 & 1 \end{vmatrix}$$

and the CR is figured as 0.047, meaning the dual-cross comparison matrix ensures consistency.

Level 4. The decision-maker's preferences are taken into account to understand the numeric relevance of IVSFSs. We will calculate weightings based on the Eq. (6) of IVSWAM.

$$IVSWAM_{\omega}(\tilde{\alpha}_1, \tilde{\alpha}_2 \ldots, \tilde{\alpha}_k) = \omega_{1.}\tilde{\alpha}_1 \otimes \omega_{2.}\tilde{\alpha}_2 \otimes \ldots \otimes \omega_{k.}\tilde{\alpha}_k$$

where

$w = 1/n$ (Eq. 6).

Level 5. We build the structure of the created hierarchy to calculate the global weights. We calculate the score ranks for each level of the hierarchy based on the preference importance of the IVSFSs. We use the full and partial IVSFAHP methods, see Eqs. (3-6) and Eqs. (7, 8), respectively, and the weights of the criteria are defuzzified.

$$Score\left(\tilde{\omega}_j^G\right) = S\left(\tilde{\omega}_j^G\right) = \frac{a^2+b^2-c^2-d^2-\left(e/2\right)^2-\left(f/2\right)^2}{2} + 1 \quad (3)$$

Eq. (4) normalizes the criteria weights:

$$\overline{\omega}_j^G = \frac{G\left(\tilde{\omega}_j^G\right)}{\sum_{J=1}^{n} G\left(\tilde{\omega}_j^G\right)} \quad (4)$$

Eq. (5) is used for weighting the decision matrix where $\tilde{\alpha}_{G_{ij}} = \overline{\omega}_j^G . \tilde{\alpha}_{G_i}$,

$$\tilde{\alpha}_{G_{ij}} = \left\{ \begin{matrix} \left[\left(1-\left(1-\alpha_{G_i}^2\right)^{\overline{\omega}_j^G}\right)^{\frac{1}{2}}, \left(1-\left(1-b_{G_i}^2\right)^{\overline{\omega}_j^G}\right)^{\frac{1}{2}} \right], \\ \left[c_{G_i}^{\overline{\omega}_j^G}, d_{G_i}^{\overline{\omega}_j^G} \right], \\ \left[\begin{matrix} \left(\left(1-\alpha_{G_i}^2\right)^{\overline{\omega}_j^G} - \left(1-\alpha_{G_i}^2-e_{G_i}^2\right)^{\overline{\omega}_j^G}\right)^{\frac{1}{2}}, \\ \left(\left(1-b_{G_i}^2\right)^{\overline{\omega}_j^G} - \left(1-b_{G_i}^2-f_{G_i}^2\right)^{\overline{\omega}_j^G}\right)^{1/2} \end{matrix} \right] \end{matrix} \right\} \quad (5)$$

Finally, the SFAHP scores are computed based on Eq. (7) fuzzy arithmetics for feasible alternatives to consider their preference relevancies. We can also use Eq. (8) to defuzzify the results as an other way of calculation.

Level 6. This is the level where the defuzzification of each digital model alternatives are computed.

Level 7. This final level of the methodology, where we sort the final weightings of alternatives.

$$IVSWAM_\omega = \left\{ \begin{array}{c} \left[\left(1-\prod_{j=1}^{k}(1-a_j^2)^{\omega_j}\right)^{1/2}, \left(1-\prod_{j=1}^{k}(1-b_j^2)^{\omega_j}\right)^{1/2}\right], \left[\prod_{j=1}^{k} c_j^{\omega_j}, \prod_{j=1}^{k} d_j^{\omega_j}\right], \\ \left[\left(\prod_{j=1}^{k}(1-a_j^2)^{\omega_j} - \prod_{j=1}^{k}(1-a_j^2-e_j^2)^{\omega_j}\right)^{1/2}, \left(\prod_{j=1}^{k}(1-b_j^2)^{\omega_j} - \prod_{j=1}^{k}(1-b_j^2-f_j^2)^{\omega_j}\right)^{1/2}\right] \end{array} \right\} \tag{6}$$

$$\tilde{F} = \sum_{j=1}^{n} \tilde{\alpha}_{G_{ij}} = \tilde{\alpha}_{G_{i1}} \otimes \tilde{\alpha}_{G_{i2}} \dots \otimes \tilde{\alpha}_{G_{in}} \forall i$$

$$i.e.\, \tilde{\alpha}_{G_{11}} \otimes \tilde{\alpha}_{G_{12}} = \left\{ \begin{array}{c} \left[\begin{array}{c} \left(\left(a_{\tilde{\alpha}_{G_{11}}}\right)^2 + \left(a_{\tilde{\alpha}_{G12}}\right)^2 - \left(a_{\tilde{\alpha}_{G_{11}}}\right)^2\left(a_{\tilde{\alpha}_{G_{12}}}\right)^2\right)^{\frac{1}{2}}, \\ \left(\left(b_{\tilde{\alpha}_{G_{11}}}\right)^2 + \left(b_{\tilde{\alpha}_{G_{12}}}\right)^2 - \left(b_{\tilde{\alpha}_{G_{11}}}\right)^2\left(b_{\tilde{\alpha}_{G_{12}}}\right)^2\right)^{\frac{1}{2}} \end{array} \right], \left[c_{\tilde{\alpha}_{G_{11}}} c_2, d_{\tilde{\alpha}_{G_{11}}} d_2\right], \\ \left[\begin{array}{c} \left(\left(1-\left(a_{\tilde{\alpha}_{G12}}\right)^2\right)\left(e_{\tilde{\alpha}_{G_{11}}}\right)^2 + \left(1-\left(a_{\tilde{\alpha}_{G_{11}}}\right)^2\right)\left(e_{\tilde{\alpha}_G}\right)^2 - \left(e_{\tilde{\alpha}_{G_{11}}}\right)^2\left(e_{\tilde{\alpha}_{G_{12}}}\right)^2\right)^{\frac{1}{2}}, \\ \left(\left(1-\left(b_{\tilde{\alpha}_{G12}}\right)^2\right)\left(f_{\tilde{\alpha}_{G_{11}}}\right)^2 + \left(1-\left(b_{\tilde{\alpha}_{G_{11}}}\right)^2\right)\left(f_{\tilde{\alpha}_{G_{12}}}\right)^2 - \left(f_{\tilde{\alpha}_{G_{11}}}\right)^2\left(f_{\tilde{\alpha}_{G_{12}}}\right)^2\right)^{\frac{1}{2}} \end{array} \right] \end{array} \right\} \tag{7}$$

$$\prod_{j=1}^{n} \tilde{\alpha}_{G_{ij}} = \tilde{\alpha}_{G_{i1}} \otimes \tilde{\alpha}_{G_{i2}} \dots \otimes \tilde{\alpha}_{G_{in}} \forall i$$

$$i.e.\, \tilde{\alpha}_{G_{11}} \otimes \tilde{\alpha}_{G_{12}} = \left\{ \begin{array}{c} \left[a_{\tilde{\alpha}_{G_{11}}} a_2, b_{\tilde{\alpha}_{G_{11}}} b_2\right], \left[\begin{array}{c} \left(\left(c_{\tilde{\alpha}_{G_{11}}}\right)^2 + \left(c_{\tilde{\alpha}_{G12}}\right)^2 - \left(c_{\tilde{\alpha}_{G_{11}}}\right)^2\left(c_{\tilde{\alpha}_{G_{12}}}\right)^2\right)^{\frac{1}{2}}, \\ \left(\left(d_{\tilde{\alpha}_{G_{11}}}\right)^2 + \left(d_{\tilde{\alpha}_{G_{12}}}\right)^2 - \left(d_{\tilde{\alpha}_{G_{11}}}\right)^2\left(d_{\tilde{\alpha}_{G_{12}}}\right)^2\right)^{\frac{1}{2}} \end{array} \right], \\ \left[\begin{array}{c} \left(\left(1-\left(c_{\tilde{\alpha}_{G12}}\right)^2\right)\left(e_{\tilde{\alpha}_{G_{11}}}\right)^2 + \left(1-\left(c_{\tilde{\alpha}_{G_{11}}}\right)^2\right)\left(e_{\tilde{\alpha}_{G_{12}}}\right)^2 - \left(e_{\tilde{\alpha}_{G_{11}}}\right)^2\left(e_{\tilde{\alpha}_{G_{12}}}\right)^2\right)^{\frac{1}{2}}, \\ \left(\left(1-\left(d_{\tilde{\alpha}_{G12}}\right)^2\right)\left(f_{\tilde{\alpha}_{G_{11}}}\right)^2 + \left(1-\left(d_{\tilde{\alpha}_{G_{11}}}\right)^2\right)\left(f_{\tilde{\alpha}_{G_{12}}}\right)^2 - \left(f_{\tilde{\alpha}_{G_{11}}}\right)^2\left(f_{\tilde{\alpha}_{G_{12}}}\right)^2\right)^{\frac{1}{2}} \end{array} \right] \end{array} \right\} \tag{8}$$

6. CONSISTENCY, RESULTS AND CONCLUSION

In our digital application, eight senior managers in sales, marketing, information technologies, finance and human resources departments in different sectors were determined as decision makers. According to the digital business model criteria and sub-criteria listed above, each decision maker has evaluated the following SuperApp digital platform business models; (A) Digital Ecosystem, (B) Multi-Digital Platform, and (C) Service Provider Models.

A "consistency index" is also provided by the traditional AHP approach of Saaty to assess the consistency of a pairwise comparison matrix. The process is encapsulated for a pairwise comparison matrix, the consistency index (CI) and consistency ratio (CR) can be calculated as follows:

$$CI = \frac{(\lambda_{max} - n)}{(n-1)} \tag{9}$$

$$CR = {}^{CI}/_{RI(n)} \tag{10}$$

In a pairwise comparison matrix of size n, λ_{max} is the maximum eigenvalue, and RI(n) is a random index that depends on n. Random index values are 0.00 for n=1 and n=2, 0.58 for n=3, 0.90 for n=4, 1.12 for n=5, 1.24 for n=6, 1.32 for n=7, 1.41 for n=8, 1.45 for n=9 and 1.49 for n=10. Consistency Ratio (CR) should be less than 0.10 for each pairwise comparison to ensure the accuracy of the results.

Table 4. Overall pairwise comparison

	C_1	C_2	C_3	$\tilde{w}_S$	w_S
C_1	*ER*	*SR*	*ER*	([0.91, 0.89], [0.77, 0.82], [0.87, 0.81])	0.283
C_2	*EXR*	*ER*	*EXR*	([0.83, 0.76], [0.58, 0.63], [0.81, 0.72])	0.433
C_3	*ER*	*SR*	*ER*	([0.91, 0.89], [0.77, 0.82], [0.87, 0.81])	0.283

CR=0.077

Table 5. Dual-cross comparison of the main criteria: Platform Building

	C_{11}	C_{12}	C_{13}	C_{14}	$\tilde{w}_S$	w_S
C_{11}	*ER*	*HER*	*HER*	*HER*	([0.75,0.85],[0.17,0.23],[0.16,0.22])	0.293
C_{12}	*ASR*	*ER*	*SR*	*SSR*	([0.42,0.49],[0.49,0.58],[0.22,0.30])	0.167
C_{13}	*VSR*	*EXR*	*ER*	*ER*	([0.54,0.62],[0.36,0.44],[0.24,0.31])	0.213
C_{14}	*VSR*	*SMR*	*ER*	*ER*	([0.55,0.64],[0.36,0.43],[0.24,0.31])	0.217
C_{15}	*VSR*	*SR*	*SR*	*VSR*	([0.28,0.33],[0.64,0.74],[0.22,0.29])	0.110

CR=0.067

Table 6. Dual-cross comparison of the main criteria: Interaction Effects

	C_{21}	C_{22}	C_{23}	$\tilde{w}_S$	w_S
C_{21}	*ER*	*ER*	*SR*	([0.43,0.48],[0.51,0.61],[0.28,0.37])	0.283
C_{22}	*ER*	*ER*	*SR*	([0.43,0.48],[0.51,0.61],[0.28,0.37])	0.283
C_{23}	*EXR*	*EXR*	*ER*	([0.61,0.70],[0.26,0.33],[0.23,0.30])	0.433

CR=0.027

Table 7. Dual-cross comparison of the main criteria: Network Features

	C_{31}	C_{32}	C_{33}	C_{34}	C_{35}	$\tilde{w}_S$	w_S
C_{31}	*ER*	*SR*	*SSR*	*ER*	*HER*	([0.51,0.59],[0.40,0.49],[0.24,0.32])	0.213
C_{32}	*EXR*	*ER*	*SMR*	*EXR*	*EXR*	([0.61,0.70],[0.25,0.30],[0.23,0.29])	0.263
C_{33}	*SMR*	*SSR*	*ER*	*SMR*	*EXR*	([0.53,0.62],[0.31,0.38],[0.25,0.31])	0.233
C_{34}	*ER*	*SR*	*SSR*	*ER*	*HER*	([0.51,0.59],[0.40,0.49],[0.24,0.32])	0.213
C_{35}	*VSR*	*SR*	*SR*	*VSR*	*E*	([0.16,0.20],[0.75,0.84],[0.16,0.20])	0.078

CR=0.015

Table 8. Dual-cross comparison of models for the criterion: C_{11}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*SMR*	*HER*	([0.61,0.70],[0.25,0.31],[0.22,0.28])	0.429
B	*SSR*	*ER*	*EXR*	([0.50,0.58],[0.36,0.44],[0.24,0.31])	0.354
C	*VSR*	*SR*	*ER*	([0.32,0.37],[0.59,0.70],[0.23,0.31])	0.214

CR=0.055

Table 9. Dual-cross comparison of models for the criterion: C_{12}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*SMR*	*HER*	([0.61,0.71],[0.27,0.33],[0.22,0.28])	0.429
B	*SSR*	*ER*	*EXR*	([0.50,0.60],[0.38,0.46],[0.26,0.33])	0.356
C	*VSR*	*SR*	*ER*	([0.32,0.37],[0.59,0.70],[0.23,0.31])	0.214

CR=0.055

Table 10. Dual-cross comparison of models for the criterion: C_{13}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*HER*	*HER*	([0.77,0.89],[0.16,0.22],[0.13,0.20])	0.501
B	*ASR*	*ER*	*SMR*	([0.43,0.51],[0.45,0.53],[0.23,0.31])	0.289
C	*ASR*	*SSR*	*ER*	([0.33,0.37],[0.58,0.69],[0.23,0.31])	0.207

CR=0.055

Table 11. Dual-cross comparison of models for the criterion: C_{14}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*SMR*	*EXR*	([0.56,0.65],[0.27,0.34],[0.24,0.30])	0.412
B	*SSR*	*ER*	*SMR*	([0.45,0.52],[0.39,0.47],[0.26,0.33])	0.337
C	*SR*	*SSR*	*ER*	([0.34,0.39],[0.53,0.63],[0.25,0.33])	0.248

CR=0.031

Table 12. Dual-cross comparison of models for the criterion: C_{15}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*EXR*	*HER*	([0.65,0.75],[0.24,0.30],[0.22,0.28])	0.448
B	*SR*	*ER*	*SMR*	([0.45,0.53],[0.42,0.50],[0.26,0.33])	0.321
C	*VSR*	*SSR*	*ER*	([0.34,0.39],[0.57,0.67],[0.25,0.33])	0.231

CR=0.056

Table 13. Dual-cross comparison of models for the criterion: C_{21}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*ER*	*SSR*	([0.44,0.49],[0.48,0.58],[0.29,0.38])	0.300
B	*ER*	*ER*	*SSR*	([0.44,0.49],[0.48,0.58],[0.29,0.38])	0.300
C	*SMR*	*SMR*	*ER*	([0.53,0.62],[0.30,0.37],[0.27,0.33])	0.399

CR=0.031

Table 14. Dual-cross comparison of models for the criterion: C_{22}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*SMR*	*SSR*	([0.45,0.52],[0.39,0.47],[0.26,0.33])	0.337
B	*SSR*	*ER*	*SR*	([0.34,0.39],[0.53,0.63],[0.25,0.33])	0.248
C	*SMR*	*EXR*	*ER*	([0.56,0.65],[0.27,0.34],[0.24,0.30])	0.412

CR=0.031

Table 15. Dual-cross comparison of models for the criterion: C_{23}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*SMR*	*ER*	([0.51,0.58],[0.36,0.44],[0.27,0.36])	0.362
B	*SSR*	*ER*	*SR*	([0.34,0.39],[0.53,0.63],[0.25,0.33])	0.248
C	*ER*	*EXR*	*ER*	([0.55,0.62],[0.33,0.41],[0.26,0.34])	0.387

CR=0.024

Table 16. Dual-cross comparison of models for the criterion: C_{31}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*SMR*	*HER*	([0.61,0.71],[0.25,0.31],[0.22,0.28])	0.429
B	*SSR*	*ER*	*EXR*	([0.50,0.58],[0.36,0.44],[0.24,0.31])	0.354
C	*VSR*	*SR*	*ER*	([0.32,0.37],[0.59,0.70],[0.23,0.31])	0.214

CR=0.055

Table 17. Dual-cross comparison of models for the criterion: C_{32}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*SMR*	*SMR*	([0.52,0.61],[0.29,0.36],[0.26,0.32])	0.394
B	*SSR*	*ER*	*SMR*	([0.45,0.52],[0.39,0.47],[0.26,0.33])	0.339
C	*SSR*	*SSR*	*ER*	([0.35,0.40],[0.50,0.60],[0.26,0.34])	0.264

CR=0.055

Table 18. Dual-cross comparison of models for the criterion: C_{33}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*ER*	*SSR*	([0.44,0.49],[0.48,0.58],[0.29,0.38])	0.300
B	*ER*	*ER*	*SSR*	([0.44,0.49],[0.48,0.58],[0.29,0.38])	0.300
C	*SMR*	*SMR*	*ER*	([0.53,0.62],[0.30,0.37],[0.27,0.33])	0.399

CR=0.055

Table 19. Dual-cross comparison of models for the criterion: C_{34}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*SMR*	*EXR*	([0.56,0.65],[0.27,0.34],[0.24,0.30])	0.412
B	*SSR*	*ER*	*SMR*	([0.45,0.52],[0.39,0.47],[0.26,0.33])	0.337
C	*SR*	*SSR*	*ER*	([0.34,0.39],[0.53,0.63],[0.25,0.33])	0.248

CR=0.031

Table 20. Dual-cross comparison of models for the criterion: C_{35}

	A	B	C	$\tilde{w}_S$	w_S
A	*ER*	*EXR*	*HER*	([0.64,0.74],[0.23,0.29],[0.21,0.27])	0.447
B	*SR*	*ER*	*SMR*	([0.44,0.52],[0.41,0.49],[0.25,0.32])	0.320
C	*VSR*	*SSR*	*ER*	([0.33,0.38],[0.56,0.66],[0.24,0.32])	0.229

CR=0.032

Table 21. Final spherical fuzzy global priority weights

	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{21}	C_{22}	C_{23}	C_{31}	C_{32}	C_{33}	C_{34}	C_{35}
A	([0.40, 0.47], [0.62, 0.67], [0.16, 0.23])	([0.26, 0.32], [0.82, 0.85], [0.11, 0.16])	([0.42, 0.54], [0.69, 0.74], [0.09, 0.19])	([0.28, 0.34], [0.76, 0.80], [0.14, 0.19])	([0.33, 0.40], [0.74, 0.78], [0.13, 0.18])	([0.23, 0.26], [0.82, 0.87], [0.16, 0.22])	([0.25, 0.29], [0.78, 0.82], [0.15, 0.20])	([0.37, 0.43], [0.62, 0.68], [0.22, 0.29])	([0.31, 0.37], [0.76, 0.79], [0.13, 0.18])	([0.31, 0.36], [0.71, 0.75], [0.17, 0.22])	([0.23, 0.25], [0.84, 0.88], [0.16, 0.22])	([0.28, 0.33], [0.77, 0.81], [0.13, 0.19])	([0.33, 0.39], [0.75, 0.78], [0.12, 0.18])
B	([0.31, 0.37], [0.71, 0.76], [0.17, 0.22])	([0.21, 0.25], [0.86, 0.89], [0.11, 0.15])	([0.21, 0.25], [0.85, 0.88], [0.12, 0.17])	([0.22, 0.26], [0.82, 0.85], [0.14, 0.19])	([0.22, 0.26], [0.83, 0.86], [0.13, 0.18])	([0.23, 0.26], [0.82, 0.87], [0.16, 0.22])	([0.18, 0.21], [0.85, 0.89], [0.14, 0.19])	([0.25, 0.28], [0.75, 0.81], [0.19, 0.25])	([0.24, 0.29], [0.82, 0.85], [0.13, 0.18])	([0.26, 0.31], [0.76, 0.80], [0.16, 0.21])	([0.23, 0.25], [0.84, 0.88], [0.16, 0.22])	([0.22, 0.26], [0.83, 0.86], [0.14, 0.18])	([0.21, 0.25], [0.84, 0.87], [0.13, 0.18])
C	([0.20, 0.23], [0.84, 0.89], [0.15, 0.20])	([0.13, 0.15], [0.93, 0.95], [0.10, 0.13])	([0.16, 0.18], [0.90, 0.93], [0.12, 0.16])	([0.17, 0.19], [0.88, 0.91], [0.13, 0.17])	([0.16, 0.19], [0.89, 0.92], [0.12, 0.17])	([0.29, 0.35], [0.73, 0.77], [0.16, 0.21])	([0.32, 0.38], [0.72, 0.76], [0.15, 0.21])	([0.40, 0.47], [0.60, 0.67], [0.21, 0.28])	([0.15, 0.18], [0.90, 0.93], [0.11, 0.15])	([0.20, 0.23], [0.82, 0.87], [0.16, 0.21])	([0.28, 0.33], [0.75, 0.78], [0.15, 0.21])	([0.16, 0.19], [0.88, 0.92], [0.12, 0.17])	([0.16, 0.18], [0.89, 0.92], [0.12, 0.16])

Table 22. Resulting values and weights of alternatives

Digital Models	Scores	Ranks
A	0.3695	1
B	0.3162	2
C	0.3143	3

To compare the results found with other widely used fuzzy AHP methods, alternative and criterion evaluations taken from decision-makers were also processed with Neutrosophic Fuzzy AHP and Interval Valued Type-2 (IVT2) Fuzzy AHP methods. The results of these other two fuzzy AHP and their comparison with IVSF AHP are given in Table 23. As can be seen, the scores of the Neutrosophic Fuzzy AHP and IVT2 Fuzzy AHP methods are calculated closer to the first alternative for the second alternative. However, the rankings of the alternatives are the same. This result can be interpreted as the IVSF AHP methodology highlighting the chosen alternative more precisely while giving results. On the other hand, from an opposing point of view, it can direct decision-makers evaluations toward the prominent alternative.

Table 23. Result comparison

Digital Models	Neutrosophic	IVT2
A	0.3469	0.3523
B	0.3382	0.3258
C	0.3149	0.3219

We recommend that researchers increase and diversify the criteria and sub-criteria numerically in future studies on the business model selection of SuperApps. Since this study is based on the managerial strategy perspective, financial figures and investment information can be added to the criteria in prospect studies. According to the evaluations made by the decision makers, the most weighted business model among the 3 different digital business models is the digital ecosystem. The other 2 digital business models are similar in weight to each other, but less weighted than the digital ecosystem model. We can evaluate that the result will be a digital ecosystem business model for a SuperApp application, because in digital ecosystems, an income is created not only by the interaction of supply and demanders on a network, but also by the interaction of business partners, competing users and other parties. So, this would be a very critical reflection of the result. The business model chosen will also directly determine which dimension of interaction the SuperApp's revenue model stems from.

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