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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

Reward Mechanisms in COVID-19 Tracking Apps and Its Impact on the Voluntary Participation of the Public in Sustainable Innovation Processes

Kovid-19 İzleme Uygulamalarında Ödül Mekanizmaları ve Sürdürülebilir Yenilik Süreçlerinde Gönüllü Kamusal Katılım Üzerinde Etkileri

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Abstract

The COVID-19 pandemic is the first pandemic after smartphones penetrated society globally. Consequently, there are not sufficient experiences and understanding of how to engage citizens in information and scientific processes that create public awareness and responsibilities according to scientific needs. For effective measures aiming to sustain the pandemic crisis, an efficient collaboration of academia, economy, culture-based, and media-based public and politics is crucial. With help of the Mobile Application Rating Scale (MARS) approach for assessment, COVID-19 tracking apps (CTAs) of different countries are analysed with help of a qualitative content analysis according to their reward mechanisms. The analysis includes

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correlation different rewards to voluntary participation. The MARS approach consists of engagement, functionality aesthetics and information quality. The protection of voluntariness is understood as the fundamental need for the ethical use of CTAs. Accordingly, patterns of voluntariness are examined in the context of legal, ethical privacy and security policies of selected CTAs. In this context, this paper will provide categories and criteria for CTA usage and its impact on citizen engagement in the Quintuple Helix collaboration process aiming to get insights into features and functionalities needed in CTAs and increased voluntary use of the public.
Keywords: COVID-19, contact tracing, reward mechanism, voluntariness, Quintuple Helix Innovation model

Öz

Kovid-19 salgını akıllı telefonların küresel anlamda toplumları etkisi altına almasından sonra yaşanan ilk salgındır. Bu nedenle, kişilerin bilimsel ihtiyaçlara göre kamusal farkındalık ve sorumluluk duygusu oluşturan bilgi ve bilimsel süreçlere nasıl dahil edilebileceği konusunda, yeterli anlayış ve deneyim henüz oluşmamıştır. Salgın kriziyle sürdürülebilir bir biçimde mücadele için, akademi, ekonomi, kültür ve basın merkezli kamu ile siyaset arasında oluşturulacak etkili bir işbirliği oldukça önemlidir. Değerlendirmede Mobil Uygulamalarda Derecelendirme Ölçeği (MUDÖ) yardımı ile farklı ülkelerdeki Kovid-19 izleme uygulamaları ödül mekanizmalarına göre niteliksel içerik analiz yöntemi kullanılarak incelenmiştir. Bu analiz farklı ödüllerin gönüllü katılıma etkileşimini içerir. Mobil Uygulamalarda Değerlendirme Ölçeği etkileşim, işlevsel estetik ve bilgi kalitesi unsurlarından oluşmaktadır. Gönüllülüğün korunması, bu uygulamaların etiğe uygun bir şekilde kullanılmasında, en temel ihtiyaç olarak anlaşılmaktadır. Buna göre, gönüllülük modelleri, seçilen kovid izleme uygulamalarının hukuki, etik, mahremiyet ve güvenlik politikaları dikkate alınarak incelenmiştir. Bu çerçevede, bu makale izleme uygulamalarının kamu içerisinde kullanımını artırmak için gereken özellik ve fonksiyonelliği kavramayı amaçlamakla birlikte kovid izleme uygulamalarının kullanımı açısından sınıflandırma yapmayı ve kriter oluşturmayı ve bunun kişilerin beşli sarmal işbirliği süreçlerine katılımına etkisini incelemektedir.
Anahtar Kelimeler: Kovid-19, izleme uygulamaları, ödül mekanizması, gönüllülük, Beşli Sarmal İnovasyon Modeli

1. Introduction

Since March 2020, the COVID-19 pandemic created great concern all over the world. Aiming to get the pandemic under control countries created and implemented strategic plans which included lockdown and curfew periods. For effective measures to combat the pandemic crisis, the efficient collaboration of academia, economy, public, and politics considering the natural environment of the pandemic are crucial. Carayannis, Barth and Campbell (2012) provide the Quintuple Helix innovation model to explain collaboration processes based on shared knowledge from five different systems (helices) as a pre-requisite for sustainable developments. This model was developed as a contribution to combat climate change but can be adapted to control pandemic crises as well. The contagious and evolving nature of the coronavirus located in the *system natural environment of the societies* is the main driver of the pandemic. The virus needs and uses the human body as its host to reproduce and survive. Accordingly, the virus develops new variants to overcome and survive human activities like physical distancing, mask mandates and vaccination developments. Academicians from different

fields participate in the knowledge of the virus with their research activities and contribute to the knowledge of *system science*. Their interdisciplinary research aims to understand and consider the impact of the pandemic on health, economy, education, psychology and other societal fields. Based on the knowledge produced by the system science, the *system economy* develops medical devices, vaccines and technological equipment to enable and facilitate public life. Professional health care workers and general practitioners who are members of the *system public* provide efficient services with help of scientific knowledge. Citizens attune their lifestyle to the insights of the system science, the products and offers of the system economy and based on regulations and measures decided and executed by policymakers of the *system politics*. In return, citizens contribute with relevant information about contacts with infected people, statistical data about hospitalized and dead patients, side-effects of vaccines, etc. The COVID-19 pandemic reveals the importance of interaction between all five systems in the context of knowledge contribution and knowledge participation. The involvement of the public plays a vital role. The systems science, politics, and economy need data about contacts, health effects, behavioural issues, personal resilience, etc. from citizens as much as possible for efficient analysis, effective measures, and targeted developments. The collaborative activities of the public in the Quintuple Helix are almost media-based. The participation of knowledge about the newest scientific results, measures, and restrictions like lockdowns decided, logistic issues about vaccination procedures, legal and ethical aspects in the context of education, home-office work, and public leisure activities is based on mediated information.

Associated with information access are diverse communication processes that are widely executed with help of social media platforms. During the H1N1 pandemic, the so-called swine flu pandemic in 2009/2010, smartphones started penetrating society worldwide. Internet is accessible nearly everywhere at any time. As a result, the mediated communication changed significantly during the COVID-19 pandemic in distinction to the H1N1 pandemic. The consumption of online news increased significantly when lockdown periods were executed. In the environment coined by isolation, social media platforms became a dominant venue for information and communication activities. But the information and communication processes of the public are typically a mixture of evidence-based and opinion-based statements. As a result, misinformation and disinformation boomed significantly (Pavio & Reno, 2022). This hampers evidence-based knowledge contributions to the quintuple helix.

2. Objective

This paper focuses on how the media-based public can be involved more efficiently in the circulation of knowledge in the Quintuple Helix. However, contact tracing plays a central role in the Quintuple Helix. The data provided by the public enables and facilitates research, innovation, and decision processes. But it requires suitable communication tools which enable information transfer between different systems. All over the world, a good number of concepts for COVID-19 tracking apps (CTAs) were developed. Nearly every country has implemented at least one CTA to identify pandemic hotspots, inform the public and health authorities about contacts with infectious citizens, and support the decision processes of policymakers (Davalbhakta et al., 2020; Terhorst et al., 2020;).

But contact tracing with CTAs is almost limited to single countries. The exchange of data generated by CTAs is restricted and impossible in many cases based on the legal situations in different countries. To increase the effectiveness of the CTAs, the communication and interaction of the different apps beyond geographical and political borders have to be improved and the concept of CTAs has to be refined according to the needs of different stakeholders. The motivation of the media-based public to voluntary participation in both, receiving and providing knowledge with help of CTAs is challenging. Klar and Lanzerath (2020) state that the ethical use of CTAs requires the protection of voluntariness.

This paper hypothesises that effective reward mechanisms are essential for the voluntary use of CTAs. It is derived from insights into online game developments. According to the flow theory (Lopez & Snyder, 2009), clear goals at every step (Csikszentmihalyi, 1990), immediate feedback (Bracken, Jeffres, & Neuendorf, 2004; Kiili, de Freitas, Arnab, & Lainema, 2012; Wang & Sun, 2011) and balance between challenge and skill (Koster, 2005) are vital. According to Deci (1972), intrinsic rewards turn game-play into player enjoyment. The second hypothesis of this paper is, that public voluntariness of using CTAs depends on the understanding of which personal gain of CTA use the citizen have.

3. Method

As the first step of CTA development, the reward strategies of existing CTAs have to be analyzed and evaluated according to visual, motivational, and communication strategies as well as gamification aspects. But since CTAs generate personal data of citizens legal and ethical aspects have to be considered. This paper attempts to shed light on the different aspects of voluntariness as the first steps of designing a pandemic tracking application for the effective knowledge transfer between science and society inside the Quintuple Helix Collaboration. As part of the project PandeVITA funded by the European Union's Horizon 2020 research and innovation program, the PandeVITA ecosystem has been defined. The project aims to offer a better understanding of societal behaviour, interaction with science and health developments as well as different stakeholders from politics and the economy in the context of pandemics. Additionally, it aims to find better ways to encourage citizens to voluntary contributions to scientific research with different kinds of data (Gallego et al., 2021) In this paper, firstly legal and ethical boundaries of COVID-19 Tacking Apps developments and usage will be described for a better understanding of why voluntariness of public participation is one of the key aspects between the poles of protecting basic human rights and efficiently combatting the pandemic. Afterwards, 23 CTAs from different countries have been analyzed and shortly presented. Aiming to develop relevant concepts of reward mechanisms for CTAs, three health applications outside of contact tracing apps were analyzed additionally. Finally, they are evaluated and discussed regarding the suitability for CTAs to support voluntary knowledge transfer in all systems of the Quintuple Helix.

4. Analysis

4.1. Legal and ethical aspects in the context of voluntary usage of CTAs

All around the world, many governments have developed smartphone applications to trace the people who are infected with coronavirus or who have been in contact with these people. Each application has a different characteristic. Most of these applications are implemented and controlled by state institutions. However, in these applications, personal health data has been frequently processed, stored, analyzed, and transferred through smartphone applications in most countries. Thus, in the use of some of these applications the risk of violation, unfair use, public disclosure, and sharing of these data have emerged and individuals have become weaker than ever.

HES Application (Hayat Eve Sığar – Life Fits Into Home) is one of the latest mobile applications which was created by the Turkish Ministry of Health for the use of the public to minimize the risks of coronavirus in social life and work daily life. As a mobile application, it has been downloaded and used by millions in a short time after June 30, 2020. During the COVID-19 pandemic, the HES code was compulsory to use, for nearly all kinds of participation in public life, such as going to shopping malls, entering public buildings, travelling from one city to another. In this application, the data of the users are collected in a central place and sometimes shared with other state institutions. With the latest update in 2020, the people needed to have a HES code and it is recorded with whom s/he travels where s/he visit. If COVID-19 is detected within the passengers of the same vehicle or in the same location within the next 14 days, everyone in that place, family doctor, and filiation team were informed warned about the situation (Hayat Eve Sığar, 2020).

The acquisition, storage, processing, transfer, sharing, deletion, and destruction of data of real persons are regulated in Data Protection Code no. 6698 in Turkey. Although many specific regulations regarding personal health data are included in data protection legislation, there are regulations in constitutional law, civil law, criminal law, and many other areas of law about the related topic.

Although the basic rule is to process personal health data only with the consent of the data owner, in exceptional cases health data can be processed according to Personal Data Protection Code Article 6/3 within the principles of compliance with the law and the rules of honesty for clear and legitimate purposes. The provisions of the Personal Data Protection Code are not applied "… *if personal data is processed within the scope of preventive, protective and intelligence activities carried out by public institutions and organizations duly authorised and assigned to maintain national defence, national security, public security, public order or economic security*…" (Data Protection Code no. 6698 Article 28/1-ç). This reveals that HES Code is regarded as an exception according to Personal Data Protection Code.

The most secure applications used in the world in the context of data protection are the ones that are decentralized and store anonymized data with voluntary use. These applications are developed and designed by experts from different disciplines. In the creation phase of these applications, engineers, IT, and computer experts worked together with the people from health care services and lawyers as legal requirements were needed for privacy and data protection issues.

Google and Apple have developed a system called Google Apple Exposure Notifications System (GAEN system) which enables smartphones, using the system, to bring out anonymized identity information to their environment via Bluetooth and GPS and stores the identity information and the secure data coming from other devices around.

During the pandemic period, many mobile applications have been developed to combat coronavirus in EU countries. These applications process the data of the users which are compatible with the EU provisions, especially GDPR (General Data Protection Regulation), as well as, the data protection regulations at the national level in each country. GDPR is the latest regulation on data protection which was passed by the European Parliament in 2016 and it is in enforced since 2018 in EU countries. As GDPR imposes very strict rules for data protection cases, the practices in EU countries have gained great importance in this area.

The European Data Protection Board (EDPB) which was founded to contribute to the application of GDPR in the EU, emphasizes that when the location data should be used, the preference should be given always to the processing of anonymized data rather than the personal data. Anonymisation refers to the use of a set of techniques to remove the ability to link the data with an identified or identifiable natural person against any "reasonable" effort (European Data Protection Board, 2021).

When the user is opt-in, the Exposure Notifications System generates a random ID for the user's device. These random keys can't be used for the identification or the location of the user to identify him/her or his/her location, as they are changed every 10 to 20 minutes. The user's phone and the phones around him/her work in the background to exchange the privacy-preserving random keys by using Bluetooth. There is no need for the user to have the app open for this process to take place. The user's telephone regularly checks the random keys associated with positive COVID-19 cases against its list.

According to GDPR article 9/1,

"*Processing of personal data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation shall be prohibited*."

As clearly stated in this article, health data is inside the special categories of data indicated in Article 9/1 which are more protected than any other personal data since they are considered sensitive data. For that reason, the health data can be processed only under some conditions declared in article 9/2 (i). The European Data Protection Board (EDPB) announced guidelines on the use of location data and contact tracing tools in the context of the COVID-19 outbreak which was adopted on 21 April 2020 to bind data processing to certain rules. Data protection authorities should ensure that in these applications, personal data is processed lawfully, respecting the fundamental rights of the individuals, by legal regulations on data protection. Andrea Jelinek the Chair of the European Data Protection Board (EDPB) declared that the applications should be developed responsibly with data protection impact assessment of all privacy by design and privacy by default mechanisms (Jelinek, 2020). Maximum attention should be taken to the contact tracing activities of these applications, to minimize the breach of data of the individuals. It is strongly recommended by EDPB that these applications should be used voluntarily under data protection principles.

4.2. Content Analysis of Reward Mechanisms Through Application Rating Scale Approach (MARS)

The current literature about the effectiveness of mobile applications and specifically mobile health applications (MHA) use the Mobile Application Rating Scale (MARS) approach for assessment. This approach "is a multidimensional instrument to assess MHA quality which was developed and based on semantic analysis and synthesis of relevant literature" (Terhorst et al., 2020, 2). The different dimensions of MARS consist of engagement, functionality aesthetics and information quality. Indeed, the initial study to validate the MARS tool indicates that all these four dimensions correlate with the degree of success of MHAs, the user acquisition and retention rates of MHAs. However, the generalizability of this finding is encumbered by the small sample size of the study (Terhorst et al., 2020, 2). Nevertheless, since the MARS is the most recent tool of MHAs' analysis, other research regarding COVID-19 related apps such as the study of the effectiveness of various COVID-19 apps use the same technique of evaluation by Davalbhakta et al. (2020). For this paper, we have translated the four dimensions of the MARS into more practical categories aiming to generate an operative concept for implementation in the development phase. These categories are Motivational, Visual, Communication, and Gamification (MVCG) strategies. The naming convention for the categories is closer to technical terms of mobile application development than the MARS, which highly assists the requirements extraction for the PandeVITA mobile app.

The aesthetics of a mobile application has a direct relationship with the usability of an app. That is because the user interface (UI) and user experience (UX) in an application determine the straightforwardness of the use of the app. For instance, in a minimalistic visual approach, prioritizing the display of essential features of the app for the specific user group provides easy use. Also, not including too many peripheral functionalities and features in the app prevents users from confusion while interacting with the app. According to an early survey executed in 2020, accessibility of scientific information and verification for the protection of personal data appear as the fundamental needs of citizens who used the COVID-19 mobile tracking tools during the early months of the pandemic (Ming, et al. 2020).

Therefore, given that CTAs target a wide range of user groups with varying technological literacies and intrinsic motivation to use the app, visual strategies play an important role in user acquisition and retention. It becomes imperative to predict the needs of this wide audience and adjust the UI and UX of the CTA to those needs. Also, CTA is a relatively new concept that has been added to the category of health apps in light of the COVID-19 pandemic. Thus, it is challenging for these apps to attract a wide group of users that are already familiar with the application's usability and have an intrinsic motivation to use the app. Since "aesthetic effects of visual elements are dependent on the context in which they appear" (Silvennoinen, Vogel, & Kujala, 2014, 47) incorporating visual strategies similar to pre-existing health apps in the market would assist the adaptability of users to CTAs.

The motivation of users to install and interact with an app plays a key role in the success of that application. These motivations are categorized into two forms, intrinsic and external motivations.

Indeed, intrinsic motivations which refer to the user's interest in the usage of an app are among the main causes of the download of an app. In research conducted in Turku, Finland in 2015 scholars studied citizen participation in urban planning. Their report, which they also presented at the International Conference on Electronic Participation in 2016, demonstrated that users are "initially motivated fairly or very much by curiosity to test the mobile participation application" (Ertiö, Ruoppila, & Thiel, 2016, 7). It can be maintained, from this research, that the contextual relevance of an application improves user acquisition since users are inclined to test the app due to personal interest.

Furthermore, to enhance the app's user retention external motivation factors need to be incorporated into the design. This type of motivational strategy refers to the particular usability of the application that appeals to the users' interest. For instance, one of these methods is providing a personalized user experience (Ertiö et al., 2016, 8) using tools such as AI-powered recommendation systems. Indeed, another effective motivational strategy is to teach users some aspects of the application about the context (Ertiö et al., 2016, 9). For CTAs the educational dimension of motivational strategies can potentially boost user interaction rate with the app since these apps deal with the prevention of new viral viruses which require regular updates of the public about the prevention methods. While CTAs are relevant to the needs of societies, especially during the pandemic which possibly warrants user acquisition, the use of external motivational strategies supports user retention of these apps.

During the current crisis, human communication patterns both within digital technologies and outside have been challenged in several ways. A significant number of new contact tracing apps have been implemented while there are still ongoing developments with the existing ones. One important factor in fully implementing CTAs in societies is to inform the public about the importance and necessity of building tracing architectures among individuals. According to one research conducted during the COVID-19 context, to achieve this end, CTAs employ communication strategies such as releasing websites, user blogs, and social media accounts (Altmann et al., 2020). The acceptability of app-based CTAs by the wider public brings in some challenges and needs. The problem of responding to issues such as personal data protection, ethical responsibilities, or access to relevant data becomes more effective and official within the public sphere thanks to the use of digital communication patterns during the retailing of contact tracing solutions.

Initiation of websites and social media accounts emerge as the backbone of any CTA that depends on user voluntariness and communication among neighbouring individuals. Related websites provide existing and potential users with information about the mission and motivation of the company or institution which develops the app, the information about the team behind the app, the new developments as well as a statement of loyalty to ethical and legal requirements. Social media accounts also function in sharing visuals, videos, stories, and live broadcasts which helps the app to build a community of users and enrich its communication strategies. Users also provide content for these platforms when they are encouraged to share their photos, videos, or experiences in this more popular and effective way. In the context of our CTA concept, an official website along with social media platforms will prove quite sufficient to meet the needs of the media, politics, economy, and science in circulating health-oriented information.

In recent years, managing health behaviour through applications has become more useful and popular as smartphones have made it easier than before. Users download and continue to use these apps for several reasons. According to research conducted in 2019 (Binnewies & Groening, 2019), the fundamental motivations to adopt health-oriented apps are identified as to entertain, educate and engage users.

Being one of the secondary motivations to use a health-oriented application, the element of gamification within digital apps is recognized as an important aspect of user engagement. Gamification can be defined as the integration of video game elements into digital non-video environments to enhance user motivation. The non-video contexts include health systems, education, traffic, socialization, sports, and fitness as well as institutional workplaces. One basic aspect of gamification used in the related fields is to motivate users by providing a sense of achievement which is found to directly influence performance, activities, and services on behalf of individuals and groups. Governments, institutions, and companies include gamification in the process of creating apps aiming for outcomes such as change and improvement in work performance, education, health behaviour, physical workout, safe drive behaviour along with user retention. (Binnewies & Groening, 2019). In this sense, gamification is a significant part of the loyalty program which enables an app to ensure long-term usage. Gamification solutions mostly sought for are fitness and nutrition, medication, self-management of chronic illnesses, management of working teams, and physical and emotional therapy.

Although motivations to download a health app might differ as identified above, achievements share similar mechanisms with classical game design and goal-setting systems. Accordingly, a fundamental reward mechanism functions as a tool for goal-setting, measuring, and rewarding. Such a mechanism usually sets up challenges and goals for individual users, classifies and rates them among other users, promotes them to a next and a higher level, prolongs the persistence in activities, and produces user feedback and assessment while providing users with information and advice. Empirical research (Altmann, 2020) shows that the effectiveness of any reward mechanism largely depends on the design of the app. In this sense, the app design is expected to include aspects of goal-setting and challenge such as classification and rating among other users, motivation for the next level, persistence and user retention, feedback and assessment, accurate information and advice along with the tools to provide medication management and personalized guidance. The significance of these features is discussed respectively below.

Users are provided with goals or tasks defined accordingly for their needs or potential within an indicated limited time. In the case of contact-tracing apps, the goals can be aimed at the longevity of self-quarantine, the lowest number of people interacting or the number of precautions taken daily.

According to their performance and persistence, users are rated on a hierarchical system that positions them and their potential to succeed among other users. Contemporary gamification is structured upon three reward elements as points, badges, graphics and leader boards. For a contact-tracing app, badges and leader boards can be designed within the scope of the app's logo. One way to

set up rewards through the achievement of points is to define performance indicators and promote certain levels and ultimate goals.

One way to set up rewards through achievements of points is to define and promote certain levels and ultimate goals within the scope of the app's design and logo. Optional bonuses and supplemental tasks leading to the final goal can also be set up. There has been empirical evidence that a low quantity of achievements leads to higher motivation than a high quantity of achievements while difficult achievements lead to higher motivation than easy achievements (Hsia, Chiang, Wu, Teng, & Rubin, 2019).

Furthermore, users tend to keep engaging with an app when they can share their scores, especially with their teams and social groups and anonymously when desired. Creating shareable loops and designing progress bars are some tools employed for longer user participation.

User activity is encouraged effectively when individuals can communicate through writing feedback and assessment for the app. For a contact-tracing app, users can be encouraged to write feedback on issues such as recording their symptoms, giving advice about self-quarantine in different conditions (for parents with kids, with elders living with them, people with pets, etc.), the duration of their sickness and the process of their healing. User response patterns also enhance knowledge exchange between science and society.

Similarly, a large group of individuals use apps to receive information or advice regularly. For a contact-tracing app, this tool can include knowledge from science, health institutions, and government-based official media.

In health-oriented apps, users find it functional and dependable if they can manage an individualized calendar to ensure the timing of their medication (Peng, Kanthawala, Yuan, & Hussain, 2016). A reward mechanism set up around a medication calendar or a healthy diet program can be applied. Elements in guidance can be maintained in the form of country-specific guidance, language option, or age-specific advice. Most users of health apps state that they want to observe changes and improvements in their condition or health behaviour (Peng et al., 2016). Otherwise, they give up or even forget to use the app. There are some barriers identified to reduce or prevent app usage. A qualitative study conducted in 2016 (Peng et al., 2016) identifies individual barriers that direct users to use or not to use a health app as follows: sharing personal information, lack of information and guidance, lack of credibility, lack of reminders and motivators and costs. Accordingly, the question of personal data protection and the lack of relevant information and guidance about the app emerges as the primary drawbacks for user sustainability. In other words, app users want to be ensured of full protection of their data and they also tend to seek instruction and advice. This qualitative report with the list of drawbacks mentioned above promises important points for the PandeVITA app such as the motivation aspects and data protection. To explore the relevance between the importance and effectiveness of each factor, the authors of this paper have also analyzed three health apps; *CafeWell, Mango Health,* and *MySugr* respectively. Compared to our list of 23 CTAs analyzed below, these health apps effectively use motivational tools to engage users.

CafeWell is a health and fitness application that allows its users to focus on living a healthier life by getting physically more active. The app motivates its users with personalized resources and incentives. The app requires what the user wants to achieve and their goals to have a healthier life. Then it proposes

specialized activities, suggestions and plans. These suggestions are designed specifically for every user for them to eat healthier, get enough sleep, reduce stress and exercise more. The app also allows the users to track the progress they are making while getting rewarded for reaching their specified goals. Hence, the app gives its users a chance to prioritize themselves. The incentive behind the app becomes the value of people which attracts users. The app also encourages its users to share this app with their immediate circle. The app's gamification strategy is based on a point system within the app. While tracking the user's progress on the app, users get rewarded with earning points.

Mango Health is a medication reminder and manager app for people who use medicine regularly. It was developed in 2012 and has been running since. The app helps its users to take their medication on time and create a healthy daily routine for it. The app not only deals with the medication intake of the user but also has other health-related sections such as checking the user's weight, hydration, blood pressure and more. Like CafeWell, Mango Health establishes a reward system based on points. Each day a user takes their medication at the correct time, the user earns points. With those points, users can win various rewards including gift cards from some stores and donations to charities and more.

MySugr is a diabetes-related app that was founded in 2012 in Austria. Operating under European Union regulations, it is now used in 79 countries with three million registers announced by 2020. Recognizing the difficulties of living with diabetes, the app aims for relieving the complexities related to having diabetes and the anxiety of the users in certain conditions. MySugr App became a part of the Roche Company in 2017 and was granted accreditation by the Association of Diabetes and Education Specialists. It provides services of personalized coaches who are trained in the related program. In addition to the Logbook where users can keep their diabetes-related data in one place, the app rewards the users with a "greenhorn" each time they log in during the day. It remains a motivation for users who want to build a diabetes routine daily. "Sweat" is another challenge for users to move more during their daily routine. It reminds users to log in exercising at least one hour on three different days a week. This can combine their fitness data with their health data. MySugr app retains a pairing feature, the Accu-Chek Performa Connect Meter. This feature automatically connects to the user's diabetes calculator through the use of a wireless adapter. Once connected, the results of the calculator are registered in LogBook saving the users the extra time devoted to continuous documentation of blood glucose levels. The users collect points, each time they log in to the app. Besides, they can have their monster or imagery that responds to every entry with comments or sounds. Adding some amount of fun to diabetes management, the users improve their living standards while getting some entertainment from a daily necessity.

The element of gamification corresponds with the project's main aim to develop a CTA with a high degree of voluntary participation. Digital tools for measuring behaviour and rewarding achievements will create a unique platform where the information flow within the quintuple helix can be maintained from directions of science, society, politics and media.

Considering the topics described and health apps analyzed above, 23 CTAs and 13 COVID-19 platforms from 18 different countries were analyzed within the PandeVITA project, according to their visual, motivational, communication and gamification strategies (Peschke et al., 2021). Table 1 summarizes the results of the CTA analyses.

Table 1: Analysis of 23 CTAs according to their reward mechanism (Peschke et al., 2016)

CTA	Country	Visual Strategy	Motivational Strategy	Communication Strategy	Gamification Strategy
Radar COVID App	Spain	• Minimalistic UI and UX • Color Scheme: Purple and white	The app encourages the user to share the download link the app with family and friends.	The app allows the user to communicate his positives about COVID. The user can check his level of risk.	None
Immuni App	Italy	• Minimalistic UI and UX • Color Scheme: Blue, red and white	The app gives instructions on how to proceed.	The app allows the user to communicate his positives about COVID.	None
Virus Radar	Hungary	• Minimalistic UI and UX • Color Scheme: Blue and white • Text, some figures	The app gives instructions on how to proceed.	In case of being infected, a person can send their data of contacts.	None
Ocio Responsable App	Spain (Castilla la Mancha region)	A clear and intuitive solution	To know if you have the possibility of being infected with COVID-19	Communicate to the health authority the possible contact people to facilitate the tracing where necessary	None
DOCANDU COVID19	Greece	• Minimalistic user interface. • Colour scheme: blue and white • Simplified interaction with closed responses	None	Once the user provides the information requested by the AI-driven consultant, the app asks for the user's consent to be contacted by a medical expert.	None
HES Code App	Turkey	• Minimalistic UI and UX • Color Scheme: green and white • Risk map: using Google Maps, Heat map illustrating the density of the virus in different areas using a colour spectrum; from low to high risk (blue, green, yellow, orange, red) • Infographic representation of contact status of the user in the past 1,7 or 14 days.	• Providing the HES code for utilizing different public facilities is mandatory. • Functions give the user the ability to acquire risk awareness about different public places and facilities he/she uses.	Functionalities allow the user to: • report Corona risk to the officials • check his/her level of the risk of his/her symptoms • provide feedback on the healthcare facilities he/she has utilized	None

Filyasyon ve İzolasyon Takip Sistemi (FITAS)	Turkey	• Minimalistic UI and UX • Color Scheme: blue and white • Nearby Cases: using maps, nearby cases are shown to be contacted by CTTs to conduct the filiation process.	• Mandatory for the conduct of filiation process by CTTs • Mandatory for the tracing of contacted people of COVID-19 patients • Ease of response to any COVID-19 patient or their contacted person	Functionalities allow the user to: • Report COVID-19 risk for contacted people to the tracing centre • Check their level of risk according to the symptoms • Report the current filiation status to the tracing centre • Allow the user to reach out to the nearest contacted person to conduct the filiation process in the fastest manner	None
Korona Önlem	Turkey	• Minimalistic UI • Color Scheme: purple and white	• Turkish Ministry of Health approved suggestions are provided if the users have COVID-19 symptoms. • Defining all the medical symptoms of COVID-19 prevents users from taking any unnecessary actions.	Functionalities allow the user to: • report their current health status to the officials • check their level of the risk or symptoms	None
Corona Warn App	Germany	• Minimalistic UI and UX • Color Scheme: green, red, blue and white • Risk cards: The app sends notifications to users about their risk to be infected according to exposure logging.	• The app has been promoted by billboard and broadcast advertisements, e.g. in cooperation with the German Football Association (DFB) and other prominent companies. • Some Virologists say when at least 60% of people in Germany use it, it would be very effective. • In her statement, Chancellor Merkel emphasized the necessity and use of this application. She also announced that it is a reliable practice for the protection of personal data. • Ability of users to warn people they interact with against the risk of infection	This App allows users to: • Warn other users about their risk of becoming infected • check if there is an infected user around them	None

Coronalert	Belgium	• Personas • Clear logos • Visible instructions and warnings	• Reinforce the importance of protecting your direct environment • Use tailored motivations	Mass communication campaigns, aiming to save your parents and grandparents by using the app, reflect tailored motivation	None
CoronaMelder	The Netherlands	• Personas • Clear logos • Visible instructions and warnings	• Reinforce the importance of protecting the user's r direct environment • Use tailored motivations	Mass communication campaigns, aiming to save the user's parents and grandparents by using the app, reflect tailored motivation	None
Smitte Stop	Denmark	• Clear logos • Visible instructions and warnings	• Reinforce the importance of protecting your direct environment • Use tailored motivations	Mass communication campaigns, aiming to save your parents and grandparents by using the app, reflect tailored motivation	None
SwissCOVID	Switzerland	• Attractive user interface. • Colour scheme: Blue, and white	None	None	None
NHS COVID-19	United Kingdom	• Minimalistic UI and UX • Tutorial about the function of the app and the privacy policy of the app	• Getting alerted if the user has come in close contact with anyone who has tested positive. • If the user tests positive they can alert and protect others, especially their acquaintances anonymously. • Check in to venues by scanning the QR code. • Ability to check symptoms and book test appointments.	Functionalities illustrated in 3.15.1 allow the user to: • Receive risk alert • Report Risk to the officials • Coronavirus knowledge base	None
Protect Scotland	Scotland	• Minimalistic UI and UX • Color Scheme: white and purple • Tutorial about the function of the app and the privacy policy of the app	• Getting alerted if the user has come in close contact with anyone who has tested positive. • If the user tests positive they can alert and protect others, especially their acquaintances anonymously.	Functionalities allow the user to: • Receive risk alert • Report Risk to the officials • Coronavirus knowledge base	None

COVID Tracker	Ireland	Written imagery and icons against a yellow background.	• The app includes Reminder Notifications to inform and educate people about what they need to do in cases of close contact. • It enables users to track their symptoms daily. • It provides information on the availability of vaccinations. • The users can also store data anonymously sent by other users' devices and keep track of possible interactions.	It includes updates and recent information about the number of positive cases in Ireland.	None
COVID Watch	USA	• Personas • Clear logos • Visible instructions and warnings	• Reinforce the importance of protecting your direct environment • Use tailored motivations	Website information	None
COVID Alert NY	USA	• Written information and icons against a purple background.	None	To encourage public health response, the app enables its users to submit feedback about the app at any time.	None
GuideSafe ™	USA	• Attractive user interface. • Colour scheme: Green and white	None	None	None
COVIDSafe	Australia	• Attractive user interface. • Colour scheme: Green, and white	None	None	None
Pass Track	Pakistan	The app has a minimalistic UI and UX design. The colour scheme is green and white.	The app has been established to stop COVID-19 entry into the country	The app reports possible COVID-19 cases to the government of Pakistan.	None
E-Tabib	Azerbaijan	The app has a colour scheme of purple and white	The overall motivation of this app is to inform people of potential COVID-19 risks and stop the spread of the infection throughout the country.	The app warns its users about possible COVID-19 risks and informs health authorities if A user is infected with COVID-19.	None
COCOA	Japan	The app's colour scheme is white, red, and blue in general. The texts are written in black.	The app's use is not mandatory and is up to voluntary use. The overall motivation for this app was to inform people of potential COVID-19 risks and stop the spread of the infection throughout the country.	The app reports COVID-19 infected contacts to the users of the app if they ever get in contact. Infected people are expected to get relevant health centres informed about their cases. Since the usage is voluntary, there is no certain way to solidify the efficiency of the app's usage.	None

5. Results and Discussion

The analyses mentioned above reveal that none of the CTAs considered gamification strategies in their app. Their visual strategies are clear and simple without extensive usage of different colours or interesting graphics. It can be inferred that the motivational strategy is almost limited to communicating the importance of usage for science and society and the communication strategy is focused on giving information about concrete contacts that the user had in the recent time and could expose him/her to risk, some basic information about infection rates and R(t) values and the opportunity to upload the digital vaccination report. In many countries like Germany, the download and usage of the CTA were advertised in different media to encourage German citizens for downloading and use the app. These are almost information and recommendation campaigns (cf. Theile, 2020). The persuading concept is based on acceptance and persuasion. As a result, approximately 30% of German citizens have downloaded the Corona Warn App (Robert Koch Institute 2021). Even though, the previous assumption states that CTAs work accurately only when they are used by at least 60% of a country's population (Servick, 2020) the efficiency increases the more participants use CTAs. However, it is expected that improved motivational and communication strategies and the improvement of CTAs with gamification strategies will increase the voluntary use of these apps.

The apps analyzed below offer mobile health solutions to users who either complain or suffer from an existing condition or want to benefit from health programs by using an app. The analyses of 23 CTAs from 18 countries revealed that the gamification aspect in all CTAs is especially underrepresented. This leads to the conclusion that gamification aspects were mainly not considered as relevant or at least less important for the usage of CTAs. Klar and Lanzerath (2020) state that the ethical use of CTAs is significantly dependent on the protection of voluntariness. In this context, effective reward mechanisms become strongly relevant. Therefore, gamification as one strategy plays a vital role. Three health care apps outside CTAs (CaféWell App, Mango Health App, MySugr App) with gamification features provide suitable strategies. Some of their mechanisms can be inspiring due to their success in user numbers and longevity in user retention. As their motivational strategy, these apps use reminders and alerts in effective ways. Additionally, they provide users with personalized patterns through which they can check or track the realization of goals and tasks. While doing these, they collect points, reach some levels, win virtual rewards, and set up final goals. Another significant tool of these apps is that users can form groups and teams with whom they can share or compare.

6. Conclusion

Since the beginning of the pandemic, COVID-19 tracking applications (CTAs) have been regarded as effective tools for contact tracing aiming to identify certain hotspots and inform society about risk situations. However, when these apps are examined carefully, it can be concluded that one common lack of recent CTA's share is a motivational strategy in terms of gamification although the studied apps were introduced in different countries across the world. The authors of this paper understand contact tracing with help of CTAs as an involvement of the media-based and culture-based public in the process of knowledge production and circulation inside the Quintuple Helix.

Therefore, the results of the mentioned analyses imply important needs and challenges for the authors involved in this project. Similar to needed activities against climate change, the fight against pandemics requires sustainable innovation processes. According to the Quintuple Helix Innovation model of Carayannis et al. (2012), the media-based public has to be understood as a vital knowledge producer on the same eye level in collaboration with science, economy and politics considering the natural environment of the pandemic. But the knowledge has to be provided voluntarily. Accordingly, the protection of voluntariness is crucial and needed for the sustainability of the apps. Therefore, the legal and ethical regulations were discussed to provide the basis for discourse to understand the role of reward mechanisms that aim to increase the voluntary use of CTAs. Afterwards, 23 CTAs from 18 different countries were analyzed according to their reward mechanisms. It could be shown that gamification strategies are completely neglected in all CTAs. In this sense, the analysis of three health applications gave a first understanding of how the implementation of gamification and additional motivational strategies can improve the voluntary use of CTAs. For instance, the MySugar app implemented LogBook functions as a significant program to channel every single information into one place saving the user from the necessity to enter each time. Simple features where users can earn points with certain activities generate an ecosystem of appreciation.

This paper provides useful results for the development of a COVID-19 tracking application with more effective reward mechanisms and will support the further steps of the development process. During the next phase, user stories should be collected and analysed aiming to understand the needs of users and stakeholders of all systems of the Quintuple Helix and to contribute to an improved knowledge circulation for sustainable innovation processes.

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