

Opinion

On Enhancing the COVID-19 Certification System for the Digitally-Illiterate People Inclusion in the European Union

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Abstract: The COVID-19 pandemic led to widespread restrictions globally, prompting governments to implement measures for containment. Vaccines, while aiding in reducing virus transmission, have also introduced the challenge of identifying vaccinated individuals for the purpose of easing restrictions. The European Union (EU) addressed this through the “digital COVID-19 certification” system, allowing citizens to travel within the EU based on their vaccination, recovery, or negative test status. However, the system’s digital format poses challenges for those who are not digitally proficient, such as seniors and those with low educational or socioeconomic status. This study aims to propose enhancements to the current system, considering the mobility needs of all citizens. The methodology involves reviewing literature on digital literacy, the digital divide, and information systems related to vaccination and certification. The paper presents straightforward recommendations to make the COVID-19 certificate more accessible to digitally excluded individuals. These proposals may serve as a valuable starting point for healthcare executives to evaluate and adapt the certification scheme to be inclusive of a broader range of stakeholders.

Keywords: COVID-19; vaccination certificate; digital COVID-19 certificate; European Union; digital literacy; digital divide; social inclusion



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1. Introduction

The outbreak of the COVID-19 pandemic, which took place in the first quarter of 2020, brought a global stir and concern about the dangers related to the coronavirus spread and interconnected issues [1]. The pandemic also affected business performance in various sectors [2–6], but despite the fact that most of them suffered, the medical industry reported a profit, e.g., due to the significant demand for vaccines against COVID-19 [2]. Presently, national vaccination programs against COVID-19 are relatively advanced in many countries worldwide (particularly in the European Union [EU]). However, when programs to increase public vaccination against COVID-19 were not yet as highly developed, there was an observable surge of interest in vaccines and interdependent threads, such as the possibility of more free movement for the vaccinated. On March 17, 2021, the European Commission initiated the introduction of the so-called “Digital Green Certificate” aimed at facilitating the movement of European Union citizens and the possibility of faster lifting of sanitary restrictions for member states [7,8].

The trend of interest in the issue of vaccination certificates (and thus being a COVID-19 convalescent or gaining a negative test result) has been a significant trend since the advent of a prevalent vaccine for the disease. It was since the announcement by the EU official bodies of work on the introduction of the so-called “COVID-19 passport”. This certification system approach is also interchangeably called “immunity certificate/passport/license” and compared to the International Certificate of Vaccination or Prophylaxis issued by WHO [9–11], as well as similar changes carried out at a similar time by, inter alia, the United States or Israeli authorities.

As of 1 February 2024, 5.63 billion people worldwide (around 70.6% of the population) have taken at least one dose of the COVID-19 vaccine, of which 338.03 million are EU citizens (around 75% of the population) [12]. Most people declaring the desire to get vaccinated indicate a “return to normal”, including freedom of movement, as one of the main motivations for getting vaccinated [13]. Mass media also plays a significant role in encouraging the public to take the COVID-19 vaccine for international travel [14]. In order to increase the efficiency of national and regional vaccination programs, there is also a need to encourage vaccination, for example in the form of greater freedom of movement [15], of which the European “Digital Green Certificate” is the answer. Mobility constraints have been shown to help stop the spread of disease, but they need to be used in conjunction with other non-pharmaceutical procedures [16], of which the COVID-19 passport can be considered as this kind of expedient countermeasure.

On the other hand, merely 55.5% of the EU citizens between the age of 16–74 have at least basic digital skills (as of 2023; see Appendix A for further elaboration) [17], which means that the remaining 44.5% of the population does not use or has significant problems with the use of modern technologies. Despite the circumstance that the COVID-19 pandemic (indirectly) increased digital literacy, e.g., among the elderly [18] or the stakeholders of higher education [19], it should be borne in mind that the introduced lockdown did not reduce the digital divide, and there is a strong recommendation for governments to immediately reduce the effects of these disparities [20,21]. The fact that the COVID-19 pandemic has further exposed and exacerbated digital inequalities (as a hidden form of social inequality) should be underlined [22]. Fostering digital literacy among the elderly ensures their health needs and thus human rights in the 21st century [23]. As generating a personal EU digital green certificate requires basic skills in using digital governmental systems (i.e., accessing the digital certificate and thus printing it as well as showing its mobile version on a compatible device), there is a justified need to implement adjustments to the current system in order not to exclude the part of citizens who are not computer literate, with no bias, like age, gender, place of living or level of education.

This article aims to present a comprehensive set of solutions in order to facilitate the use of the European COVID-19 Certificate for digitally illiterate. The article poses a challenge for health system managers throughout the European Union and proposes new modifications to the existing certification system solution. The proposals take into account the state and concept of the digital divide as well as aspects related to the issues of convenience of usage, capabilities, data protection, or sustainability. The research methodology is the analysis of literature sources in the form of communications and regulations at the national and European levels, as well as scientific articles on the subject of digital literacy, the digital divide, and information systems on vaccination and certification methods. The delineated problem led to the formulation of the following research questions:

1. How can the COVID-19 certification system in its current form be enhanced for digitally illiterate individuals?
2. What are the barriers to the digital format for those lacking digital proficiency, and how can they be mitigated?
3. How can healthcare executives adapt the proposed enhancements for inclusive mobility needs and a broader range of stakeholders?

This paper tackles the digital challenges brought about by the COVID-19 pandemic. Despite no longer being in its most acute phase, the pandemic has underscored the persistent issues that still need to be addressed. The challenges particularly cover the issues of ensuring equitable access to benefits such as travel within the EU through the COVID-19 certification scheme. By proposing enhancements to make the certification more accessible to all individuals (regardless of their socioeconomic status or digital skills level), this study offers valuable insights for healthcare executives to foster inclusivity and adapt the certification scheme to meet the diverse mobility needs of citizens. Improvements to the current COVID-19 certification scheme, despite the restoration of many of the population mobility

comforts, may prove useful, for the eventual emergence of other pandemic-like situations requiring lockdown in the future.

The structure of the paper is as follows. Section 2 is devoted to the description of the current COVID-19 certification system in the EU. It is also focused on recognizing the digital divide problem affecting the use of COVID-19 certification schemes. Section 3 illustrates the proposed alterations in the current shape of the COVID-19 certification system in the EU. Section 4 contains the discussion, while Section 5 summarizes the paper.

2. Current “Digital” Landscape in the Times of COVID-19

2.1. Current COVID-19 Certification System in the European Union

The current form of electronic vaccination certificates in the European Union takes the form of a QR code which is printed or displayed on a mobile device. This certificate contains personal information as well as the test result, confirmation of passing the COVID-19 disease (being convalescent), or received vaccine details. As it can be read from the official EU sources [8], the certificate is issued by the medical unit administering the vaccine (or carrying out the test), then it is entered into a secure database of the member state (being a national of which) and lastly linked by the decentralized European system. This particular system serves as a gateway connecting national systems to verify the validity and authenticity of the certificate. The technical issues and methods of functioning of the current EU COVID-19 certification system can be compared to the scheme proposed by Eisenstadt et al. [24] which draws on the blockchain notion as well as W3C (The World Wide Web Consortium) standards in the field of decentralized “verifiable credentials”.

The certificate in its current form is issued free of charge at the request of every EU citizen and is valid throughout the whole EU territory. With its help, governments can more effectively coordinate the lifting of individual sanitary restrictions (aimed at limiting the spread of COVID-19 disease) and allow more free movement between the countries of the European Community (by abolishing the obligation of additional testing and going through compulsory quarantine). Following the suggestion of Volpp et al. [25], this certificate could also be used for possible preferred (easier) access to certain establishments or facilities, such as restaurants, shopping malls, gyms, or cinemas, but also for domestic long-distance public transport, as held for example in France, according to “Health Pass” model [26].

2.2. The Current State of Digital Divide in Context of COVID-19 and Health Policy

Nevertheless, there is an observable problem with the convenience of the current form of certification system [27], as not all citizens (not only in the European Union, specifically, but worldwide, in general), like seniors or citizens with merely basic education, are digital-ready. The phenomenon of the digital divide, which may split into three levels of advancement, is one of the most challenging problems among information societies, in particular during the COVID-19 pandemic [28]. These furtherance levels of the digital divide notion encompass [28]:

- First-level: access to digital tools and digitized equipment.
- Second-level: effective use of digital solutions and e-skills possession.
- Third-level: ability to deploy digital resources to reach specific objectives (performance linked with ICT (Information and Communications Technology) and offline outcomes).

Digital exclusion and digital divide are present not only among the elderly [29], but also among the less educated, those with a lower material status, or those with insufficient social and health awareness, which translates into a lack of digital skills [30,31]. The gender and age digital divide is also noticeable, influencing the disproportions in digital skills between men and women in different age groups [32,33]. A similar situation is related to the availability of broadband Internet which occurs among the inhabitants of rural areas [20,34] but also among neighborhoods with low levels of education, low income, and high racial and ethnic diversity, which translates into higher levels of hospitalization and mortality [35]. Ramsetty and Adams [36] distinguish the following aspects influencing the

augmentation of the digital divide phenomenon, with particular emphasis on the health services sector in times of COVID-19 pandemic:

- Regional limitations in access to broadband Internet.
- Sociological and cultural conditions cause mistrust and failure to meet expectations.
- The level of education directly influences the level of digital literacy.
- Unstable economic situation of the household, results in the inability to afford an electronic device.
- Failure to adjust the level of technological advancement of the solutions used in the (public) health industry to the skills of an ordinary patient.

Scientists propose to counteract the digital divide phenomenon, which was especially worsened during the COVID-19 pandemic [20,29,34,37–39]. First and foremost, the focus and particular emphasis should be on building an inclusive society, also in the case of building digital awareness and enlarging access to the Internet and technology, as well as adopting governmental ICT strategies [20,38]. In addition to a fairly “conventional” approach to mitigating the digital divide, it is advisable to take extensive measures to increase digital literacy in society, which may have long-term positive effects [22,38]. In order to adequately bridge the digital exclusion problem, the indispensable role of human engagement in providing long-term help, intervention, commitment, and care is underlined [39]. There is also a significant accentuation on providing equitable ICT solutions in the health services sector (like telemedicine) with a particular focus on eliminating any bias and broadly understood human inclusion [38]. A summary of the spotted factors having a direct influence on the digital divide along with the ways to thwart this phenomenon are presented in Figure 1.

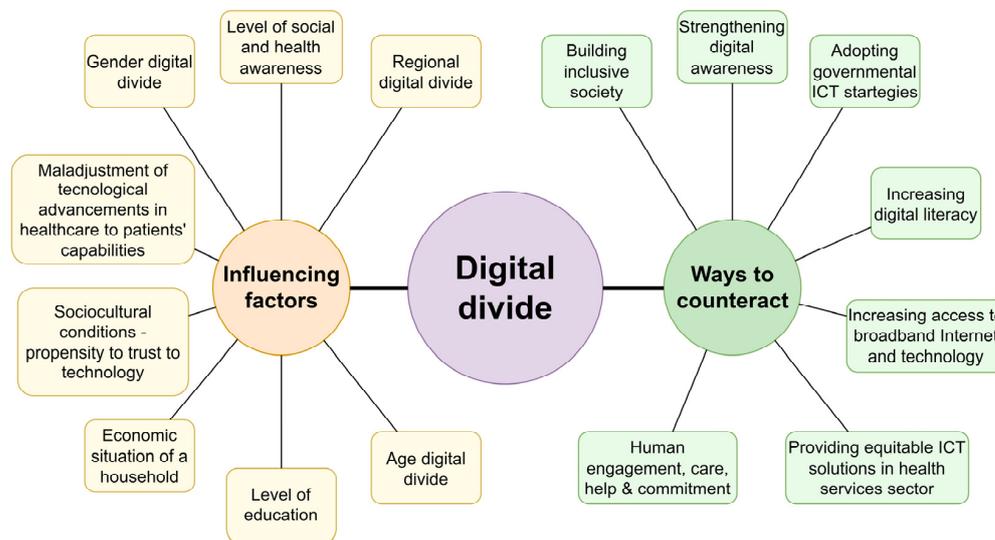


Figure 1. Factors influencing digital divide and ways to counteract this phenomenon. Source: own elaboration.

A significant fraction of digital-unready people barely use smartphones with Internet access (or do not use them at all) [40], while carrying an additional printout (along with other personal documents) may be considered non-handly. The printing of the certificate itself also often requires the ability to log into the “digital/online patient account” in order to generate and download it. Not all citizens have printing devices at home nor have created the “verifiable credentials” (like “Trusted Profile/National Electronic Identification Node” in Poland [pol. “Profil Zaufany/Krajowy Węzeł Identyfikacji Elektronicznej”] used to authenticate personal identity in a digitized manner [41]) needed to log into the e-governmental system. It is underlined that patient engagement in health care is becoming

increasingly reliant on digital competencies and having the requisite skills is seen to be crucial to accessing commonplace healthcare services under constant digitization [42].

In addition, examples from outside the European Union, such as the case of the Philippines, show that the digitization of COVID-19 certificates counterfeits potential abuse, i.e., fraudulent use, e.g., during passport controls [43] because of the vulnerability to forgery among the traditional version of certifications [44]. Therefore, it is highly relevant to raise the issue related to privacy and data security. The COVID-19 pandemic has indeed raised significant concerns about these matters. During the pandemic, there have been various attempts related to the privacy of sensitive data handling. Moulaei et al. [45] conducted a survey-based study to understand the attitudes of COVID-19 patients toward sharing their health data, revealing heightened concerns about the security and privacy of personally identifiable information. Xing et al. [46] investigate the influence of privacy concerns and cultural distinctions on public opinion during the COVID-19 pandemic, highlighting the crisis' worldwide scope and ramifications for public image. Additionally, Xie et al. [47] conducted a pilot study in the Republic of Ireland, revealing a shift in attitude towards privacy during the pandemic, with more individuals expressing willingness to share their data in the interest of saving lives. Due to the potential hazards linked with personal data security, the emerging challenges due to the lack of sufficient digital skills among a significant part of citizens should not be omitted.

3. On Enhancing the Current COVID-19 EU Certification System—Propositions

In terms of technology, the COVID-19 pandemic has prompted large, instantaneous, and unforeseen changes in people's use of digital technologies and media [48]. As the COVID-19 crisis gave the explicit and unambiguous lesson to re-design the public health system [49] and there is still room for improvement in this case, the authors of this study note several possible ways to improve the currently functioning EU COVID-19 certification system, which are:

1. Uniting the personal identification number (and thus the ID card) with the COVID-19 certificate.
2. Issuance of a hard copy of a certificate immediately after having a negative test of SARS-CoV-2 presence or full vaccination.
3. Mailing the vaccination/recovery certificate.
4. Increasing the number of accessible community centers for assistance in the issuance of paper/digital certificates.

Each of these solutions requires compromises on the part of both the service provider and the user of the certificate, as presented in the paragraphs below. However, the authors argue that the advantages of the proposed variants (which may, in some respects, combine with each other) outweigh the flawed current scheme of functioning of the current EU COVID-19 certification system.

3.1. *Uniting the Personal Identification Number with a COVID-19 Certificate*

Co-joining the "COVID-19 certificate" in question with a personal identification number and thus an identity card or passport may bring significant facilitation, especially for individuals that are digitally illiterate. This technical solution would exclude the need to use QR codes, by only simply presenting an identity card or passport before authorized bodies (such as the police, border guards, airport services, etc.). If a member state increases the number of places to which access will be possible only with a certificate (as in the Israeli "green pass" or French "health pass" models [26,50]), then simply presenting an ID card would be sufficient, as COVID-19 related information would be assigned directly to a personal identification number. It is worth emphasizing at this point the value of the Israeli anti-COVID-19 solution, which is the "green pass," which is recognized by scientists as a determinant of an appropriate model to counteract the spread of COVID-19 disease [51]. Additional identification possibilities by authorized services would be in the case of issuing ID cards with a digital layer (i.e., with a QR code or RFID support containing

personal information) because then an appropriate scan of the document would be enough to connect to the database of a given country (via the EU gateway) and thus obtain relevant personal information in the context of COVID-19. It should be noted that presenting an identity card or passport to an authorized body (such as the police or border guard) in order to obtain information about vaccination/recovery/test results would be a voluntary and additional form of identification, apart from the QR code version of the certificate. This solution, which aims to reduce the widespread use of paper certificates can, therefore, be considered a sustainable solution to counteract climate change.

In carrying out improvements in the currently functioning “digital green certification” system in the European Union, it would not be necessary to drastically modify it or change the database structures. The most important change would be to create an additional field storing the “personal identification number” in the database (as a non-obligatory field to be completed). In this case, the key is to obtain an appropriate (semi-anonymous) connection of the EU citizen’s identification number with the national database. As each member country has its own unique ID number format for its citizens, it can apply a field formatting pattern in this database, which could be used for internal validation of the value syntax. It should be noted that presenting an ID card as an additional form of verification would be significantly more difficult for foreigners permanently residing in the EU country where the COVID-19 vaccine has been accepted. However, they could still use the “traditional” form of the COVID-19 certificate.

In order to ensure sufficient privacy and considerations regarding the protection of personal data, it is also important to obtain additional consent from the person (apart from that regarding obtaining the basic certificate). Considering non-digital people, i.e., those who have difficulties using modern technologies, such as the elderly, this consent can be obtained not only in the digital but also in the “analog” form. Consent can be thus obtained also in writing from the unit performing the vaccination or test (immediately after the procedure), as well as post factum by, for example, a dedicated helpline or a visit to the commune office. In parallel with the national database storing the vaccination data of individual citizens secured with unique keys, there should be a linked space for storing consents to use an additional form of identification through identity cards or passports. This space should be associated with the main database, as well as with individual records through secured protocols. At this point, it should be remembered to follow the recommendation on striving for “decentralization of identifiers”, issued by the W3C, which standardizes the practices of digitized/web solutions [24,52]. To avoid potential problems with personal data breaches in the context of an improperly designed IT system, it is recommended to use an authentication system that, on the one hand, ensures full data privacy through the use of generally recognized standards, while on the other gives users a relatively large freedom to use it, such as the one proposed by Lux et al. [53].

Despite the will to be compliant with the legal aspects, there are also some potential dangers involved in this solution. It should be noted that due to the legislative changes, there may be heightened concern regarding potential data breaches due to much more data being captured. There is also a risk of fraudulent use of an individual’s ID document by another to access the benefits of the green pass. It is worth emphasizing that it is governments that have a moral and legal responsibility to counteract unethical behavior, including instituting preventative precautions to counteract the possible malpractice of using forged COVID-19 vaccination certificates [54]. Hence, it is advised that this variant serves as a parallel solution, next to the currently functioning one, and that the identification of a personal document should be carried out only by civil forces (such as the police, border guard, etc.), which are able to confirm the compliance of the document with the person holding it. Abid et al. [55] noted that centralizing databases with sensitive data (such as health-related) can make this data more vulnerable to leakage and increase privacy-oriented concerns. Hence, they recommend creating a database of COVID-19 certificates (containing data on vaccination or test results) based on blockchain technology. This approach is also displayed in the work of Aslan and Ataşen [56]. This is in line with the angle presented

by Eisenstadt et al. [24]. A system for administering COVID-19 certificates on the basis of blockchain technology following the aforementioned recommendations, besides that proposed by Abid et al. [55], was also presented by Pericàs-Gornals et al. [57]. Mbunge et al. [58] also emphasize the significant role of the Internet of Medical Things in the proper and equal distribution of vaccination certificates.

3.2. Issuance of a Hard-Copy Certificate after Having a SARS-CoV-2 Presence Test or Vaccination

Currently, there are no general regulations at the national level to issue a hardcopy certificate immediately after the procedure in the form of a coronavirus test or a full vaccination cycle. It is always the user's responsibility to print out such a certificate. Due to the fact that the noticeable majority of the EU society has limited opportunities to use modern technologies, such a solution could contribute not only to the increased use of COVID-19 certificates, e.g., in public utilities and public transport, but can also encourage the elderly or low-educated people to vaccinate. Medical bodies such as testing points for SARS-CoV-2 presence and COVID-19 vaccination points would be responsible for printing such a certificate. Then, a hardcopy of a certificate would be issued immediately after a negative test result (in the case of "rapid tests" such as antibody tests) and after the full dose of vaccination has been completed.

As this variant is only an extension of the currently functioning COVID-19 certification system, there are also the previously discussed shortcomings of this solution. Among other things, the lack of comfort of using such a solution due to the bulky sheet of paper that can be easily damaged should be considered. Therefore, the application of such legal regulations to issue certificates immediately after the procedure is performed in order to increase the inclusion of individuals that are digitally illiterate is justified, but the form of the certificate itself remains unchanged, thus making it less comfortable to use. It should also be emphasized that it has a moderate negative impact on the environment due to the higher consumption of paper and energy for printing COVID-19 passports.

3.3. Mailing the Vaccination/Recovery Certificate

Another proposal extending the currently operating certification system in the EU is sending the certificate traditionally (via postal services). People who do not have a device with which to download and print the COVID-19 vaccination certificate could submit such a query both electronically and by traditional means by filling in the appropriate form (e.g., at the commune office, at the post office, etc.). Such an inquiry could also be made directly to the point carrying out the tests or vaccinations, e.g. in the case when such a point cannot be printed (e.g. when there is a failure of the printing device).

When ordering such a hardcopy of certificate, it is also worth considering changing the form of presenting this certificate, i.e., the possibility of choosing between a certificate printed on a sheet of paper and issuing it in a plastic form—similar in size to a credit card or an ID card. This form would eliminate the potential inconvenience of use problems of the paper form due to the smaller size and greater durability of the material, in comparison with the paper copy. The plastic form of the certificate could also contain all necessary vaccination/recovery information (same as the paper form) required by local law. A permanent (plastic) certificate may turn out to be affordable not only for people who have difficulties using IT tools but also for any other citizen, eliminating, among other things, the problem of the mobile device (on which the digital version of the certificate is installed) is going to run out of power. It is worth emphasizing that a plastic document is less susceptible to counterfeiting than a paper one [59] and having a digital layer through a plastic certificate makes its use almost equal to that of a regular printout with a digital code.

However, it should be borne in mind that issuing a certificate in a plastic form would involve a longer waiting time due to the longer production process. The new form of the certificate would require supplements to the regulations concerning its design. Moreover, it should be emphasized that such an amendment requires costly changes in the form of the creation of a document production system and a new distribution chain. Therefore,

depending on the financial condition of a given country, a modest fee may be introduced to cover the production costs of the plastic certificate. Regardless of the choice of the form of the issued certificate (paper or plastic), it should always be remembered about the additional time of postal delivery. Moreover, as in the case of printing paper hardcopy after vaccination, a sustainability issue should be underlined, which manifests itself not only through the printing of paper itself or the production of a plastic document but also through an additional process of enveloping and logistic distribution.

3.4. Increasing the Number of Accessible Community Centers for Assistance in Issuance of COVID-19 Certificate

In parallel to the changes in the system itself, including COVID-19 certification, it is also worth creating common and accessible centers to help people that are digitally illiterate to print the certificate and submit an application for sending a plastic form. These points could be present, for example, in municipal offices, but it is also worth considering creating a special position in common and publicly accessible places, such as post offices. It is important that these guidance points are adapted to people with reduced mobility, as a considerable group of people with a digital literacy deficiency belong to the older age groups. The rationale for implementing this concept finds its confirmation in the document by Zerkina et al. [60], who indicate that increasing support centers may also be an appropriate educational tool by increasing digital awareness and digital skills.

4. Discussion

The introduction of alterations to the European COVID-19 certification system in the form of the possibility of showing a private identity card or passport will certainly contribute to increasing mobility among EU citizens, especially those not characterized by “digital literacy”. It should be noted that such alterations could be used by all with digital illiteracy, i.e., not only the elderly but also those with a lower level of education or material status or without a desire to use modern technologies. As noted, it would be a benefit for all citizens, and changes to the structure of the database (used to verify vaccination data) would not be complicated. However, the potential risks associated with the implementation of this solution should be borne in mind. Summarizing Table 1 presents the benefits of implementing systemic changes that should be made at the level of EU law (directive) or local regulations. It also recaps these aspects with regard to other possible improvements to the COVID-19 certificate, as discussed earlier.

The above comparative table does not include the solution in the form of increasing the number of accessible assistive community centers for issuing a COVID-19 certificate because authors believe that they can be introduced in parallel to the above-mentioned proposed changes, without the need to introduce modifications to systemic and legal aspects.

The above deliberations demonstrate that the current COVID-19 certification system in the EU has significant shortcomings for non-ICT-savvy people, and thus it should be adapted. Our proposals for changes in the “COVID-19 passport” system in the European Union clearly contribute to the mitigation of the digital divide and are a step towards building a more inclusive society. Moreover, they are in line with the noticed ways to counteract the digital divide phenomenon, i.e., human care, adopting governmental ICT strategies, and finally providing equitable ICT solutions in healthcare [38,39].

Considering all the solutions presented in the paper, it would seem that the best solution would be unifying the COVID-19 certificate with a personal ID due to the highest convenience for digitally excluded, relatively low implementation costs, and high sustainability against climate change. However, in view of the high level of risk in terms of personal data protection, we recommend this solution as appropriate only in contact with state services that can additionally verify the identity. If the COVID-19 certificate is used in public places, we suggest assistance in issuing it by printing it immediately after being vaccinated or at specially prepared points (which would not require the implementation of complicated system changes). This solution, indeed, is not sustainable but can be perceived

as convenient, especially for the elderly. Such centers could also serve as information points in connection with the COVID-19 pandemic. Increasing the number of such centers may take place irrespective of changes in the certification policy. A more convenient solution for individuals that are digitally illiterate would be to use a plastic form of the certificate, but due to the high implementation costs and time burden of this variant, we endorse this solution for countries with high financial conditions. It also requires slight alterations to national legal regulations.

Table 1. Comparison of EU Digital COVID Certificate before and after implementation of particular enhancements.

Property\Form of Enhancement	EU Digital COVID Certificate in the Current Form	Unifying Personal ID with COVID Certificate	Issuance of a Printout after a Vaccination/Negative Test	Mailing a Plastic Form of Certificate
Form of identification	QR code with a digital signature—mobile application or printout (hard copy)	Additionally: presentation of an ID card or passport (instead of showing a QR code)	Same as in the current form of EU Digital COVID Certificate (QR code with a digital signature—hard copy)	Plastic card (similar to ID) with the QR code and all the necessary information of vaccination
Voluntariness	Yes	Yes	Yes	Yes
Level of convenience for digitally-illiterates	Low	Very high	Low/mediocre	High
Convenience—description	Necessity to have a mobile application or a printout (besides a personal ID)	Only having a personal ID (or a passport) is sufficient	Necessity to have a printout (besides a personal ID)	Necessity to have a plastic certificate
Capabilities/permissions	Defined by EU bodies and national governments	Defined by EU bodies and national governments	Defined by EU bodies and national governments	Defined by EU bodies and national governments
Waiting time for issuance	Immediately	Immediately (after getting a consent)	Immediately (long time—if it’s sent via traditional mail)	Very long time (production + delivery time)
Potential data breach	Low	High	Low	Very low
Amount of additional data captured	Not applicable	Very high	Not applicable—the same amount of data as is captured in the case of the current system	Not applicable—the same amount of data as is captured in the case of the current system
Additional consent	Acceptance of the internal regulations	May be required (cf. “the principle of data minimization”—GDPR)	May be required (cf. “the principle of data minimization”—GDPR)	May be required (cf. “the principle of data minimization”—GDPR)
Requirement to have a digital device	Yes (in order to print the certificate or download it to a mobile device)	No	No	No
Sustainability issues	Only the digital form is sustainable	Sustainable	Not sustainable (paper usage, energy consumption)	Not sustainable (paper envelopes, road transport, plastic involvement)
Cost of implementation	Not applicable	Low	Low	High (production and creating a new distribution path)

Source: own elaboration.

5. A Word of Conclusion

Recapitulating, our set of enhancements proposals for the EU COVID-19 certificate shown in the paper is a more complete approach to addressing the digital divide problem, than the currently functioning system, because each of our proposed solutions may be applied separately or in (sub)sets, adequately to the level of digital exclusion and current legal state of a given country (region). Other authors most often offer merely one solution, especially in the context of the COVID-19 pandemic. Naturally, our scheme still needs to be verified and further advanced, but it can already be seen as an apt starting point for

further research activities aimed at the inclusion of people that are digitally illiterate in broadly understood health cyberspace. The presented solutions contribute to increasing the usefulness of the electronic form of COVID-19 certification in the EU, regardless of the level of digital skills and thence reducing the digital divide. The proposals vary in terms of implementation costs, sustainability, data protection, and convenience of use, but overall, the set of solutions can be considered a good starting point for healthcare managers to analyze the current shape of the COVID-19 certification scheme and adapt it to a wider group of stakeholders.

5.1. Limitations of the Study

The research's main limitation lies in its theoretical nature, providing only an overview of current approaches without empirical validation or practical implementation. The proposed enhancements to the COVID-19 certification scheme lack real-world testing, relying solely on a literature review of digital literacy, the digital divide, and information systems. The study's focus on theoretical exploration limits its ability to address practical challenges or unforeseen obstacles in implementing the suggested changes, potentially hindering a comprehensive understanding of the proposed enhancements' effectiveness and feasibility in addressing the challenges posed by the digital format of the COVID-19 certificate system.

5.2. Directions for Further Research

This study suggests exploring alternative technologies for improving accessibility to the COVID-19 certification system, focusing on individuals with limited digital literacy. It calls for a critical examination of the societal impacts of digital health policies and advocates for the evaluation and adjustment of current health policies to ensure inclusivity, especially for travel within the EU. Further research is recommended on strategies for implementing inclusive health technologies and a longitudinal study to assess the sustained impact of the proposed enhancements across diverse demographic groups, providing insights into long-term effectiveness.

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Appendix A

This Appendix explains the methodology used in determining the level of digital skills among the EU population. The utilized methodology was Digital Skills Indicator 2.0 (DSI), which is the official indicator used by EU authorities to measure digital skills. It is used in official Eurostat data. As can be read from the [61], the Internet and software-related activities that people in the age of 16 and 74 complete in five distinct areas—information and data literacy, communication and collaboration, digital content creation, safety, and problem solving—are the basis of the DSI, a composite indicator. It is considered that people who have engaged in specific activities possess the associated abilities. As a result, the indications may be used as a stand-in for a person's digital skills. The EU survey on ICT usage by people and households served as the basis for the indicator.

References

1. Strzelecki, A.; Rizun, M. Infodemiological Study Using Google Trends on Coronavirus Epidemic in Wuhan, China. *Int. J. Online Biomed. Eng.* **2020**, *16*, 139–146. [CrossRef]
2. Kubiczek, J.; Derej, W. Financial Performance of Business in the COVID-19 Pandemic Conditions—Comparative Study. *Pol. J. Manag. Stud.* **2021**, *24*, 183–201. [CrossRef]
3. Wieczorek-Kosmala, M. COVID-19 Impact on the Hospitality Industry: Exploratory Study of Financial-Slack-Driven Risk Preparedness. *Int. J. Hosp. Manag.* **2021**, *94*, 102799. [CrossRef] [PubMed]
4. Menzel, S.; Springer, S.; Zieger, M.; Strzelecki, A. Google Trends Confirms (COVID)-19 Impact on Tourist Industry. *Tour. Cult. Commun.* **2023**, *23*, 97–102. [CrossRef]
5. Zhang, T.; Gerlowski, D.; Acs, Z. Working from Home: Small Business Performance and the COVID-19 Pandemic. *Small Bus. Econ.* **2022**, *58*, 611–636. [CrossRef]
6. Hadasik, B.; Kubiczek, J. E-Commerce Market Environment Formed by the COVID-19 Pandemic—A Strategic Analysis. *Forum Sci. Oeconomia* **2022**, *10*, 25–52. [CrossRef]
7. European Commission Website Communication from the Commission to the European Parliament, the European Council and the Council: A Common Path to Safe and Sustained Re-Opening. Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0129&from=EN> (accessed on 29 May 2021).
8. European Commission website COVID-19: Digital Green Certificates. Available online: https://ec.europa.eu/info/live-work-travel-eu/coronavirus-response/safe-covid-19-vaccines-europeans/covid-19-digital-green-certificates_en (accessed on 29 May 2021).
9. Chen, L.H.; Freedman, D.O.; Visser, L.G. COVID-19 Immunity Passport to Ease Travel Restrictions? *J. Travel Med.* **2020**, *27*, taaa085. [CrossRef] [PubMed]
10. Petersen, E.; Lucey, D.; Blumberg, L.; Kramer, L.D.; Al-Abri, S.; Lee, S.S.; Pinto, T.d.C.A.; Obiero, C.W.; Rodriguez-Morales, A.J.; Yapi, R.; et al. COVID-19 Vaccines under the International Health Regulations—We Must Use the WHO International Certificate of Vaccination or Prophylaxis. *Int. J. Infect. Dis.* **2021**, *104*, 175–177. [CrossRef]
11. Liew, C.H.; Flaherty, G.T. Immunity Passports to Travel during the COVID-19 Pandemic: Controversies and Public Health Risks. *J. Public Health* **2021**, *43*, e135–e136. [CrossRef]
12. Mathieu, E.; Ritchie, H.; Ortiz-Ospina, E.; Roser, M.; Hasell, J.; Appel, C.; Giattino, C.; Rodés-Guirao, L. A Global Database of COVID-19 Vaccinations. *Nat. Hum. Behav.* **2021**, *5*, 947–953. [CrossRef]
13. Wentzell, E.; Racila, A.-M. The Social Experience of Participation in a COVID-19 Vaccine Trial: Subjects’ Motivations, Others’ Concerns, and Insights for Vaccine Promotion. *Vaccine* **2021**, *39*, 2445–2451. [CrossRef] [PubMed]
14. Radic, A.; Koo, B.; Gil-Cordero, E.; Cabrera-Sánchez, J.P.; Han, H. Intention to Take COVID-19 Vaccine as a Precondition for International Travel: Application of Extended Norm-Activation Model. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3104. [CrossRef] [PubMed]
15. Higgins, S.T.; Klemperer, E.M.; Coleman, S.R.M. Looking to the Empirical Literature on the Potential for Financial Incentives to Enhance Adherence with COVID-19 Vaccination. *Prev. Med.* **2021**, *145*, 106421. [CrossRef]
16. Strzelecki, A. The Apple Mobility Trends Data in Human Mobility Patterns during Restrictions and Prediction of COVID-19: A Systematic Review and Meta-Analysis. *Healthcare* **2022**, *10*, 2425. [CrossRef] [PubMed]
17. Eurostat Database Individuals’ Level of Digital Skills. Available online: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_sk_dskl_i&lang=en (accessed on 30 May 2021).
18. Martínez-Alcalá, C.I.; Rosales-Lagarde, A.; Pérez-Pérez, Y.M.; Lopez-Noguerola, J.S.; Bautista-Díaz, M.L.; Agis-Juarez, R.A. The Effects of COVID-19 on the Digital Literacy of the Elderly: Norms for Digital Inclusion. *Front. Educ.* **2021**, *6*, 245. [CrossRef]
19. Cicha, K.; Rutecka, P.; Rizun, M.; Strzelecki, A. Digital and Media Literacies in the Polish Education System—Pre- and Post-COVID-19 Perspective. *Educ. Sci.* **2021**, *11*, 532. [CrossRef]
20. Aziz, A.; Islam, M.M.; Zakaria, M. COVID-19 Exposes Digital Divide, Social Stigma, and Information Crisis in Bangladesh. *Media Asia* **2020**, *47*, 144–151. [CrossRef]
21. Martins Van Jaarsveld, G. The Effects of COVID-19 Among the Elderly Population: A Case for Closing the Digital Divide. *Front. Psychiatry* **2020**, *11*, 577427. [CrossRef]
22. Beaunoyer, E.; Dupéré, S.; Guitton, M.J. COVID-19 and Digital Inequalities: Reciprocal Impacts and Mitigation Strategies. *Comput. Hum. Behav.* **2020**, *111*, 106424. [CrossRef]
23. Susło, R.; Paplicki, M.; Dopierała, K.; Drobniak, J. Fostering Digital Literacy in the Elderly as a Means to Secure Their Health Needs and Human Rights in the Reality of the Twenty-First Century. *Fam. Med. Prim. Care Rev.* **2018**, *20*, 271–275. [CrossRef]
24. Eisenstadt, M.; Ramachandran, M.; Chowdhury, N.; Third, A.; Domingue, J. COVID-19 Antibody Test/Vaccination Certification: There’s an App for That. *IEEE Open J. Eng. Med. Biol.* **2020**, *1*, 148–155. [CrossRef] [PubMed]
25. Volpp, K.G.; Loewenstein, G.; Buttenheim, A.M. Behaviorally Informed Strategies for a National COVID-19 Vaccine Promotion Program. *JAMA* **2021**, *325*, 125–126. [CrossRef] [PubMed]
26. Gouvernement.fr Coronavirus COVID-19. Available online: <https://www.gouvernement.fr/en/coronavirus-covid-19> (accessed on 7 September 2021).
27. Niculaescu, C.E.; Sassoon, I.; Landa-Avila, I.C.; Colak, O.; Jun, G.T.; Balatsoukas, P. Why ‘One Size Fits All’ Is Not Enough When Designing COVID-19 Immunity Certificates for Domestic Use: A UK-Wide Cross-Sectional Online Survey. *BMJ Open* **2022**, *12*, e058317. [CrossRef]

28. Aissaoui, N. The Digital Divide: A Literature Review and Some Directions for Future Research in Light of COVID-19. *Glob. Knowl. Mem. Commun.* **2021**, *71*, 686–708. [[CrossRef](#)]
29. Seifert, A. The Digital Exclusion of Older Adults during the COVID-19 Pandemic. *J. Gerontol. Soc. Work* **2020**, *63*, 674–676. [[CrossRef](#)] [[PubMed](#)]
30. Seo, H.; Erba, J.; Altschwager, D.; Geana, M. Evidence-Based Digital Literacy Class for Older, Low-Income African-American Adults. *J. Appl. Commun. Res.* **2019**, *47*, 130–152. [[CrossRef](#)]
31. Nedungadi, P.P.; Menon, R.; Gutjahr, G.; Erickson, L.; Raman, R. Towards an Inclusive Digital Literacy Framework for Digital India. *Educ. Train.* **2018**, *60*, 516–528. [[CrossRef](#)]
32. Abdulai, A.-F.; Tiffere, A.-H.; Adam, F.; Kabanunye, M.M. COVID-19 Information-Related Digital Literacy among Online Health Consumers in a Low-Income Country. *Int. J. Med. Inf.* **2021**, *145*, 104322. [[CrossRef](#)]
33. Suwana, F.; Lily. Empowering Indonesian Women through Building Digital Media Literacy. *Kasetsart J. Soc. Sci.* **2017**, *38*, 212–217. [[CrossRef](#)]
34. Lai, J.; Widmar, N.O. Revisiting the Digital Divide in the COVID-19 Era. *Appl. Econ. Perspect. Policy* **2021**, *43*, 458–464. [[CrossRef](#)]
35. Wadhera, R.K.; Wadhera, P.; Gaba, P.; Figueroa, J.F.; Joynt Maddox, K.E.; Yeh, R.W.; Shen, C. Variation in COVID-19 Hospitalizations and Deaths Across New York City Boroughs. *JAMA* **2020**, *323*, 2192. [[CrossRef](#)]
36. Ramsetty, A.; Adams, C. Impact of the Digital Divide in the Age of COVID-19. *J. Am. Med. Inform. Assoc.* **2020**, *27*, 1147–1148. [[CrossRef](#)] [[PubMed](#)]
37. Gann, B. Combating Digital Health Inequality in the Time of Coronavirus. *J. Consum. Health Internet* **2020**, *24*, 278–284. [[CrossRef](#)]
38. Eruchalu, C.N.; Pichardo, M.S.; Bharadwaj, M.; Rodriguez, C.B.; Rodriguez, J.A.; Bergmark, R.W.; Bates, D.W.; Ortega, G. The Expanding Digital Divide: Digital Health Access Inequities during the COVID-19 Pandemic in New York City. *J. Urban Health* **2021**, *98*, 183–186. [[CrossRef](#)] [[PubMed](#)]
39. Watts, G. COVID-19 and the Digital Divide in the UK. *Lancet Digit. Health* **2020**, *2*, e395–e396. [[CrossRef](#)] [[PubMed](#)]
40. Datta, A.; Bhatia, V.; Noll, J.; Dixit, S. Bridging the Digital Divide: Challenges in Opening the Digital World to the Elderly, Poor, and Digitally Illiterate. *IEEE Consum. Electron. Mag.* **2019**, *8*, 78–81. [[CrossRef](#)]
41. Jakubowski, S.; Romaszewski, A.; Kopański, Z.; Strychar, J.; Liniarski, M.; Kilian, T. National, Transborder and Commercial Electronic Identification Hub. *J. Public Health Nurs. Med. Rescue* **2018**, *4*, 14–16.
42. Harris, K.; Jacobs, G.; Reeder, J. Health Systems and Adult Basic Education: A Critical Partnership in Supporting Digital Health Literacy. *Health Lit. Res. Pract.* **2019**, *3*, S33–S36. [[CrossRef](#)]
43. Rocha, I.C.N. How to Avoid Fake COVID-19 Vaccine Passports as a Travel Requirement? *J. Public Health* **2021**, *44*, e608–e609. [[CrossRef](#)]
44. Marhold, K.; Fell, J. Electronic Vaccination Certificates: Avoiding a Repeat of the Contact-Tracing ‘Format Wars. *Nat. Med.* **2021**, *27*, 738–739. [[CrossRef](#)]
45. Moulaei, K.; Iranmanesh, E.; Amiri, P.; Ahmadian, L. Attitudes of COVID-19 Patients toward Sharing Their Health Data: A Survey-based Study to Understand Security and Privacy Concerns. *Health Sci. Rep.* **2023**, *6*. [[CrossRef](#)]
46. Xing, Y.; Li, Y.; Wang, F.-K. How Privacy Concerns and Cultural Differences Affect Public Opinion during the COVID-19 Pandemic: A Case Study. *Aslib J. Inf. Manag.* **2021**, *73*, 517–542. [[CrossRef](#)]
47. Xie, G.; Lohar, P.; Florea, C.; Bendechache, M.; Trestian, R.; Brennan, R.; Connolly, R.; Tal, I. Privacy in Times of COVID-19: A Pilot Study in the Republic of Ireland. In Proceedings of the 16th International Conference on Availability, Reliability and Security, Vienna, Austria, 17–20 August 2021; ACM: New York, NY, USA, 2021; pp. 1–6. [[CrossRef](#)]
48. Guitton, M.J. Cyberpsychology Research and COVID-19. *Comput. Hum. Behav.* **2020**, *111*, 106357. [[CrossRef](#)] [[PubMed](#)]
49. Sturmberg, J.P.; Tsisis, P.; Hoemeke, L. COVID-19—An Opportunity to Redesign Health Policy Thinking. *Int. J. Health Policy Manag.* **2022**, *11*, 409–413. [[CrossRef](#)] [[PubMed](#)]
50. Israeli Ministry of Health (Corona) website What Is a Green Pass? Available online: <https://corona.health.gov.il/en/directives/green-pass-info/> (accessed on 30 August 2021).
51. Waitzberg, R.; Triki, N.; Alroy-Preis, S.; Lotan, T.; Shiran, L.; Ash, N. The Israeli Experience with the “Green Pass” Policy Highlights Issues to Be Considered by Policymakers in Other Countries. *Int. J. Environ. Res. Public Health* **2021**, *18*, 11212. [[CrossRef](#)] [[PubMed](#)]
52. Halpin, H. Vision: A Critique of Immunity Passports and W3C Decentralized Identifiers. In *SSR 2020: Security Standardisation Research; Lecture Notes in Computer Science*; van der Merwe, T., Mitchell, C., Mehrnezhad, M., Eds.; Springer: Cham, Switzerland, 2020; pp. 148–168. [[CrossRef](#)]
53. Lux, Z.A.; Thatmann, D.; Zickau, S.; Beierle, F. Distributed-Ledger-Based Authentication with Decentralized Identifiers and Verifiable Credentials. In Proceedings of the 2020 2nd Conference on Blockchain Research & Applications for Innovative Networks and Services (BRAINS), Paris, France, 28–30 September 2020; IEEE: Paris, France, 2020; pp. 71–78.
54. Deguma, M.C.; Deguma, J.J. The Possible Threat of Faking COVID-19 Diagnostic Tests and Vaccination Certifications: A Call to an Immediate Action. *J. Public Health* **2021**, *43*, e340–e341. [[CrossRef](#)] [[PubMed](#)]
55. Abid, A.; Cheikhrouhou, S.; Kallel, S.; Jmaiel, M. NovidChain: Blockchain-based Privacy-preserving Platform for COVID-19 Test/Vaccine Certificates. *Softw. Pract. Exp.* **2022**, *52*, 841–867. [[CrossRef](#)] [[PubMed](#)]
56. Aslan, B.; Ataşen, K. COVID-19 Information Sharing with Blockchain. *Inf. Technol. Control* **2021**, *50*, 674–685. [[CrossRef](#)]

57. Pericàs-Gornals, R.; Mut-Puigserver, M.; Payeras-Capellà, M.M. Highly Private Blockchain-Based Management System for Digital COVID-19 Certificates. *Int. J. Inf. Secur.* **2022**, *21*, 1069–1090. [[CrossRef](#)]
58. Mbunge, E.; Dzinamarira, T.; Fashoto, S.G.; Batani, J. Emerging Technologies and COVID-19 Digital Vaccination Certificates and Passports. *Public Health Pract.* **2021**, *2*, 100136. [[CrossRef](#)]
59. Baechler, S. Document Fraud: Will Your Identity Be Secure in the Twenty-First Century? *Eur. J. Crim. Pol. Res.* **2020**, *26*, 379–398. [[CrossRef](#)]
60. Zerkina, N.; Lomakina, Y.; Kisel, O.; Lazarou, E. Extend Centre’s Resources for Increasing General Digital Literacy. In Proceedings of the the 15th International Scientific Conference eLearning and Software for Education, Bucharest, Romania, 11–12 April 2019; pp. 140–145. [[CrossRef](#)]
61. Vuorikari, R.; Jerzak, N.; Karpinski, Z.; Pokropek, A.; Tudek, J. *Measuring Digital Skills across the EU—Digital Skills Indicator 2.0*; Publications Office of the European Union: Luxembourg, 2022.

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