INTERNATIONALE HOCHSCHULE

www.iu.de

IU DISCUSSION PAPERS

IT & Engineering

Towards Acceptance Criteria for a Digital Euro

NICOLAI KRÜGER

JAN BUSCHE

IU Internationale Hochschule

Main Campus: Erfurt

Juri-Gagarin-Ring 152

99084 Erfurt

Telefon: +49 421.166985.23

Fax: +49 2224.9605.115

Kontakt/Contact: kerstin.janson@iu.org

Autorenkontakt/Contact to the author(s):
Prof. Dr. Nicolai Krüger
ORCID-ID: 0000-0002-0848-6856

IU Internationale Hochschule - Campus Düsseldorf

Hildebrandtstraße 24c

40215 Düsseldorf

Email: nicolai.krueger@iu.org

IU Discussion Papers, Reihe: IT & Engineering, Vol. 4, No. 3 (Juli 2022)

ISSN-Nummer: 2750-073X

Website: https://www.iu.de/forschung/publikationen/

Towards Acceptance Criteria for a Digital Euro

Nicolai Krüger

Jan Busche

ABSTRACT:

Alongside other central banks, the European Central Bank (ECB) is currently exploring the potential of a Central Bank Digital Currency (CBDC). Such a significant payment innovation requires compliance with the ECB's mandate based on the Treaties of the European Union, in addition to socio-technical and socio-economic considerations. Thus, Information Systems (IS) researchers might witness and actively participate in one of the most important changes associated to currency-related fundamental rights in our time in the euro area. IS research can provide useful insights into technology acceptance criteria of a CBDC, which is a novel and unfamiliar technology for most people, and help identify requirements. Our paper provides an overview of the current state of development. Furthermore, we present a Technology Acceptance Model – based vignette study (N = 207) and derive design principles for a prospective digital euro (PDE). The results of the study show that acceptance by the German population can be assumed. However, there are significant differences depending on the final design choices.

KEYWORDS:

Central Bank Digital Currency, European Central Bank, Digital Euro, Technology Acceptance Model, Intention to use, Cryptocurrencies.

AUTHORS

Prof. Dr. Nicolai Krüger *is Professor of Information Systems at IU Düsseldorf. His research interests include Digital Innovation, Transformation and Entrepreneurship (DITE) and the application of Generative Artifical Intelligence. He is also the founder of the innovation consultancy pitchnext and a regular jury member of several entrepreneurship programs, especially the Founders@IU program.*

Jan Busche *is a payments and banking expert working for one of the largest IT providers of German banking infrastructure. He has gained extensive experience in various frontend, backend and process-related projects.*

Introduction

In recent years, more and more institutions have been involved in the development and introduction of digital currencies. These include public institutions such as central banks. As early as 2020, 86% of all central banks worldwide were involved in the introduction of digital central bank money, a so-called Central Bank Digital Currency, referred as CBDC in the forthcoming (Boar and Wehrli, 2021). The demand for digital currencies and the innovations that come along with them is growing in the private sector, e.g., for easy peer-to-peer money transfer or save e-commerce transactions. Programmable money and Distributed Ledger Technology (DLT) in general are associated with disruptive potential for the financial world (Bech et al., 2020a; Berentsen et al., 2020). However, by their inherent nature, National Central Banks (NCBs) mostly agree on advantages of programmable and digital currencies but necessarily act as currency guardians, which would contradict the ideology of DLT and the upcoming alternative finance sector of decentralized finance (DeFi).

Nevertheless, the Covid 19 pandemic reduced the usage of cash even further and drastically increased contactless payment and e-commerce, which both made digital payment solutions necessary (Bhatti et al., 2020; Puriwat & Tripopsakul, 2021). Such payment solutions are mainly dominated by US companies, like PayPal (Toh & Tran, 2020). In the US market, Apple, as a so-called non-bank, even offers a peer-to-peer payment solution for their devices which do not require any further hardware than the iPhone itself (Li et al., 2021). This can be interpreted as one motivation for the European Central Bank (ECB) to provide an accessible alternative to the people in the euro zone.

Additionally, the ECB is being urged to act in order to maintain its influence on payment transactions to prevent this sector from instable, decentralized and unregulated alternatives arising in the field of crypto-markets (European Central Bank, 2020; Panetta, 2022a).

In 2021, the project to study and launch the ECB's digital Euro, officially called eEuro[1], started (European Central Bank, 2021a). At the time of submitting this paper, ECB plans to issue the eEURO as a so-called retail CBDC (we present general architectural design patterns in section 2), accessible to everyone, with a time horizon of 2026 at the earliest and technology openness (Panetta, 2022b; Sandner et al., 2021). Digital access to central bank money is thus intended to support the two-tier monetary system and strengthen the autonomy of European payment transactions, which are predominantly dominated by non-European companies in the digital sector. To make this possible, the ECB's digital Euro needs to be used in the daily lives of the European population (European Central Bank, 2022a). In this context, an advantageous design is a key factor in offering added value compared to existing payment solutions (KPMG, 2023). Thus, we derive the following research question:

What are user-centric acceptance criteria for a prospective digital euro and what are the associated requirements?

The paper is structured as follows: First, we provide further theoretical background divided into core information about a digital euro as such and related research. In order to be able to measure already now to what extent the ECB's digital Euro has the potential to be accepted, prototypes of potential

[1] While most official ECB documents use the term eEuro, many other formulations are used synonymously in EU committee papers and the academic literature. Thus, in this paper we will also refer to the Prospective Digital Euro (PDE), the Digital Euro, e€uro and the eEuro as different expressions for the same meaning, i.e. a CBDC issued by the ECB.

designs are presented alongside our research method. Using the Technology Acceptance Model (TAM) 2 (Venkatesh et al., 2000) and the Model of Consumer Acceptance of Electronic Commerce (Pavlou, 2003), the intention to use is examined in more detail and design principles for a digital euro presented. We discuss our findings and derive implications for research policy makers, while we also show boundaries of our research approach. Here we derive future research ideas. Finally, we conclude our study.

Theoretical Background

TECHNOLOGICAL SCOPE OF A DIGITAL EURO

In 2021 the decision was made by the ECB committee to investigate potential steps toward a digital currency (see figure 1). Against this backdrop, several regulatory, legal and technical initiatives have been launched, but also a user-centred approach was implemented by the involvement of user groups (Bundesfinanzministerium, 2023). First technological decisions are made, others are still under consideraiton: The digital euro will be issued as a so-called retail CBDC and thus be available to all European citizens (Panetta, 2021a). In contrast to this form would be a wholesale CBDC, which could only be used in the interbank market and would therefore not be accessible to the public (Klein et al., 2020). However, the fundamental architectural design decision, which technology could be used for the digital Euro, has not been decided yet (European Central Bank, 2023a). Different possible approaches are being discussed (Bechtel et al., 2022): On the one hand, an account-based option in which every person would open an account with the ECB or a national central bank such as the Deutsche Bundesbank (Berentsen et al., 2020). Credit balances on these accounts would be central bank money and thus fail-safe. Such an account could be included in the online banking of the respective credit institution via interfaces to the respective house banks of the persons and connection to payment transaction systems and would thus be digital central bank money (Panetta, 2022c).

Alternatively, it would be thinkable to issue the digital Euro as a DLT (Sandner et al., 2021; Guo et al., 2022). With this rather newer technology, it would be possible to program the digital Euro, which could bring additional functions and innovations based on them. Examples would be smart contracts, machine-to-machine payments or microtransactions (Sandner et al., 2021; Forster et al., 2021). Further, ECB aims to enable offline payments as well. These could be used for peer-to-peer (P2P) and peer-to-business (P2B) payments. In addition, the functionality of pseudonymised payments shall represent current cash characteristics (European Central Bank, 2021b; Bank for International Settlements, 2022).

The following table presents the basic characteristics of possible CBDC implementations.

Implementation	Characteristics	Example(s)
Cryptocurrency	• Based on DLT • Linkable to the DeFi world • High perceiEved privacy • Unregulated and decentral • Thus, practically and logically not an option for a central currency	Logically no examples possible, however, some countries like El Salvador have adopted cryptocurrencies and try to allow them as currency in daily life

Account-based	• Ease of implementation & use • High regulation capability • Utilizes existing infrastructure between ECB and NCB • Would de facto launch an alternative and new payment system • Not necessearily interoparable with DLT-systems	• Digital Yuan (China) • E-Krona (Sweden), however, DLT-based • Sand Dollar (Bahamas)
Trigger solution	• Virtual simulation of a digital euro • Would utilize existing infrastructure • Payments through smart contracts • Retail banks would only show a representation of a digital currency without building new infrastructure	No real word implemetations yet
Hybrid	• Central bank issuance • Intermediary distribution • Balance between central control & private-sector innovation • Decoupled validation & value transfer	

Table 1 Characteristics of CBDC implementations

In addition to these different technological approaches, general product features have also been discussed. To prevent digital bank runs or the disintermediation of the banking sector, a maximum amount of 3,000 digital Euros per person or a two-tier interest system are being considered (Bindseil, 2020; Panetta, 2021). Just such restrictions could also have a negative impact on acceptance (Balz, 2022). Moreover, keeping such an account or wallet is not intended as a substitute for the house bank account and thus not as a salary account. In order to have a credit balance, a link to a source of liquidity, such as a bank account, would be necessary, via which a manual or automatic charging can take place (Bindseil et al., 2022).

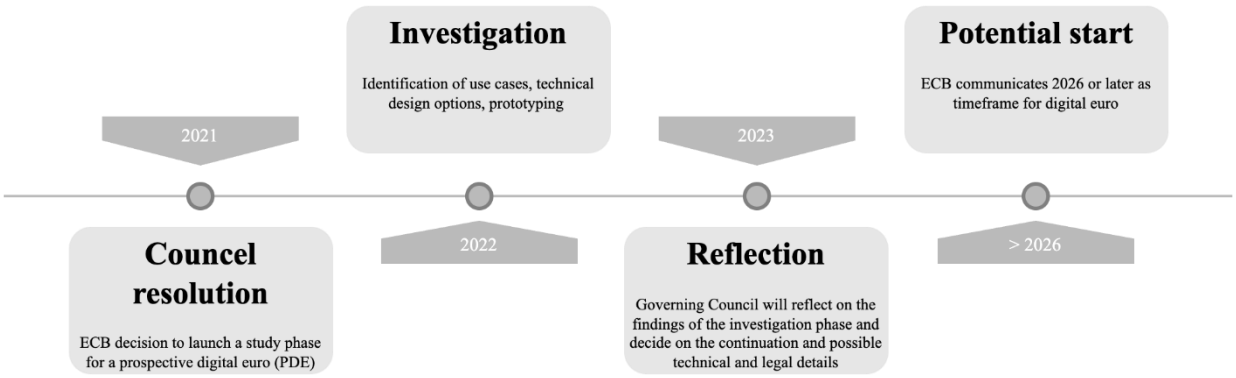

Figure 1 Timeline of the digital euro project (based on European Central Bank, 2023b)

RELATED WORK

Due to the heterogeneous nature of the questions related to the topic, a wide bandwidth of research lenses can be found in the body of literature. This section aims to enlighten the cornerstones of that bandwidth. Hamm (2023) designed a study to understand the trust in cryptocurrencies. While the final results are still pending, the author argues that trust and perceived risk may differ for stable coins, peer-

to-peer cryptocurrencies, and CBDCs. Tronnier et al. (2023) focus in their study on the privacy concerns of potential users, as privacy seems to be a driving factor for the acceptance and diffusion of a CBDC.

In the context of the ECB's legal mandate, technical decisions have to be made in compliance with the existing legal framework. For example, Mooij (2023) presented a paper under the umbrella of banking regulation. A general design choice can be made between a token/blockchain-based implementation of a digital euro or an account-based solution. However, the author rejects a token-based solution due to the lack of socio-economic benefits. The remaining solution is described by Mooij as account-based in the sense that an account would be available for every citizen in the euro system at the level of the ECB or the national central banks (NCBs), which would declare both as competitors to commercial banks and thus be incompatible with the ECB's mandate.

The decision on a prospective digital euro (PDE) is neither a decision of a single national central bank in the Eurosystem, nor an invitation only to the ECB. From a regulatory perspective, the European Parliament will debate such fundamental changes in the fiscal system. For example, Angeloni (2023a) provides an in-depth report (on request) to the relevant ECON committee of the EU Parliament. Sandner & Gross (2023) argue that the euro is "losing ground around digital currencies" (p. 6). This argument is based on the upcoming CBDC initiatives of several countries, but also reflects the market growth and acceptance of decentralized finance (hereafter referred to as DeFi), FinTechs, and blockchain-based services.

Angeloni (2023b) sees the preparation, i.e. understanding, prototyping, legal evaluation, of a digital euro as fruitful, but recommends not to start with the implementation before there is enough knowledge and a clear need for a digital euro.

A summary of the references, findings and associated research lenses is presented in the table below.

Research Lense	**Findings**	**Reference**
Technology adoption	• (Classical) Cryptocurrencies, stablecoins and CBDC form a comparable set of trust-risk considerations • This is, because from a user-perspective they represent alternative payment systems • Backing by central banks (CBDCs) might lower the percieved risk • Ongoing study, i.e., preliminary findings	Hamm (2023)
Banking regulation and economic policy	• The paper estimates different regulatory drivers, which might justify a digital euro and their derived technical implementations • Price stability and unbanked population: Amount of unbanked people (i.e., people without a personal bank account) is too low and not putting prise stability at risk as that the ECB mandate justify a digital euro based on that • Treaty on the Functioning of the European Union (TFEU): The paper questions that the current contracts of EU partners would allow a digital euro at all • ECB mandate: A CDBC requires a deep technical integration of NCBs and ECB – the paper derives doubts that the current ECB mandate would cover that	Mooij (2023)

Privacy concerns	• Identification of privacy parameters (sender and data subject, recipients, information type, transmission principles) • Users distinguish between transaction-related and identity-related information • Information flow and transmission principles rank higher than the information as such • Data gathering by unknown entities is a clear threat • Confidentiality and anonymity standards are a significant factors for accepting a digital euro	Tronnier et al. (2023)
Policy makers	• Technically and practically, a CDBC launch would mean that the ECB becomes a payment service provider (PSP) • Thus, a digital euro would compete with existing payment solutions and must therefore neither be too successfull, nor unattractive, in order to succeed in the market without disrupting existing payment infrastructure solutions • A digital bank run could materilise in case of a financial crises more easily compared to a world without a digital euro • A digital euro would ease a variety of payment problems (e.g., cross-border payments) but not increase financial inclusion	Angeloni (2023a) Angeloni (2023b)
Intersection of geopolitics and technology	• Digital and therefore programmable money is a geopolitcal question, at least driven by the fact, that other currencies and states already have solutions (or at least testing phases) in stage • Trigger-solution could work as workarround and could be used in the B2B field • Stablecoin-/DLT-solutions are no alternatives for NCBs around the world so far and are mainly popular in the Peer-to-Peer segment • Paper sees CBDC solution as the preferred and logical technological solution and capable of meeting know-your-customer (KYD) requirements	Sandner & Gross (2023)

Table 2 Research lenses in the body of literature with regards to the digital euro

Research Method

Vignette studies are a profound and well-elaborated method in Information Systems when it comes to the socio-technical understanding of innovation diffusion, especially in scenarios of general social interest, early acceptance studies can help decision makers; Corona-Warn-App or ChatGPT are other popular examples in that methodological field (Behne et al., 2021).

Based on these design approaches, two prototypes of a possible digital Euro were created. These are based on the two technical implementation options of a retail CBDC. The aim of this prototyping step in our research project is to be able to depict as comprehensibly as possible how a future digital Euro could look and function. For the account-based digital Euro, an approach was chosen in which it is integrated as an additional account in the online banking of a house bank. The front end of an

exemplary banking app was used for this as a starting point in our user interface design, to provide users with an environment that is as familiar to them.

For the second prototype, a wallet was designed analogous to the ECB studies (European Central Bank, 2021b), which represents the possible innovative functions of a DLT-based digital Euro. The Bank of Ireland Banking App served as a model for the most innovative design possible. In order to distinguish both approaches from digital fiat money, credit balances in the ECB's digital Euro were each labelled as "e-Euro". Figure 2 shows the two prototypes, with markings indicating the most important aspects.

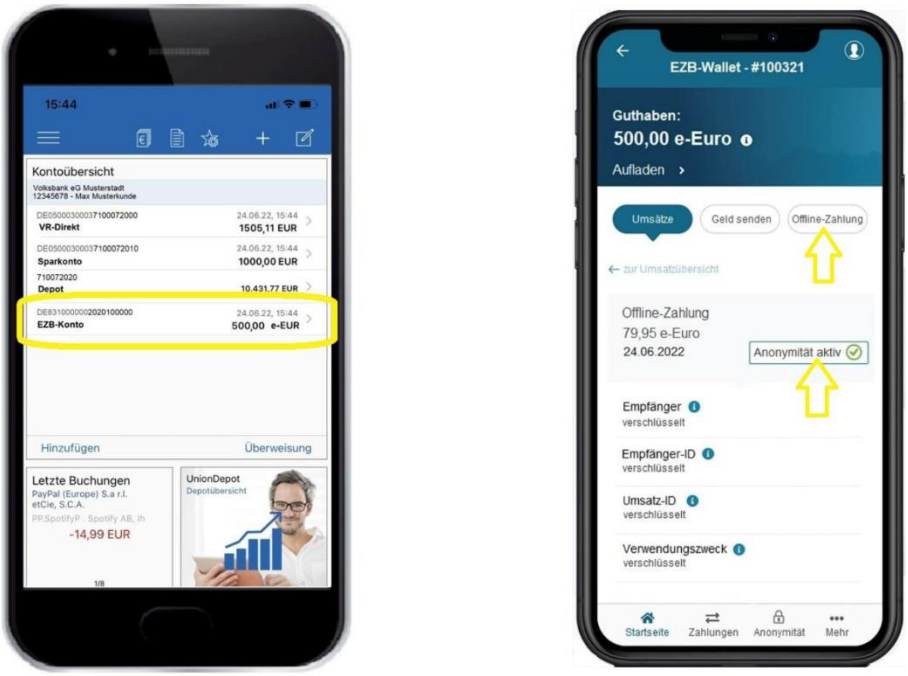

Figure 2 Structure of the prototypes "account-based digital Euro" (left) and "DLT- based digital Euro" (right)

Beside the vignette part of our study, participants were invited to share qualitative feedback and thoughts on the digital euro.

Results

In order to investigate a possible intention to use the prototypes and their background, the TAM2 (Venkatesh et al., 2000) was applied and extended by the variable *trust* from the Model of Consumer Acceptance of Electronic Commerce (Pavlou, 2003). The variables *Subjective Norm*, *Image*, *Output Quality* and *Perceived Ease of Use* were selected from the TAM2 and a direct influence on the intention to use was implied, which is only indirectly present in the original TAM2 via *Perceived Usefulness* (Venkatesh et al., 2000). The research model is shown in Figure 3 below.

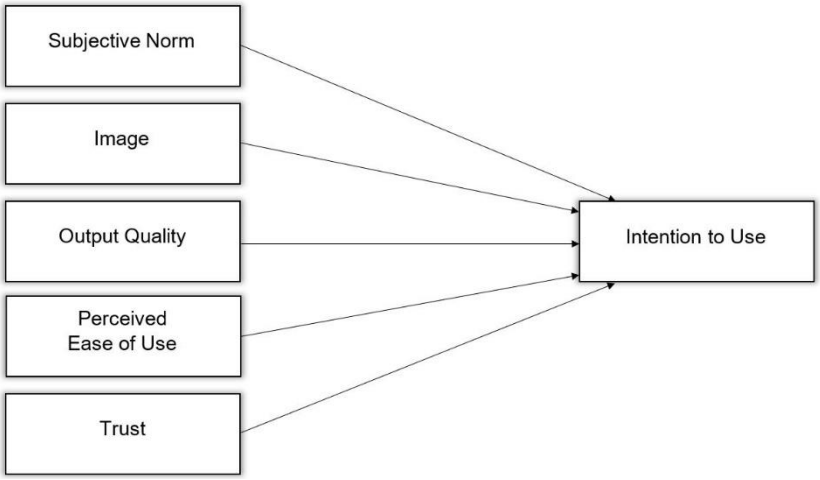

Figure 3 Research model based on TAM2 [11].

Within the framework of a quantitative survey, the two prototypes were presented to different test persons one after the other and the various model variables and the intention to use were examined via items. In order to understand the price elasticity for the ECB's digital Euro, the intention to use it was also covered in the survey by adding monthly costs of €1.00. The online questionnaire was used to acquire participants. To acquire participants, the online questionnaire was distributed to students and shared on social media. Over a period of four weeks, the questionnaire was accessed by 285 people and completed in full by 207. Of these, 205 participants stated that they lived in Germany, which is why only these participants were considered further. 203 people provided information about their age. The 205 people considered were divided into 106 male and 99 female participants. A five-point Likert scale was used for the rating, with *1* expressing the lowest and *5* the highest agreement with the respective item. For comparability of the two prototypes, the mean values of the variables were calculated (Kuckartz et al., 2013). The results are shown in Figure 4.

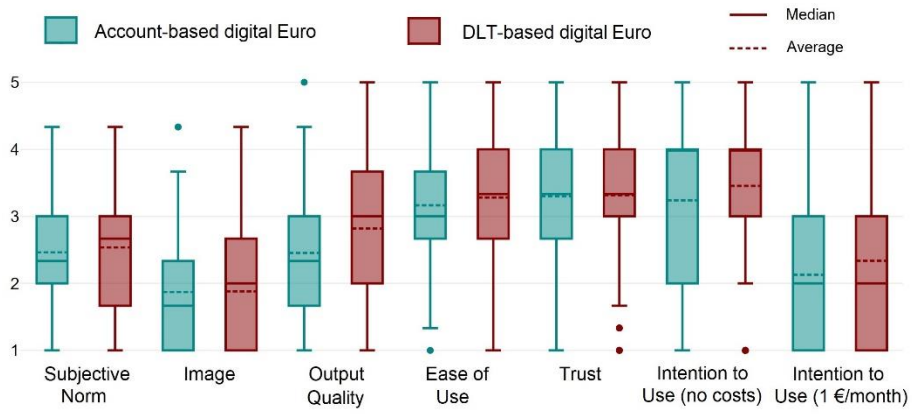

Figure 4 Results of the evaluation (*1* expressing the lowest and *5* the highest agreement with the respective item)

Significant differences between the two prototypes were found in the "output quality" ($t(204) = -5.81$, $p < 0.001$), the "perceived ease of use" ($t(204) = -2.34$, $p = 0.02$) and the final intention to use ($t(204) = -3.08$, $p = 0.002$). The difference in intention to use without price and with the addition of monthly fees was also significant for both prototypes (Account-based digital Euro: 13.35, $p < 0.001$; DLT-based digital Euro: 12.99, $p < 0.001$). In addition, a significant, slightly negative correlation with age was found for the

DLT-based digital Euro ($r = -0.19$; $p = 0.01$; $n = 203$). With regard to gender, no significant correlation of the intention to use could be found for any of the prototypes.

Through the qualitative question of our survey, we received concrete user-centered feedback, which we first summarized as themes in Figure 5. Then we formulated meta-requirements and concluded them as design principles. In general, we found issues related to acceptance and functionality. Issues that we grouped under acceptance were driven by doubts about the added value of a digital euro. On the other hand, several users expressed concerns about their traceability in terms of cash flows and possible surveillance. The group of feature-related issues represented the cash substitution requirement, e.g., easy offline payment. From this we derived four meta-requirements. First, it seems that - despite all the communication and popularity in the public media - the potential benefits of a PDE are not yet clear. Especially when it comes to transparency and trustworthiness. Third, interestingly, a digital alternative to traditional cash is a clear meta-requirement. Fourth, it should be well and seamlessly integrated into the existing landscape of banking applications.

With this in mind, we concluded two design principles. User-centricity could be strengthened right now. This could be achieved through more media presence, social media campaigns, etc. As the 19 countries are part of the euro zone, this design principle should also include the involvement of users with different cultural backgrounds and heterogeneous expectations. Early access to (non-functional) prototypes could be helpful, as well as early access programs at a later stage. Our second design principle addresses the fact that the ECB is de facto creating a competitive payment system in two directions: First, it will compete with the existing classical banking and payment system SEPA. Technically, this could be implemented as a so-called payment scheme (Bundesfinanzministerium, 2023). This could strengthen the perspective on the payment innovation inherent in the digital euro. Second, the ECB will directly attack existing non-SEPA solutions such as PayPal. For example, payment must be device and operating system independent. In addition, the ECB and NCBs must offer retail banks a well-designed system to enable these intermediaries in their role as front-end designers.

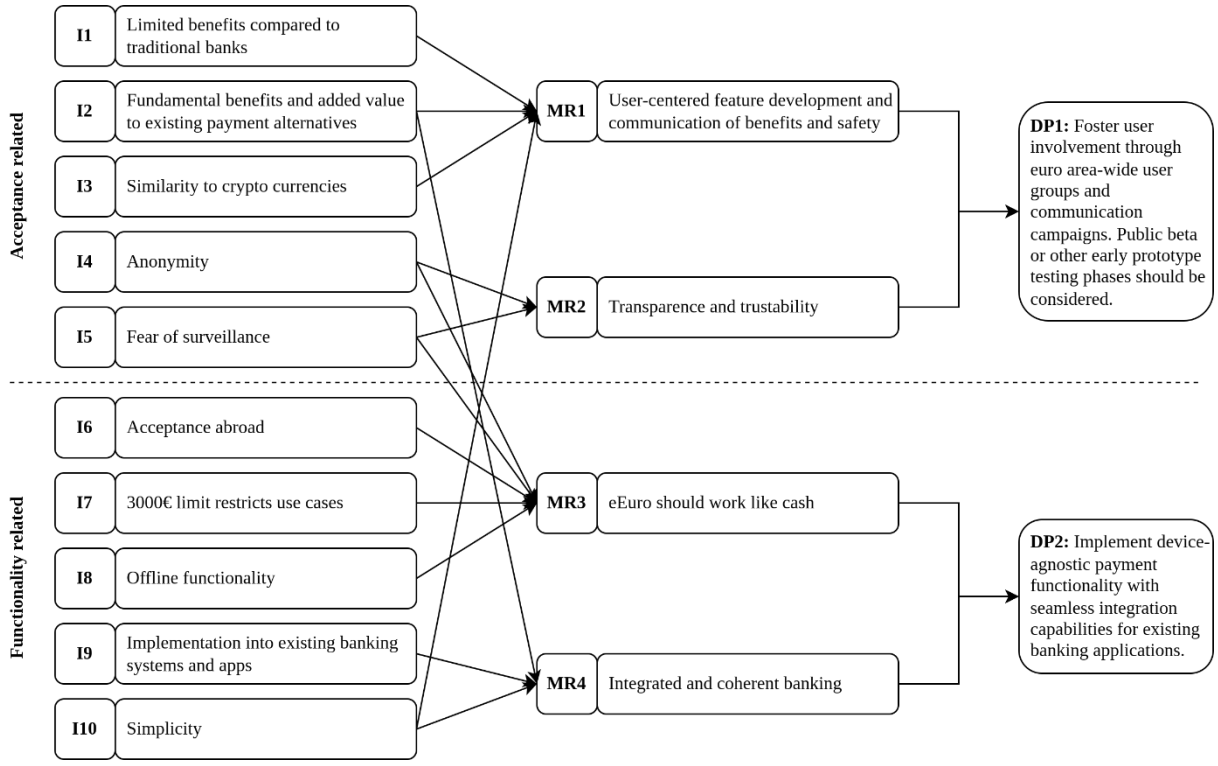

Figure 5 Derived issues, meta requirements and design principles

Discussion

The scientific contribution of our study is twofold. Our sample data provide first insights into the hypothetical acceptance of the digital euro. The two prototypes, which are supposed to represent a future digital euro of the ECB as realistically as possible, provide first insights into a possible intention to use the digital euro among the German private individuals in our sample. For both prototypes, a rather positive intention to use was measured, which was above the neutral value *3* in both cases. The DLT-based digital euro recorded a significantly higher intention to use (3.45) than the account-based digital euro (3.24). On the basis of the variables evaluated, it can be concluded that this difference is due to the different perceptions of *quality of issue* and *perceived ease of use*. The *issuing quality* also expresses the added value compared to other payment solutions. This supports the ECB's statement that added value is necessary for the successful establishment of the digital euro (Panetta, 2022d). The high price elasticity is also noticeable, as the intention to use the system decreases significantly when costs are added. This is in line with the ECB's previous findings on the product features that users demand from a digital euro (Kantar Public, 2022).

The open-ended part of the survey reflected the fact that in some cases there was little perceived difference or added value compared to traditional bank accounts or fiat money. Creating this added value and communicating it to potential users could be a key component for the use of the digital euro. It has already been found in the Netherlands that better knowledge of a CBDC increases the intention to use it (Bijlsma et al., 2021), reflecting the general influence of knowledge and technology acceptance (Stibe et al., 2022).

Future research should further investigate the interdisciplinary characteristics of the digital euro. From an IS perspective, additional acceptance studies should overcome the limitations of our study, which is obviously a sample group from only one euro member country. Thus, a euro area-wide representative study would be recommended. Another limitation of our study lies in the fast-moving nature of the topic, which can hardly be addressed in the academic publication pipeline. In our case, this limitation means a data set in the light of mid-2022.

Our study also aims to add knowledge to the literature for practitioners and policy makers. Our design principles provide high-level ideas for a digital euro implementation. In line with the existing literature, our data show that trust and transparency are of paramount importance. This also implies a clear differentiation from cryptocurrencies, DLT and Defi. To strengthen the common knowledge about the digital euro as a major innovation in payment technology, early and intensive communication, user involvement, user experience research and feedback gathering should be initiated.

Conclusion

While the configuration of a digital euro is still under discussion, its growing relevance can be observed in academic papers and EU policy drafts. Thus, researchers play a fundamental role in providing knowledge on this socio-technological and socio-economic issue. In our paper, we presented an overview of the current (technological) state of the art. Furthermore, we contributed aspects of CBDC acceptance for a sample of the German Euro population. While the general acceptance seems to be positive, several doubts and therefore requirements were addressed in our paper. Based on these issues, we derived meta-requirements and design principles to provide researchers and policy makers with a better understanding of user attitudes. Among many other findings, the current retail banking approach could be a promising option as it could allow banks to seamlessly integrate a digital euro into existing banking solutions.

References

Angeloni, I. (2023). *Digital Euro: When in doubt, abstain (but be prepared)*. European Parliament.

Angeloni, I. (2023b). The digital euro: A precautionary device, not a deus ex machina. *SAFE Policy Letter* (No. 99).

Behne, A., Krüger, N., Beinke, J. H., & Teuteberg, F. (2021). Learnings from the design and acceptance of the German COVID-19 tracing app for IS-driven crisis management: a design science research. *BMC Medical Informatics and Decision Making*, *21*(1), 238.

Bhatti, A., Akram, H., Basit, H. M., Khan, A. U., Raza, S. M., & Naqvi, M. B. (2020). E-commerce trends during COVID-19 Pandemic. *International Journal of Future Generation Communication and Networking*, 13(2), 1449-1452.

Bundesfinanzministerium (2023). Digitales Zentralbankgeld und der digitale Euro. *Monatsbericht des BMF April 2023*. https://www.bundesfinanzministerium.de/Monatsberichte/2023/04/Inhalte/Kapitel-3-Analysen/3-1-digitales-zentralbankgeld-und-digitaler-euro.html (accessed 13th July 2023).

Hamm, P. (2023). Cryptocurrencies, Stablecoins, and Central Bank Digital Currencies: The Impact of Trust and Perceived Risk. *ECIS 2023 Proceedings*. Kristiansand.

Stibe, A., Krüger, N., & Behne, A. (2022). Knowledge behavior gap model: An application for technology acceptance. In *International Conference on Mobile Web and Intelligent Information Systems* (pp. 3-17). Cham: Springer International Publishing.

Mooij, A. M. (2023). A digital euro for everyone: Can the European System of Central Banks introduce general purpose CBDC as part of its economic mandate? *Journal of Banking Regulation*, *24*(1), 89-104.

Sandner, P., & Gross, J. (2023). The digital euro from a geopolitical perspective: Will Europe lag behind?. In *Fintech, Pandemic, and the Financial System: Challenges and Opportunities* (pp. 223-240). Emerald Publishing Limited.

Tronnier, F., Biker, P., Baur, E., & Löbner, S. (2023). An Evaluation of Information Flows in Digital Euro Transactions Using Contextual Integrity Theory. In *Proceedings of the 2023 European Interdisciplinary Cybersecurity Conference* (pp. 7-12).

Balz, B. (2022). CBDC – The acceptance and adoption challenge. *Deutsche Bundesbank Speeches*, https://www.bundesbank.de/en/press/speeches/cbdc-the-acceptance-and-adoption-challenge-804788 (accessed 13th July 2023).

Bank for International Settlements (2022). The future monetary system. *BIS Annual Eco-nomic Report*, June 2022, 75-112.

Bech, M., Hancock, J., Rice, T. & Wadsworth, A. (2020). On the future of securities settlement. *BIS Quarterly Review*, March 2020, 67-83.

Bechtel, A., Ferreira, A., Gross, J. & Sandner, P. (2022). The Future of Payments in a DLT-Based European Economy: A Roadmap. In Heckel, W. & Waldenberger, F. (eds), *The Future of Financial Systems in the Digital Age – Perspectives from Europe and Japan*, Springer, pp. 89-116.

Berentsen, A. (2020). Plädoyer für den E-Euro - Implikationen für die Gesellschaft. Basel.

Bijlsma, M., van der Cruijsen, C., Jonker, N. & Reijerink, J. (2021). What triggers consumer adoption of CBDC?, *De Nederlandsche Bank Working Paper*, 709.

Bindseil, U. (2020). Tiered CBDC and the financial system. *ECB Working Paper Series*, 2351.

Bindseil, U., Panetta, F. & Terol, I. (2021). Central Bank Digital Currency, functional scope, pricing and controls. *Occasional Paper Series*, December 2021, 286.

Boar, C. & Wehrli, A. (2021). Ready, steady, go? – Results of the third BIS survey on central bank digital currency. *BIS Papers*, 114.

European Central Bank (2020). Report on a digital euro. Frankfurt am Main.

European Central Bank (2021a). Eurosystem launches digital euro project. https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210714~d99198ea23.en.html (accessed 13th July 2023).

European Central Bank (2021b). Digital euro experimentation scope and key learnings. Frankfurt am Main.

European Central Bank (2021c). Eurosystem report on the public consultation on a digital euro. Frankfurt am Main.

European Central Bank (2022a). The case for a digital euro: key objectives and design considerations. https://www.ecb.europa.eu/pub/pdf/other/key_objectives_digital_euro~f11592d6fb.en.pdf (accessed 13th July 2023).

European Central Bank (2022b). ECB selects external companies for joint prototyping of user interfaces for a digital euro. https://www.ecb.europa.eu/paym/intro/news/html/ecb.mipnews220916.en.html (accessed 13th July 2023).

European Central Bank (2022c). Documents for the digital euro prototyping exercise. https://www.ecb.europa.eu/paym/intro/news/html/ecb.mipnews221207.en.html (accessed 13th July 2023).

European Central Bank (2023a). FAQs on the digital euro. https://www.ecb.europa.eu/paym

/digital_euro/faqs/html/ecb.faq_digital_euro.en.html (accessed 13th July 2023).

European Central Bank (2023b). Digital euro. https://www.ecb.europa.eu/paym/digital_euro/html/index.en.html (accessed 13th July 2023).

Forster, M., Gross, J., Kamping, A. K., Katilmis, S., Reichel, M., Sandner, P. & Schröder, P. (2021). Whitepaper: Der Zahlungsverkehr der Zukunft: Programmierbare Zahlungen im Bereich IoT. http://explore-ip.com/2021-IoT-Payments.pdf (accessed 13th July 2023).

Guo, S., Kreitem, J. & Moser, T. (2022). DLT options for CBDC. https://dx.doi.org/10.2139/ssrn.4219738 (accessed 13th July 2023).

Kantar Public (2022). Study on New Digital Payment Methods. European Central Bank, https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs220330_report.en.pdf (accessed 13th July 2023).

Klein, M., Gross, J. & Sandner, P. (2020). The Digital Euro and the Role of DLT for Cen-tral Bank Digital Currencies. *Frankfurt School Blockchain Center Working Paper*.

Korschinowski, S. (2022). Wer hat Angst vor'm digitalen Euro? Niemand! Aber, brauchen wir ihn? KPMG, https://klardenker.kpmg.de/digital-hub/wer-hat-angst-vorm-digitalen-euro/ (accessed 13th July 2023).

KPMG (2023). The digital euro and ist impact on banking. https://kpmg.com/nl/en/home/insights/2022/12/the-digital-euro-and-its-impact-on-banking.html (accessed 13th July 2023).

Li, L., Freeman, G., & Wohn, D. Y. (2021). The interplay of financial exchanges and offline interpersonal relationships through digital peer-to-peer payments. *Telematics and Informatics*, 63, 101671.

Kuckartz, U., Rädiker, S., Ebert, T., Schehl, J. (2013). t-Test: zwei Mittelwerte vergleichen. In: *Statistik*, Springer, pp. 159-184.

Panetta, F. (2021a). Speech: Designing a digital euro for the retail payments landscape of tomorrow. *European Central Bank*, https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp211118~b36013b7c5.en.html (accessed 13th July 2023).

Panetta, F. (2021b). Interview with Financial Times, European Central Bank, https://www.ecb.europa.eu/press/inter/date/2021/html/ecb.in210620~c8acf4bc2b.en.html (accessed 13th July 2023).

Panetta, F. (2022a). The digital euro and the evolution of the financial system. European Central Bank, https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220615~0b859eb8bc.en.html (accessed 13th July 2023).

Panetta, F. (2022b). Public money for the digital era: towards a digital euro. Bank of International Settlements. https://www.bis.org/review/r220517a.pdf (accessed 13th July 2023).

Panetta, F. (2022c). More than an intellectual game: exploring the monetary policy and financial stability implications of central bank digital currencies', European Central Bank. https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220408~980e39957b.en.html (accessed 13th July 2023).

Panetta, F. (2022d). A digital euro that serves the needs of the public: striking the right balance. European Central Bank. https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220330_1~f9fa9a6137.en.html (accessed 13th July 2023).

Pavlou, P. A. (2003). Consumer Acceptance of Electronic Commerce: Integrating Trust and Risk with the Technology Acceptance Model. *International Journal of Electronic Commerce* 7(3), 101-134.

Puriwat, W., & Tripopsakul, S. (2021). Explaining an adoption and continuance intention to use contactless payment technologies: during the COVID-19 pandemic. *Emerging Science Journal*, 5(1), 85-95.

Sandner, P., Gross, J. & Chung, J.-C. (2021). The Programmable Euro: Review and Outlook. Munich.

Stibe, A., Krüger, N., & Behne, A. (2022). Knowledge behavior gap model: An application for technology acceptance. *MobiWIS* 2022 Proceedings (pp. 3-17).

Toh, Y. L., & Tran, T. (2020). How the COVID-19 pandemic may reshape the digital payments landscape. *Payments System Research Briefing*, 1-10.

Venkatesh, V. & Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science* 46(2), 186-204.