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Multidimensional Study on Users' Evaluation of the KRAKEN Personal Data Sharing Platform

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Abstract: Background: Recent advances in the design of blockchain-based personal data sharing platforms bring the benefit of empowering users with more control and privacy-preserving measures in sharing data products. However, so far very little is known about users' intentions to adopt such platforms for providing or consuming data products. Objective: This study aims to investigate users' main expectations, preferences, and concerns regarding the adoption of blockchain-based personal data sharing platforms in the health and education domains. Methods: Fifteen participants were involved in a multidimensional evaluation of a prototyped release of the KRAKEN blockchain-based data sharing platform and asked to assess it in the health or education pilot domains. Data collected during online group interviews with participants were analyzed by applying the micro interlocutor technique to provide a descriptive overview of participant responses. Results: Participants showed a marginal acceptance of the prototype usability, asking for some improvements of the user experience and for a more transparent presentation of the platform security and privacy preserving capabilities. Participants expressed interest in using the platform as data providers and consumers as well as setting privacy policies for sharing data products with third parties, including the possibility of revoking access to data. Conclusions: Blockchain-based data sharing platforms are more likely to engage target users when technical design is informed by a deeper knowledge of their needs, expectations, and relevant concerns.

Keywords: data sharing platform; blockchain; users' adoption; privacy-preserving systems; user-centered design; focus-group interviews

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1. Introduction

In recent years, blockchain technology promises to return Internet users control over their personal data [1], and this might pave the way to a more user-centered management of personal data [2] in several application domains such as healthcare and education. Blockchain is a decentralized ledger where data storage, validation, and synchronization can only be completed when all the contributing system participants (i.e., nodes) contribute their computational capacity [2,3]. Blockchain-based systems can significantly decrease the risk of data breach, falsification, and tampering, protecting data security and privacy to a level that other existing systems are unable to reach [4]. Thus, providing Internet users with blockchain also provides individuals with the opportunity to share personal data at their discretion with interested third parties, while privacy and security risks are minimized [5,6]. In this paper, we refer to third parties as any stakeholders holding interest in individuals' health or education data, such as medical researchers, pharmaceutical

companies, digital health companies, universities, and employers. These third parties, as key players in the Internet ecosystem, may require assess to an individual's data for their organizational activities, though they should avoid collecting and exploiting the data without the individual's consent or sharing the data in a way that jeopardizes the individual's privacy [7,8]. Although studies have shown that individuals are generally not opposed to data sharing with these third parties [7–9], the concerns about privacy and security are growing, and individuals demand greater transparency as to who can access their data after they are shared and for what purposes the data are used [8–10]. Since blockchain can combine cryptography with smart contracts (smart contracts being small bits of code that embed procedural logic, which is automatically executable), blockchain-based systems can ensure that it is individuals who initiate data sharing. This capability allows individuals to determine which data to share with which third party and under what conditions [5–11], preserving their privacy and their right to be informed in a more transparent way. In addition, smart contracts can be combined with data tokenization, the transformation through cryptography of data into discrete objects that can be transferred over a blockchain network. Blockchain-based systems can offer individuals the possibility of being rewarded for sharing personal data. In this way, users can be more motivated to actively share data with third parties, such as researchers and digital health companies, which can greatly benefit medical research and care management [12,13]. The data can be tokenized, and the third parties may pay for the data use with cryptocurrency or other value tokens. Due to the series of advantages provided by blockchain-based data sharing systems, researchers' interest for blockchain architecture and platform deployment is growing [6–14]. However, both academics and practitioners have mainly focused on the technical components of blockchain-based data sharing systems and have conducted these studies mainly from the perspective of institutional data providers and consumers. Very little is known about individuals' intentions to adopt the blockchain-based system, specifically whether they perceive themselves as motivated to take, and capable of taking, greater control of personal data sharing; what concerns they may have about blockchain-based data sharing systems; and how these concerns can be addressed to remove barriers to adoption. Shading light on these matters is key to inform researchers and practitioners about the issues that need to be considered when designing a blockchain-based data sharing system, to deploy a real user-centered design approach [15]. This paper presents a multidimensional evaluation of a blockchain-based platform developed in the H2020 project KRAKEN (BroKeRage and MArKet platform for pErsoNal data, grant agreement No 871473) to enable personal data sharing in the health and education domains [16].

KRAKEN is devoted to developing a trusted and secure personal data platform using cutting-edge privacy preserving analytics technologies. Metadata and query privacy are also guaranteed, allowing data providers to control their personal and sensitive data, facilitating and encouraging citizens to share data [17]. The main pillars of the KRAKEN solution are the Self-Sovereign Identity (SSI) paradigm that provides a decentralized user-centric approach for access control to data, where the data provider controls their data and their later use under explicit user consent; the provision of different analytic techniques based on advanced crypto tools to enable privacy-preserving data analysis, by ensuring end-to-end secure data sharing, using tools such as SMPC (Secure Multi-Party Computation), FE (Functional Encryption), PRE (Proxy Re-Encryption), or ZKP (Zero Knowldege Proof); and, finally, a data marketplace that brings both pillars together on an open and decentralized exchange system leveraging blockchain and smart contracts, following GDPR (General Data Protection Regulation), allowing privacy preserving sharing of personal data in the health and education pilot domains, and developing fair-trading protocols and incentive models to be applied on the data space domain [18].

Results from group interviews with initial testers of the KRAKEN prototype helped us to better understand users' expectations, preferences, and possible concerns in adopting such a system for personal data sharing in the two piloting domains.

2. Methods

In Autumn 2021, we conducted a two-phase evaluation of the KRAKEN prototype by involving an overall sample of 15 participants. Each participant was asked, first, to individually access and use the prototype to assess its usability. The prototyped data sharing platform was composed by a Self-Sovereign Identity (SSI) mobile application required to access the KRAKEN data-sharing marketplace, populated with sample data products in the health and education piloting domains. Participants were asked to perform a set of key tasks representing the main functionalities supported by the prototype and to fill in a digital version of the System Usability Scale (SUS) questionnaire [19] to assess its usability.

Examples of tasks performed by participants involved in the health pilot evaluation were registering to the KRAKEN marketplace by means of the KRAKEN SSI mobile app, browsing the available products in the health sector, requesting access to a data product, and offering access to a data product by setting the relevant privacy options to access it. Examples of tasks performed by participants involved in the education pilot evaluation were logging in to the education connector, connecting the wallet app to the education connector, exporting a credential (grade or diploma) into the mobile wallet, displaying the credential in the wallet on the web-based marketplace, registering to the KRAKEN marketplace, accessing/browsing the available data products, and updating the user profile.

After the usability assessment, participants were invited to join an online group interview (duration 1.5 h each) to further report about their expectations, preferences, and concerns regarding the KRAKEN solution tested. A total of 4 group interviews were carried out, 3 for the health pilot evaluation (attended by 12 participants) and 1 for the education pilot evaluation (3 participants), each moderated by a researcher with expertise in Human-Computer Interaction and video-recorded to enable a more detailed analysis of participants' responses. The moderator, initially, provided a brief introduction to the interview objectives. Then, participants were asked to answer a series of semi-structured questions regarding their expectations, preferences, ethics concerns, and intention to use the KRAKEN data sharing platform. Table 1 shows the list of topics and questions posed to participants involved in the health pilot evaluation, while Table 2 shows the list of topics and questions posed to participants involved in the education pilot evaluation. Group interviews or focus groups are suitable for a more in-depth investigation of users' attitudes and preferences toward new technological solutions, since open-ended discussions with users can help researchers to better understand the issues and concerns related to the possible future adoption of these solutions [20].

The recruitment of participants was based on personal contacts of partners in the KRAKEN consortium, selected based on representativeness of the key target user groups addressed by the KRAKEN solution. The key target user groups were identified in the initial design phase of the project by means of research and market analysis activities to develop the relevant use case scenarios for both the health and education pilot domains. As an example, in the health pilot domain, the main target user groups identified in the categories of data providers and data consumers were: researchers managing projects in the area of big data, blockchain technologies and digital health solutions on behalf of research centers/institutions, managers or representatives of private companies working at the development of digital health solutions, and project managers working in public health projects and solutions. In the education pilot domain, the main target user group for data providers was represented by university students enrolled at the Technical University of Graz (TUGraz, Austria), partner of the KRAKEN project and leading the development of the KRAKEN education pilot. For the evaluation study, representatives of these target user groups were identified and invited by the FBK (Fondazione Bruno Kessler) and TUGraz partners to take part to the study. All participants signed a consent form approved by the institutional ethics board of FBK and TUGraz in charge of collecting data for the evaluation study.

Table 1. Questions posed to participants attending the health pilot evaluation.

Topic Investigated	Questions
Set 1: Health Data Management	1.1 Would you trust a platform like KRAKEN to share personal data? 1.2 Would you be interested to use KRAKEN for providing/consuming data products like the ones you have seen provided by the KRAKEN prototype? Why or why not?
Set 2: Privacy preserving data sharing systems	2.1 Are you interested to use the privacy preserving analytics of KRAKEN? 2.2 Would you be willing to use a web system that will secure your data, even if you will have to authenticate through a mobile app?
Set 3: Sharing health data	3.1 Would you be willing to share your data product with other entities through the KRAKEN platform if it's pseudoanonymized, anonymized (e.g., universities pharmaceutical companies, private organizations, research institutions)? Why and why not? 3.2 What factors do you consider important when deciding to share your information with another entity?
Set 4: Compensation for Sharing Data and Data valorization	4.1 What type of compensation would you be looking for in exchange for your data products? 4.2 Do you feel comfortable in defining a price for your data product? 4.3 Would you need any support from for example an available tool in the platform to define or check if your price is sensible/correct?
Set 5: Acceptance, ethics	5.1 What is your impression of the level of data protection and privacy of the KRAKEN platform? 5.2 Can you think of any data protection or privacy risks that you could encounter using the KRAKEN platform? 5.3 Is the provided information relating to your data protection and privacy rights and freedoms sufficiently clear and understandable?

Table 2. Questions posed to participants attending the education pilot evaluation.

Topic Investigated	Questions
Set 1: Education Data Management	1.1 Would you trust a platform like KRAKEN to share personal data? 1.2 Would you be interested to use KRAKEN for providing/consuming data products like the ones you have seen provided by the KRAKEN prototype? Why or why not? 1.3 What is your motivation to share (or sell) your education data?
Set 2: Privacy preserving data sharing systems	2.1 Are you interested to use the privacy preserving analytics of KRAKEN? 2.2 Would you be willing to use a web system that will secure your data, even if you will have to authenticate through a mobile app?
Set 3: Sharing education data	3.1 What types of data do you feel comfortable sharing/selling? What types of data should the edu pilot support in addition to the ones we support? 3.2 Which kinds of entities would you be willing to share it with? 3.3 Will you feel comfortable letting other entities (organizations, universities) see your data using the KRAKEN platform? Do you think it will be secure?

Table 2. *Cont.*

Topic Investigated	Questions
Set 4: Compensation for Sharing Data and Data valorization	4.1 Would you seek compensation in exchange for securely sharing your data products?
Set 5: Acceptance, ethics	5.1 Will your acceptance for the KRAKEN data sharing services differ if it was provided by a company like Google? A recruiting company? Or an IT company like IBM? 5.2 Do you see any ethics concerns in using a data sharing platform like KRAKEN?

2.1. Participants Characteristics

In total, 12 individuals (6 men and 6 women) participated in the health pilot evaluation, 8 (66.7%) were aged 35 to 54, 2 (16.7%) were aged 18 to 34, and 2 (16.7%) were aged 55 to 64. Of these, 3 participants were researchers, 2 of them with expertise in Big Data projects for healthcare and 1 with expertise on blockchain technologies for health, 2 participants were legal experts working in projects related to personal data sharing, 2 participants were managers in private companies offering digital health solutions, and 5 participants were project managers of public health solutions.

Moreover, 3 individuals (1 man, 2 women) were involved in the education pilot evaluation; they were students at the Technical University of Graz with computer science background, all aged 18 to 34.

2.2. Data Analysis

The data collected during the group interview were analyzed by applying the micro interlocutor analysis method [21] to the videorecorded sessions, whose main results are reported in Section 3. The micro interlocutor analysis is a method used to analyze focus group data in health-related research [21,22]. It not only reveals each participant's attitude, stance, and arguments, but also provides researchers with a quantitative overview of participant grouping [21]. Following [21], we first analyzed all the transcriptions of the group interviews, to get an overall understanding of the transcriptions. Next, we coded participants' responses to each discussion question in the dedicated health or education interviews. We paid attention to their words throughout the group discussion and coded their responses by interpreting all the words they contributed. By taking this step, we produced descriptive statistics for all the questions, as summarized in Section 3. In this way, it is possible to see how each participant responded to each question, but also to get an overview of the responses of the group, based on how we generated the insights explained in the results section.

3. Results

Results from the participants individual assessment of the KRAKEN prototype, based on the SUS questionnaire, showed an average score on a scale 0–100 of 51.87 (SD 23.67) for the health pilot evaluation and an average score of 55 (SD 10.89) for the education pilot evaluation. These scores correspond to the grade D, percentile range 15–34; they can be defined with the adjective OK/Fair, meaning that there was a marginal level of acceptance of the prototype usability, which, however, needs further improvements to ensure a full usability of the final solution [23,24].

Tables 3 and 4 display how each participant in the group interviews responded to each question, including the indication of agreement, indication of dissent, ambivalent response, no response, and response given with an elaboration. We then explain our results for each question included in the health and education pilot evaluation, providing a descriptive statistical overview of the types of responses (including nonresponses) and qualitative categorizations of participants' elaborations.

Table 3. Participants' responses in the health pilot evaluation.

Question	Type of Response					
	A [a]	SE [b]	NR [c]	D [d]	SD [e]	AR [f]
1.1	3	4	-	-	1	4
1.2	6	1	-	-	-	5
2.1	3	8	1	-	-	-
2.2	4	1	-	1	4	2
3.1	5	1	-	-	-	6
3.2	7	3	-	-	-	2
4.1	5	5	1	-	-	1
4.2	-	1	-	5	6	-
4.3	7	5	-	-	-	-
5.1	2	-	3	5	-	2
5.2	7	3	2	-	-	-
5.3	1	-	3	5	3	-

[a] A: Indicated agreement. [b] SE: Provided significant example suggesting agreement. [c] NR: Did not indicate agreement or dissent (i.e., nonresponse or did not know). [d] D: Indicated dissent. [e] SD: Provided significant example suggesting dissent. [f] AR: Ambivalent response.

Table 4. Participants' responses in the education pilot evaluation.

Question	Type of Response					
	A [a]	SE [b]	NR [c]	D [d]	SD [e]	AR [f]
1.1	1	1	-	-	-	1
1.2	-	2	-	1	-	-
1.3	1	-	-	-	-	2
2.1	1	-	1	-	-	1
2.2	2	-	-	-	-	1
3.1	2	1	-	-	-	-
3.2	-	3	-	-	-	-
3.3	-	3	-	-	-	-
4.1	-	-	-	-	-	3
5.1	-	-	-	2	1	-
5.2	-	2	-	-	-	1

[a] A: Indicated agreement. [b] SE: Provided significant example suggesting agreement. [c] NR: Did not indicate agreement or dissent (i.e., nonresponse or did not know). [d] D: Indicated dissent. [e] SD: Provided significant example suggesting dissent. [f] AR: Ambivalent response.

3.1. Health or Education Data Management

Participants to the health pilot were asked "Would you trust a platform like KRAKEN to share personal data?" In response, seven participants expressed interest and trust in the platform while five had some concerns related to security and privacy of sharing data, due to a lack of understanding of the privacy preserving technology supporting it. Those who were interested expressed trust in the blockchain technology behind the platform and in the KRAKEN consortium, as it is a publicly funded project supported by the European Commission. Those who expressed concerns mentioned a lack of transparency in the way personal data are protected and treated by KRAKEN; they asked for clearer information on the entities supporting the project as well as clearer and more accessible explanations on the mechanisms ensuring privacy and security of data. We also asked participants "Would you be interested to use KRAKEN for providing/consuming data products like the ones you have seen provided by the KRAKEN prototype? Why or why not?" Four participants said they were very interested in consuming data through KRAKEN, three had a stronger interest for providing data through the platform, and five said they were

potentially interested to use KRAKEN for sharing data if the platform was able to ensure security, privacy, and quality of data sharing. Most participants thought KRAKEN should guarantee that the personal data shared are reliable and accurate as well as ensure that usage of the data shared is compliant with the goals and privacy settings stated by the data provider when offering access to a data product.

Participants to the education pilot were asked "Would you trust a platform like KRAKEN to share personal data?" In response, two participants said they would trust KRAKEN since they appreciated the concept behind the KRAKEN solution, but they would trust it more if the user interaction with the prototype would be improved. One participant stressed the fact that the problems they met in using the prototype decreased their trust in the system, but generally they were more in favor of using open access, source code transparent systems. We asked participants "Would you be interested to use KRAKEN for providing/consuming data products like the ones you have seen provided by the KRAKEN prototype? Why or why not?" Two participants said they would be interested to share educational data through the platform, while one mentioned that the KRAKEN concept and use case is much needed, since recruiting companies and employers might be interested to access more easily and reliably these data through the data marketplace. One participant initially said they did not want to provide access to their education data through a marketplace. A following question asked: "What is your motivation to share (or sell) your education data?" Two participants said they would feel motivated to share their education data when applying for a job, to avoid, for example, sending scanned copies of printed documents. One participant explained they would prefer to share data about a study (e.g., a thesis work) but only if anonymized, while they would not feel motivated to share other types of data.

3.2. Privacy Preserving Data Sharing Systems

Participants to the health pilot were asked "Are you interested to use the privacy preserving analytics of KRAKEN?" In response, 11 participants expressed interest to access this type of service offered by the platform, while 1 participant did not provide any answer. In general, the privacy preserving analytics were considered as a service providing an added value to users of the platform, especially for those interested to access statistics for research purposes. One participant mentioned the importance of having access to customizable analytics, fitting the needs of each study. Another participant stressed the need for the platform to be kept updated with the latest crypto techniques and to provide state-of-the-art anonymization mechanisms for data sharing. We asked participants "Would you be willing to use a web system that will secure your data, even if you will have to authenticate through a mobile app?" Five participants replied that the double authentication modality is nowadays quite familiar to users, so they did not see any obstacle in using this method also to access the KRAKEN marketplace. Three participants expressed a preference for using already existing certified systems to authenticate (e.g., SPID), to lower the effort required by the user to download and install the mobile app. Four participants reported their frustration with installing and using the KRAKEN SSI mobile app, due to compatibility and usability problems experienced with the prototype release tested during the evaluation; therefore, they recommended to improve its usability to avoid future users from abandoning the platform after the first interaction.

Participants to the education pilot were asked "Are you interested to use the privacy preserving analytics of KRAKEN?" In response, two participants replied they would require knowing or read more about this functionality to have an opinion on that. One participant said they might be interested in using such a service, once supported by the platform. When asked "Would you be willing to use a web system that will secure your data, even if you will have to authenticate through a mobile app?", all three participants agreed that they would be willing to use such an authentication modality, since it is quite common and secure nowadays. However, they all stressed the need of improving the usability of the SSI

app and its synchronization with the marketplace to avoid confusing the user in their first interaction with the KRAKEN solution.

3.3. Sharing Health or Education Data

Participants to the health pilot were asked "Would you be willing to share your data product with other entities through the KRAKEN platform if it's pseudo anonymized, anonymized (e.g., universities pharmaceutical companies, private organizations, research institutions)? Why and why not?" Six participants expressed willingness to share anonymized data products, while six participants replied that they would be willing to share data only for research purposes, not for commercial purposes, since they were motivated mainly by ethics reasons for sharing personal data. Three participants explicitly mentioned they would share data with public entities (universities, research foundations) for research goals, but not with private entities, such as pharmaceutic companies. Participants were also asked "Which kinds of entities would you be willing to share it with?" In response, seven participants mentioned they would share their data with an entity if they clearly knew the purpose of the data usage, two participants said they would share data in case they can keep control over their data and can even revoke access to data, two participants mentioned ethics reasons (e.g., contributing to improving healthcare treatments), and one participant said they would be motivated by receiving some form of acknowledgement or credit for sharing their data.

Participants to the education pilot were asked "What types of data do you feel comfortable sharing/selling? What types of data should the education pilot support in addition to the ones we support?" All three participants expressed interest for sharing education data, such as CVs and diploma. They were willing to share also other personal data, such as passports, citizenship certificates, but they had more concerns in sharing for example health data. Participants were also asked "Which kinds of entities would you be willing to share data with?" In response, two participants said they would prefer to share data with universities, employers, government agencies, since this would facilitate bureaucratic processes in a secure and privacy preserving mode. One participant said he would be willing to share data with these entities if the KRAKEN platform provides guarantee that the user keeps control of his data, and the platform properly manages any possible system failure. We asked participants "Will you feel comfortable letting other entities (organizations, universities) see your data using the KRAKEN platform? Do you think it will be secure?" Here, all three participants stressed they would provide access to their education data to universities and state entities, rather than private companies that may want to access data with a commercial purpose. One participant said KRAKEN would allow to share data in a more secure way if compared with transfer of documents in hard copies, and it would support a better control of personal data by providers.

3.4. Compensation for Sharing Data and Data Valorisation

We asked participants to the health pilot "What type of compensation would you be looking for in exchange for your data products?" Five participants replied that a monetary compensation would be appreciated for sharing their data products, since this would be the easiest way of managing a compensation for this type of products. Five participants expressed a preference for having a non-monetary form of compensation, mentioning more knowledge on their health condition, free access to services (e.g., counselling, premium contents on relevant health topics), gift cards or other credits. One participant thought that deciding for a type of compensation is a complex issue, since the platform should also compensate intermediary entities that may ensure the quality and standardization of the data products offered through the platform. One participant said they had no clear position on the type of compensation that should be provided. Participants were asked "Do you feel comfortable in defining a price for your data product?" In response, 11 participants expressed difficulties in defining a price for a data product, while just 1 participant said that they would be fine with defining a price for research purposes,

by referring to other available datasets of health data that can be bought online. Two participants mentioned the need for having a general regulation helping to define prices for health data in a more standardized way. We also asked participants "Would you need any support from for example an available tool in the platform to define or check if your price is sensible/correct?" To this question, 12 participants expressed appreciation for having a tool or reference system in the platform supporting in defining a fair and sensible price for their data products. One participant proposed to develop a bidding system for data products, to promote quality of the data shared and incentives to share better data products. In general, there was large agreement among participants for the need of providing such a tool to help define prices and to valorize data products over time.

We asked participants to the education pilot "Would you seek compensation in exchange for securely sharing your data products?" All three participants said they were not interested in sharing their education data for a monetary compensation. One participant had concerns with companies such as LinkedIn selling data entered by users in that platform. Another participant expressed interest for receiving a different form of compensation, for example free access to educational licenses of software.

3.5. Acceptance, Ethics

Participants to the health pilot were asked "What is your impression of the level of data protection and privacy of the KRAKEN platform?" Five participants replied that it was not clear from their interaction with the prototype how KRAKEN was ensuring data protection and privacy of data products. Two participants said they knew how blockchain technologies contribute to data protection and privacy, so they would trust KRAKEN just by knowing it is based on this type of technology. Two participants admitted that users typically read very superficially the conditions of use of a new system and then click accept, but in the case of KRAKEN it would be useful to be reminded about fundamental aspects of privacy and ethics at the specific moment when the user takes decisions about creating and publishing a data product. Three participants did not have a clear impression on how KRAKEN was dealing with privacy and data protection issues and asked to have more information on that. We asked participants "Can you think of any data protection or privacy risks that you could encounter using the KRAKEN platform?" In response, eight participants agreed that there is no software system or platform that can be considered completely secure, but they thought that the role of KRAKEN was to minimize the risk as far as possible, since the type of data shared are particularly sensitive. Among the risks identified by participants were misuse of data, data leakage, hackers' attacks, risk of deleting data by mistake, unclear specification about who to contact in case of problems (e.g., local vs European authorities). One participant said it would be important to provide more information on data protection and privacy when registering an account in the marketplace, another participant mentioned that quantum computing may represent a future threat for blockchain-based platforms such as KRAKEN. Two participants had nothing to add to this question. In addition, participants were asked "Is the provided information relating to your data protection and privacy rights and freedoms sufficiently clear and understandable?" Three participants replied that they appreciated the fact that KRAKEN considered this issue, and the quality of information provided is sufficient for the status of the prototype released. Six participants asked for having clearer information on this topic and proposed to use icons to present information on privacy and GDPR compliance, to provide more information on privacy by design measured adopted, more contextual information on privacy and data protection when performing key actions in the platform for publishing data products. Three participants had no clear answer to this question or had a neutral position regarding this issue.

Participants to the education pilot were asked "Will your acceptance for the KRAKEN data sharing services differ if it was provided by a company like Google? A recruiting company? Or an IT company like IBM?" All three participants replied they would not share their data with Google or IBM since they store data in the U.S. out of Europe, and in the case of recruiting companies, they would prefer to decide each time with whom to share

or not share their data. We asked participants "Do you see any ethics concerns in using a data sharing platform like KRAKEN?" In response, one participant said it is important that KRAKEN supports data sharing in a secure way, by ensuring that data is not sold or used differently from what stated by the data provider. One participant was concerned about possible changes in regulation and discontinuity of the platform once the KRAKEN project is over. One participant mentioned they would prefer to start using KRAKEN by providing noncritical data, and, then, after some months of usage, if everything works fine, they might be willing to share more sensitive personal data (e.g., health data) through it.

4. Discussion

This study presents a multidimensional evaluation of the KRAKEN personal data sharing platform, tested by 15 individuals representing key target user groups of the platform in the health and education pilot domains. Our main findings show that the usability of the prototyped platform was perceived by users as marginally acceptable but requiring further improvements before its final release. The importance of the usability dimension was also stressed by participants during the online group interviews, where most of them expressed interest and trust in using the data sharing solution, both as providers and consumers of data products, if the user experience ensured is good, and the security and privacy preserving components of the platform, including its privacy preserving analytics, are clearly presented to the user. This finding confirms previous research in showing that there could be barriers to the adoption of blockchain-based data sharing platforms, if the security and privacy preserving mechanisms provided are not fully transparent and understandable by the user [2–14]. Regarding the sharing of health or education data through the platform, most of our participants expressed a preference for sharing data for research or non-profit purposes, while they were less inclined to share data for commercial reasons. Our findings are aligned with previous work showing that factors such as specification of the end purpose for sharing data [7], as well as the possibility of revoking access to shared data products [25] or setting privacy policies to access data, are key capabilities enabled by blockchain-based platforms that may meet the needs and preferences of users and positively affect future adoption. Concerning the possible incentives to users for sharing data products, our findings suggest that participants were interested in receiving either monetary or nonmonetary forms of compensation. Nonmonetary compensation seems to be particularly relevant to data sharing in the health and education domains, where altruistic reasons for sharing data products may be key drivers of a system's adoption and user engagement [2–26]. Our investigation into the possible user concerns regarding the ethics dimension of using the platform revealed that the participants need for being supported at the point of taking key decisions affects the creation or sharing of a data product, for example, by being reminded about possible consequences of their action, and helped in understanding and revising the related privacy or ethics issues. All these considerations should inform the user-centered design of a data sharing platform such as KRAKEN to better fit the needs and expectations of its future adopters, as well as to ensure a more functional coevolution of its technical capabilities with user preferences and behaviors.

The study presented has some limitations. The sample size is rather small and participants involved in the health pilot belonged mainly to the research field, while those involved in the education pilot represented mainly the perspective of data providers rather than that of data consumers. In a future evaluation study, we intend to recruit a larger and more diversified sample of participants to better represent the broader target population. Moreover, the set of technical capabilities offered by the KRAKEN prototype deployed in this study was quite limited, and participants were asked to test the platform with sample data products created for evaluation purposes. Future studies may investigate more in depth the users' preferences and concerns of users when conducting transactions on real data products over more mature and complete versions of data sharing platforms.

Based on the current findings, the user's willingness to engage platforms such as KRAKEN and adopting new cutting-age technologies such as blockchain, Self-Sovereign Identity, or crypto tools for privacy-preserving analytics, depends on the data management transparency and easiness of use. This is the main challenge that KRAKEN and similar platforms need to address. In this sense, KRAKEN is working to provide an improved mobile application as well as clearer and friendlier user interfaces for the final version of the KRAKEN platform, facilitating the use and control of the data to share, while also diminishing the complexity of the technologies behind the scenes.

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