TSD: A GENERATIVE RESEARCH PLATFORM IN THE AGE OF THE PANDEMICS

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Abstract

Platform based IT ecosystems enable new ways of organizing the relation between consumers and providers. This also applies to research platforms established to facilitate the relationship between individuals and organizations in producing knowledge across professional research work. This is especially important when researchers need to store, safeguard, and secure real-time harvested data during a pandemic. The platform literature has previously addressed consumer-oriented generativity and how the dynamic interaction between consumers and platform owners affords new business ideas. In research platforms, we propose, these mechanisms are different since the consumerization aspects are less prominent.

To investigate this interest, we ask: How can we establish a generative platform for real-time research?

We frame our study within the platform literature and the literature on generativity. Our empirical evidence is a research platform called TSD (Tjenester (services) for sensitive data), which became central to a corona study in Norway. We offer two contributions; first, we establish a generativity framework and applies this framework to explain how generativity in research platforms differ from consumer platforms. Then we analyze in-depth, generativity in research platforms. Second, we contribute by demonstrating how this generativity framework can explain the fast establishment of a real-time research study.

Keywords: Digital Platforms, Research platform, Generativity

1 Introduction

When Covid-19 hit the world in spring 2020, everything seemed to stop - except digitalization. The pandemic triggered a wave of digital solutions and use, from videoconferences and virtual Friday beers to tracking apps and surveillance. Many researchers assume that the long-term effects of these developments will be significant (The Economist, April 11, 2020).

One of the key topics of the pandemic was *real-time research* (Mitsuya and Kokudo, 2020); i.e. "the capacity to re-order the relationship between data gathering, analysis, and circulation to offer the possibility of simultaneity in research and the multiplication of viewpoints" (Back, L. et al., 2020). Real-time research offers the opportunity to monitor a phenomenon as it unfolds, and possibly make interventions. Research has shown that social media and crowd-sourcing can be utilized to collect data (Callaghan, 2016) and dashboard can be used for visualization and decision support. During the Covid-19 pandemic, a number of such digital solutions were introduced, for instance in medicine (Dong et al. 2020) and education (Zhu et al., 2020).

To conduct real-time research during a crisis, it is crucial to satisfy some requirements. Since there is little time for preparation, the instruments to register observations must be available or quickly configurable. Since there is little time for confidence building, the researcher and/or the

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tool must be widely accepted in the context. And since data collection, analysis, and decision making evolve in parallel, it is highly beneficial to have an integrated solution.

In this study, we investigate how research platforms can support a real-time research initiative in the corona crisis. Research platforms share some characteristics with commercial platforms such as Uber, but are also different, in that they are mediating devices that constitute the production of knowledge across a range of geocultural settings (Kanngieser et al., 2014).

While we have extensive knowledge about commercial platforms (Parker et al., 2016), we know much less about the structure and mechanisms of research platforms. We investigate this issue through a study of a Norwegian platform called TSD (Services for sensitive data), which was used in March 2020 to create and operate a real-time study of the spread of the Covit-19 disease. The platform offered not only a technical solution but had previously been established as a trusted resource for researchers. To develop our argument we build on the research on *generativity*, i.e. a system's capacity to produce new solutions without central control (Zittrain, 2008).

Our research question is: *How can we establish a generative platform for real-time research?*

To develop our argument, we draw on the literature on generativity. Our case is from the University of Oslo, where a platform was made to handle research projects that needed to store sensitive data. The key argument is that research platforms contribute to establishing research ecosystems by having particular generative abilities that facilitate open, contextual, and professional interaction. This lay the foundation for real-time research.

We proceed by reviewing the platform literature and divide between consumer platforms and research platforms before we describe our method and the case. We then proceed to describe our findings, before we in section 6 discuss our contribution to the platform literature.

2 Conceptual background

Digitalization has changed all sectors of society and is dramatically changing the way we work, live, communicate, and interact. Digitalization has also transformed manufacturing, retail, and entertainment industries (Hess et al., 2016). The platform literature has helped us understand some of the underlying causes of this transformation. It has identified how platform types can be understood as structures for promoting economic strategies (Evans and Schmalensee, 2017; Parker et al., 2016), to coordinate organizational practices (Gawer, 2014), or to establish social media platforms (Butcher and Helmond, 2015). The software engineering perspective (Tiwana, 2013) addresses the technical organization needed to realize the flexible and threefold platform architecture (Baldwin and Woodward, 2009). All these issues are fundamental both in consumer platforms and research platforms.

2.1 Consumer platforms and research platforms

The inspiration for research data platforms comes from the spectacular success of commercial platform ecosystems, such as Uber and Airbnb (Parker et al., 2016). Technically, a platform ecosystem consists of a central database for large transaction volumes and connects various stakeholders (often with apps) to sell and buy. The power of commercial platform ecosystems lies in their scalability and network effects; the more Uber cars available, the more Uber customers, and so on. However, the commercial, n-sided type of platform ecosystem described above, cannot be adopted in its classic form for research purposes, but some key principles can be leveraged. The most important of these principles in our context is that platforms are also

forming the relations between participants, and the organizations that perform these interactions (Cennamo and Santaló, 2018).

Research platforms build on the insights from the platform literature. Examples are media research platforms (Ipsos Digital 2020), medical platforms developed in-house (Askeland et al., 2015; McGrath et al., 2009), consumer research medical platforms (Thieme, 2020, Berlin Institute of Health, 2020; Eureka, 2020), and public sector platforms (OECD, 2017; University of Melbourne, 2020). These are mainly commercial or administrative platforms and less concerned with research.

We build on (Kanngieser et al., 2014) in our definition of research platforms as, *a secure technological structure established to connect individuals and organizations in the activity of producing knowledge across professional research work.* This clearly indicates that a research platform is more aimed at knowledge sharing than a consumer platform is, and consequently, that generativity has a different role in such platforms. Since boundary resources (Ghazwaneh and Henfridsson, 2013) are important interfaces between a platform's core and its periphery, we proceed by recapitulating the important role such resources have in platform ecosystems.

2.2 Boundary resources

A core mechanism promoting the success of platform structures are boundary resources (Ghazwaneh and Henfridsson, 2013). Boundary resources enable collaboration between the platform core and third-party developers; they include both digital elements (such as APIs, security mechanisms, etc.) and governance principles (such as decision-making authority, access control, and monitoring). Boundary resources are often divided into "resourcing" and "securing" in the platform literature. While resourcing is "the process by which the scope and diversity of a platform are enhanced" securing is defined as "the process by which the control of a platform and its related services is increased" (Ghazwaneh and Henfridsson, 2013, p. 176).

Resourcing can again be divided into how the platform owner translates innovative third-party input into the design, and how third-party usage benefits from this design. This also relates boundary resources to the concept of generativity. With generativity, we refer to "the ecosystem's capacity to foster complementary innovation from autonomous, heterogeneous firms" (Cennamo and Santaló. 2018, p. 617). This form of digital innovation is considered necessary to keep the platform core dynamic, usable, and competitive.

The key point is that the platform ecosystem must bring about the dynamic interaction between the different parts, for two reasons: i) The platform core depends on third party actors to dynamically change as the ecosystem changes, ii) Third-party developers depend on the offerings from the platform core for development to take place (Jacobides et al., 2018; Parker et al., 2018). This generative dynamic is salient both in consumer platforms and research platform. We will address these issues using the generativity lens.

3 Generativity

Although the concept of generativity has been used in several areas (see Avital and Te'Eni, 2009), the use in the field of information systems can be traced back to Zittrain (2008). Since then the concept has been used creatively to emphasize the innovative potential of information systems (Avital and Te'Eni, 2009), infrastructures (Bygstad, 2017), and platforms (Cennamo and Santaló, 2018). We systematize key aspects of generativity in three categories: open generativity, contextual generativity, and professional generativity.

By *open generativity*, we refer to Zittrain's relatively liberal definition where generativity becomes "the overall system's capacity to produce new output through unfiltered contributions from broad and varied audiences" (Zittrain, 2008, p. 70). Although Zittrain highlights the new and potentially path-breaking abilities of digital technology, he is less concerned with what Cennamo and Santaló (2018, p. 618) referred to as "generativity tensions", that is, "tensions between a positive spillover effect which provides more collective resources for complementors and a negative free-rider effect which reduces the benefit from joint contribution." In Zittrain's framing, generativity becomes very open and liberal, anything goes.

Generativity is in most contexts a socio-technical concept (Bygstad, 2017) and includes both system-technical elements such as digital resources and social elements such as capabilities and relationships, but these relationships must be shaped. We therefore conceptualize the second type of generativity as *contextual* (Lane, 2011) since it frames generativity as "a relationship that can induce changes in the way the participants see their world and act in it and even give rise to new entities, such as agents, artifacts, even institutions." (Lane and Maxfield, 1996, p. 216). Lane and Maxfield are concerned with the generative relationship and the opportunities for change and innovation between complementors in the wider ecosystem. An important aspect of consumer platforms is that "complementors are not direct partners with each other" (Cennamo and Santaló, 2018, p. 620), which enables them to focus on private benefits while still contributing to the collective good. This interrelationship may be different in research platforms, since the goal is not consumer innovation, but knowledge sharing and research.

Furthermore, Avital and Te'eni (2009) are concerned with how generativity must be formed in an interaction between capacity and fit. While capacity is "one's ability to produce something ingenious or at least new in a particular context", fit is defined as "the extent to which an IT artifact is conducive to evoking and enhancing that generative capacity." We see this as *professional generativity* due to its occupation with how technologists use their capacity to adapt the product or service to specific contexts. Empirical examples of the result of contextual and professional generativity are given in Henfridsson and Bygstad (2013). Through their investigation, they identify three generative mechanisms – innovation, adoption, and scaling - all self-reinforcing processes aimed at shaping the digital infrastructure to fit business expansion.

We hypothesize that these three elements will behave differently in professional research platforms compared to consumer platforms, for two main reasons. Serving the market is different from serving research not least because of the economy (there is a difference between companies registered on the stock exchange, which is dependent on ongoing revenue, and research platforms used to address pandemics). As Srnicek (2017) observed, all types of consumer platforms rely heavily on the current market economy regime (Srnicek 2017). It can also be argued that since a research platform often is funded publicly through research funding and other political allocations, relationships and trust bonds that generate a different type of network effect than in consumer platforms, may arise. Table 1 highlights the generativity in consumer platforms.

Generativity	**Generativity in consumer platforms**
Open generativity	Digital resources and organizational capabilities are used for consumer innovation.
Contextual generativity (relationships)	Relationships are created between consumers, manufacturers, and subcontractors
Professional generativity (capacity + fit)	The relationships are characterized by market insight, consumer orientation, and innovation ability

Table 1: Generativity in consumer platforms

To summarize, while open generativity addresses the possibilities enabled by digital technology to establish solutions without central control, contextual generativity addresses the user environments and developer communities, and the need for dynamic interaction between them. By professional generativity, we refer to the particular relationships needed to establish safe and strong professional trust.

To investigate how generativity behaves differently in research platforms, we will in section 5 investigate the TSD platform, and how it enabled tight relationships between developers and researchers. First, however, we describe our method.

4 Research method

Our qualitative case study (Yin, 1994) is taking place at the University of Oslo (UiO), which is the highest rated university in Norway, with 28.000 students and 6.000 employees. The TSD solution was developed by USIT (University Center for Information Technology), which is UIO's central IT organization with around 220 employees. USIT is one of the largest in-house government owned IT organizations in Norway, and delivers a range of services including specialist services, both locally, nationally, and internationally.

4.1 Data collection

The paper is a result of a longitudinal study on the development, implementation, and maintenance of a research platform. The study started in 2019, and 7 interviews were performed from August 2019 to January 2020 with key personnel from management, architecture development, and app development, to investigate central issues related to the historical development of the platform. We also analysed a broad range of requirement specifications, user manuals, design sketches, and white papers, and podcasts, as well as participated in web meetings and user forums where we could interact with TSD designers and architects. In addition, one of the authors was the project manager during the development and is today head of the USIT division responsible for the research platform.

When Norway closed down as a result of the pandemics, and the corona study was established, we followed up with further interviews on this distinct case, and its use of TSD. We performed 5 more interviews with project managers and developers at USIT and researchers at Oslo University Hospital.

Data collection	Activity	Data
Interviews	12 interviews with managers, architects, and app developers	History of TSD, emergent strategies, and development issues. From March 2020 we investigated, in particular, the Corona study.
Documents	Studying strategy documents, requirements specifications, design sketches, and white papers	In all 250 pages on requirements and strategical issues
Workshops and user fora	Participating in both physical and digital online meetings	Presentations from on-going research projects, new features, and debates between developers and users

Table 2: Data collection

4.2 Data analysis

Our analyses were conducted in four steps. First, we identified key events leading to the establishment and use of the research platform. We noticed that there were two major challenges, first to create an agile architectural structure that enabled the fast development of new services, and then to make sure that the implementations were scalable and maintained.

Second, we built a generativity framework (Zittrain, 2008; Lane and Maxfield, 1996; Lane, 2011; Avital and Te'Eni, 2009) through a process of abduction where different theoretical perspectives and explanations for the investigated phenomena were tested (Bygstad et al., 2011). The resulting framework consists of three types of generativity relevant to both consumer platforms and research platforms; open generativity, contextual generativity, and professional generativity. We used the framework to compare consumer platforms and research platforms.

Third, we used the generativity framework to analyse empirical data. Fourth, we found that although consumer platforms and research platform are based on similar technical mechanisms, their requirements for interaction within the ecosystem differs. We moved on to analyse the concept of generativity in TSD and identified what we call knowledge-oriented generativity (see table 5 below) which can explain the fast establishment of a real-time research study on corona.

Step	Activity	Result and section
1	Key events	Section 5.1-5.3
2	Building analytical framework from the literature	Generativity framework, Table 1
3	Analyse empirical data using the generativity framework	Section 5, Table 4
4	Establish a foundation for mechanisms in research platforms	Section 6, Table 5

Table 3: Data analysis

5 Findings: A platform for real-time research on pandemics

The coronavirus entered Norway in March 2020 when infected skiing tourists returned from winter holiday in Austria and Italy. In mid-March, the Norwegian Institute of Public Health (NIPH) announced that the infection was out of control. The political authorities took charge and closed schools, universities, as well as services such as hairdressers, hotels, and restaurants. Airports were also gradually closed down, except some domestic routes. There is no antidote for the virus, and the health care system had to be rigged to deal with the first wave of patients.

The main goal for the authorities was to get R or the "effective reproduction number" (a way of rating a disease's ability to spread) below 1. At the same time, the testing capacity was limited. Patients with symptoms had to call their GP, and the GP then decided if testing should be done. Because of the limited capacity, and the most probable existence of unrecorded infections, the authorities needed creative solutions to extend the amount of testing. A group of clinicians at OUS decided to create a research project where citizens could report online if they had symptoms. This research project was set up in less than 24 hours, thanks to the agility of the TSD research platform. The modular structure of the platform and its resources enabled a scalable solution that was put on the air and used by more than 150.000 responses within a month.

To explain the various factors that contribute to making TSD a research platform for real-time research in the age of pandemic, we employ the concept of generativity (see table 4)

Generativity	Research activities	Result
Open Generativity	-A digital platform that attracts researchers -Researchers can create apps	A technical solution that enables research data to be made digital and stored safely
Contextual Generativity	-Collaboration over time, professional integrity, security and safety -The researchers knew the system and were able to modify	An ecosystem of scientific researchers.
Professional Generativity	-Information elements already present -Knowledgeable teams present when projects are planned -Services can be added instantly to a reasonable cost -Spirit of participation from the citizens	-Digital "whole" in relation between technology and researchers -The rapid development of the corona study -Real-time research to identify ways of contagion

Table 4: Generativity and Research activities in TSD

5.1 Open generativity

TSD is a platform developed in-house by USIT to meet the needs of UiO researchers for a lawful, secure, good, functional, and remote-accessible research platform for sensitive data. The project had a stumbling start in 2010, but after a re-initiation of the project in 2012, the system was launched in May 2014 and experienced strong growth in the number of users (> 4,000), data volume (> 3 PiB), and rising demand for new services. In early 2018, TSD also became the official national supplier of supercomputing (HPC) and massive storage (projects needing > 10TiB), for sensitive data, through Uninett Sigma2 AS. TSD has also evolved because of the directive from the university director, stating that TSD is to be offered as a free base platform for UiO's researchers, while the researchers from other institutions will cover both operational costs and operating costs.

To conform to security regulations, the TSD group, a unit established at USIT to govern the development of TSD, created a new architecture, SAPEIN (Secure API for E-INfrastructures). The SAPEIN architecture had functionality for two-factor login, as well as the storing of all data in USIT server-rooms where only a very limited number of trusted USIT and Estate department employees (using card and code) are granted access. All data traffic in TSD traffic is encrypted and uses SSL certificates compliant with Uninett AS. TSD requirements meant that the existing architecture had to be gradually replaced. SAPEIN is based on architectural principles such as modularization and loose coupling:

> "We definitely needed something else than what we had. Our challenges lie in defining an optimal architecture and then getting there. We had to use Cerebrum [the existing integration engine at UIO] as the point of departure, but we created a layer above and gradually established new integrations. We needed to move away from a monolithic system towards more modular interfaces based on SOA and Web Services, where services interact more seamlessly and are unhindered by the complexity. While we were building TSD we had to make sure that reliability and security were maintained." [Architect]

The architecture, thus, ensures safe and secure access to a variety of resources that can be used to create research projects. Central to the development environment is "nettskjema" ("webform"), a modular resource with a variety of features and which easily can be integrated within apps.

> "We have created a set of libraries [in webform] that we distribute ... the apps that are created are not very complicated, they may consist of 4-5 questions. However, this means that scaling is rampant and building basic apps is cheap" [Project manager and architect]

Data from web form and apps can be stored in TSD. One of the main objectives of the project was for the customer to be able to create apps themselves:

> "Customers can create the apps since we give them access to an input and output API. Calculations and the like can be stored in the app. However…we do not accept all kinds of apps, we need security routines. Further, the hospital's main trust is in us [rather than any third-party company], and they like us to create the apps." [Project manager]

More than 15 corona research projects have been initiated on TSD, and we describe the most comprehensive and successful. The Oslo University Hospital (OUS) Corona study was initiated to identify where people get infected. Is it at work? On the bus? Or in the shops and stores? The main goal was to identify which ways of contagion are the most important in Norway, throughout the epidemic. This included identifying why some of the infected become seriously ill. The solution consists of a web form accessible online that you log into using BankID (Standardized Electronic Identification). The participants then fill out an electronic questionnaire with questions about habits and lifestyle related to the corona epidemic. The data is stored in TSD. This information can be used to analyse the differences between those who have been infected by the coronavirus and those who have not.

The corona study immediately provided new knowledge about the behavior of the inhabitants during the pandemic:

> "We can already see that Norwegians have changed their habits to a large extent through cleansing routines and by staying away from large assemblies." [Researcher]

Since the study is based on an electronic questionnaire it allows researchers to follow the development of the epidemic almost in real-time. At the same time, new questionnaires can be sent to participants as Norway gradually opens up schools and shops. Then it becomes extra important to follow the development of infection.

In summary, USIT created TSD for researchers to have a common place to store and analyze sensitive data. As part of the development, basic resources were created that could be accessed through boundary resources. This also enables the platform core to be constantly expanded with new resources, which in turn allows researchers to create apps. The result of this form of generativity is digital and flexible resources that enable research data to be made digital and stored safely.

5.2 Contextual generativity

The collaboration between USIT and the researchers has gradually increased over time because of the professional integrity and trust as well as the security and safety mechanisms provided by USIT. The researchers knew the system and had also been fundamental in shaping it.

> "We established some reference groups with users from the Psychological Institute, Bioinformatics, and the Department of Medical Genetics. The users defined very clearly what they needed. This collaboration across research disciplines is very important for TSD. Moreover, we have established user forums and lately also net-meetings, where system requirements and modifications are discussed and clarified. This has been a success. One hypothesis at the start-up

> was that one could get 50 projects in TSD, now there are more than 1000 active projects." [Project manager]

The corona study came about through teamwork between the Microbiology department and the Occupational Medicine department at Oslo University Hospital (OUS). They were supported from the very top at the Orthopaedic department and Microbiological departments at Fürst, Vestre Viken, and Ahus.

TSD facilitates the development of these relationships, combining professional integrity with security. The result is an ecosystem of scientific researchers.

5.3 Professional generativity

Researchers need high computing power, statistical tools, common access to registry data, and secure storage space. With this in mind, USIT also created several APIs that could be used to store and retrieve data from the TSD. These two capacities, professional scientists and professional technologists applied their knowledge of research to adapt the product or service to specific contexts. This can explain why the Corona study was established in a very short time. The IT resources and information elements needed to create the questionnaires were already present. And the pre-established trust and safe relations between the researchers and the TSD group meant that the researchers could use TSD instead of acquiring costly products from the market. This also meant that knowledgeable teams were present when the projects were planned and that services could be added instantly to a reasonable cost. The tight bonds between the technologists and the researcher created a sort of "digital whole" that facilitated the establishment of real-time research in the age of Corona. A researcher also emphasizes the spirit of participation (in Norwegian "dugnadsånd") amongst the citizens. The spirit of participation can also be related to the general trust amongst Norwegian citizens in politicians, health workers, and scientific researchers.

> "We are very impressed by the completeness by which the citizens have responded to our questions. The completeness gives us a range of very exciting data, and this means that we can identify new ways of contagion and if needed how to deal with the infection fairly quickly." [Researcher]

The questionnaire has currently been filled out by more than 150.000 citizens.

TSD has over time developed, distributed, and expanded a rich library of information elements, and the project managers and developers have basic knowledge of the solutions. This means that foundations for rapid scaling were present, resulting in special solutions such as the corona study to be developed quickly. Moreover, since the spirit of participation amongst the citizens and the confidence in the government and health authorities is high, the citizens may participate very fast. The result is real-time research.

6 Discussion

Our goal in this paper was to investigate the fundamentals of a research platform needed to address real-time research projects. In particular, we were interested in understanding the generativity of research platforms. Our research question is:

How can we establish a generative platform for real-time research?

Our point of departure was that although consumer platforms and research platforms are built using similar structural mechanisms, there are certain differences. We define a research platform as, *a secure technological structure established to connect individuals and organizations in the activity of producing knowledge across professional research work.*

To address our research question, we used the generativity framework where open, contextual, and professional generativity interacts with appropriate digital resources, research ecosystems, and professional collaboration. These interactions facilitate the establishment of a knowledge-oriented platform for real-time research. The framework consisting of three types of generativity is thereby an important element in explaining a real-time research platform.

The key mechanism for commercial platforms is network effects (Parker et al., 2016). Commercial platforms share three types of mechanisms with research platforms: recombination, digital relationships, and generative capacity and fit, but the content is somewhat different in research platforms. We will discuss this issue in 6.1, 6.2, and 6.3. Table 5 gives an overview

Generativity	Definition	Key mechanism
Open generativity	The fundamental ability of digital technology to combine manual and fragmented research data in a way that facilitates the use and reuse across professional settings.	Recombination (Zittrain, 2008)
Contextual generativity	The trusted relationship between researchers and developers required for real-time research on sensitive data with privacy issues to take place.	Trusted relationships (Lane, 2011)
Professional generativity	The ability of professional developers and researchers to collaborate in order to generate and connect sensitive research data in a way that facilitates (non-consumerised) real-time research	Professional fit (Avital and Te'eni, 2009)

Table 5: Generativity in research platforms

6.1 Open generativity – Recombination

Commercial platforms share with research platforms the recombination mechanism. By recombination in consumer platforms, we referred to how digital resources and organizational capabilities are used for consumer innovation (Parker et al., 2016). By recombination, in a research platform, we refer to the fundamental ability of digital technology to combine manual and fragmented research data in a way that facilitates the use and reuse across professional settings. This is why recombination relies on a platform core where datasets are stored and systematized to be effective. A digital solution where data are safe and securely stored attracts and facilitates research collaboration across a wide network of researchers.

6.2 Contextual generativity – Trusted relationships

We referred to contextual generativity in consumer platforms as the relationships created between consumers, manufacturers, and subcontractors. In research platforms, we find, *trusted relationships* (Lane 2011) are particularly important as a prerequisite for real-time research because a research platform deals with sensitive data that require a high level of security and privacy but also allows for sharing. In a crisis, it would take far too long to establish this level of trust without an existing network of mutually recognized partners. As our case rillustrates, the established ecosystem of TSD made it possible to implement the OUS corona project in real-time, within 24 hours.

6.3 Professional generativity – Professional fit

We define professional generativity in consumer platforms as relationships characterized by market insight, consumer orientation, and innovation ability. The professional fit is the extent to which an IT artifact is conducive to evoking and enhancing the generative capacity (Avital and Te'eni, 2009). In research platforms, professional generativity becomes even more important as dealing with sensitive research data in order to monitor the ways of contagion in the society should be done by dedicated non-consumer oriented professionals. As shown in our case, the TSD solution was designed to support a rich set of forms of inquiry, enabling the researchers to (i) design the web-form (ii) leverage the security and privacy components, (iii) monitor in real-time the responses (iv) analyse the results, and provide input to decision-makers for possible inventions.

Our theoretical contribution then is the creation of a framework for analysing generativity in research platforms, as well as identifying how generativity is different in research platforms compared with consumer platforms. In particular, for a research platform to be usable for real-time research, it needs a special storage and security regime, it needs a trustful relationship between developers and professionals, and professional customization.

Our practical contribution is an insight into how a research platform can be established, and how it can be used to managing real-time research in the age of a pandemic. We have demonstrated how the corona study was established within 24 hours, building on a pre-established secure and confident relationship between technologists and researchers. This support can have major positive consequences for pandemic research. The fact that researchers can study the ways of contagion almost in real-time means that the causes for the resurgence of infection can be quickly identified and neutralized.

6.4 Further research

Further research on research platforms may be oriented towards identifying the particular high-level mechanisms similar to *network* effects that operate in collaboration between researchers and developers in non-consumer platforms.

Further, based on Jacobides et al., (2018), we can see that groups and organizations of researchers interacting through research platform establish research ecosystems. This ecosystem greatly benefits from research platforms like TSD. The ecosystem needs trustful relationships, a safe place to store data, and professional collaboration.

7 Conclusion

In this paper, our goal is to investigate the establishment of a generative platform for real-time research. To distinguish consumer platforms and research platforms, we established a framework to enable comparison. We find that although similar types of generativity are operative in both types of platforms, the generativity is different. In particular, it is important to observe and take into account the trusted relationships and professional collaboration between developers and researchers as fundamentals for the fast establishment of a research platform for real-time research.

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