

Modelling for Ethical Concerns for Traceability in Time of Pandemic “Do no Harm” or “Better Safe than Sorry!”

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Abstract

We propose a service design for ethics framework that applies the four diamonds-of-context model for complex service design (4DocMod) framework to analyze, decompose, and interpret the main edicts of ethics (credibility, transferability, and validity) in data collection and use in public health complex service systems. We illustrate how different contexts of different actors can be accommodated ethically at the service design level. The paper explains the main artefacts of the 4DocMod framework (diamonds See, Recognize, Organize, Do) against community and individual ethics in several case studies related to the current COVID-19 pandemics facing the use of traceability technologies. The main contribution of the paper highlights how actions and goals in healthcare as a service ecosystem (H-SES) may have contexts, while contextual interpretation of activities constitutes the basis for ethical evaluation.

1. Introduction

The current situation in healthcare is strongly focused on the hospital system and deserves to be changed through a sort of reconstruction and new care formulas, due to the well-known worldwide pandemic condition. In the wake of the COVID-19 pandemic, authorities and public health practitioners have sought the use of digital technologies for pandemic management¹. Digital tools are deployed for disease surveillance, using sensing and data capture devices for proximity and contact tracing, symptom monitoring, and also for analysis leading to quarantine control, and flow modeling. These tools must be ethically compliant to ensure that no “harm is done” to fundamental ethical principles that must safeguard the autonomy, privacy, and non-discrimination of individuals in today’s society [1].

¹<https://www.bcg.com/publications/2020/learning-from-covid-transforming-health-systems.aspx>

Attracted by the premise of a new digital paradigm, to attempt a rapid digital transformation, technology companies stepped in with a set of solutions. For example, in Czech Republic, the government and the private sector have cooperated to develop and implement smart solutions in response to the COVID-19 pandemic, nicknamed “Smart Quarantine” [2]. The design have comprised of interconnected solutions expected to limit and control the spread of infection. Information was collected, then triangulated, taken into account (1) location data from mobile phone operators, (2) card payment data, and (3) information gathered through the mobile contact tracing based on Bluetooth technology. The Smart Quarantine project ran into roadblocks due to the inability of the operators to interpret the extensive disparity of the captured data-set, the inaccuracy of the tracing data when subjects are in close proximity, and the reluctance of some people to turn on their tracing technology, out of fear of loss of privacy autonomy [2].

However, the ethical and legal boundaries of deploying digital tools for disease surveillance and control purposes are generally unclear. A rapidly evolving debate has emerged globally around the risks of mobilizing digital tools for public health [3]. The plethora of recent literature recommends the establishment of ethical guiding principles, operating within the realm of local and international laws, yet, side-baring contextual definitions of applicability [3].

It is elsewhere noted that data collectors and analysts must respect the ethical standards of their own countries and the cultural expectations of the societies in which studies are undertaken (*community ethics*). On the other hand, operators of data collection and analysis may risk harming their reputation by pursuing work that host communities find acceptable, but their own ethical standards consider offensive (*individual ethics*) [4]. Therefore, ethical thinking is contextual, related to the qualities of the situation that we face and to what responses are appropriate within that situation [5].

Who owns our healthcare data, who uses our healthcare data and for what purpose? “While patient

data offers a trove of information that can be used for further research or population health studies from a government or policy perspective, a key concern still remains – do patients themselves know or approve of how of their health information is used²?” This question takes center stage in practitioner circles, today.

We develop this paper in the context of Healthcare systems, which are complex service systems [6] with challenges in data collection, analysis and representation, required to maintain ethics, privacy, and transparency across the interaction between actors of the system. These multidimensional challenges span the realms of the legal, with the potential ability to triangulate financial, health and socio-demographic information, breaching the edges of privacy, and the technical, where accuracy, timeliness, and completeness become essential to ensure data quality and robustness of outcome. This is a reminder of the paradoxical duality of Quality vs. Privacy, such as Quality data must be complete, yet, it must also respect privacy, by blurring some elements of completeness.

The article is organized as follows. Section 2 discusses the necessity of new value propositions for ethics in healthcare as a service ecosystem (H-SES). Section 3 discusses the main edicts of ethics (credibility, transferability, and validity) in data collection and use in public health complex service systems. Section 4 introduces the framework for development of a service model that accommodates the ethical considerations in using digital technologies in time of pandemic, which is based on the four diamonds-of-context model for complex service design (4DocMod) framework described in [7]. The 4DocMod framework explores and integrates Stanicek’s Diamond Path Framework³ [8] towards a more insightful understanding and interpretation of Smart City smart services [9], [10] and the resilience of city public services during emergency [7]. Section 5 concludes the paper.

2. Healthcare, Complex Service System

Notably, it is a misconstrued assumption that most ethical issues will arise in the context of research, and that the collection and use of data for non-clinical purposes is assumed more vulnerable to ethical breach than in clinical settings. In the latter, where a relationship between data sources (patients as a group) and data users in health care organizations (such as clinical teams, hospitals) is considered more personable and less anonymous. Reality is that data users in clinical

contexts are no more or less likely, than researchers, to pursue potentially unethical activities [11]. Sensing, capture and dissemination of data have a great impact on the interaction between the actors of the system with a direct effect on quality of care [12]. Yet, the advantages of value creation opportunities offered by data integration and use, are offset by ethical challenges of maintaining patient data privacy, improving medical care transparency and managing the cost of operating the complex system.

This begs the question about how to ensure that the collection and analysis of data from patients within a *health care ecosystem* is carried out ethically. This is a complex argument. The answer could lie in the basic premise that collecting and using healthcare data is ethically sound only if there is a clear application of the principle of *Do No Harm*; where “*given an existing context, it may be better to do nothing, than to risk causing more harm than good.*” This applies to the need to scrutinize data collection methodologies, define approaches to conservation of ethics, while maintaining the quality and confidentiality of data (maintaining the patient’s privacy) and weighing the benefits to society [13].

We know that healthcare is a complex service system of integrated resources [6], [14]. It is based on the sophisticated combination and the continuous reconfiguration of multiple actors [15], involving *people* (characterized by behaviors, values, knowledge), *processes* (characterized by collaboration, customization), and *technology* (characterized by software, hardware, infrastructures) that increasingly rely on the collection, interpretation, integration and assimilation of data across the system. Therefore, healthcare can be intended as a service ecosystem (H-SES), based on the interactions among multiple actors [16], dealing with reference to provided services and service processes [17]. Actors in this ecosystem must want to and be able to follow the goals as facilities and guidelines are established. Within this H-SES, service providers are responding to the shift toward consumer-directed care by offering new value propositions that are dynamically co-created [16]. The shared institutional logic [18], on which H-SES is based, boosts resource integration and re-bundling processes as a way for ensuring sustainability and the well-being of all of the involved actors [6]. In designing the complex healthcare ecosystem, therefore, we must maintain the principles of privacy by design and by default [3].

In a pandemic event, the organized care system becomes overwhelmed stretching the need to exploit a “care at home” service as part of this complex care system that aims at providing quality care. The later

²<https://www.healthcareitnews.com/news/asia-pacific/patient-data-access-privacy-ownership>

³https://seslab.fi.muni.cz/media/3277865/ssmestar_manuscript.pdf

is often compromised when placing large numbers of infected people in a congested setting that could severely promote the spread [19]. The ill that could self quarantine and heal resorts to receiving home care services. For instance, part of this complex ecosystem, health at home, has its own ethical, legal and clinical practice issues to deal with. This is due to data-security, patients' privacy, training of family care-giver, discharge planning, etc. Medical teams have to include in their decisions patients' preferences, the agreed free choice can contrast with hospital proposals, the digital divide can make some troubles in terms of distant treatments, there can be such a problem of infrastructure constraints, like the accessibility, or difficulties in sensitization and informed consent. Other frictions could occur when the service is experienced ineffectively, as in the case when the care at home comes too late as a consequence of previous errors in diagnosis, or when rapid re-admissions are not possible/practical.

This short discussion on the complexity of assuring healthcare service in times of pandemic stresses the value of multiple contexts in service design based on various digital technologies. One of the premises of complex service design is that stakeholders act within different contexts, creating rich service interactions, because most cases are with more than one value proposition chains in service delivery. The design of such complex services cannot be in isolation from other services in the entire service ecosystem. Therefore, this paper proposes a model to show how the service can be decomposed to atomic elements and how they can be used to design service with a better *value proposition for ethics* for service receivers [10], [7].

3. Data and Ethical Considerations in the Use of Traceability Technologies

The respect for the individual autonomy in decision making, the prevention of harm and maximizing equality, fairness and impartiality are main principles of ethics in medical practice [20]. Patients and data collectors have an ethical responsibility to help with ensuring quality of data captured and stored [21]. To start, data elements, considered essential resources for analysis, must be *credible* (from a trusted source), *transferable* (in the right context), and *valid* (referring to the level of dependability and confirm-ability required for decision-making). The concept of scientific validity, also referred to as relevance, relate to the degree to which rigor is applied in the collection process and temporal validity bounds to the timeliness and expiration of data elements.

Credibility: Accuracy challenges, most often connected

to credibility of the sources for data collection, must be overcome. Modern data collection approaches may depend on *sources* (such as social media, blogs, mainstream, unreliable actors) that may not be credible, too revealing, and sometimes invalid for use. While the temptation to use social media or other inaccurate data sources for discovery and analytics is omnipresent among data-ambitious researcher and scientists, the amount of chatter can be counter to the required standards of quality. The irregularity of the language used in social media often renders data collection from this ubiquitous source, unusable, creating doubt in the quality of data captured [22].

Scientific and temporal validity: Sensing mechanisms must be implemented to gather the “real” by the meaning of actual and factual data elements, transform them into usable information, and summarize genuine knowledge into useful guidance. Four main categories of digital public health technologies developed for pandemic management are identified in [3], as listed here forth:

- Proximity / Contact tracing - Provide a measure of the spatial proximity between users to track their interaction.
- Symptom checkers - Provide syndromic surveillance that collect, analyze, interpret, and disseminate health-related data
- Quarantine compliance tools - Measure real-time monitoring of whether symptomatic patients or non-symptomatic individuals are complying with quarantine restrictions
- Flow modeling tools - Provide mobility reports that quantify, and track people's movements in specified geographic regions

When deployed, these types of digital public health technologies raise both cross-sectional and domain-specific ethical-legal considerations [2]. These considerations are rooted in the basic principles and moral considerations of public health ethics and data ethics with a requirement that a clear public benefit from use must be proportionate to the level of impingement on individual rights. Additionally, all these tools have contextual challenges based upon uptake, which will vary according to location, the existence of other measures, and disease prevalence. On the other hand, sensing technologies produce a high level of data - Big Data - across designated points of monitoring and traceability. The veracity of this aspect of Big Data and the velocity of growth and sheer volume of mixed data

sources become a problem for unmatched tools that have to decipher truths from anecdotes [23].

Transferability (context): Using healthcare data without explicit consent runs the risk of disclosing information that might cause harm, if misused. Further, informed consent practices and privacy laws make it difficult to anticipate all future uses of data collected [24]. Data elements are never completely anonymized. The potential re-identification of individuals is a persistent risk of re-purposing the information collected in form of bio-surveillance [3]. The potential for discrimination is eminent. The transferability of data (data collected for one context to be used in another) may present legal implication of use [25]; especially as we start collecting and linking financial, demographic and clinical data on a certain patient / individual. The risk associated with analytics, especially predictive analytics, can cross the boundary of ethics as data may be weaponized against its source [25].

Hence, data element attributes of credibility, scientific and temporal validity and transferability are all connected to the contextual domains under which they are considered. Ethical principles, designed to maintain contextual validity and respect the boundaries of data use and re-purposing for public benefit, are rooted in practices that maintain goals of privacy, transparency and quality of the acquired data [26]. Methods, approaches and tools that safeguard ethical and legal considerations must respect guidelines for context and use.

4. Developing a Service Model for Ethics in Time of Pandemic

In complex services system design, actions and goals have contexts and contextual interpretations of activities can provide a basis for ethical evaluation. In a pandemic event, the goal is to maintain quality of care, including the control of the spread of the pandemic, through ethical data collection and analysis practices. The collection and analysis of data must serve the goal of detection, assessment and coordination of activities related to safeguarding public health. Mitigation measures inform policy-making for lasting post pandemic preparedness.

Henceforth, we reference the *four diamonds-of-context model for complex service design (4DocMod) framework* [7] in order to further analyze, decompose, and interpret the main edicts of ethics in data collection and use for the public health complex service system.

4.1. Modelling for Ethics in a Framework of Contexts

The need for context sensitive modelling calls for an approach to analyze a specific situation in a specific context, then to model the process of service provision in the stated context.

Diamonds: In the approach of the four diamonds-of-context model for service design, composed of the diamonds *See* (Figure 1), *Recognize* (Figure 2), *Organize* (Figure 3), and *Do* (Figure 4), the central notion is that agents perform activities to reach predefined goals in a given set of contexts and constraints [8], [10]. Agents can be *Authors* of the goal(s) defining the desired state and outcome, or *Learners* and *Followers* that take action towards the goal. The actions and interaction among these agents are referred to *Activities* and *Flows* directed towards achieving the goal [9], [10], [7].

In the context of Pandemic management, we identify two goals that contributes to transforming real data into information, and convert it into knowledge without breaching ethical boundaries: a) to perform an effective function of public health monitoring and pandemic control through the collection and analysis of data that is accurate, timely, complete and available, and b) to maintain data and ethical considerations of credibility, validity and transferability.

Building a service model based on the four diamonds-of-context approach is intended to instruct the service designer on how to understand the world around us (the *See* diamond - the description of a situation in the Agent's view also the diamond of focusing attention to a specific context, Figure 1), and how any other stakeholder may understand it (the *Recognize* diamond - the diamond of cognitive elements guiding the understanding of the situation in a multi-stakeholders' perspective, Figure 2). In real life, each person has a very clear categorization of any seen object (or sets of objects), and a recollection of associated operations (what to do) for each of them, including rules on how these operations can be used in a specific context. The response of any individual on how to act towards a specific object, depends on their pre-existing experiences in life including their background, education, profession and financial situation, as well as the context in which they operate. Therefore, there is a modeling of reality individually, in each person's mind.

This is a major reason why stakeholders may have different, sometimes simplified, or even divergent concepts of ethics in their own mind. Here, we can find many examples of personal interpretation of ethics.

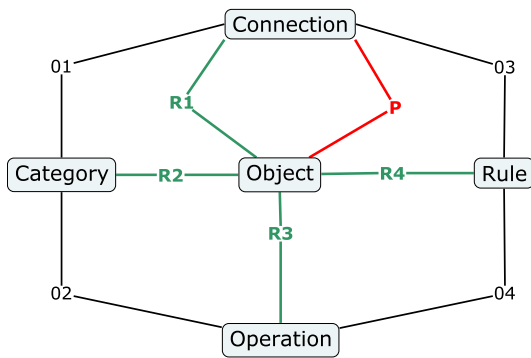


Figure 1. 4DocMod framework - See diamond, from [7], [10], [8]

What is understood about ethics limits the ethical data handling, which can work only in a social group within the same context and mindset. Stated simply, it is a matter of perspective.

4.2. Identifying the Context for the Service

The process of complex service modeling, using the 4DocMod framework, starts with the first diamond, the See Diamond (Figure 1). This diamond describes how "easily" people model aspects of their lives, in their own minds. The solution to a certain constraint can be based on their own mind set. For example, in a pandemic, through the epidemiological lenses, some authorities may suggest isolating the population without realizing the economic or social consequences to this event. A witness to this, is our current COVID-19 related economic and financial hardship of many worldwide.

Whereas, from a point of view that operates in a technologically heavy context of environment, some stakeholders may suggest sharing all necessary information (like position, interaction, and other data about everyone's behavior). From their perspective (context), it is the best approach to pandemic control, as in the case of deploying proximity, contact tracing, and flow modelling tools. All movements are tracked, all interactions are monitored to an intrusive levels, sometimes revealing the reasons why. Elsewhere, data protection experts protest the unrestricted usage of private data, while social networks providers advocate monitoring behavioral patterns of their subscribers and find ways to monetize data for financial gain.

The See diamond includes perspective and does not address context, because what matters for the observers *see* is what exists within the boundaries of their context. That is incomplete as, in service delivery actors perform in different settings and actors' goals and activities can

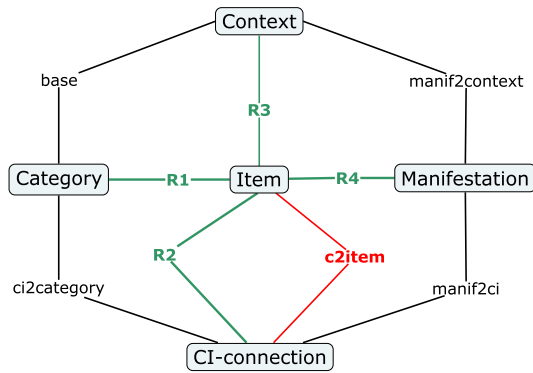


Figure 2. 4DocMod framework - Recognize diamond, from [7], [10], [8]

be part of more than one context.

That said, we advance to the guidance of the Recognize diamond (Figure 2) that informs that the understanding of the context depends on knowing how overall components are connected in it and why. This ties in to the level of certainty that the item belongs into a specific category. For example in this case, the public perception of masks has significantly changed in the context of the COVID-19 pandemic. Masks, as an object, have long be viewed as a safety precaution measure in a medical environment. However, in this pandemic their symbolism has been altered by certain groups that view it as a sign of oppression and therefore operate differently in their presence.

The exercise of defining context is about defining sets of categories to be used when one category can exist in more contexts and vice versa. For our example, the context of proximity and contact tracing and flow modeling tools may provide different perception of value for epidemiologists, technical tools manufactures, data analysts and economists. The level of ethical challenges of over tracking and data may be more of a concern for analysts, while the importance of credibility, validity and transferability of data may provide different context for epidemiologists. This makes defining a specific ethical boundary for data use quite a challenge. Symptom checkers may provide proper surveillance for planning and preparedness but quarantine compliance tools may be seen as an encroachment to personal liberties.

To continue our example from above, now we can imagine that we have a consortium of epidemiology and technology experts that are framing the context of their observations. They may realize the pitfalls and that isolating decision making may lead to overreach in privacy and breach ethical boundaries. They conclude,

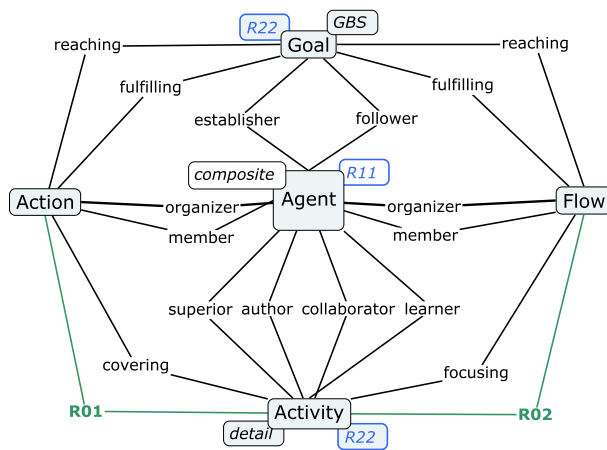


Figure 3. 4DocMod framework - Organize diamond, from [7], [10], [8]

therefore, that the amount of collected information can limit to those that are necessary to protect the society from the epidemiology perspective. For example, there would not be a need to monitor transient activities, unrelated to public health threats.

These initial notions in unification of views and terms refer as a first step in service design. Thus, the idea that a solution must illustrate the integration of multiple views for sense making and context is addressed in the *Organize diamond* (Figure 3).

This diamond guides the identification of all (or the most of) stakeholders involved in activities, referred to as *Agents*. It is intended to gain a better understanding of how agents are driving their behavior in a multi contextual environment in order to reach a stated goal.

4.3. Defining Target Goals

Goals: As seen earlier, in managing pandemics, the goals can be complex, both technical and ethical. Public health monitoring and pandemic control must maintain data and ethical considerations of credibility, validity and transferability. Goals are not independent and cannot be defined in isolation. Every Goal is related to other goals by relationships of context. They can be structured in a Goal Breakdown Structure (GBS), made up of subsets of goals that must be fulfilled in specific order or setting and goals that can cascade into multiple dependent goals where a goal set in one context affects goals in other context. This approach of combining context-sensitive relationships modeling and representation with goal-driven development methods allows closer interconnection of goals and value proposition [27].

In this paper’s context, we can identify two general

goals:

Goal 1: Perform an effective function of public health monitoring and pandemic control through the collection and analysis of data that is accurate, timely, complete and available;

Goal 2: Maintain data and ethical considerations of credibility, validity and transferability.

4.4. Planning for Necessary Resources and Activities to Achieve the Goal

Agents: One of the most important roles in service modelling is the role of the Agent, which can be the provider, collaborator, or receiver of the service. The 4DocMod framework described in [7] details a comprehensive list of roles for the agents: Establisher (author of the goal); Follower (must/wants to follow the goal); Author (creates new activity); Superior (controls the activity); Collaborator (participates on the activity with another agent); Learner (observes the activity, improving the skills); Organizer (responsible for or modify the rules of the process implementation); Member (is just following the rules defined by other Agent(s)).

Agents in different roles collaborate actively on the tasks and actions required. For instance, the *establisher* agents, authors of the goals, must identify relevant and trusted source for data, and define conditions and protocols for mapping of data requirements for pandemic control. *Followers* will apply specific protocols for data protection and obfuscation to limit the potential exposure through transferability. Other collaborators provide evaluation data for planning and resource requirements, or / and skill reconfiguration.

Activities: A clear definition of activities that must be undertaken and controls that must be in place for the agents to perform the required activities and improving their ability to do so, while keeping the focus on the goal, is needed.

The flow and interaction of activities is purposefully planned to transform data into information for re-configuration of knowledge / skills / capability. Agents in this system must maintain the ability to create or modify the rules - norms of action - of their process within a specifically defined context that lead to the goal. For instance, pandemic control activities of detection, assessment, coordination by epidemiologists are supplemented with activities of other agents collecting data for interpretation and correlation (sense making), for preparedness and planning. The 4DocMod framework includes several flow activities, such as:

- Reaching: These are Actions or Flows to reach

the Goal(s). To reach a goal, actors must a) implement technology to capture and correlate data from multiple points in the system; b) collect multidimensional data for assessment activities, mapping of events; and c) apply data analytics for predictive planning, through the potential use of early pandemic warning systems;

- Fulfilling: Action defined from framework of the Goal(s). It may involve the identification of relevant and trusted source for data and defining conditions and mapping of data requirements;
- Covering: Action is covered by the set of Activities. It may provide real-time access to (non-sensitive) data to all stakeholders and assess incident response capacity through information gathering on the preparedness level and mitigation measures supporting policy-making;
- Focusing: Flow is focused on the set of Activities. It may provide evaluation data for planning and resource requirements, and / or skill reconfiguration.

Following our example of COVID-19 solution, several Agents may be identified:

- State authority – is building the framework for other Agents – formulating general Goal of the resilience of the society and motivate the others to put it into their GBS. It should help with the adaptation of their Flows and Actions in the most linked contexts;
- Monitoring Service Provider – an organization designing and providing the monitoring service. It needs to establish the flows how to register a new user, store the data and maintain them. Also the Action to find interactions if the particular COVID-19 test is positive must be established. Its goal is to store and analyze data. It is established as the reaction to State authority Goal;
- Service Customer – everybody who must (or is willing to) use the service. The willingness to participate depends on the context understanding and on the level of adaptability – he/she must add the context of COVID-19 into his/her current Flows and Actions. The critical point for the acceptance is the level of its influence to current Flows and Activities (the less influence on the current behavior should mean better acceptance)

Stakeholders affected by the primary solution (service) can be also identified:

- Medical staff - doctors, nurses and administration of hospitals who need to adapt their flows and actions to new situation;
- Emergency services in general - not only doctors, but also policemen and firemen need to be informed if they could face the danger of infection. If the people forget to inform them about the infection, all members of emergency unit must go to the quarantine for two weeks - that can paralyze the service provision;
- City authorities - all cities has their own flows and actions. But facing a new situation, they need to adapt, but also create a new one, but in synergy with our monitoring service. If they will ignore it, it will lead into the confusion of people and increasing of chaos.

Many times the service designers forget to take into account the related contexts and agents that are affected by the actions in primary context. Deep analysis, using the *Organize* diamond helps to identify the stakeholders that could be positively or negatively be affected. As the common solution we need to focus to the Goals of all stakeholders across of all related contexts and via analysis of their GBS find an optimal solution. As mentioned before, the Goals are related not only in the "main" context, but also in all linked Contexts.

4.5. Use Cases become Templates in the Model for Service Design

Finally, the *Do* diamond (Figure 4), tries to answer the question on how to design and offer the service in a multi-contextual environment. We recall that, the central guidance of this diamond is that a service is a result of the defined requirements aligned with the stated goals. Orthogonal to this notion is that requirements and accumulated knowledge represent use cases that occur in specific context and inform and guide the designer to adapt the context to the service. These two dimensions must be complementary.

But how can that be reached? In our case, the service is about providing pandemic control within the boundary of the ethical. The stipulation is that all data collection activities, that are part of pandemic management and control, are ethical if certain steps are taken. This is to make sure that data elements are collected and used for the specific objectives, to provide baseline information to control the spread of the pandemic and provide the healthcare services required for effective quarantine with the right resources available, in the most vulnerable or exposed regions. This implies limiting such data collection and use

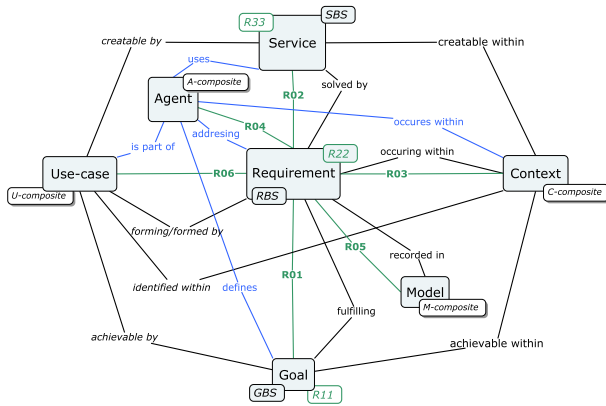


Figure 4. 4DocMod framework - Do diamond, from [7], [10], [8]

activity to credible, valid, and minimally transferable data sets.

In our example of Smart Quarantine, it is necessary to investigate all similar solutions (Use - Cases) that have reached their goals in their related context. The success of the service (the value for the final receiver), can be based on the results, coming from different context. If the service receivers are not used to share the data and do not trust the municipality to keep their data in privacy, all the effect of the service can be lost.

A. The case for patient engagement. The City of Boston’s handling of the Pandemic information management explicates the use of dashboards to solicit citizen engagement and trust during the collection and handling of re-usable public data [28]. The city of Boston launched two platforms as part of its e-services to provide real-time information on the COVID-19 pandemic. One of the dashboards provides daily status updates on ten sectors: schools, city buildings, status of city departments, trash and recycling, street cleaning, parking meters, tow lot, meal sites for youth, restaurants and bars and city construction. These initiatives are part of a wider suite of digital tools, some of which are pre-existing while others created as a response to the virus. This suite includes a multi language texting service, online city services and digital resources and fact sheets. In a similar case, the Private Automated Contact Tracing (PACT), developed by MIT, working with partners collected information on binary contact events but also on the distance and time duration of a contact event. The use of a tokenized data approach with only Bluetooth connectivity meant that data was captured and secured by a token only, within

a short distance from the subjects. Only the event and the tokenized data are collected by authority, with the explicit patient’s consent. The patient receives a permission number from the authority, which is then posted in a public database. The public database verifies the permission number and updates itself with the contact numbers shared by the patient [29]. Other users can compare their contact event numbers with the publicly posted contact event numbers. If there is a match, they are noticed that they may have been exposed to the virus and need self-quarantine, without knowledge of the source of the information. In both use cases, Citizens felt engaged and in control of their information, which was an essential factor in building trust in the transparency and ethics of managing their data. They were able to validate the data, monitor the use of their data and have unfettered access to their data.

B. Feedback and justifiable use of information.

The implementation of a platform that demonstrates the impact of the social distance measures, by The Urban Observatory at University of Newcastle [30] introduces another relevant use case with a different context. The observatory analysed over 1.8 billion observational data from pre-existing sensors, using deep learning algorithms, to create a real time dashboard to provide information on pedestrian movement, vehicle movement, car parking and air quality, and how it has changed with the implementation of the new measures against COVID-19 [30]. In this case, data acted as a direct feedback mechanism providing insights into the positive or negative effects of the anti-COVID measures on the complex public health ecosystem. This use case can provide information on the changes that the agent needs to perform to respond to the goal (related to the *Organize* and *Do* diamonds), as such data may impact predictive behavior. We can also identify new specific *Flows* (such as need to wear masks, use the disinfection during every visit) and *Actions*, depending on existence of the new context of COVID-19. Such real-time feedback mechanisms emphasizes the value of the implemented solution and relieve the ethical pressure on the uncertainty of need to collect, the use and relevance of collected data. This represents a case of “ethically justified levels” of data use as it constitutes the minimal information needed “for the benefit of public health”.

The previous Use Case may show how to adapt to the current context of Czech Republic to build trust in data privacy and ethics. Even it is not related with Covid-19 directly, the design of the dashboards and trust in the data sources mat help teach people to use the service and obtain better value. Therefore, to improve the service of Smart Quarantine, the way is to increase the

communication about ethical aspects of the service and involve the stakeholders in the first line of COVID-19 protection. Additionally, the example may support finding a solution of a service design to emphasize actor engagement and to implement methods for providing data privacy, feedback for flow tuning, and a justifiable use of information.

Back to our modelling, the diamond *Do* provides the instructions how to design the real smart service - how to analyze multi contextual environment, find Use Cases that are necessary to support the design and adapt the service design to increase its value to society. The ethics component is presented as one of the typical example of the Goal, that is affecting how service value is perceived across linked contexts.

5. Conclusions

The enlarged access of citizens to participatory processes and their underlying engagement through science and technology to critical aspects of public health open a serious discussion on the ethics of service digital processes. In a smart service ecosystem citizens are not only recipients of services, additionally they may offer their data to better inform the decision-making processes [31]. The smart service ecosystem has the provision of advanced, user-centric and user co-created services to its citizens [32] as a main goal. Citizens can become *non-traditional knowledge actors* involved in collaborative multi-actor service processes [33], co-producers of knowledge and active participants in service design and delivery in local communities. Decision makers in the ecosystem should recognize that the delivery of services will become better by becoming citizen centric, as citizens are the active users of smart city services [34]. Citizen access to information is considered as a key aspect of smart cities and should be facilitated through a secure digital infrastructure that has adopted an open access approach to re-usable public data⁴.

Public engagement is important in implementing a successful project based on data otherwise considered private. It is essential to be able to demonstrate a level of preservation of data privacy, while serving the public good [14]. For all stakeholders and agents (medical, emergency or otherwise) to be integrated in the interaction, we must ensure a design that addresses all the data needs, access to information, and their intended goals. Only after they understand the value of the information and the extent of its applicability, is when we have implemented an ethical sound initiative.

⁴<https://www.gov.uk/government/publications/smart-cities-background-paper>

This paper approaches the discussion of what is ethical and what are acceptable ethical boundaries in traceability for pandemic management. This is a matter of perspective. Solutions can be ethical in one's perspective and infringing in others. Ethical challenges tie to the handling, storage and use of the collected data (privacy, de-identification, etc.). In the time of emergency, where priority is on survival, we tend to emphasize "*Better Safe than Sorry!*", sometimes at the expense of collateral impact to other aspects of a citizen's life - Privacy "*Do no Harm*". Consequently, the development of these public services is prone to context. There are different contexts for different stakeholders on the same objective. Various Actors may have various goals to pursue. Instead of developing different service designs for different context, we can develop one design able to integrate the various contexts of Actors. Therefore, these contexts may be accommodated ethically at a service design level.

The paper highlights how actions and goals in healthcare as a service ecosystem may have context, while contextual interpretation of activities constitutes the basics for ethical evaluation. The paper contributes to the literature on system design and data governance by introducing the issue of ethics. The authors provide entrepreneurs a guideline that they need to have a mindset that they should only collect the data that fulfill their goal. We posit that by applying the suggested framework to decompose the case of COVID-19, practitioners can better ensure the security of the data collection process and the alignment of service contexts. The example used may support finding a solution of a service design to emphasize actor engagement and to implement methods for providing methods for data privacy, feedback for flow tuning, and a justifiable use of information.

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