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June 2024

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EMBRACING THE INSTITUTIONAL COMPLEXITY OF IS DESIGN: A CONFIGURATIONAL STUDY OF COVID-19 CONTACT TRACING SOFTWARE

Completed Research Paper

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Abstract

The COVID-19 pandemic has impacted our societies with unprecedented magnitude. Various social rules and technological solutions have been designed to limit the spread of the virus. We have seen that governments have chosen very different approaches in utilizing mobile tracing software products to control the pandemic. We utilize fuzzy set qualitative analysis to investigate the causal complexity underlying institutional conditions and the information systems (IS) design outcome. By drawing from a data set of 48 case countries, we are able to make visible configurational paths leading to democratic and autocratic characteristics of IS design. This study's contribution to the research is two-fold. First, we advance the theorization of institutional conditions influencing IS design outcomes. Second, we demonstrate how qualitative comparative analysis can provide a rigorous method to analyze organizational aspects in medium N case studies in IS research.

Keywords: IS design outcomes, institutional conditions, configurational analysis.

1 Introduction

Digital innovation and its use, when viewed as an organizational phenomenon, are always situated within a specific institutional context. Institutional context can be seen as an external environment of an organization with its regulatory, normative, and cognitive structures. It exerts pressure on and shapes collaborative work within organizations (Little, 1990) and influence design decisions. Our perspective on values in information systems (IS) design posits that neither the design work within IS organizations (Peppard, 2018) nor the resulting technology can be void of values. Certain technologies promote and foster democracy and justice, while some can endanger these principles (Pols and Spahn, 2015). A better understanding of the values embedded in specific design outputs could provide a valuable lens to elaborate the IS design practice in a society shaped by local structures, norms, knowledge, sectoral skills, capabilities, and the society's historical legacy. Extreme events initiating similar design efforts simultaneously worldwide create unique opportunities to understand how institutional context influences attributes in the IS design outputs. COVID-19 triggered the emergence of new solutions to help societies mitigate its spread.

Contact tracing software is a new technological solution shaping the pattern and content of human activity (cf. Mumford, 1964). Two key factors make the IS design practice and research novel in this case and context. First, the practice involves unique temporal aspects. The COVID-19 pandemic is an extreme event that has initiated simultaneous (within months) design endeavors all around the world. While concurrent innovation projects and diffusion also occur under normal conditions, the extreme event context creates basic needs common across countries and markets. It introduces atypical urgency into commercial product and service development, driven by socially constructed market needs, and often slow market uptake. Second, an extreme event is an institutional change, an external factor, and it

will have significant implications for IS organizations' design practice and choices without providing many opportunities to design (aka shape) institutions (Goodin, 1996). In doing so, the case research opens up new avenues to understanding the role of institutions in IS organizations.

In this paper, we analyze the interplay of institutional conditions under which contact tracing products can deliver high user autonomy, and recognize the institutional aspects that might lead to IS design outcomes with low user autonomy. By institutional conditions we mean rules, norms, policies and regulations that shape the development of information systems within an organization. In addition to organizational factors and design practice examination, design outcome can be seen as a synthesis of these factors.

The justifications for this study are theoretical but also practical in nature. To date, academic research around contact tracing has focused on practical opportunities as to how technology can support non-pharmaceutical interventions (Ishmaev, Dennis and van den Hoven, 2021). It has also critically examined privacy and surveillance concerns (Rowe, 2020), and how app developers make decision choices and bring in ethical-political design norms (Hoffman et al., 2020; Umbrello and van de Poel, 2021). Furthermore, Covid trackers have inspired researchers to develop new frameworks on digital contact tracing, and the measurement of their impact (Vinuesa et al., 2020). What has not yet been studied is the relationship between societal level pressures, societal sector-specific competencies, values influencing technology development, and the universal values embedded in the technological outcomes. These conditions may lead us to different outcomes, even though the set objectives may appear equal at project level. The present study aims to answer the following research question:

- How do the institutional conditions and their interlinkages shape IS design towards democratic or autocratic characteristics and outcomes?

By examining why mandatory tracing applications emerge from specific institutional contexts while others rely on voluntary tracing provides us an opportunity to rethink IS design practice. We argue that increasing the transparency in IS design practice also requires the capability to reflect on institutional conditions that influence design choices during design processes. In other words, in "reflective conversation with the situation" (Valkenburg and Dorst, 1998), designers frame a problem in a certain way. Still, they should also work to recognize the relevant factors in the situation, including institutional factors. After this, designers are better equipped to move toward a solution and evaluate those moves. Notably, in IS design projects under public procurement, it is essential to understand how the interplay of institutional conditions influences outcomes.

2 Theoretical Background

In this section, we introduce the key concepts and theories of the study. We begin by reviewing literature on technological design and how values shape the design. We mostly draw from Science and Technology Studies (STS) and acknowledge that the literature on this topic spans across a number of disciplines. This section lays the foundation for the study as we aim to explain design outcomes with different embedded values. We then move to the institutional context of design at a generic level and provide an overview of institutional theories. Finally, we delve deeper into the specifics of the institutional context and sectoral characteristics, discussing the health care sector and how extant literature has examined the influence of institutional context.

2.1 Democratic values in technological design

Technology wields significant influence in modern societies, often surpassing political systems. However, we do not require the same democratic standards of technologies as we expect from other political institutions (Feenberg, 2002, p. 131). Therefore, the design process, as it now stands, is illegitimate, and there is a need to extend democracy beyond its traditional spheres. Otherwise, democracy's use-value will decline, participation will decrease, and the institutions maintaining a free society will disappear (Feenberg, 2004).

The academic literature, particularly Science and Technology Studies (STS), has underscored how technologies tend to promote particular ideologies and values while ignoring others (Mumford, 1964; Cowan, 1983; Latour, 1992). In *Authoritarian and Democratic Technics* (Mumford, 1964), technology was classified into human-centered “democratic technics” and “authoritarian technics” where power is taken away from the individual (Mumford, 1964). Regarding contact tracing applications, democratic technics are demonstrated with high user autonomy and privacy (Warnier, Dechesne and Brazier, 2015; Draper and Sorell, 2017). Authoritarian technics in this context do not respect user’s privacy (Banerjee, Hemphill and Longstreet, 2018; Papageorgiou *et al.*, 2018), and lack algorithmic transparency (Vayena, Blasimme and Cohen, 2018). Privacy can be understood from different perspectives, including freedom from intrusion (right to be left alone), control of information about yourself, and freedom from surveillance (Warnier, Dechesne and Brazier, 2015).

The crucial choices influencing the future of technological progress are ultimately made by the designer in the initial stage of technology development. Our paper pays particular attention to the two value categories of technology, namely democratic and authoritarian.

In addition to the critical stance above, technology can be seen as an amplifier of democracy (Pols and Spahn, 2015, pp. 342–350). While we recognize both of the above standpoints, we argue that technology is both input and outcome, and is created and used in a specific institutional setting. This can reflect the authoritarian aspects of a society or reflect democratic values (Mumford, 1964). It is a matter of human agency within the institutional context to shape the technology towards an amplifier of democracy.

2.2 Taking institutional perspective to understand health care digital innovation

To understand the institutional context that shapes the IS design outcomes of digital health care technology, we look to institutional theories and contextual factors that have been examined in the extant research on the health care sector.

Institutions shape organizational practices, structures and outcomes. The institutional perspective has emerged to explain how organizational founding and change were driven by symbolic actions and external influences (Meyer and Rowan, 1977; Hinings, Gegenhuber and Greenwood, 2018). Consequently, institutional theories constitute a useful perspective from which to examine technological development, since technological design always occurs within a specific institutional context and in cooperation with a wide range of stakeholder groups. One of the central interests has been to examine on how institutional effects affect a human agency in IS decision making and placing cultural-cognitive, normative, and regulatory aspects on the front (Miranda and Kim, 2006; Hu, Hart and Cooke, 2007; Wang and Swanson, 2007).

DiMaggio’s and Powell’s seminal works on institutional theory (DiMaggio and Powell, 1983) and institutional forces have helped scholars understand how isomorphism occurs in organizations. A digital health care technology design, diffusion, and use take place under three institutional forces which derive from different conditions and lead to different outcomes. Coercive pressures stem from legitimacy and political influence (*ibid.*). Policies can, for example, limit certain kinds of use or users of the technology (Milner, 2006), or force the implementation of a certain type of technology (Xue, Liang, and Boulton, 2008). Second, mimetic pressures derive from uncertainty, and are often created by the environment or ambiguous goals (DiMaggio and Powell, 1983). These forces can drive organizations to imitate their successful competitors, if the technology is poorly understood (Xue, Liang, and Boulton, 2008). Mimetic pressures can also influence the organization unintentionally, via new employees or as directed by, for example, consulting firms (DiMaggio and Powell, 1983). Finally, normative pressures cause people in different organizations to operate similarly, due to a shared set of values and industrial norms (Xue, Liang, and Boulton, 2008). National norms may make it difficult for alternative technological ideas to gain a foothold, and new technologies do not succeed without the co-evolution of relevant institutions (Chlebna and Simmie, 2018).

The health care technology and digitalization involves interconnected beliefs, practices, norms and materiality which together form an institutional logic (Schildt, 2022). A wide range of resources are needed to design of digital health care technology and they serve as a foundation on which institutional logic becomes visible. These resources can be economic, and they may be human capital and knowledge-related capabilities (Powell and DiMaggio, 1991; Sewell, 1992; Oakes, Townley and Cooper, 2005). Decision-making within healthcare sector is ordered by the recursive relationship between institutional logics and resources. In health care technology design, the capabilities of the health care and ICT sectors are central. Investing in this kind of human capital increases access to information and supports technical knowledge long-term (Coccia, 2010). A well-established ICT infrastructure promotes networked innovation and triple helix collaboration among universities, industry, and government (Lee et al., 2016). Cooperation between sectors can be seen as crucial, especially when developing large-scale, national software products.

Health care innovations are strongly influenced by institutional arrangements and the social context in which they are embedded. Countries that rank high on public health institutions' capabilities also have strong national health innovation systems (Proksch et al., 2019). Similarly, if the public institutions are weak, poor and deteriorating innovation performance may follow (ibid.).

Recent research has shown that local innovation projects require support from public institutions (Rodríguez-Pose and Zhang, 2020) and institutional barriers can hinder the health care innovations (Kulkov, Tsvetkova and Ivanova-Gongne, 2023). Strong institutions are needed, especially when coping with the high levels of uncertainty that apply to innovation activities (Edquist, 1997, p. 52). Notably, in extreme event contexts, such as a global pandemic, strong institutions are crucial for building a stable platform for a complex project aiming for socio-technical change.

2.3 The democratic governance and health care design choices

The design of health care technology has some specific characteristics. Its purpose is to improve health care efficiency, quality, safety, and cost (Dahl *et al.*, 2016). Furthermore, design work is often commissioned and directed by a public organization. Typically, a public health care organization subcontracts the design of the new solutions to an external organization and chooses the experts with whom to cooperate. Consequently, the developer organization is under public administration or political governance, which feeds society's normative pressures into the design practice.

The implemented health measures reflect social and cultural norms, such as the appropriate balance between security and liberty generally accepted in the country (Gostin, Bayer and Fairchild, 2003). Organizations can confront incompatible prescriptions from multiple institutional logics. There can be a need for quick intrusive monitoring of people to stop the pandemic. On the other hand, the technology should follow a specific ethical guideline i.e., it should be voluntary to use. Organizations tend to cope with these conflicting forces or demands through different strategies and structures (Greenwood et al., 2011).

Technology implementations in autocratic states vary from those in liberal democracies due to local socio-cultural factors. Research indicates that authoritarian states are more likely to accept technology that infringes on citizens' liberty and rights (Xu, 2021). Autocracy has broader negative effects, such as hindering innovation and damaging socio-cultural elements beneficial for technological development. In contrast, democratization drives technological progress, fostering innovation and productivity (Coccia, 2010).

Past political experiences can lead to long-lasting differences in institutions across countries. The legacy of institutions can persist to the present day (Acemoglu, Johnson and Robinson, 2001). Thus, when studying democratization, it is crucial to include legacy variables in the analysis to avoid giving too much weight to current conditions (Bernhard and Karakoç, 2007). Conditions in democratic or autocratic states can be seen as a product of their legacy. The duration of an authoritarian rule (Carden

and James, 2013) and stigmatization of antidemocratic practices (Manucci, 2019) matter especially in discussing the long-lasting consequences of an autocratic regime for human and social capital.

In addition to the technology's embedded universal value characteristics, a number of relevant studies have focused on the contextualized and culturally situated values of patients, care providers, and technology developers (Pan, Pan and Devadoss, 2005; Dahl et al., 2016; Stahl and Coeckelbergh, 2016).

3 Methods and Data

3.1 Empirical data

We analyzed 48 early mover cases in COVID-19 tracing software development across different regions to achieve a global reach, and purposeful case sampling criteria were employed. Each case country took similar actions in utilizing software-based solutions, enabling a comparative case study setting.

Yet, each of the selected countries had its own unique set of reactions to this extreme event (Greckhamer, Misangyi and Fiss, 2013). Consequently, very different design decisions were made on the technological dimensions of the software product to manage the pandemic's spread. Thus, every case becomes relevant with respect to the literature, and both high and low user autonomy outcomes are well represented in the sample. The secondary data analysis was conducted to make informed decisions regarding data operationalization and analysis.

3.2 A configurational approach to study design outcomes

Design decisions as organizational work can rarely be well-understood by testing antecedents in isolation. We claim that design outcomes are configurational and feature equifinality. The concept of equifinality implies that it is possible to achieve a specific outcome via different paths, by combining other conditions which can be either present or absent. In analyzing the design outcomes, antecedents to democratic outcomes may not operate in isolation but interdependently, and certain combinations of those antecedents are likely to be meaningful in determining design outcomes with democratic characteristics. In other words, design outcomes are a result of the conjunctural causation of multiple causal conditions.

In this study countries form cases that are comparable. To systemize the research and case comparison, we rely on qualitative comparative analysis (QCA) (Ragin, 1987; Rihoux and Ragin, 2008). QCA differs from correlation-based approaches by allowing us to focus on configurations of conditions leading to the outcome.

QCA is a comparative approach initially developed for political science. The method has proved useful in various disciplines, for example, when comparing new technological outcomes (Huarng, 2015), studying product development and innovation (Juntunen, 2014; Hofman, Faems and Schleimer, 2017), or conducting business and management research (Fainshmidt *et al.*, 2020; Meuer and Fiss, 2020).

The strengths of QCA lie in its ability to recognize conjunctural causation, equifinality, and causal asymmetry. In the analysis of IS design outcomes, institutional conditions are unlikely to operate in isolation but rather in an interdependent manner and an autocratic or democratic outcome is a result of the conjunctural causation of multiple causal conditions. QCA is also able to reveal multiple pathways to the outcome, which is called equifinality (Fiss, 2007; Rihoux and Ragin, 2008, pp. 8–9). Furthermore, QCA does not expect causality to be symmetrical in the presence and absence of the outcome. In other words, it makes possible to see different explanations behind opposite outcomes (Rihoux and Ragin, 2008, pp. 1–17).

QCA adopts a holistic view of the cases, since each individual case can be taken as a complex whole, known at its specific level. The key feature is the interplay between theoretical knowledge and case-orientated knowledge. Thus, the researcher needs to understand each case in-depth (Rihoux and Ragin,

2008). The key question regarding the causal conditions or combination of conditions in QCA is whether they are necessary or sufficient for the outcome (ibid.). A condition or combination of conditions is considered necessary when it is always present when the outcome occurs, that is, the outcome cannot occur without this type of condition. A sufficient condition means that when a condition or combination of conditions is present, the outcome occurs. In this case, however, the outcome can also be produced as a result of other conditions (ibid.).

Our configurational model is built by drawing on the previous literature (Misangyi et al., 2017), and utilizing case knowledge when needed (Basurto and Speer, 2012). We now elaborate on the outcome, conditions and their operationalization.

3.3 Details of the configurational model

Outcome. Our interest is to assess how institutional conditions shape design outcomes, towards either democratic or autocratic characteristics. Since there was no pre-existing organized information regarding design decisions for information systems during COVID-19, the secondary dataset serves as a suitable initial foundation for the exploration of COVID-19-driven IS design (Sarkar, Ghosh and Petter, 2020). Our data set and measurements utilize the work (O'Neill, Ryan-Mosley and Johnson, 2020) in MIT Technology Review (see Table 1). We constructed the measurement of the democratic characteristics of the design outcome through four dimensions. First being voluntary software use. If the outcome does not fulfill this metric, it automatically rates 0. Along with the voluntary software use, we selected dimensions corresponding to each of the data life cycle main stages; onboarding, usage and end-of use (Labadie and Legner, 2020). In this case, the operationalization of the outcome reflects the precise control that user gains over relevant aspects at the main stages of data life cycle. **Thus**, second, data minimization (onboarding): only essential location data (GPS and data mining vs. Bluetooth) for the purpose of COVID-19 tracing are collected. Third, transparency (usage): a person can easily find information on the data life cycle: what data are acquired, from where, how they are used, and who has access to them. And fourth, expiration date (end-of use): the data will be deleted once they are no longer relevant in terms of limiting the spread of COVID-19. In addition to voluntary use, we require that two other dimensions are positive in order to go beyond the cross-over point and merit membership in a positive outcome set.

Based on the above review, we can conclude that the extant literature constitutes a solid theoretical base of institutional conditions interplaying and forming complex causal relations in design practice, and influencing design outcomes. In the following, we explain how fsQCA was applied to each of the five institutional conditions. We build a model to examine interplay of institutional logics (The long-lasting legacy of autocracy and Strong current democratic governance), capabilities (Strong current democratic governance and High capacity of national health care system) and level of extreme condition causing stress to institutional configuration.

We follow earlier studies (Knutson *et al.*, 2019; Njangang *et al.*, 2022) to operationalize conditions related to democracy and rely on data provided by V-Dem Institute (V-Dem Institute, 2020). To measure *the long-lasting legacy of autocracy*, we counted the number of years under an authoritarian regime, in the egalitarian democracy index from 1919 to 2019. The data point is set at 1919 because the interwar period can be characterized as a time of general struggle between democratic and authoritarian forces (Bermeo, 1997).

Strong current democratic governance is the second condition of our model. Similarly to the above introduced longitudinal condition, we use the egalitarian democracy index (V-Dem Institute, 2020) data from 2019, the latest index iteration before the onset of the pandemic.

High capacity of national health care system is the third condition, operationalized based on infant mortality rates. A lower number is associated with the higher capacity of the national health care system. The measurement is selected because of its causal link to national health outcome, which has a causal link to the health care system in general (Brenner, 1973). In addition, infant mortality is a particularly

sensitive indicator of structural changes. Sensitivity to structural changes is essential when studying the system-level conditions in a macro context. IMR is better measured than more comprehensive data about the health care system (Reidpath, 2003). The dataset WHO (2020) was used in the analysis.

We followed the earlier literature (Maneejuk and Yamaka, 2020; Mirzaei Abbasabadi and Soleimani, 2021) to operationalize the fourth condition, *strong ICT capabilities* based on The International Telecommunication Union ICT Development Index.

High stress level on institutions. During crises, technological innovations may emerge as a response to the unique challenges posed by the situation (Hassankhani *et al.*, 2021). However, the more stressed the system, the more likely it is that decision-makers will ignore stakeholders and their specific values (Christensen and Kohls, 2003) and mimic the routine decision processes common to more authoritarian states (Trumbore and Boyer, 2000). The strength of power centers and cooperation with stakeholders are reduced, especially due to a heightened sense of limitations on time (Pearson and Clair, 1998; Trumbore and Boyer, 2000). In technology development, a lack of potential stakeholder engagement can negatively affect the final outcome. The operationalization of the *high stress level on institutions* condition is guided by the (effective) reproduction number $R(t)$ at day t , which represents the average number of people that someone infected at time t would themselves infect, if conditions remained the same (Hotz *et al.*, 2020). The mean of 10 days’ estimated reproduction numbers is measured for each case country, between 17.3. -26.3.2020. The higher the mean, the higher the stress level on institutions. The high stress level can be triangulated from Google Trends data. The first high Google search peak for the term “corona app” was in late March 2020. We claim that decisions on whether or not to start a project and on design outcomes were taken during this period.

While other conditions might also be influential, we aim to theorize about configurations rather than about the existence of conditions (Mattke *et al.*, 2021). The five conditions jointly are particularly crucial in the context of technological design because they encompass the aspects of technical and social systems aspects of institutional settings (STS).

Outcome / condition	Description	Data set	Operationalization	Data scale	Min	Max
Outcome	Democratic/autocratic characteristics of IS design (measured by level of user autonomy)	Data from MIT Technology Review’s Covid Tracing Tracker online dataset (O’Neill, Ryan-Mosley and Johnson, 2020).	Measured by utilizing four dimensions (voluntary use, expiration date, data minimization, data transparency). Count of the presence of democratic characteristics	0 to 4	0	4
Condition 1	Current ‘democratic governance (democracy)	Based on the Varieties of Democracy (V-Dem) dataset (V-Dem Institute, 2020).	Egalitarian Democracy Index.	0 to 1	0.09	0.87
Condition 2	National legacy of autocracy (autohistory)	Based on the Varieties of Democracy (V-Dem) dataset (V-	Number of years under autocratic regime legacy between years 1919-	0 to 102	0	102

		Dem Institute, 2020).	2020.			
Condition 3	High capacity of national health care system (healthcare)	WHO Global Health Observatory data repository (WHO, 2020).	Infant mortality: Probability of dying between birth and age 1 per 1000 live births.	0 to 1000	1.06	33.90
Condition 4	Strong ICT capabilities (ICT)	The International Telecommunication Union (ITU, 2017).	ICT Development Index 2017.	0 to 10	3.03	8.98
Condition 5	High level of stress on institutions (pandemia)	Monitoring the spread of COVID-19 by estimating reproduction numbers over time. AG Stochastik, Technische Universität Ilmenau (Hotz <i>et al.</i> , 2020).	The mean of 10 days reproduction number during the early stage of the application development projects (17.3.-26.3.2020).	0 to inf.	0.85	3.30

Table 1. Data sets and operationalization of outcome and condition.

3.4 Calibration of data

The fuzzy set analysis provides a method to define whether a case belongs to a particular set. In our calibration, the qualitative anchors are used to transform the original interval-scaled values into a fuzzy-value scale ranging from 0 to 1.

We calibrated the outcome variable, democratic characteristics of design outcome, utilizing data from four technological dimensions (Appendix 1). Voluntary use of the application is the central dimension; if absent, the outcome is always coded 0. The additional dimensions contribute 0.33 each to the outcome (c.f. section 2.3 outcome for the list of dimensions), and with voluntary use and three other dimensions outcome is calibrated to 1. The fuzzy set calibrations were used for institutional conditions. The calibration was performed using the direct method (Rihoux and Ragin, 2008, p. 85). We relied on prior theoretical knowledge, case knowledge, and visible value breaks to define the anchor points for thresholds. The calibration table with entries can be found in Appendix 2.

3.5 Data analysis

The configurational analysis was performed using the QCA version 3.20 (Dusa, 2018) and SetMethods version 4.0 (Oana *et al.*, 2020) package for R version 4.3.1. In the beginning of the analysis the truth table was formed (Appendix 3). The necessity test in QCA reveals whether one or multiple conditions is/are necessary to generate an outcome. Conditions can be either present or absent. We analyzed necessity with high consistency threshold (0.9), coverage (0.6), and relevance of necessity thresholds (0.8) (Schneider and Wagemann, 2012, p. 236; Schneider, 2018) in subset/superset functions of the R package, looking for single or combinations of conditions that could together form a necessary condition for a positive or a negative outcome. We used consistency (0.9), coverage (0.6), and RoN (0.5) thresholds. However, no necessary solutions were found.

We then proceeded to the sufficiency analysis which was based on Enhanced Standard Analysis (ESA) (Schneider and Wagemann, 2013). First, the frequency threshold was set for the analysis. In this study,

the number of cases is intermediate, and we set the frequency threshold at 1. The final consistency threshold was set at 0.55, which resulted in solution consistency of 0.81 and solution coverage of 0.71 for the positive outcome. For the negative outcome, with a consistency threshold of 0.8, we received solution coverage of 0.87 and solution consistency of 0.60. We followed the intermediate solution (Rihoux and Ragin, 2008). We made theoretically informed directional expectations which enabled us to distinguish core and peripheral conditions in each configuration. We assumed that the presence of current democratic governance is associated with a positive outcome and the absence of the condition is associated with the negative outcome.

We performed several robustness checks during the process. To ensure the robustness of decisions related to the anchors, we performed an analysis with a frequency cut-off 2, and slightly different consistency thresholds in an iterative manner (Greckhamer *et al.*, 2018). We also tested results with alternative solution consistency cut-offs.

4 Results

The configurations can be found in Table 2 below. A black circle means the condition is present, while a strike-through circle indicates its absence. The difference between the core conditions and peripheral conditions, with stronger or weaker ties to the outcome, is indicated using large and small circles. A blank space means the presence of a condition is not essential, that is, it can be present or absent.

The results of the analysis, two configurations leading to a positive outcome and two to a negative outcome, are scrutinized with complementary qualitative case knowledge in the following. This paves the way for the theoretical propositions developed in the paper’s discussion section.

	Configurations associated with democratic characteristics of IS design outcome		Configurations associated with autocratic characteristics of IS design outcome	
	D1: Liberal democratic knowledge societies	D2: Liberal democratic societies with long-lasting legacy of autocracy	A1: Societies with a long-lasting legacy of autocracy and weak ICT capabilities	A2: Societies with a long-lasting legacy of autocracy and weak national capabilities
National legacy of autocracy		●	●	●
Current democratic governance	●	●	⊗	⊗
High capacity of national health care system	●	●		⊗
Strong ICT capabilities	●		⊗	⊗
High level of stress on institutions			●	
Consistency	0.85	0.75	0.87	0.91
Unique coverage	0.36	0.03	0.03	0.16
Number of case countries under the configuration	19	8	14	20
Case countries	Australia, Austria, Finland, Germany, Iceland, Ireland, Norway, Switzerland, Canada, Denmark, France, Israel, New Zealand, United Kingdom, Japan, Belgium, Cyprus, Estonia, Spain	Czech Republic, Italy, Poland, Japan, Belgium, Cyprus, Estonia, Spain	Algeria, Colombia, India, Iran, Kuwait, Mexico, Peru, Philippines, Qatar, Saudi Arabia, South Africa, Turkey, United Arab Emirates, Hungary	Bulgaria, China, Ghana, Indonesia, Malaysia, Thailand, Vietnam; Algeria, Colombia, India, Iran, Kuwait, Mexico, Peru, Philippines, Qatar, Saudi Arabia, South Africa, Turkey, United Arab Emirates
Solution consistency	0.81		0.87	
Solution coverage	0.71		0.60	
Key:	●	Causal condition present		
	⊗	Causal condition absent		
	●	Peripheral causal condition present		
	⊗	Peripheral causal condition absent		

Table 2. fsQCA analysis results.

4.1 Configurations associated with democratic characteristics of IS design outcome

The first institutional configuration (D1) for a positive outcome is grounded on current democratic governance in the country, high capacity of the national health care system, and strong ICT capabilities. The knowledge base supports the technological development process, and, irrespective of different

histories in autocracy or stress level with the pandemic, these countries were able to implement tracing software with democratic characteristics. Germany, a part of this group, initially planned to use location data for infection tracking through the open-source Corona-Warn-App developed by Deutsche Telekom and SAP, leading German ICT companies. However, due to public criticism, the German government changed its approach. (Simon and Rieder, 2021). It then collaborated with a coalition of European technology firms called Healthy Together, known for user-centered design and data protection expertise. The final app launched incorporated democratic features like Bluetooth proximity tracing.

Countries fitting the second institutional configuration (D2) also developed tracing software with democratic characteristics. These countries have current democratic governance regime, history of autocracy, strong health care system capabilities but relatively lower ICT capabilities compared to liberal democracies (D1). COVID-19 did not hit these countries hard in its initial phase.

Japan, belonging to D2 group, introduced voluntary contact tracing software Cocoa, which utilizes Bluetooth technology. The data is deleted after 14 days, and users can easily find information on the data lifecycle on the Ministry of Health, Labour and Welfare's website. Japan's success in this software development project is due to its robust telecommunications infrastructure, having been a global ICT leader with extensive ICT access and usage. Despite this technological prowess, the Cocoa software faced issues, such as the inability to register a positive test.

4.2 Configurations associated with autocratic characteristics of design outcome

Our analysis for a negative outcome, that is, configurations associated with the autocratic design outcome, produced two institutional configurations. The first (A1) features a long-lasting autocratic regime and weak ICT capabilities. A high level of stress is a peripheral condition to the outcome.

Peru, belonging to A1 group, struggles with a weak degree of democracy, high stress level on institutions, legacy of autocracy, limited national health care system, and low national ICT capabilities. Peru's tracing software, "Perú en tus manos," offers a health questionnaire, a symptom heat map, and virus exposure alerts. While the use of the software is voluntary, it collects location data (GPS and Bluetooth) and personal information like ID numbers and medical history upon download. Currently, there are no policies ensuring data use limitations, and the tracing may continue beyond COVID-19 measures.

The final institutional configuration, A2, shares some characteristics with A1, a long-lasting autocratic regime linked to limited sectoral capabilities, but here both ICT and health care are weak. Irrespective of how severely the countries were affected by the pandemic, or the level of stress, they implemented a solution with autocratic characteristics.

Indonesia belongs to A2 group, with its voluntary contact tracing software PeduliLindungi. The Ministry of Information released the software, and its use is voluntary. The app monitors users' location data by cross-referencing it with telecommunications provider data (O'Neill, Ryan-Mosley and Johnson, 2020). It also requests access to the phone's cameras and memory card. User data is deleted after the extreme event, but Indonesia lacks a specific data protection oversight institution or punitive measures for data breaches.

5 Discussion and Conclusion

The Covid pandemic pushed countries around the globe to develop technological solutions to trace the spread of the disease. This is a rare moment in history where we have seen design efforts with similar targets taking place simultaneously in many countries with very different institutional contexts. Thus, it has presented a unique opportunity to analyze how institutional conditions shape IS design outcomes.

The current IS literature mainly concentrates on the technical features of the technology and organizations' inner structures (Peppard, 2018). In this paper, we argue that IS design is always

embedded in a broader institutional context that influences IS organizations design choices. We looked to reveal the causal complexity of institutional conditions associated with the democratic or autocratic characteristics of the IS design outcomes. These institutional conditions include sector-specific knowledge, technological capabilities, current governance regimes, and collective memories.

Our results indicate that strong democratic institutions with supportive sectoral capabilities are essential to yielding democratic characteristics of IS design outcomes. Our results are in line with existing research that has looked contextual influences from a motivational perspective (Hapsara, Imran and Turner, 2017). Our results provide a more nuanced understanding of the contextual influences on information system design, and we propose the following:

Proposition 1: Liberal democratic countries provide a solid base for IS organizations to produce design outputs with democratic characteristics.

However, our configurational analysis features equifinality, and there are several routes to design outputs with democratic characteristics. The second configuration leading to a positive outcome features strong health care sector capabilities and regime change from an autocratic to current democratic regime.

In the case of COVID-19 software trackers, a strong health care system seems especially crucial to implementing just IS design outcomes successfully. The countries with high ICT capabilities have tended to adapt technology in accordance with local requirements, such as the democratic values of self-management, transparency, and data security. This is not the full picture, and our results indicate that the health care sector is more crucial to the design process and decisions than the ICT sector. ICT capabilities matter, but in the specification work, broader institutional conditions, such as a democratic regime and the focal sector's competencies, are the most crucial in shaping the IS design outcomes. The ICT sector is a cross-cutting sector and knowledge base and seems to have an intermediating role in implementation. Our study aligns with the recent findings of Stratu-Strelet et al. (2023) which also establish links between country-level technology capabilities and the democratic system. Similarly, in our study we cannot confirm that ICT capabilities have a necessary condition status, but they do play a supporting role in a specific context. This leads to the following proposition:

Proposition 2: ICT sector capabilities have a supportive role in IS design efforts. A lack of ICT capabilities can be compensated with other conditions that support IS design efforts to create outputs with democratic characteristics.

It is noteworthy that configuration D2 also features a regime change from autocracy to current democratic governance. Our results imply that collective memory or autocracy can support IS design endeavors in liberal democratic knowledge societies. The studies of post-authoritarian societies have turned to the notion of authoritarian politics' long-term effects on individuals and organizations. (Marquis and Qiao, 2020; Wyrwich et al., 2022). Thus, we propose the following:

Proposition 3: National collective memory of autocracy is an institutional condition that supports IS design outputs with democratic characteristics if the current regime is based on democratic governance.

One of the critical features of QCA is support for asymmetry in results. In other words, configurations leading to a negative outcome are not mirrored images of those leading to a positive outcome. Our results demonstrate this feature. Countries featuring low capabilities and long-lasting autocratic regimes provided an institutional setting for IS organizations that is prone to produce outputs with autocratic characteristics.

The earlier research on ICT technology under authoritarian control has produced similar indications (Morgenbesser, 2020; Xu, 2021). Non-democratic governance tends to set up higher levels of digital surveillance and dispense less freedom for individual control. Thus, we propose:

Proposition 4: Nations with low sectoral capabilities and long-lasting autocracy are creating an institutional setting that is associated with IS design outcomes with autocratic characteristics.

In sum, our main contribution is to expand the unit of analysis to the institutional context of IS design, which opens new avenues to understanding information systems choices in organizations. Furthermore, this paper makes a methodological contribution to studies on information technologies and social organization, by broadening small N inductive case-oriented research to study medium N data sets with configurational methods, namely fsQCA. As Bruce Archer (1981) puts it *Research is a systematic inquiry, the goal of which is knowledge*. With fsQCA, we demonstrate how we can adopt a systematic approach in case-oriented research, and increase rigor with novel social science methods that have to date rarely been used to theorize information technologies and social organizations related knowledge.

The present paper has some limitations that must be acknowledged. First, the analysis is inductive and theory-building, which prevents us from testing significance. Second, the data sets were retrieved from public sources, and we did not have complete coverage around the world for all types of tracing software implementations. Third, although several robustness checks were performed, with different calibration thresholds and consistency cut-offs in the analysis, these decisions influence the results of fsQCA analysis. We see that future research could extend the studies of institutional conditions and design outcomes by taking into account organization-specific antecedents.

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