The ethics and politics of design for the common good: a lesson from Alibaug

The Ethics and Politics of Design for the Common Good: A Lesson from India

Jose Abdelnour Nocera

Abstract

In this chapter I argue for a socio-technical approach to technology design for the common good that addresses its ethical and political aspects. The background is that the life of marginalized people in contemporary society is challenging and uncertain. The marginalized can face health and cognitive issues as well as a lack of stability in social structures such as family, work and social inclusion. In this context, certain democratic values embedded in technology design can conceal political asymmetries and fail to deliver ethical value exchange, where value extraction is not dominated by one party but equally shared across all stakeholders. I discuss two socio-technical perspectives called human work interaction design (HWID) and Technological Frames (TF) to expose and tackle the challenges of designing technology for the common good. I introduce and evaluate an ongoing case of a digital service delivered through an app to support a fishing community in Alibaug, India. The evaluation of the socio-technical infrastructure surrounding this app is done in two parts: firstly, I use HWID to highlight inwardly and outwardly socio-technical, ethical and power relations between human work and interaction design; secondly, an argument for the use of the concept of TF to understand the constructionist and semiotic power dynamics of different groups in participatory technology design is presented. It is shown how dominant groups' frames can construct meanings of design decisions in terms of whether they are appropriate or not. The political leverage of the scripts embedded in artefacts used in the process of design is also explained from a semiotic perspective. I conclude by highlighting the

value of an ethical and political socio-technical framework for technology design for the common good with people at the margins.

Introduction:

Ethics is moving to the forefront of technology design in these years, adding a new dimension to the current user experience and web 2.0 platform designs (Gardien *et al.*, 2014). For example, an emerging network for product and service innovation in resource constrained environments explores new design methods, experiences and knowledge of doing innovation with people 'at the margins', for example in South Africa, India and Brazil (Abdelnour-Nocera *et al.*, 2017). In these projects that look at Global South Service Innovation there is a lot of focus on a frontstage mindset (e.g., touchpoints, user friendliness, user interfaces), but the methods, tools and infrastructure used to analyse and/or do backstage 'work' are envisioned and driven to a large extent by Global North assumptions (e.g., analytical cognitive styles, horizontal decision-making structures, economically-driven thinking). The life of people living in resource-constrained environments is challenging and uncertain. Approaching these people is challenging – their relative exclusion from society and societal resources has created estrangement. Moreover, a lack of resources may make it hard for them to take part in the dominant patterns of innovation and consumption. In addition, it is a significant problem that stereotypes of these people at the margins fail to grasp their experiences and life perspectives (Cabrero, 2016). There is therefore a need to revisit analysis and participatory methods with the aim to co-create alternative patterns of innovation that include the marginalized in technology design.

Furthermore, in the emerging transformation economy, the focus on assessing the ethical value of design with trust and collaboration in the foreground requires empathic, in-context experimentation and data collection, which requires a socio-technical, context-sensitive approach to technology design (Gardien *et al.*, 2014).

In the context of the study of a project supporting sustainable fishing through a mobile app in Alibaug, India, we argue that through a socio-technical[1] design approach, exemplified with the Human Work Interaction Design (HWID) model (Clemmensen, 2011), researchers and designers can visualize and do something about these critical gaps, and more generally, contribute to technology design of an 'ethical value exchange' (Gardien *et al.*, 2014) where value extraction is not dominated by one party but equally shared across all stakeholders. The larger questions that I want to contribute to answer by analysing this case on sustainable fishing in India (Hertzum *et al.*, 2018) are how we can innovate together with people 'at the margins', how socio-technical design methods can address the local societal context, and how to make the design sustainable in the face of current planetary challenges (e.g., climate change).

While fishing is an important source of income in Alibaug it is also an uncertain business in the sense that going fishing is no guarantee of catching any fish. Without fish there is no income but the costs of the fishing trip, in terms of for example ice and diesel, still must be paid. On top of the certain costs and uncertain incomes fishing also incurs risks to the fishers' health. High wind speeds, large waves, and dynamically changing weather conditions may damage equipment, injure fishers, and cause fisher boats to go down. These conditions have motivated the development of an app with a map that shows where the concentration of fish is currently likely to be high. The app also provides local weather forecasts. In this paper, we investigate the socio-technical infrastructure of which this app is part.

In this chapter I also reflect on the politics of user and stakeholder participation that took place during the project. I frame this discussion by making reference to the concept of technological frame (TF) (Bijker, 1995) developed to make sense of the social shaping of technology and the technological shaping of society. Bijker's TF places an important focus on the political processes influencing socio-technical change, including design.

[1] In this paper we use the term socio-technical in a broad sense to cover various traditions thinking

This chapter is an extended version from a previous publication (Abdelnour-Nocera *et al.*, 2019) where this case study is presented. In this chapter I develop these arguments through theoretical reflections, present HWID and TF as instances of socio-technical design and analysis to expose the different power relations of the socio-technical infrastructure found in Alibaug. I conclude the paper by demonstrating the value of socio-technical design for sustainable and ethical design for the common good.

Socio-Technical Design, Participatory Design and Democracy

The emphasis on usability engineering developed in the human-computer interaction (HCI) discipline to make technology more usable and user friendly was frequently criticised in the 1980s, because of its lack of focus on the context of use and on non-tangible aspects of the user engagement with interactive systems, i.e. their experience. The response to these criticisms was what Bannon and Bødker (Bannon and Bodker, 1991) would refer to as the second wave in human-computer interaction, the shift from 'human factors to human actors'(Bannon, 1991). This shift triggered an increasing focus away from individual cognitive theories of human action into social theories such as ethnomethodology (e.g., Suchman, 1987) and hermeneutics (e.g., Winograd and Flores, 1986), where context, meaning and collective action were central. However, none of these theories provided a distinct focus on users' work in the way of socio-technical systems theory as articulated by Mumford in her ETHICS approach (Mumford and Weir, 1979; e.g., Mumford, 1996). ETHICS was Mumford's attempt to re-articulate the tradition of the earlier work of the Tavistock Institute on human relations in the context of information systems design. Socio-technical approaches' emphasise user involvement and decision making in organisational work contexts, but no clear handles have been provided by authors like Mumford and Weir (1979) or Cherns (1976) to interactive system designers trying to make their systems more useful and satisfying from a user experience perspective. Dillon (2000, p. 124) defines this gap very well by pointing

social and technical changes together, including the more recent term sociomaterial.

out that 'Criteria for effectiveness, efficiency and satisfaction must be derived from the social not the individual context of use' and calls for socio-technical approaches to be operationalised at the level where user interactions are designed. Participatory design reflects democratic values within socio-technical design to enable access to the social context of use (Abdelnour Nocera *et al.*, 2021).

Since the beginning of HCI, discussions of democracy have been around, e.g. (Bødker *et al.*, 2000; Bjørn-Andersen and Clemmensen, 2017). It may even be fair to say that the key notion of usability aims to support the citizens of a democratic society or one that could be co-designed by its citizens. Originally, usability and the larger fields of HCI and participatory design were conceived for western democracies. Acknowledging that the meaning of emancipatory socio-technical design depends on our ideas about the ideal society, models of democracy and participation becomes important. A review of studies of HCI and policy recapped basic models of democracy found in the literature (Nelimarkka, 2019). Their models of democracy included a deliberative democracy, which is a system of governance that uses arguments in discussions until consensus is reached (Denmark may be an example); a Marxist system of governance that sees decision-making on policy as related to the economic system (China may be an example); and a cosmopolitan democracy (Archibugi, Koenig-Archibugi and Marchetti, 2011) system of governance that highlights citizens', no matter their geographical location, rights to political participation in global affairs (UN may be an example). For HCI and participatory design approaches, the government system in its wider societal context is thus both a context for design and the ultimate end-goal of the design activities. These approaches are both shaped by and may contribute to design of particular Marxist, deliberate, and cosmopolitan systems of governance. Policy makers and researchers may therefore benefit from knowing about and considering socio-technical approaches when they study and perform "democracy".

Following the above arguments, it can be seen how participatory design methods were first implemented in the developed world and in consequence they embed certain assumptions about stakeholder relations (Bratteteig and Wagner, 2014). These

assumptions underpin certain values over how interaction and knowledge exchange should occur, and which stakeholders can engage and in what stages in the process of design. For instance, participatory design embeds strong ideals of democracy due to its Scandinavian origins, reflecting its suitability to more horizontal societies. However, when PD is tried to implement in more vertical societies, there are some potential conflicts as the issue of who gets to have a voice or a say follows different social arrangements. At the same time, it has also been recognized that insufficient indigenous perspectives have been dedicated to participatory design in the developing world (Puri *et al.*, 2004) Successful participatory design experiences in Namibia indicate an appropriation of not only methods but also of key values defining participation closely linked to Ubuntu philosophy (Winschiers-Theophilus *et al.*, 2010).

A review of the literature in Participatory IT Design and Participatory Development by Dearden and Rizvi (2008) highlight this type of tensions where 'designers who claim to be participatory, must reflect critically on their skills, their motivations, their practices, their relationships and their priorities' (p. 89). Considering local and indigenous perspectives should lead to a common conversation code while discussing and adapting well-known participatory design methods for local cultures.

From the above it can be seen that socio-technical focuses on the participatory design of IT but insists that the social should be considered in various ways. First, the social should be taken into account at the user interface level. Second, Socio-technical sees the social in terms of considering the individual worker (job satisfaction, job design, automation), organizational issues (decentralization, decision making, business models, strategy), and societal, political and ethical matters (access to IT, unemployment, privacy, wealth distribution) (Bjørn-Andersen and Clemmensen, 2017). An updated socio-technical design approach for the study of workers'

interactions should reflect that any interaction is embedded in a larger context (Gardien *et al.*, 2014). We use the HWID framework (Clemmensen, 2011) as an emerging socio-technical design approach that studies how we can analyse and design for the complex and emergent contexts in which human life and work are entangled. HWID builds on cognitive work analysis and design (Rasmussen, Pejtersen and Goodstein, 1994). It aims to be an updated socio-technical framework for participative technology design, with a narrow focus on the relations between human work analysis and interaction design.

Human-Work Interaction Design

HWID emerged around 2005 (Clemmensen, Orngreen and Pejtersen, 2005). It is a framework sitting in a social-relativistic paradigm (Hirschheim and Klein, 1989)and can thus contribute to the design of systems supporting work satisfaction and organisational socio-technical design goals. HWID leans heavily on the HCI and human factors traditions' specific interpretation of the *social* and the *technical* elements of a system. In HWID the social is analysed as end-users' work tasks performed through IT systems within a given work domain. The focus is on the user's experience of tasks (procedures) and modelling the IT artefact based on its purposes and the constraints imposed by the environment, including task distribution across humans and IT artefacts, and how these agents could communicate and cooperate. Hierarchical Task Analysis (Annett and Duncan, 1967) and Work Domain Analysis (Salmon *et al.*, 2010) are among the methods that can be used to analyse the goal-directed tasks, and map the work environmental constraints and opportunities for behaviour. In addition, there is a strong tradition technology design for studying work with ethnographic methods (Button and Sharrock, 2009) and from socio-technical perspectives, (e.g. Abdelnour-Nocera, Dunckley and Sharp, 2007). These approaches focus on work as end-user actions performed together with other people in a field setting, that is, the user's experience of using systems is social and organizational. Various approaches and techniques for analysing and interpreting the human work can influence user experience, usability and interaction

design, which eventually manifests in the design of technological products, systems and applications.

In HWID the technical focus is either on interaction designs as such, i.e., user interfaces, or at interaction design methods and techniques, i.e., usability evaluation, sketches, prototypes, and more. Interaction design is presented in textbooks as an approach consisting of conceptual models, scenarios, task analysis, persona, usability evaluation, and other user-centred techniques (Cooper, Reimann and Cronin, 2007; Rogers, Sharp and Preece, 2011) . Importantly, prototypes, storyboards and sketches are presented as sources of inspiration in the design process rather than as the interaction design itself. For example, sketches, such as freehand drawings or low-fidelity prototypes, have been studied for their role in design and have been found to stimulate reflection, particularly in the early stages of design (Oh, Do and Gross, 2004). When moving from analysis to design, that is, from conceptual models to physical design, interaction design relies on the iterative testing of prototypes with users of the future product. In many of these techniques, communication between stakeholders about user requirements is supported by the use of prototypes, mock-ups, and sketches. These relations between work and interaction design are illustrated later in Table 2 in the context of the Alibaug case study. For the original framework see (Clemmensen, Orngreen and Pejtersen, 2005).

The value propositions of HWID for ethical value exchange are inspired by Gardien (2014). These imply that HWID theories should conceptualize interaction at the individual level as well as at the organizational, societal, and global levels to help determine what is ethical when speaking of technology design. Users should not be stereotyped in socio-technical design methods, which must unfold within the local societal context where they are used. The need for a stronger socio-technical perspectives in technology design methods, mainly focused on individual user experience, has already been indicated in the literature (Dillon, 2000). HWID brings this wider perspective to interaction design activities and artefacts.

Technological Frames and Its Political Dimension

How we bridge the technological divide may well mean something different to the Kenyan farmers we worked with. With this in mind, we thought of TF as a '(...) framework for assessing how context and local culture shape the utility and usability of systems in situ, that is, once they are deployed to their actual contexts of use' (Abdelnour-Nocera, Dunckley and Sharp, 2007). This concept was first developed by Bijker in trying to understand the socio-technical processes that guided the interactions of groups of scientists and technologists in the invention and development of bakelite and the fluorescent lamp. TF is constituted by knowledge, assumptions, expectations, practices, workarounds and other tools shared in a community that influence how meanings are attached to technology and how it evolves within that community.

Bijker's approach has been useful in previous research that aims at understanding the political processes involved in participatory design (Sarkkinen, 2004) the implementation of intranets in complex organisational settings (Pellegrino, 2005)and the adoption of enterprise information systems by small companies (Abdelnour-Nocera et al., 2007). TF have also been used in information systems (IS) research in trying to understand how users make sense of groupware and intranet technologies as these are introduced into organizations (Orlikowski and Gash, 1994; Khoo, 2001; Lin and Silva, 2005).

The power of the TF concept lies in the dual consideration of the constructionist and semiotic processes that underpin the appropriation of systems: constructionist, since it focuses on the interpretive flexibility of technology; semiotic, since it studies how the 'scripts' inscribed in technology configure its users (Akrich, 1995)

TF have already been used in previous research to understand the political processes involved in the design and adoption of technology within organisational cultures (Lin and Silva, 2005; Pellegrino, 2005; Sarkkinen, 2004) or in organisational relations around data and technology (Azad and Faraj, 2013; Wolf, 2017). According to Bijker

(1995) this configuration occurs through the exercise of power in which two political processes take place: one referred to the 'micro-politics' of creation, transformation and negotiation of meanings attributed to technology, in which powerful groups tend to impose their own perspectives; and other referred to as 'semiotic power', in which meanings, once fixed in diverse elements of a TF by dominant stakeholders (e.g. artefacts, accepted practices, norms, etc.), in turn constrain and structure action and particular interpretations of technology. The idea of semiotic power is derived from semiotic approaches in the Sociology of Technology, which study processes of user and producer configuration (Woolgar, 1991; Akrich, 1995; Mackay *et al.*, 2000). These approaches coincide with Stuart Hall's (1999) ideas about the significance of cultural backgrounds in the encoding and decoding of media texts.

The Alibaug Fishery Case Study

Fishing provides jobs for nearly a million fishers in coastal Indian towns. In addition to the fishers, fishing also provides the livelihood for several million people in the processing and marketing of the landed fish. This makes fishing an important source of income for a sizable group of people in regions with low average incomes and high illiteracy rates. The fishing sector in India faces multiple challenges, which include catch reduction, increased cost of the catch, harsh sea conditions, quality management and also international security concerns.

Technology, especially Information and Communication Technology (ICT) like mobile phone apps, can play an important role in addressing many of these challenges. It can be used to relay information about, for example, the Potential Fishing Zone (PFZ), wind speed, and wave height to the fishers. The development of the app, called mKRISHI® Fisheries, has been a decade-long collaboration between Tata Consultancy Services (TCS), Indian Council of Agricultural Research (ICAR), Central Marine Fisheries Research Institute (ICAR-CMFRI), Indian National Center for Ocean Information Services (INCOIS), and the local fishery societies in a consortium led by the Indian Agricultural Research Institute (ICAR-IARI). Table 1 shows key events in the project. Eight years of design and development elapsed from

the project was initiated to the fishers started using the app. Since then the app has gone through multiple revisions and it has, in turn, influenced fishing practices in Alibaug.

Table 1. Project timeline

Year	Project event
2011	Idea conceptualization and first stakeholder meeting with fishers, fishing societies, data scientists, and ICT developers. Launch of the first prototype with PFZ and the Wind Speed and Direction Forecast. PFZ forecast available twice a week.
2012	Services extended to 13 fishing societies. User Interaction Review workshop with the fishers. Service modified to access the information offline (in a no or low mobile signal network range). Fishers demanded PFZ information on daily basis. Designing the pilot for the signal extension in deep sea.
2013	Mobile signal extension in deep sea. Signal extended up to 30 km in sea, across a 120 km coastal area, creating a 3600 sq. km digital highway. User Interaction Review workshop held. Services extended to 56 fishing societies. Image processing algorithm applied to reduce the size of the PFZ images to below 100KB to make it easy to download on a 2G network. Newer services like Tsunami added. Services rolled out in Ganjam in Oriya language. Service appreciated during Extremely Severe Cyclonic Storm Phailin.
2014	User Interaction Review workshop held. Wave Height information service and IMD Weather forecast added to provide a land based weather forecast along with Oceanic state forecast.
2015	User Interaction Review workshop held. Use of local

	language and colloquial terms generally used by the fishers. This reduced the "Learning curve" and dependency on external sources to "interpret the messages". Added Best Management Practices.
2016	User Interaction Review workshop held in other Indian states. A single mobile app (One App) supporting multiple languages and multiple regions (coastal states) has been developed.
2017	User Interaction Review workshop during Interact 2017.
2018	Single line local language PFZ advisory SMS for the fishers with basic mobile phone handset has been started.

The resulting app has two main features, see Figure 2. The first is the PFZ map that shows the locations at which the concentration of fish is likely to be high. The map is updated four times a day on the basis of satellite data. For example, the satellite data give the water colour, which can be used to infer the amount of plankton in the water. Plankton is a crucial food source for the fish; thus, a large amount of plankton in the water attracts a large number of fish. In combination with other information, such as the water temperature, the water colour can be used for predicting the location of fish. The second main feature of the app is weather forecasts. Like the PFZ map the weather forecasts are derived from satellite data. The weather forecasts are tailored to the fishers' needs and, thus, give the wave height, wind speed, and wind direction. This information is particularly important because the area is frequented by tropical storms during which the fishers and their boats are at considerable risk, if they are at sea. While some of the big fishing boats have equipment such as sonars for locating fish, most of the fishers rely on their traditional knowledge. For them fishing was to a large extent a trial-and-error process before the app became available. In addition, the small fishing boats have little or no safety equipment, which increases their vulnerability to bad weather conditions. The information in the

app is presented graphically, thereby reducing the need for reading skills. In addition, training sessions have been organized to explain the content and use of the app to the fishers.

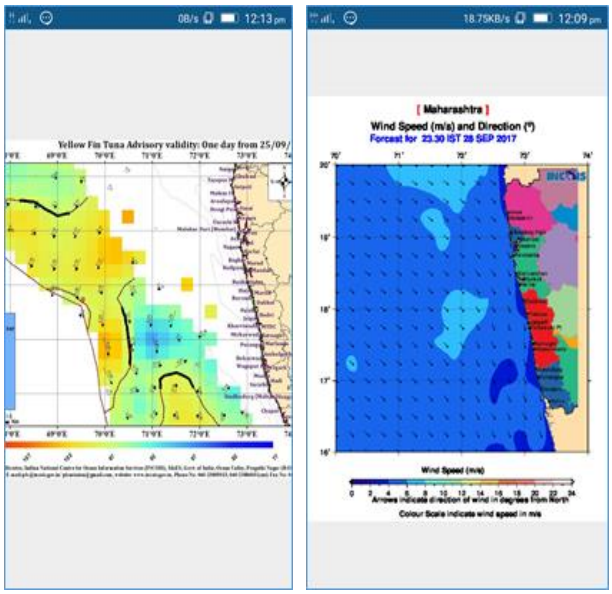

Figure 2. The two main features of the mKRISHI® Fisheries app: the PFZ map with the predicted location of fish (left) and the weather forecast (right).

On the basis of their first-hand experience with the PFZ map that marked the predicted location of fish, the fishers had a high degree of confidence in its predictions. One of the fishers explained it like this: "You can go and catch fish everywhere but the marking shows: more fish here!" Previously, this pertinent information had been unavailable, or it had merely existed as individual fishers' intuitions. Often, fishers would keep such intuitions to themselves in order not to lose a good catch to someone else. With the app, which was free of charge, this information became openly available. The only thing the fishers needed to access the information was a mobile phone with basic features; almost 90% of the fisher families had such a feature phone. The widespread adoption of feature phones among the fishers had been key to the decision to develop the app for such phones, as opposed to for example smartphones. While the predictions were not infallible, their open availability accentuated a longstanding tension between traditional and industrial fishers. The traditional fishers have small boats and are, therefore, restricted to one-day fishing trips close to the coast. The industrial fishers have big boats for multi-day

trips further away from the coast. Because the most attractive fishing locations on the map are often not reachable within one-day trips, the fish at these locations are caught by the industrial fishers. The traditional fishers feel that, as a result, fewer fish come sufficiently close to the coast to become reachable within one-day fishing trips. Without sufficient quantities of fish close to the coast the traditional fishers may not be able to sustain their livelihood. To facilitate a regulation of this tension the project includes activities other than those directly related to the development and deployment of the app. For several days a month TCS and ICAR-CMFRI have officials at the landing centers to monitor the amount of fish landed by traditional versus industrial fishers. This monitoring feeds into long-term efforts to support sustainable fishing practices and illustrates that the app is but one component in a complex socio-technical network.

While the app supports the fishers in locating fish and foreseeing the weather, it also serves to bring out tensions in this socio-technical infrastructure. On the one hand, such tensions must be addressed by the project for the app to support the traditional fishers, who are its main target group. On the other hand, the ability of the app to bring out such tensions creates opportunities for the project to identify and, hence, work with critical features of the socio-technical infrastructure. It is by seizing such opportunities that the project has continued relevantly for more than a decade.

HWID Analysis of Alibaug Case Study

The Alibaug study was the focus of a workshop at a HCI conference in India. This was a unique opportunity for local and overseas researchers and mKRISHI® Fisheries project members (including the authors of this paper) to observe and engage with technology-mediated innovative work practices in informal settings. In this context, away from the mainstream industrial sites of the global north, the workshop used the HWID approach to analyse findings related to opportunities for design research in this type of work domain. On day one, workshop participants did a field trip to visit Alibaug. On day two, the workshop participants gathered and reflected critically on the ethical and other aspects of the ICT solution and proposed add-ons and design revisions. The workshop participants and the TCS and CMFRI

representatives shared interpretations from the field trip and discussed HWID activities for ethical value exchange. Since the workshop more discussions have taken place about the status and evolution of the mKRISHI® Fisheries project in Alibaug.

An observation script based on the above presented HWID model and research objective was used to collect data and engage during the field trip and workshop. Based on these data and activities, we used the HWID framework to analyze how the app has become an entry point for the project and fishing community to evolve fishing practices in Alibaug in a sustainable manner. Table 2 shows the different phenomena and relevant relation-theories that went together to form the HWID gestalt emerging in the Alibaug case. Table 2 cites previous studies and theories to help make sense of the socio-technical relations, with a specific focus on ethical value exchange.

Table 2. HWID Analysis of Alibaug ST Infrastructure

#	Human Work	Socio-technical phenomena and relevant Relation Theories	Interaction Design
1.	Affordable and accessible app for low end android phones.	Direct Supportive relation. Designing for bottom of the pyramid users drive Alibaug fishers' work life (Subrahmanyan and Tomas Gomez-Arias, 2008; Chavan *et al.*, 2009).	Co-designed visuals and language for easy understanding by illiterate and semiliterate fishers.
2.	Go or No Go Advisory shared among fishers. They	Direct Supportive relation. Work analysis of small scale fishery	Colour coded Wind Speed Visibility Interface for easy decision

	can verify relation between physical conditions and prediction and save diesel.	construct requirements to design of interactions (Celestino *et al.*, 2012; Saldanha *et al.*, 2012).	making.
3.	Previously, this information had not been available at all or merely as intuitions held by individual fishers, who would often keep such intuitions to themselves in order not to lose a good catch to someone else.	Conflict with existing practice. Design interventions conflict with fishery work practices and vice versa (Fox, 2000; Brynjarsdóttir and Sengers, 2009).	Potential Fishing Zone (PFZ) Location service map Interface.
4.	Fishers Society as a coordinating and regulatory body, including distribution of diesel.	Indirect positive consequence (save diesel). Unintended relational consequences of design (Fulton *et al.*, 2011; Abbott and Haynie, 2012)	Wind and weather advisory information.
5.	Different fishing technologies, boat sizes and fishing gears.	Takes risks into account. Interaction design decreases risk involved in losing boat, fishing gears and nets (Singh *et al.*, 2016; Valtolina *et al.*, 2017)	Risk information needed according to type of boat.
6.	Community of elderly males lose power, as local key knowledge	Community of elders delegate decision power to app users, app can be	mKrishi® fisheries app is designed to be used by any skilled individual,

	can be de- and reclassified using the app and thus change gender, e.g., female users of the app might tag areas with fish in new ways.	used by non-males. Relational construction of interaction design and fisher(men) gender (Hinman and Matovu, 2010; Van der Velden and Mörtberg, 2012).	e.g., tagging of fishing areas can be done by any IT knowledgeable person.
7.	Small size of the app and the visual content in the app.	Direct Supportive relation. Designing for bottom of the pyramid users in the low infrastructure region (poor mobile signal network) (Subrahmanyan and Tomas Gomez-Arias, 2008; Chavan *et al.*, 2009).	Co-creation based on the input on the network speed and availability.

Because an HWID analysis is grounded in the dual epistemology of a social-relativistic paradigm (Hirschheim and Klein, 1989), both 'outwardly looking' HWID relations that made sense of existing socio-technical tensions (including political and practice ones) and 'inwardly looking' HWID relations were identified as informing socio-technical design interventions (articulating social and organizational insights for design). Inwardly looking relations of experience design to work artefacts (#1, #5, #7) and work analysis to design requirements (#2), were intertwined with outwardly looking relations of implemented design interfaces to choices of how to do the fishery work (#3, #4) and chosen changes in work practices to appropriation of interaction designs (#6).

Each of these relations in the table invite further discussion. For instance, the first (#1) inwardly relation we identified was how interaction design directly supports human work in the Alibaug case. How specific kinds of design (co-designed visuals and language for easy understanding) support the work of the 'bottom of the

pyramid users' (illiterate and semiliterate fishers) has been discussed both in practical HCI and in more general consumer research literature (Subrahmanyan and Tomas Gomez-Arias, 2008; Chavan *et al.*, 2009). Outwardly relation #3 denotes a relation of conflict between the service provided by the mobile app, granting open access information about fishing zones, and previous knowledge sharing practices among fishers. This phenomenon is identified as echoing recent research on unintended consequences of technology adoption in cultural heritage and economic structures in traditional fishing villages (Brynjarsdóttir and Sengers, 2009). Moreover, this type of tension can be framed, from an Actor Network Theory perspective (Fox, 2000), as a shift in power relations in a community of practice when its actors 'translate' new technology. While there is no space in this paper to discuss each of the relations in the analysis in detail, we hope these two examples illustrate the rationale of an socio-technical design approach. While HWID resembles other design-in-use theories e.g. (Torkilsheyggi and Hertzum, 2017), it provides not only design but broader socio-technical interventions-in-use.

TF Analysis of Alibaug Case Study

Mediated by their TF the mKRISHI team assessed their own assumptions and expectations of ICT and to define, anticipate and control problems that are likely to arise in the development of the farming support system. The main aim was to design effective find-fishing technology the common good of the fishing village. The tensions between the TF of mKRISHI team and the fishing communities were made evident in the previous HWID analysis of socio-technical relations. This evaluation of scenarios and app use indicates contrasting interpretive frames and practices of the different stakeholders in the project, but also provide an opportunity of how these could be understood and modified or mitigated. However, in retrospective we could apply a political reading to what was the process of participation in the design of the mKRISHI applications.

From a micro-political perspective, the interactions between the frames of producer and user communities of the mKRISHI app showed how the latter were configured

by the former (Woolgar, 1991). mKRISHI scientists and the IT developers and designers visited the village with a pre-defined set of methods and technologies to probe the requirements of users. While the local community participated in activities such as usability testing to evaluate user interface components and functions of the app, they were not involved in the choice of technology to be used or the high-level design decisions that were made. This means the Alibaug fishers were not involved in the process of translation of local knowledge and practices into design decisions as they were not 'domain experts'. This gave producers increased power to configure the fishers as mere "users"of the app, which led to the kind of tensions indicated above..

An instance of semiotic power can be seen in the language used by TCS and ICAR-CMFRI, which was encoded in such a way that defined the usefulness of the app for an audience of technologists and scientists rather than users in the local community. The power dynamics in the process of design participation mediated what was presented as a process of democratic choices, but that in reality posed concrete scripts that defined the type and level of interaction with the fishers. Thus, the TCS and ICAR-CMFRI team presented initial scenarios and sketches of the proposed solutions – this was a post-fact activity and therefore an attempt at transforming the TF of users and how they viewed their fishing practices in the context the new app, which could be seen as an instance of micropolitics of power. Similarly, it was seen how the design documents and testing protocols provided 'scripts' for community members to follow (Akrich, 1995): it constrained and configured the type of activities and information sharing practices that users could do with the proposed app.

Nonetheless, this configuration was not a fixed linear process that went simply from the TCS and ICAR-CMFRI team to users in the community. As Mackay et al. suggest (2000) users can reconfigure the producers of a system: as it can be seen from the HWID analysis fishers also implemented workarounds to make the app "work' for them, or mitigate the frictions caused to their previous way of finding fish and relevant stakeholder relations, e.g. having to monitor and control the amount of fish

brought by industrial and traditional fishers to the landing centre; relaying via radio fish location to boats far away from the coast once mobile phone signal was lost. These workarounds presented a form of cultural resistance and domestication of the mKRISHI solutions that not only involved material and cognitive work – in the sense of learning to use the system – but also symbolic work (Sorenson, Aune and Hatling, 2000). This symbolic work can be seen in how workarounds prompted by the introduction of actions discussed above not considered as provisional but as permanent and not part of the original socio-technical infrastructure.

Conclusions

As socio-technical frameworks, HWID and TF in this study helped create a holistic gestalt of emerging working and political relations and tensions in the Alibaug fishers' life. This study provided us with the opportunity to explore how technology design as a democratic process and as product could be adapted, through the socio-technical lens of HWID and TF, to articulate political and ethical issues of value exchange with technology projects that are aimed for the common good.

Through the context-sensitivity of the HWID framework, social issues, technological issues and their interrelations have been considered to address questions about ethical value exchange:

How can we innovate together with people 'at the margins'? The suggested socio-technical design approach visualizes power relations in the process of design in order to give people a 'say' and not only a 'voice' (Bratteteig and Wagner, 2014); the Alibaug experience shows that while you can ask for feedback and input into the design of interfaces and features, this does not guarantee a full participation by the community where they would be able to articulate the main political agendas driving their livelihoods and knowledge sharing practices. How can socio-technical design methods address the local societal context? The identified outwardly and inwardly HWID relations show how a predominant focus on the front-end use and experience of the app could overlook delicate and tacit social and cultural back-end arrangements, and what has been and can be done to address these. How to make

the design for the common good? Socio-technical design forces the necessary questions for this beyond interface design principles and provides designers with handles to address sustainability and equality, as important socio-technical dimensions (Dillon, 2000).

Explicating the TFs of the different groups engaged in the participatory design of a technological solution will enable an understanding of sense making and political processes shaping the direction of design. Focusing on the politics of socio-technical change TF offers a powerful explanatory mechanism as it involves the meanings, processes and artefacts driving stakeholder participation in technological design. From a constructionist perspective (Lin and Silva, 2005), TFs highlight the micro-political processes whereby dominant groups manage to attach meanings to a design decision or artefact of what is, for instance, appropriate or not. From a semiotic power perspective, TFs highlight how scripts embedded in artefacts such as diaries, boundary objects or probes, among others, condition differentially the engagement of different actors in participatory design with the unavoidable income of certain groups having more leverage than others in this
Despite power imbalances in technology design, the study of TF recognizes that the less powerful stakeholders are not always configured but also have opportunities to configure directly or indirectly either other actors or the usefulness of the solutions being designed, even if this is in the form of workarounds.

All in all, this case study illustrates that designing for the common good is not only a matter of extraction and equal distribution of resources but also of ethical and political importance to avoid destabilizing existing traditions and tacit agreements. I also showed with this experience how traditional forms of democracy *a la Western*, *e.g.* deliberative democracy, do not always fit or can be implemented in local different cultural and political realities as in the case of Alibaug. Being aware of these issues is an ethical obligation for technology designers and those setting policy around these activities.

References

Abbott, J.K. and Haynie, A.C. (2012) 'What are we protecting? Fisher behavior and the unintended consequences of spatial closures as a fishery management tool', *Ecological Applications*, 22(3), pp. 762–777.

Abdelnour Nocera, J. *et al.* (2021) 'Geopolitical Issues in Human Computer Interaction', in *IFIP Conference on Human-Computer Interaction*. Springer, pp. 536–541.

Abdelnour-Nocera, J. *et al.* (2017) 'Socio-technical HCI for Ethical Value Exchange: A Case of Service Design and Innovation "at the Margins" in Resource Constrained Environments', in *The 16th IFIP TC13 International Conference on Human–Computer Interaction*. Springer, pp. 254–262.

Abdelnour-Nocera, J. *et al.* (2019) 'Socio-Technical HCI for Ethical Value Exchange: Lessons from India', in *International Conference on Social Implications of Computers in Developing Countries*. Springer, Cham, pp. 229–240.

Abdelnour-Nocera, J., Dunckley, L. and Sharp, H. (2007) 'An approach to the evaluation of usefulness as a social construct using technological frames', *International Journal of Human-Computer Interaction*, 22(1–2), pp. 153–172.

Akrich, M. (1995) 'User representations: Practices, Methods and Sociology', in *Managing technology in society: The approach of constructive technology assessment*. London: Pinter Publishers, pp. 167–184.

Annett, J. and Duncan, K.D. (1967) 'Task analysis and training design.'

Archibugi, D., Koenig-Archibugi, M. and Marchetti, R. (2011) 'Introduction: Mapping global democracy'.

Azad, B. and Faraj, S. (2013) 'Using signature matrix to analyze conflicting frames during the IS implementation process', *Methodologies in AIS Research*, 14(2), pp. 120–126. doi:10.1016/j.accinf.2011.06.003.

Bannon, L. (1991) *From Human Factors to Human Actors. Book Chapter in Greenbaum, J. & Kyng, M.(Eds.) Design at Work: Cooperative Design of Computer Systems (pp. 25-44)*. Hillsdale: Lawrence Erlbaum Associates.

Bannon, L. and Bodker, S. (1991) 'Beyond the interface: Encountering Artifacts.', in *Designing interaction: Psychology at the Human-Computer Interface*. Cambridge: Cambridge University Press, pp. 227–253.

Bijker, W.E. (1995) *Of bicycles, bakelites, and bulbs : toward a theory of sociotechnical change*. Cambridge, MA: MIT Press.

Bjørn-Andersen, N. and Clemmensen, T. (2017) 'The Shaping of the Scandinavian Socio-technical IS Research Tradition', *Scandinavian Journal of Information Systems*, 29(1), pp. 79–118.

Bødker, S. *et al.* (2000) 'Co-operative Design—perspectives on 20 years with "the Scandinavian IT Design Model"', in *proceedings of NordiCHI*, pp. 22–24.

Bratteteig, T. and Wagner, I. (2014) *Disentangling participation: power and decision-making in participatory design*. Springer.

Brynjarsdóttir, H. and Sengers, P. (2009) 'Ubicomp from the edge of the north atlantic: Lessons from fishing villages in iceland and newfoundland', in *Ubicomp'09 workshop*. Citeseer.

Button, G. and Sharrock, W. (2009) 'Studies of Work and the Workplace in HCI: Concepts and Techniques', *Synthesis Lectures on Human-Centered Informatics*, 2(1), pp. 1–96.

Cabrero, A.-N.J., Daniel G.,. Winschiers-Theophilus, Heike (2016) 'Re-Conceptualising Personas across Cultures: Stereotypes, Archetypes and Collective Personas in Pastoral Namibia', in *10th Culture, Technology, Communication International Conference (CaTaC'16), London, United Kingdom*.

Celestino, J.E.M. *et al.* (2012) 'Ergonomics and environmental sustainability: a case study of raft fisherman activity at Ponta Negra Beach, Natal-RN', *Work*, 41(Supplement 1), pp. 648–655.

Chavan, A.L. *et al.* (2009) 'How mobile money can drive financial inclusion for women at the Bottom of the Pyramid (BOP) in Indian urban centers', in *International Conference on Internationalization, Design and Global Development*. Springer, pp. 475–484.

Cherns, A.B. (1976) 'The Principles of Socio-Technical Design', *Human Relations*, 29, pp. 783–792.

Clemmensen, T. (2011) 'A Human Work Interaction Design (HWID) Case Study in E-Government and Public Information Systems', *International Journal of Public Information Systems*, 2011(3), pp. 105–113.

Clemmensen, T., Orngreen, R. and Pejtersen, A.M. (2005) 'Describing Users in Contexts: Perspectives on Human-Work Interaction Design', in *Workshop Proceedings of Interact*. Citeseer.

Cooper, A., Reimann, R. and Cronin, D. (2007) *About face 3: the essentials of interaction design*. John Wiley & Sons.

Dearden, A. and Rizvi, H. (2008) 'Participatory IT Design and Participatory Development: A Comparative Review', in *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008*. Indianapolis, IN, USA: Indiana University (PDC '08), pp. 81–91. Available at: http://dl.acm.org/citation.cfm?id=1795234.1795246.

Dillon, A. (2000) 'Group Dynamics Meet Cognition: applying socio-technical concepts in the design of information systems', in *The New SocioTech: Graffiti on the Long Wall*. London: Springer Verlag, pp. 119–125.

Fox, S. (2000) 'Communities Of Practice, Foucault And Actor-Network Therory', *Journal of management studies*, 37(6), pp. 853–868.

Fulton, E.A. *et al.* (2011) 'Human behaviour: the key source of uncertainty in fisheries management', *Fish and fisheries*, 12(1), pp. 2–17.

Gardien, P. *et al.* (2014) 'Changing your hammer: The implications of paradigmatic innovation for design practice', *International Journal of Design*, 8(2).

Hall, S. (1999) 'Encoding, Decoding', in *The Cultural Studies Reader*. London: Routledge, pp. 507–517.

Hertzum, M. *et al.* (2018) 'A mobile app for supporting sustainable fishing practices in Alibaug', *Interactions*, 25(3), pp. 40–45.

Hinman, R. and Matovu, J. (2010) 'Opportunities and challenges for mobile-based financial services in rural Uganda', in *CHI'10 Extended Abstracts on Human Factors in Computing Systems*. ACM, pp. 3925–3930.

Hirschheim, R. and Klein, H.K. (1989) ‘Four paradigms of information systems development’, *Communications of the ACM*, 32(10), pp. 1199–1216.

Khoo, M. (2001) ‘Community design of DLESE’s collections review policy: a technological frames analysis’, in *Proceedings of the 1st ACM/IEEE-CS joint conference on Digital libraries*. Roanoke, Virginia, United States: ACM Press, pp. 157–164.

Lin, A. and Silva, L. (2005) ‘The social and political construction of technological frames’, *European Journal of Information Systems*, 14(1), pp. 49–59.

Mackay, H. *et al.* (2000) ‘Reconfiguring the user: using Rapid Application Development’, *Social Studies of Science*, 30(5), pp. 737–757.

Mumford, E. (1996) *Systems Design: ethical tools for ethical change*. Macmillan.

Mumford, E. and Weir, M. (1979) ‘Computer systems in work design: The ETHICS method’, *NY: John Wiley* [Preprint].

Nelimarkka, M. (2019) ‘A Review of Research on Participation in Democratic Decision-Making Presented at SIGCHI Conferences. Toward an Improved Trading Zone Between Political Science and HCI’, *Proceedings of the ACM on Human-Computer Interaction*, 3(CSCW), pp. 1–29.

Oh, Y., Do, E.Y.-L. and Gross, M.D. (2004) ‘Intelligent critiquing of design sketches’, *Making Pen-Based Interaction Intelligent and Natural (Ed, Randall Davis, JL, Stahovich, T, Miller, R, and Saund, E), AAAI Press, Arlington, Virginia*, pp. 127–133.

Orlikowski, W. and Gash, D.C. (1994) ‘Technological Frames: Making Sense of Information Technology in Organisations’, *ACM Transactions on Information Systems*, 12(2), pp. 174–207.

Pellegrino, G. (2005) ‘Thickening the Frame: Cross-Theoretical Accounts of Contexts Inside and Around Technology’, *Bulletin of Science Technology Society*, 25(1), pp. 63–72.

Puri, S.K. *et al.* (2004) ‘Contextuality of participation in IS design: a developing country perspective’, in *Proceedings of the eighth conference on Participatory design*. ACM Press, pp. 42–52. doi:10.1145/1011870.1011876.

Rasmussen, J., Pejtersen, A.M. and Goodstein, L.P. (1994) *Cognitive systems engineering*. Wiley.

Rogers, Y., Sharp, H. and Preece, J. (2011) *Interaction design: beyond human-computer interaction*. 3rd ed. Chichester, West Sussex, U.K: Wiley.

Saldanha, M.C.W. *et al.* (2012) ‘The construction of ergonomic demands: application on artisan fishing using jangada fishing rafts in the beach of Ponta Negra’, *Work*, 41(Supplement 1), pp. 628–635.

Salmon, P. *et al.* (2010) ‘Hierarchical task analysis vs. cognitive work analysis: comparison of theory, methodology and contribution to system design’, *Theoretical Issues in Ergonomics Science*, 11(6), pp. 504–531.

Sarkkinen, J. (2004) ‘Examining a Planning Discourse: How a Manager Represents Issues within a Planning Frame and How the Other Could Do the Same.’, in *Participatory Design Conference*. Toronto, Canada: ACM.

Singh, D. *et al.* (2016) ‘Visual Design for Blue Ocean Services: mKRISHI® Fisheries’, in *Proceedings of the 8th Indian Conference on Human Computer Interaction*. ACM, pp. 96–101.

Sorenson, K.H., Aune, M. and Hatling, M. (2000) ‘Against linearity: On the cultural appropriation of science and technology’, in *Between Understanding and Trust*.

Subrahmanyan, S. and Tomas Gomez-Arias, J. (2008) 'Integrated approach to understanding consumer behavior at bottom of pyramid', *Journal of Consumer Marketing*, 25(7), pp. 402–412.

Suchman, L. (1987) *Plans and Situated Actions.* Cambridge: Cambridge University Press.

Torkilsheyggi, A.M. á and Hertzum, M. (2017) 'Incomplete by design: A study of a design-in-use approach to systems implementation', *Scandinavian Journal of Information Systems*, 29(2), pp. 35–60.

Valtolina, S. *et al.* (2017) 'Socio-technical Design of an App for Migrants Rescue Operations', in *IFIP Conference on Human-Computer Interaction*. Springer, pp. 140–147.

Van der Velden, M. and Mörtberg, C. (2012) 'Between need and desire: Exploring strategies for gendering design', *Science, Technology, & Human Values*, 37(6), pp. 663–683.

Winograd, T. and Flores, F. (1986) *Understanding Computers and Cognition*. New Jersey: Ablex Publishing.

Winschiers-Theophilus, H. *et al.* (2010) 'Being Participated: A Community Approach', in *Proceedings of the 11th Biennial Participatory Design Conference*. New York, NY, USA: ACM (PDC '10), pp. 1–10. doi:10.1145/1900441.1900443.

Wolf, C.T. (2017) *Narrative Assembly: Technological Framing, Storytelling, and the Situating of "Data Analytics" in Organizational Life*. PhD Thesis. UC Irvine.

Woolgar, S. (1991) 'Configuring the user: The case of usability trials', in *A Sociology of monsters: essays on Power, Technology and Domination*. London: Routledge, pp. 58–100.