Socio-Technical HCI for Ethical Value Exchange:

Lessons from India

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Abstract. Ethical value exchange is moving to the forefront of the global challenges that HCI will have to address in the coming years. We argue that applying a context-sensitive, socio-technical approach to HCI can help meet this challenge. 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. Three questions are of concern when innovating together with people 'at the margins': how can we describe users without stereotyping badly, what socio-technical HCI methods fit the local context, and how to make the design sustainable in the face of current planetary challenges (e.g., climate change)? We discuss a socio-technical HCI approach called human work interaction design (HWID) to meet the challenges of designing for ethical value exchange where value extraction is not dominated by one party but equally shared across all stakeholders. We introduce an ongoing case of a digital service to support fishers in Alibaug, India. As a multidisciplinary team of researchers we evaluate the socio-technical infrastructure surrounding a mobile app to support sustainable fishing. This is done through the lens of HWID by highlighting inwardly and outwardly socio-technical relations between human work and interaction design. We conclude by highlighting the value of a context sensitive, ethical socio-technical framework for HCI.

Keywords: socio-technical, human work interaction design, ethical value exchange.

1 Introduction

Ethics is moving to the forefront of Human-Computer Interaction (HCI) in these years, adding a new dimension to the current user experience and web 2.0 platform designs [1]. 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 [2]. 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 [3].

There is therefore a need to revisit HCI analysis and design methods with the aim to co-create alternative patterns of innovation that include the marginalized. 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 (ST), context-sensitive approach to HCI [1]. This paper illustrates with a concrete case study premises proposed in a previous publication [4].

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] HCI (ST HCI) design approach, exemplified with the Human Work Interaction Design (HWID) model [5], researchers and designers can visualize and do something about these critical gaps, and more generally, contribute to an HCI of 'ethical value exchange' [1] where value extraction is not dominated by one party but equally shared across all stakeholders. The larger questions that we want to contribute to answer by analysing this case on sustainable fishing in India [6] are how we can innovate together with people 'at the margins', how ST HCI 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 have to 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

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[1] In this paper we use the term socio-technical in a broad sense to cover various traditions thinking social and technical changes together, including the more recent term sociomaterial.

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 ST infrastructure of which this app is part. We develop these arguments through theoretical reflections on ST HCI, present HWID as an instance of ST HCI and then apply HWID to analyse different relations of the ST infrastructure found in Alibaug. We conclude the paper by demonstrating the value of ST HCI for sustainable and ethical design.

2 Socio-Technical Human Computer Interaction

The usability concept, method and professional practice 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 [7] would refer to as the second wave in HCI, the shift from 'human factors to human actors'[8]. This shift triggered an increasing focus away from individual cognitive theories of human action into social theories such as ethnomethodology [e.g., 9] and hermeneutics [e.g., 10], where context, meaning and collective action were central. However, none of these theories provided a distinct focus on users' work in the way of ST systems theory as articulated by Mumford in her ETHICS approach [e.g., 11, 12]. 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. ST approaches' emphasise user involvement and decision making in organisational work contexts, but no clear handles have been provided by authors like Mumford and Weir [12] or Cherns [13] to interactive system designers trying to make their systems more useful and satisfying from a user experience perspective. Dillon [14] defines this gap very well by pointing out that 'Criteria for effectiveness, efficiency and satisfaction must be derived from the social not the individual context of use' and calls for ST approaches to be operationalised at the level where user interactions are designed.

ST focuses on the design of IT but insists that the social should be taken into account in various ways. First, the social should be taken into account at the interface level (HCI, UX, interface). Second, ST 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 and ethical matters (access to IT, unemployment, privacy, wealth distribution) [15]. An updated ST HCI approach for the study of workers' interactions should reflect that any interaction is embedded in a larger context [1]. We use the HWID framework [5] as an emerging ST HCI 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 [16]. It aims to be an updated ST framework for HCI, with a narrow focus on the relations between human work analysis and interaction design.

3   Human Work Interaction Design

HWID emerged around 2005 [17]. It is a framework sitting in a social-relativistic paradigm [18]and can thus contribute to the design of systems supporting work satisfaction and organisational ST HCI design goals. HWID leans heavily on the HCI and human factors traditions' specific interpretation of the *social* and the *technical* elements of the ST 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 [19] and Work Domain Analysis [20] 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 in HCI for studying work with ethnographic methods [21] and from ST perspectives, [e.g. 22]. 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 [23, 24] . 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 [25]. 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 [17].

The value propositions of HWID for ethical value exchange are inspired by Gardien [1]. 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 HCI. Users should not be stereotyped in ST HCI methods, which must unfold within the local societal context where they are used. The need for a stronger socio-technical perspective in HCI methods, mainly focused on individual user experience, has already been indicated in the literature [14]. HWID brings this wider perspective to interaction design activities and artefacts.

4 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.
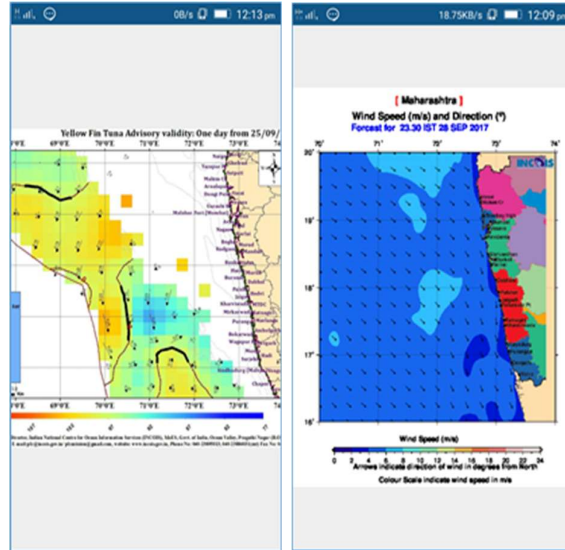
Figure 2. The two main features of the mKRISHI® Fisheries app: the PFZ map with the predicted location of fish (left) and the weather forecast (right).

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 ST network.

While the app supports the fishers in locating fish and foreseeing the weather, it also serves to bring out tensions in this ST infrastructure. On the one hand, such tensions must be addressed by the project in order 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 ST infrastructure. It is by seizing such opportunities that the project has continued relevantly for more than a decade.

5   HWID Analysis and Discussion

The Alibaug study was the focus of a workshop at a major 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 ST-HCI relations, with a specific focus on ethical value exchange.

Table 2. HWID Analysis of Alibaug ST Infrastructure

#	Human Work	ST-HCI 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 [26, 27].	Co-designed visuals and language for easy understanding by illiterate and semiliterate fishers.
2.	Go or No Go Advisory shared among fishers. They can verify relation between physical conditions and prediction and save diesel.	Direct Supportive relation. Work analysis of small scale fishery construct requirements to design of interactions [28, 29].	Colour coded Wind Speed Visibility Interface for easy decision 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 [30, 31].	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 [32, 33]	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 [34, 35]	Risk information needed according to type of boat.
6.	Community of elderly males lose power, as local key knowledge 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.	Community of elders delegate decision power to app users, app can be used by non-males. Relational construction of interaction design and fisher(men) gender [36, 37].	mKrishi® fisheries app is designed to be used by any skilled individual, 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) [26, 27].	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 [18], we identified both 'outwardly looking' HWID relations that made sense of existing ST tensions (including political and practice ones) and 'inwardly looking' HWID relations that informed ST HCI 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 [26, 27]. 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 [30]. Moreover, this type of tension can be framed, from an Actor Network Theory perspective [31], 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 ST HCI approach. While HWID resembles other design-in-use theories e.g. [38], it provides not only design but broader ST HCI interventions-in-use.

6   Conclusions

As a conceptual framework, HWID in this study helped us create a holistic gestalt of emerging computer-human relations in the Alibaug fishermen's' life. This study provided us with the opportunity to explore how technology design as process and as product could be adapted, through the ST lens of HWID, to articulate ethical issues of value exchange. Through the context-sensitivity of the HWID framework, social issues, technological issues and their interrelations have been considered to address our three questions about ethical value exchange:

How can we innovate together with people 'at the margins'? Our suggested ST HCI approach visualizes power relations in the process of design in order to give people a 'say' and not only a 'voice'[39]; 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 agendas driving their livelihoods and knowledge sharing practices. How can ST HCI methods address the local societal context? We have demonstrated through outwardly and inwardly looking HWID relations 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 sustainable? ST HCI forces the necessary questions for this beyond interface design principles and provides designers with handles to address sustainability, as an important ST dimension [14]. Thereby, this case study illustrates that sustainability is not only a matter of resource extraction but also of avoiding to destabilize existing traditions and tacit agreements.

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