Seeing in Context: Traditional Visual Communication Practices in Rural Bangladesh

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There is a risk that modern practices of information communication and visualization in human-computer interaction can sideline communities due to their prioritization of scientific rationality. Such ideological hegemony can complicate interactions with data and computers, especially for low-literate communities in the global south. Through a six-month long ethnographic study with *Nakshi-Katha* makers, Hindu Idol makers, and witchcraft practitioners, we investigated how rural practitioners use their own forms of representation and narrative in record keeping, social and religious storytelling, and information mediated decision making. We find that traditionally developed approaches towards presenting and communicating information often make use of concrete units to represent entities and connect to designers' cultural practices and the physical location. Further, we identify how medium has significant influence in meaning-making. Often these strategies and conventions are passed down through generations within the community. In this paper, we discuss how this rural tradition differs from the modern information communication practices, discussing how an understanding of traditional practices for representing information can be useful in developing more accessible, and culturally appropriate modern tools and technologies for the people of rural Bangladesh and similar communities.

CCS Concepts: • **Human-centered computing** → *Empirical studies in HCI*; *Visualization theory, concepts and paradigms.*

Additional Key Words and Phrases: Alternative Rationality; Rurality; Witchcraft; Idol Making; Nakshi-Katha; Traditional Visual Symbols, Arts and Crafts; Bangladesh

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1 INTRODUCTION

Individuals across the world produce an immense amount of data [58]. In order to help make sense of this tide, computer-supported cooperative work (CSCW), human-computer interaction (HCI), and information visualization researchers employ different graphic marks and visual presentations to make data and statistics accessible. Information communication and visualization systems are currently being developed for the global south to visualize financial, agricultural, and health-related information [11, 28, 48, 70, 73], with the potential to reach billions of individuals. However, such systems risk encoding modern scientific assumptions that do not work in a traditional culture.

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These assumptions often emerge from *scientific rationality*, serving the *universalist* mode of science generated from western colonization as a hegemonic ideology [56]. This ideological hegemony can easily sacrifice the broader social, cultural, and emotional values of human life in the world in favor of *rational* representations. As a result, these technologies may not be as accessible and useful for many of the people in global south as they could otherwise be if designed to account for this imbalance. [49, 50, 96].

To understand the challenges for individuals engaging with information, researchers often observe current practices or observe how individuals use present systems. For example, a growing body of work has investigated how novices interpret data visualizations [60] by developing methodologies to understand their meaning-making practices in a controlled environment. New interaction modalities such as natural language querying [95] and feedback [94] deliver potentially more accessible data tools. Narrative [69] and pictorial [107] visualizations help to make more engaging and effective presentations for a variety of audiences. However, assumptions emerging from the aforementioned ideological hegemony built on such universal scientific rationality remain encoded in much of ongoing research, potentially limiting their reach despite developing efforts in the community to broaden access to data tools [59]. Presuppositions about how iconic, abstract, or aggregate representations will be interpreted; in what manner the cause and the effect from narratives will be inferred; and how individuals' domain expertise will be integrated all may not be universally applicable

We extend this body of work and address these concerns in the context of rural Bangladeshi low-literate and low-income populations by taking a step back. Instead of creating novel systems and techniques and conducting usability tests with the users or engaging in a user-centered design process, we engaged with three types of practitioner communities in rural Jessore in Bangladesh who produce and interact with different types of information through their work: traditional Hindu idol makers, professional *'Nakshi-Katha'* (traditional handmade and hand-stitched quilt) designers and embroiderer communities, and local witchcraft practitioners in 10 villages in rural Jessore. In our six-month long ethnographic study, we investigated the techniques they employed in communicating information, telling stories, and keeping records. Over the course of this fieldwork, we asked three research questions:

> *RQ1:* How do rural Bangladeshi people encode information, analyse, and keep records?
> *RQ2:* How does the grammar of these representations connect to their cultural practices, religions, and local myths?
> *RQ3:* What differences emerge between rural traditional practices and modern scientific practices in industry and the research community?

Our findings show that practitioners in rural Bangladesh apply concrete representations, use a variety of media, and draw on their cultural practices in working withn information. Our investigation identifies how the physical location of designers and communities also shapes visualizations. We found that these communities reference objects available in their day-to-day life and appropriate them through re-occurrences, varied colors, and varied sizes to order and intensify information. Often the practices and their associated grammar are passed down through generations.

Our work contributes to computer supported cooperative work, social computing, information and communication technologies and development (ICTD), and information visualization. First, we present a thorough ethnographic description of information storage and communication practices associated with three local traditions in rural Bangladesh: *Nakshi-Katha* making, Hindu Idol making, and witchcraft. Second, building on these traditional practices, we present practices and a visual grammar that the local people have developed and passed down through the generations. We discuss how these information practices align and clash with mainstream grammar of modern scientific

information practices. Finally, we stretch this discussion towards developing more accessible, and culturally appropriate tools and technologies, making information more accessible and usable for the people of rural Bangladesh and similar communities by integrating traditional values.

2 BACKGROUND AND RELATED WORK

At it's core, our work considers practices of storing, communicating, and making sense of information. These elements have long been a focus for information visualization research (and an area of interest for CSCW and HCI research). Scholars have defined information visualization in a number of ways. Among them, Matthew O. Ward, Georges Grinstein, and Daniel Keim define it as: *"...the process of representing data, information, and knowledge in a visual form to support the tasks of exploration, confirmation, presentation, and understanding"* [104]. For this project, we aim to define information visualization as a broad socio-technical practice that communicates (mostly quantitative) data in through a graphical representation. This broad generalization captures a wide range of contemporary practices of communicating data from using visual metaphors, including graphs, charts, and clouds, to more interactive forms of information exploration including zooming, rotating, feeling, and dismantling. By scoping more broadly, we hope to better capture liminal practices that may not fall under the guise of formal information visualization but have relevance to the design of information systems. Recently the research community has focused on how to apply information visualization techniques with young students in academic spaces and investigated how learners and educators interact with educational data tools [35, 37]. While not directly connected to visualization practice in the global south, these investigations consider broader populations of data users and the implications of designing tools which support their needs. Along these lines, continuing work has investigated how mobile devices can assist in teaching data visualization to elementary school students [7]. A number of researchers have explored the ways that information visualization can be used to study individuals' cognitive capabilities [78]; motivation, attraction effect, and affective priming [26, 34, 40]; deception and bias [55]; and group dynamics and collaboration [90]. However, the group of low-resource, non-expert, and low-literate users in global south and their disadvantaged access to modern visualization techniques still remain an under-attended topic in modern information communication and visualization literature.

2.1 Art, Symbols, and Information

While arts and crafts are a distinct practice from information visualization, information visualization is often informed by them. Early communication of information was rooted in the arts and crafts that individuals used in their everyday lives. One of the earliest artworks found in *Chauvet Cave* near Ardeche river, in France [63] from 30,000 B.C.E. potentially depicts figural forms as well as images of at least eleven animals. Some theorize that non-figurative forms in the paintings catalogue a volcano eruption in that area [77, 79], using both abstract and concrete representations as a record of events. Over time, representations became more sophisticated with the expansion of technology and commerce, branching out to include qualitative and quantitative record-keeping. For instance, a vast assortment of Mesopotamian society record tablets and trade tokens remain in the material record [89]. It is hypothesized that the Inca civilization practiced data keeping through encoded woven record [10], providing further evidence of the link between art, craft, and data.

Over time, information visualization practices were refined and conventionalized by civilizations. Tables were used to catalogue astronomical information to aide in navigation [30]. Early astronomers used graphical charts to map the movement of stellar objects to attempt to model orbits [32, 33, 84]. Moving forward in time, much of modern visualization conventions in the West were established in the 18th and 19th century in concert with other technologies following the age of exploration (including cartography, mathematics, and statistics) [31]. Individuals such as William Playfair

created information visualization metaphors such as pie charts which remain prevalent today [82, 83]. As a result of this early standardization before the advent of digital systems, these same conventions have continued forward into the design of modern digital information technology. Hence, while today's information visualization systems offer affordances to explore and interact with a huge amount of data, they still embody many basic rules of communication and aesthetics which are rooted in their historical origin in an Western scientific environment. Consequently, those visualization techniques risk inaccessibility for many who belong to a different culture. Thus, while established as a distinct practice on its own, information visualization-and visual communication more generally-nonetheless emerges from a specific cultural and scientific lineage which may not be globally applicable [30].

2.2 Visualization (Il)literacy, Information Poverty, and Global South

The capability of understanding information visualization is often termed *visualization literacy*. Boy et al. define this capability as "the ability to use well established data visualization (e.g., line graphs) to handle information in an effective, efficient, and confident manner" [13, pg.1963]. Borner advanced this definition and added the capability of correlating the graphics with data to the list of criteria, as he defines visualization literacy this way: "the ability to make meaning from and to interpret patterns, trends, and correlations in visual representations of data" [12, pg.3]. Lee et al. have defined visualization literacy as the ability and skill to read and interpret visually represented data in and to extract information from data visualizations [62]. To them, visualization literacy consists the capability of a person "to read, comprehend, and interpret" graphs.

A rich body of research has focused on addressing this issue of not understanding graphs and reported that users' unfamiliarity with foreign terms used in the visualizations [29], graphical representations lacking sufficient annotation [61] and users' inadequate training with the tools and technique [68] might lead to possible failure in this regard. Peck et al. found that people often relate visualizations to political affiliation and personal experience [81]. Hakone et al. reported that such challenging interactions influenced the older patients at the hospital to choose comparatively less effective visualizations while receiving treatment [38]. As a possible solution to these set of problems, Elias et al. suggested integrating local language support in visual representations [29]. Building on the findings from their recent study with rural Pennsylvanians, Peck et al. argued that the perception of visualization is personal and better interests people if they can connect the agenda to themselves [81].

While all of the aforementioned well-established definitions of visualization literacy are emphasizing users' understanding of graphs, the capability of understanding and using information associated with the visualization in the first place is equally important. Thus, *visualization (il)literacy* is associated with another form of (in)capability, namely *information poverty* [106]. Information scientists have related this disadvantage to the users' ethnicity, age [22], literacy [3, 6], cognitive (dis)ability [71, 85], gender [1, 2, 42, 43, 75], profession [4, 52, 86], and marital status [16–21, 45, 74] for decades. Later, at the beginning of this century, information scientist Alfred Kagan added citizens of developing countries, residents or rural areas, the culturally and socially marginalised, and ethnic and religious minorities to this *information poor* group [53]. This group of people is disadvantaged in this digital world not only because they might lack sufficient data that relate to their life, but also because they encounter data and technologies that are not their own. Recently, information scientist Liangzhi Yu has defined *information illiterates* as the group of people who are disadvantaged by their lacking access to information and often do not know how to use and interact with such information [106]. Yu further explained that even if people manage to sensitize themselves to the attributes of graphic forms and objects, they might still fail to interact with visualization techniques due to their information poverty. Recent studies in HCI4D and ICTD

also highlight that, while the struggle of such 'othered' users is partly constituted by their lack of mastery over operating with large numbers and complicated modern mathematics, it is also shaped by differences in graphic 'language' [39], rationales [98], and motivations [100].

The challenge of visualization accessibility is often attributed to users' cognitive limitations and lack of training [54, 61, 68, 103]. However, a group of scholars have resisted this notion by highlighting the cultural differences in the practices around information visualization. For example, Luria and Vigostky have said that most people all over the world possess similar level of intelligence, however, many of their mental processes are usually originated from the socio-historic facts of the culture within which they grow up [65, 87, 102]. Thus, in their study, when people who were less familiar with geometric shapes were asked to perform abstraction, categorization, and sorting on them, there was always some action performed by the people regardless of the fact that they followed researchers' reasoning, causation, and rationale. Such studies and opinions help us understand that people in the global south who have limited access to modern information and scientific visualization tools could be holding some other propositional language influenced by a different set of rationality, aesthetics, and causality. Motivated by this understanding, we investigate the the forms, symbols, and grammar of visualization used in three traditional practices in rural Bangladesh so that we can design more culturally appropriate and accessible information tools.

3 METHODS

This paper draws on a six-month-long ethnographic study in ten villages in the district of Jessore, Bangladesh, with sites in Kandarpur, Satighata, Shyamnagar, Vaina, Kazipur, Ramnagar, Nilgonj, Bejpara, and Mandartola. Over the course of our fieldwork, we engaged with villagers and studied *Nakshi-Katha* makers, Hindu-idol makers, and Witchcraft practitioner communities through participants observations, semi-structured interviews, and focus groups. This section briefly discusses the methods and relevant details of the study.

3.1 Access to the participants

Our access to participants in the villages was facilitated by the Rural Reconstruction Foundation (RRF), a non-profit global development organization that offers microfinance, education, health, and agricultural programs [88]. Their officials introduced us to front-line microcredit workers who make weekly visits to rural clients' homes. These workers helped the first author reach participants by taking her to villages where they work. After arriving in the village, the first author held a public community meeting with the microcredit clients and explained the purpose of the research study. After answering any questions and concerns the clients had, the first author recruited participants from the meetings based on their availability. Further recruitment was performed through snowball sampling.

The author who conducted the fieldwork is a native Bengali speaker and has a long term (20 years) familiarity with the neighborhood. She was born and raised in Jessore and has lived in various parts of the district. This positionality helped her access the population and build rapport with participants. All interactions with participants were conducted in Bengali, the local language, which all the participants and the ethnographer speak fluently. We obtained oral consent from the participants, since many villagers were low-literate and would have trouble reading and understanding a written informed consent form.

3.2 Observation

We started our study by observing our participants to understand their profession and their lifestyle. We observed their daily work, hangouts, regular meetings with friends, and fun activities to understand how they develop and interact with information alone, in groups, and in their

Total Number of Participants:	103 (Female: 68, Male: 35, NB: 0)
Type of Participation	
Interview only:	18 (Female: 18, Male: 0)
FGD only:	55 (Female: 34, Male: 21)
Interview + FGD:	30 (Female: 16, Male: 14)
Age range (in Years)	
All:	19-60, median 38
Female:	19-60, median 30
Male:	19-56, median 38
Family Income Range (per month, in BDT)	
All:	5,000-50,000, median 10,000
Female:	8,000-20,000, median 9,400
Male:	5,000-50,000, median 8,500
Education	
No Formal Schooling:	34 (Female: 26, Male: 8)
Primary School:	21 (Female: 15, Male: 6)
Secondary School Certificate:	21 (Female: 14, Male: 7)
Higher Secondary School Certificate:	18 (Female: 10, Male: 8)
Undergraduate College and Above:	9 (Female: 3, Male: 6)

Table 1. Demographic characteristics of the interview and focus group discussion participants

professional settings. The mode of observation was participatory. We took part in each of these activities with the participants with their permission, observed their actions and responses, and recorded them in our notes. We also asked questions to the participants and requested an explanation about their activities if they were confusing or requires domain expertise. We conducted hundreds of hours of observation sessions with more than 220 people in the ten villages (8 hours a day for two months).

3.3 Focus Group Discussion

We also conducted fifteen focus group discussions with 85 participants in the villages. Each group consisted of four to eight participants. The participants of focus group were identified through snowball sampling with the help of RRF microcredit fieldworkers. The topics included their daily lives; the forms of social, religious, and economic information and visualizations with which they interact; and the challenges they face while interacting. We further investigated how different information and representations are associated with their professional life and shape their daily lives. The discussion sessions were semi-structured – the researcher led the discussion and asked related questions to engage the participants, clarified their responses, and went deeper into the topic. The questions asked by the ethnographer during sessions spurred further discussions on related topics. The sessions were generally thirty-five to forty-five minutes long. We took detailed notes and audio-recorded most of the discussions if the participants permitted.

3.4 One-on-one Interviews

We conducted one-on-one interviews with 48 participants. Each interview lasted approximately thirty minutes and was conducted wherever it was convenient for the participant, often in their homes. Participants were sought based on rapport with the ethnographer in earlier sessions and further through a snowball sampling. We asked them about their usual interaction with mundane

quantitative information including money, time, days in a month, age, etc. along with the social, religious, and spiritual information they often encounter. We also asked them about the mechanisms they use to manage and keep records of such information. Interviews were again semi-structured, so we asked further related questions to understand the participant's responses and go deeper into topics. Each interview lasted around 30-40 minutes. We took detailed notes of all the interviews and audio-recorded 22 of them (an average of 25 mins) with participant permission.

3.5 Data Collection and Analysis

We collected approximately 12.5 hours of audio recordings and 230 pages of field notes which were transcribed and translated into English. We then performed thematic analysis on our transcription [14], starting by reading through the transcripts carefully, allowing codes to develop. Seventy-eight codes spontaneously developed initially. After a few iterations, we clustered related codes into themes, for example, motifs, stitching style, memory, religion, homage, spirituality, etc. We present our major findings in the following section.

3.6 Ethical Concerns and Approval

During the fieldwork, we studied traditional qualitative and quantitative data use, management, communication, and the application of visualization in it. Many of their practices in this regard, especially social and spiritual practices, were not based on scientific rationality. Rather, they relied on some alternative rationale. However, we made sure we do not impose or demean their values and refrained ourselves from pushing our judgement to them. We did not perform any intervention to respect the existing cultural values of the villagers.

Part of our investigation also included villagers' use of visuals in healthcare and in well-being data management with rural witches. However, as health, help-seeking, and the efficacy of treatments was not the objective of our research, we did not inquire about these factors. Furthermore, we made sure that our fieldwork did not encourage villagers to seek help from such services and resources. When prompted, we also clarified our point of view on this matter and explained why we prefer seeking help from formal healthcare providers. Although discussion of rural well-being is not a concentration of this project, we discussed these concerns with the ethical review board of the researchers' institutions. They examined and approved them in a formal review.

4 ARTS AND CRAFTS IN RURAL JESSORE

Jessore is one of the oldest districts in Bangladesh. The British empire declared it a district in 1781 and constructed roads, highways, and a number of administrative centers. This area thus also grew as one of the culturally rich neighborhoods of the subcontinent for the past two centuries. Along with many writers and painters, a number of artists and craftsmen have also established their villages in the greater Jessore area over time. For example, this district is a hub of *'Nakshi-Katha'* (specially crafted handmade quilts and other traditional hand-stitch textile designs), textiles, pottery, sculpted clay Hindu idols, and bamboo and cane craft products [27]. Such arts and crafts have not only been serving a major part of the local economy, but also each of these practices has complex traditional practices which include information storage and transmission. We conducted our ethnographic work with *'Nakshi-Katha'* makers, Hindu idol makers, and the witchcraft practitioners, studying how they use different visual elements to convey information. We provide with a brief background of these three industries in this section.

4.1 Case-1: Nakshi-Katha

Bengali *Nakshi-Katha*, embroidered textiles, have been made for several thousands of years [25]. Renowned myths, poems, and novels have mentions of *Nakshi-Katha* in Bangladesh and West

Fig. 1. (a) During an observation session, two of our participants are crafting *Nakshi-Katha* in their yard in the afternoon, (b) One of the participants using *Jessore Stitch* to create the motif of lotus, the leaves on the both side of the flower indicates that it is floating on the water. Next below the lotus, the pointy petal of the half-seen flower indicates flower of crops. Since the lotus floating in the water is right next the crop, this indicates the crop-field is next to the water source landmark. (c) An old piece on which the designer symbolically depicted her memories of running away from home to enjoy theatre at the local market.

Bengal in India. There are six different *Nakshi-Katha* hubs in Bangladesh and West Bengal. Jessore, where we conducted our fieldwork, is one of those six hubs and *Nakshi-Katha* are one of the biggest economic drivers of the district. Close to 12% local population is somehow engaged in this business contributing to investment, contracting, supplying labor and materials, and providing transportation of goods. We studied five groups of people in five different villages who are engaged in this industry.

Our participants explained to us that *'Nakshi'* means designer and *'Katha'* means quilt in Bengali. Thus, *Nakshi-Katha* means an special type of embroidered quilt. *Nakshi-Katha* come in different sizes and shapes with varying purposes. Often the designers make small size *Nakshi-Katha* as cushion covers and curtains in front of lockers. Traditionally, larger size (king or queen size) *Nakshi-Katha* were used as a part of dowries, a token of gift for motherhood, and for similar familial occasions. Today, larger size *Nakshi-Katha* are generally made as a hanging decoration in the living room and also as a bedding on especial occasions. These occasions include *'Eid'* (Muslim festival), *'Puja'* (Hindu festival), Bengali new years eve, and son-in-laws visiting their in-laws house (this is a very important occasion in Bengali culture).

The type of stitch and embroidery performed on a *Nakshi-Katha* is called *'Nakshi-Shelai'* ('Shelai' is the local synonym for stitching style). A participant mentioned that all of the six hubs in West Bengal and Bangladesh have their own style of *Nakshi-Shelai*, distinguishable by their patterns. Using *Nakshi-Shelai* on fashion attire is also prominent across the country. Through our observations and engagement with the people, we discovered that *'Jessore-Stitch'*, *'Anarashi'*(means pineapple stitch), and *'Lik Jhumka'*(hat-shaped air-ring style stitch) are some of the popular *Nakshi-Shelai* among rural Jessorian *Nakshi-Katha* makers. Design motifs and *'Nakshi-Shelai'* style not only influence the aesthetics but also play a role in representing the intended narrative of the piece. Use of motifs and *'Nakshi-Shelai'* style varies based on the type of *'Nakshi-Katha'* and purpose of quilting it. Through stitch patterns or designs, various messages and narratives are encoded.

4.1.1 The Nakshi-Katha Makers. Although both our female and male participants were part of the *Nakshi-Katha* supply chain, only the rural women participate in design, stitching, and embroidery of the quilt. Women from all of the groups mentioned that most of them were trained since their childhood as *Nakshi-Katha* craftsman. One of the participants explained:

> *"I learned it as I kept watching my mother and aunts at home doing this. After getting married, my mother-in-law supervised me to craft Nakshi-Katha for my sister-in-laws' prospective marriage. This is a common for every household, it is going to be a shame if any Jessorian woman claims not to know how to craft one." (P25)*

Thus local women of a wider range of age groups are engaged in crafting *Nakshi-Katha* in this area. Generally, more experienced and older women design and instruct the subordinates and the younger women follow the lead in crafting. Our participants mentioned that they find time for quilting after finishing household work in the afternoon and spend that time chatting and crafting quilts together with other neighborhood ladies (see Fig-1(a), two neighbors having their regular afternoon chat and quilting together sitting in a common space in between their houses).

4.1.2 Themes and Motifs in Design. The design of *Nakshi-Katha* often comes with a theme. Such themes include mythological stories, renowned local histories (e.g. the fall of Nawab Siraj-Ud-Dowla empire and British invasion), and religious purposes (e.g. quilting Nakshi-Katha with various Hindu symbols to use it behind the idol of Goddess Laxmi during Puja). Twelve of our participants gave us examples of their familial *Nakshi-Kathas* where special family events (marriage or death) were recorded or family log-keeping was performed. For example, one of the participants, P18, showed us a *Nakshi-Katha* (see Fig-1(c)) from her collection that used to belong to her mother-in-law a few decades back. It portrayed a scene of a group of people enjoying a local open-air theatre in a market place. She explained:

> *"Those days women were not allowed to go market, asking to go and enjoy theatre is beyond any question. She (her mother-in-law) was only 10 years old, did not tell anyone, and secretly ran away from home with another of her female friend to enjoy the theatre. You can see in the image that she and the friend are the only women in the scene, and some people in audience are focused more on the ladies than the actual theatre... Her parents did not know until she was finished making this, by the time she was married. Later they also discovered that her husband actually saw her at the theatre, investigated her, and send the marriage proposal to the family."(P18)*

The smallest elements of a *Nakshi-Katha* are called *'Pod'* (means motif in local language). Each of the *Pods* generally represent the exact item they depict, with some exceptions. For example, living beings including plants, humans, and animals mean life, flying birds mean sky, and strange animals refers to fairy tale. However, some complex *Pods* have a conventional meaning from history, as one of the lead designers woman in a village gave examples and explained to us:

> *"In my design, trees and plants, lotus, and mandala at the center are inferred as a symbol of life and leading the nature (pointing to the motif in Fig-1(b)); wild animals mean natural environment and domestic animals and agricultural stuff mean wellbeing of household; and steady non-flying birds mean spiritual realm, fishes and reptiles together in a 'Pod' with wave mean river while they separately means positive and negative spiritual forces. I learned these meanings from my elders."(P43)*

The type of stitches, motifs, and sealing of the border of a *Nakshi-Katha* generally indicate where among those six hubs it was crafted. Our participants also informed us that the meaning and interpretation of the motifs might change depending where it was designed.

4.1.3 Process of Crafting. The process of preparing the base and quilting a *Nakshi-Katha* consists of three steps - preparing the *'Pata'*, transferring the design, and finally stitching and embroidery. Each of the steps are important since there is very limited room for recovering from mistakes if they occur. Thus, *Nakshi-Katha* needs expertise and extensive training on stitching. We explain the steps below:

Step-1: While crafting a *Nakshi-Katha*, the stitch-patterns are performed on a few layers of base-quilt locally named *'Pata'*. Generally, *Pata* is made of old sarees (6 yard long and 1 yard wide female clothing) and lungis (1.2 yard wide male-skirts). However, all the group of quilt-makers informed us that they recently came to buy brand new cotton cloths specially woven for *Nakshi-Katha* to prepare *Pata* since *Nakshi-Katha* have been recognized as arts and crafts for purposes beyond household bedding. First, layers of cloths are bound together to a required size. Generally, this part of the task is done carefully on a ground for uniformity of the layers. Once the layers are smoothed with no fold or creases, then they are hand-stitched with parallel lines with a gap of 6 to 10 inches and the borders are sealed.

Step-2: Then comes the part of designing on the *Pata* to convert it into *Nakshi-Katha*. In this process, the designers draw their designs on tracing paper. Then they make small holes on the tracing paper following the lines. These holes are useful to transfer the design on the *Pata*. The designers place the tracing paper with holes on the *Pata* and drops oil with color on it, thus the colored oil travel through the holes, landing on the *Pata*, and copying the design on it. Our participants mentioned that they often remain careful with this step since any mistakenly dropped oil would leave a smudge and ruin the theme.

Step-3: Once the *Patas* had the transfer designs on them, they are ready for stitching and embroidery. Different types of stitches and embroidery are done with a variety of needles due the different requirements of density of threads and stitch-sizes. For example, women use *'Shona-Mukhi'* needle (needle that has the hole made of gold) to stitch any tiny but important sharp-edged forms like stars and eyes. Generally, women group together and quilt larger size *Nakshi-Katha*. Our participants informed us that a queen size *Nakshi-Katha* would normally take a few months if quilted by 3-4 women. Our participants mentioned that monsoon season is ideal for quilting, although many of them craft *Nakshi-Katha* all year long to meet large scale commercial orders of those across the country and abroad.

4.2 Case-2: Hindu Idol Crafting

Jessore has a higher density of Hindu practitioners (around 15%) compared to other parts of the country. This area always has demand for idols of Gods and Goddesses for various religious occasions. As a result, a number of renowned small and large outfits of Hindu idol-makers form an established local industry. Hindu Idol crafting is locally called *'Thakur-Gora'*. *Thakur* means God and *Gora* is crafting or making. The craftspeople themselves are locally referred to as *Thakurer-Karigors*. We conducted our fieldwork with fourteen idol-makers in two groups in two different locations, Bejpara and Kapuriapotti, in Jessore.

Hindu practitioners in Jessore and nearby areas generally celebrate three major *'Pujas'* (Hindu festivals) that would require brand new idols of *Thakurs*: *'Durga Puja'*, *'Kali Puja'*, and *'Saraswati Puja'*. Other than these festivals, the *Thakurer-Karigors* often accept contracts to set up neighborhood temples and small-scale domestic temples at home with *'Laxmi Thakur'*, *'Radha and Krishna Thakur'*, *'Ram and Sita Thakur'*, *'Tara Thakur'*, *'Shiva Thakur'*, and many other *Thakurs* during the other months of the year.

The *Thakurer-Karigors* categorized the *Thakur* idols in small, mid, and large sizes. Generally the small-size *Thakurs* are 18-36 inches, mid-size ones are 48-60 inches, and the large size could be 12 to 20 feet depending on the demand in the contract. Generally, low and middle income families request small size *Thakurs* and higher income families make contracts for mid size *Thakurs* for their domestic temples. On the other hand, larger size *Thakurs* are requested by neighborhood temples or by political leaders who intend to host Pujas at a temporary podium, open for the public.

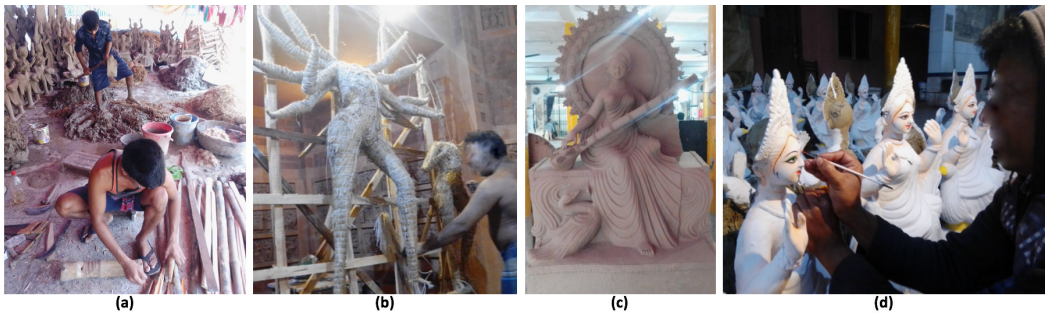

Fig. 2. Photos taken at a Hindu idol-making workshop. (a) One of the *Karigors* in the back is preparing the clay mixture while the *Karigor* in the front is working on a *Bena* for a small size *Thakur*. (b) The head *Karigor* is tying the *Gothon* of Goddess Durga to its *Bena* on the main frame. (c) Setup of Goddess Saraswati sitting on lotus seat holding a Tanpura is drying, and (d) A *Karigor* is drawing the face of Goddess Saraswati

4.2.1 'Thakurer-Karigors'- the Idol Makers. The group of people who are engaged in *Thakur-Gora* are locally called *'Shilpis'*, *'Thakur-Gorar Karigors'*, or *'Thakurer-Karigors'* (*Karigor* is the Bengali synonym of craftsman). Generally, they adopt this profession by inheritance. By history, this is a strictly cast-based profession. Ideally, the *'Pal'* families practice this craftsmanship and generally train their male children for years at home and at local *Thakurer-Karigors*. One of the group leaders explained the rules:

> *"We are 9 people in this group, all are 'Pals'. Traditionally and by law of the religion, only 'Pals' should participate in 'Thakur-Gora'. It is because they were blessed by Gods to make their image so that normal people can pray to the Gods. Also, the Pals are trained for this, for example, they knows better what ingredients are needs, the steps of when to do what, and troubleshooting, just random potters can't do this." (P31)*

However, our participants informed us that *Thakur-Gora* is a comparatively low-paid job and the number of *Thakurer-Karigors* is gradually deteriorating. Thus, the group-leader of the other *Thakurer-Karigors* mentioned that he occasionally recruits *non-Pal Thakurer-Karigors* if they are thoroughly trained and experienced.

4.2.2 Design, Embodiment, and Decoration. Our participants informed us that most of the lead *Thakurer-Karigors* have their design books for making *Thakurs*. The design of *'Thakur-Gora'* generally follows the design books of the lead *Thakurer-Karigors* while making contracts with the clients. Each of the Gods and Goddesses has a story – their job is to tell that through the embodiment and decoration of the whole tableau of Thakur, including the idols, other protagonist characters related to that stories, and the related surrounding objects. *'Thakur-Gora'* crafting is a complex process consisting five steps - mixing and preparing the clay; setting up *'Bena'* (armatures); *'Gothon'*; layering with clay; and coloring, dressing up, and make-up. The *Thakurer-Karigors* first start with the clay mixing. We briefly discuss below how each of the steps in this process contributes to form the full embodiment of the *Thakur*'s narrative.

Step-1: Generally a mixture of clay, silt, and sand and another portion of mixed silt and clay are needed in this step. The *Thakurer-Karigors* mix them and keep them to moist for 3-4 days. Different God and Goddesses have different key ingredients to put into their idols as instructed in myths and *'Shastra'* (Hindu religion grammar books). The *Karigors* add those ingredients to the clay in this stage. There is a subgroup of *Karigors* specialized in clay manipulation. Our participants mentioned that a bad mixture of clay with wrong proportions may result in a deformed *Thakur*, leading to the

propagation of the wrong message in the community though a flawed display. See Fig-2(a), one of the *Karigors* in the back is preparing the clay mixture.

Step-2: While one subgroup works on the clay, another subgroup takes charge of the second task and prepares the *'Bena'*. This is made of bamboo sticks and supports the idols as an axis armature. A small size idol's *Bena* takes 20 mins to half an hour for one *Karigor* if the bamboo sticks are ready. For large size idol, it might take several hours for a whole group to set up the idol's *Bena*. In this part of the work, the *Karigors* set up the initial positions, sizes, and tilts of the character-idols and objects to embody the narrative of the particular God and Goddesses. Our participants mentioned that they often remain careful and check the tie of the *Bena* several times since a weak one might tilt or distort the *Thakur* on the Puja-stage, spoiling the ritual. (See Fig-2(a), a *Karigor* in the front is tying a *Bena* for a small size *Thakur*.)

Step-3: This step is named *'Gothon'*, which means shaping in Bengali. In a small size *Thakur*, the *Karigors* put the mixture of clay and straw straight on the *Bena*. However, for the mid and large size *Thakurs*, they build the body-parts of the Gods, Goddesses, and surrounding characters separately first and tie them together. In this process, they also create the axes, shapes, and postures of the bodies. Later they put them and tie them with the *Bena*. This step generally takes a few hours to one or two days depending on the size of the *Thakur*. The axes, shapes, and posture of the *Thakur* is associated with their interplay with other protagonists characters present on the same Puja-stage (Goddess Laxmi and Saraswati with Durga, for example) and thus any mistake in this step of making might lead to misinformation and misinterpretation. (See Fig-2(b), a *Karigor* is tying the *Gothon* of Goddess Durga to its *Bena* in the main frame.)

Step-4: In this step, the *Karigors* put a mixture of clay and straw on the straw-bodies. A smooth layer of the clay is required for high fidelity in the characters and the objects. Also, the proportion of clay and the straw is important here so that the skin of the characters and object do not crack. The *Karigors* use the clay mixture that they prepare in the first step. They also create the shapes of clothes and ornaments in this step unless the clients provides them with a set of real clothes and ornaments. The final coating is done only with clay to make the objects and bodies more smooth and capable of holding colors in the upcoming step. Then they leave it to dry for 3-4 days. In Fig-2(c), a setup of Goddess Saraswati is drying and preparing to be ready for the upcoming step.

Step-5: Once the bodies on the *Bena* are dry, the *Karigors* now prime the idols with white paint. Then they color the body parts, clothes, ornaments, and other objects. They finish this step by drawing the faces of the characters (see Fig-2(d), a *Karigor* drawing the face of Goddess Saraswati). There might be a additional step of adding real clothes on the Gods and Goddesses and real ornaments if those are supplied by the clients. Then the *Thakur* is left to dry for a whole day or two.

Within about a week in total, the visual display of the narrative of the Gods and Goddesses are created by the *Thakurer-Karigors* and sent out for delivery to clients.

4.3 Case-3: Witchcraft Practices

As occult and witchcraft practices vary in terms of belief, practice, and social acceptance, defining witchcraft precisely is difficult. Previous work in HCI on Bangladeshi witchcraft practices defined witchcraft as the practice of magical skills and abilities exercised by solitary practitioners and groups aiming to address physical and mental well-being issues and solve local problems [97]. They included sorcery, shamanism, exorcism, and traditional healing under a broad umbrella of 'witchcraft'. We adapt their definition of witchcraft practice in this paper. During the fieldwork, we engaged with seven witches in rural Jessore and studied their practice.

The two major witchcraft prescriptions are- (i)*'Allahr Kalam'* and (ii) *'Kali Mantra'*. *Allahr Kalam* adapts most of its craft and treatment methods from the Islamic *Holy Quran* and *Hadith*.

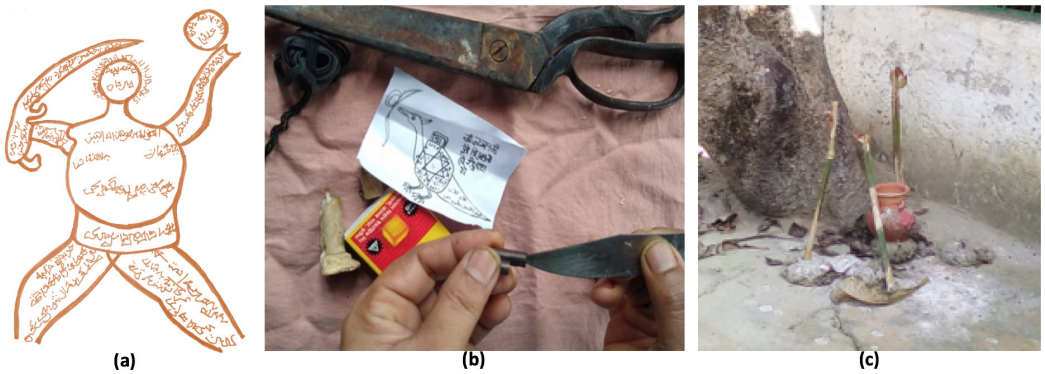

Fig. 3. Objects used in witchcraft practice: (a) A human shaped *Jantra* having *Mantra/Dua* written all over it, (b) process of making *Tabiz*, the *Jantra* in use is a hybrid one having both Islamic scripts and *Kali-Mantra*, (c) a *Tantra* performed to protect a house from evil spirits. It uses bamboo sticks, a clay pot with scripts and vermilion, and the trunk of the tree posting a warning about the spell.

This therapy includes prayer, *Jhar-phuk*(blowing air after reciting something), holding *Tabizs*, restriction in movements, visiting holy places, etc. On the other hand, *Kali Mantra* adapts its craft and treatment methods from the Hindu scriptures- *Veda* and *Bhagabat Geeta*. It includes worshipping in Hindu-graveyards, stealing bones and vermilion from dead bodies, and sending a harmful virtual weapon locally named as *'Baan'* (see [97] for more details on *Allahr Kalam* and *Kali Matra*). Our findings show that their spiritual and para-religious therapies use various visual artifacts and media in their practice. Information is also embedded in witchcraft instructions and treatments.

4.3.1 The Witchcraft Practitioners. The witches use exclusive attire, materials, and artifacts which are highly influenced by two of the region's prominent religions- Islam and Hindu. Their traditional amulets; locally known as *'Tabiz'*, *'Maduli'*, or sometimes instead *'Tulsimalo'* (basil plant necklace); and red vermilion in the middle of both eyebrows known as *'Tika'* work as visual indicators of their profession. The craft requires an extensive training for years before a witch starts their practice. They are generally trained within the family and pass down knowledge to the next generation.

4.3.2 Design and Embodiment of Objects. Witchcraft practitioners use three types of artifacts in their therapy: *'Mantra'*, *'Jantras'*, and *'Tantra'*. First, *Dua* (in *Allahr Kalam*) and *Mantra* (in *Kali Mantra* context) are statements or excerpts from the *Holy Quran*, *Hadith*; and *Veda*, *Bhagabat Geeta*, respectively. The witches often suggest to recite these along with meditation. Counting of recitations must be performed using a special thread of beads known as *Tasbih* or *Rudrakshi*. *Tasbih* or *Rudrakshi* are significant artifacts in Muslim and Hindu religions.

Second, *Tabizs*, also known as *Madulis*, or *Jantras* are similar wearable amulets holding slightly different religious associations (See Fig-3(b) and Fig-5(b)). These are usually pendants worn on the neck, arms, or waist using black thread. These *Tabiz* are filled in with some Mantra or adapted religious scripts written on paper forming a ritual artifact. The witches often infuse some numbers with religious words in these *Mantras*. These numbers are generally adapted from vedic astrology and have roles in the process. They organize and curate the information in order to convey specific effects.

Third, *Kria/Tantra (Group of Activities)* consists of *Jantra* when combined with some parareligious and spiritual activities. The materials used in these processes are considered to possess power once

the witch has performed *Jhar-phuk* on them. *Tantras* are engaged in solving critical complexities such as matchmaking, divorce cases, and incurable diseases. *Tantras* adapts several *Jantras* and thus produce a set of mixed method activities. Often *Jantras* here function as an indicator or marker.

4.3.3 Visual Objects as Equipment in Therapy. A witchcraft therapy consists of a set of complex procedures including investigation, explanations and predictions, keramoti, analysis, and treatment (see [97] for further specific details of witchcraft therapy in rural Bangladesh). We followed therapy sessions to find out which of the stages use artifacts and symbols and observe how information is stored and conveyed during practice. Among these, the stages of explanation and prediction, performance, treatment, and integration involve most of the spiritual and parareligious practices and present information.

Step-1: In this step, the witches investigate the problem of the petitioners and how decide they should be addressed. If the petitioners alone are troubled (for example, they can't sleep at night) but do not really know what is troubling them, then often ask the witches to suggest to them some *Mantra* and *Jantra*. For example, during an observation session with a witch, P5, we found one help-seeker who has difficulty sleeping. Upon further discussion, the witch suggested that they recite some scripts one thousand times while copying the same script on paper. They then were to bury it under the plant next to their window, and follow the change in the color of the leaves. Such a change of color was part of the investigation.

Step-2: In the next steps of explanation and prediction, the witches follow the investigation, explaining the problem and possible roots of it to the help-seekers. Continuing with the example from Step-1, the same person again came to the witch, P5, in her next therapy session with a leaf to show the changes. After a discussion and close examination of the leaf, she informed him that he has been spelled by someone who lives close to him. Later, the witch explained to us that she sensed it from his replies as he kept mentioning that he is worried about how land deed papers might be snatched from him. Here, she used the color changing *Jantra* as a tool of her investigation and the changed color of the leaf confirmed her intuition.

Step-3: In the last step of the therapy, treatment, the witches use both *Jantra* and *Tantra* as visual tool for intervention. For example, a particular *Tantra* named *'Tappi'* (name of *Jantra* when made on cloths) is often used in therapies to help women conceive. During an observation session with one of our witches, P4, she was prescribing this to a lady for her pregnancy, explaining:

> *"You have to start drawing on the signs on the colored circles right next Saturday of the end of your menstruation and keep going with the drawing every week. You should also target having intercourse with your husband when two circles are done. The first sign should be the lotus, then 'Swastika' (sign of peace according to Hindu myths), then the signs of half-moon, and finally this one (a set of Arabic alphabet). The last one is 'Allahr-Kalam'. You can only draw on this once you finish the steps. Once all the circles are filled in, then you may proceed to the next stages of this process. Next time bring it back to me, I will investigate, and suggest you the next step of the therapy." (P4)*

Thus, the witches often use different local and mundane materials and visual objects as their tools of investigation and equipment in their therapies. The witches informed us that they often hybridize and juxtapose their methods and make changes in the use their investigation tools, *Jantra* and *Tantra* for a better effects based on specific situations and locales.

5 FINDINGS

After several rounds of iterations on our initial themes which arose from open coding and focused coding stages, we clustered our major findings into several areas: practitioners' use of medium; adaptation or appropriation of concrete units; strategies for quantifying, ordering, and instantiating;

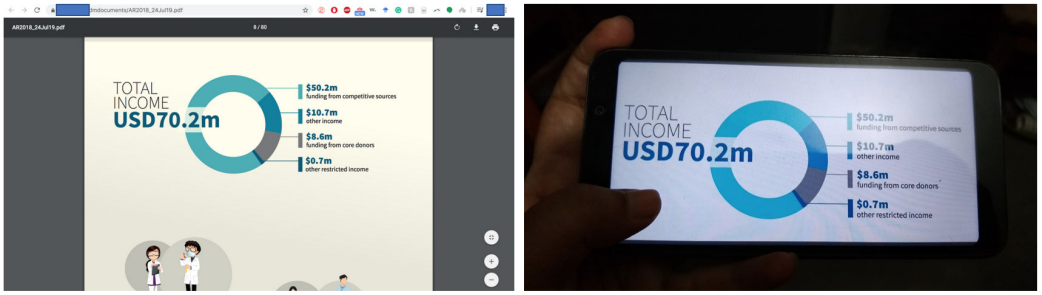

Fig. 4. Snapshot of a icddr,b funding, research, training and clinical services dashboard for 2018: (left) user is watching the publicly available electronic copy of the report opened in their browser and (right) another user is watching the same portion of the report on their mobile phone.

storyteller provenance; and the practice of situating the reading and interpretation of information in local grammar and place. In the following subsections we discuss these themes and then step back to discuss general findings emerging across our data.

5.1 Use of Medium

In many cases, the specific software used to produce a digital representation of information are not exposed to the end user (or made salient if they had been) beyond their impact on the aesthetics and effectiveness of the design. The meaning encoded in the presentation is not affected by the medium beyond the general constraints and affordances that different media offer (e.g. interactivity, tangibility). As long as the same visual grammar is used, convention implies that the user will arrive at a similar understanding of the data irrespective of the medium or viewing location (but potentially influenced by data expertise, domain knowledge, etc.).

Fig-4(a) depicts a doughnut chart showing a snapshot of icddr,b (one of the world's leading global health research institutes, based in Dhaka, Bangladesh [47]) funding, research, training and clinical services from various sources over the year of 2018 [46]. The user took an screenshot of their computer screen while watching the chart on an electronic copy of the report (this is publicly available on their website) opened in a browser. In Fig-4(b), the user employs their mobile phone to view the same data. The general impression and insights conveyed by the visuals are invariant of this dramatic change in context.

However, in rural traditional practices we observed in Jessore, the type of medium used was not only important, but often was amplified and integrated into the presentation as a critical component of its whole. We observed in our idol-making and witchcraft sites how materials used in transmitting information were themselves part of the message and were the subject of intense consideration on the part of the designer.

5.1.1 Religious Influence in Medium Use. In *Thakur-Gora*, the ingredients used in the decoration of Gods and Goddesses are significant, and choices are integrated into the particular message the artist has been commissioned to convey. They must work within specific rules and guided instruction for the use of color and media. For example, God Krishna has to be blue-ish and Goddess Kali has to be black, while skin color and complexion of other Gods and Goddesses might be flexible between the range of tan to fair, depending on the area where they were made. The ornaments used by the Gods are Goddesses also hold significance, as another lead idol-maker showed us the idol of Goddess Durga and Goddes Kali, showing examples of their bangles and explaining:

> *"The Bangles Goddess Durga puts on have to be exact same bangles that a 'Shwoti-nari' (means a pure female, happily married to a man, and never had any romantic relationship with any other male) is supposed to put on all of her 10 hands, with no exception. Those are specially crafted from shells. You can't put plastic bangles on Durga. Sometimes rich people insist to put gold bangles along with those while having the Puja in their domestic territory. However, the case is not as rigid for Goddess Kali. Locally made bangles are often used for her decoration." (P37)*

Any deviation from such preset combinations is not generally appreciated in the community since those are related to religious practices and often seen as a violation of religious rules. Also, use of any prominent medium employed primarily for religious purpose is discouraged in a non-religious context. For example, using floor-tiles with religious scripts or images of Gods are not accepted on general purpose structural walls- they are reserved for domestic or public temples. The material combination in producing the visual medium is another important aspect in *Thakur-Gora* practice. For example, Durga Thakur is made with a combination of 4 different key ingredients and 7 different types of mud, clay, and sand. This combination of mud makes elevates the *Thakur* and helps to differentiate the message it conveys from other, secular uses of ceramics. While some elements serve an important role in clay composition of the sculpture (e.g. serving as grog), some are included purely for conveying meaning.

5.1.2 Sustainable and Long-lasting Embodiment. In *Thakur-Gora* practice, the combination of ingredients are also important. Continuing the example of mud-clay combination mentioned above, the 11 types of mud used in Durga *Thakur-Gora* are themselves collected from different sources following religious guidelines. The practice itself of collecting the medium of transmission becomes encoded in the eventual meaning conveyed. Further, uses of clay and sand in process follows specific rules and ratios to ensure that the *Thakur* will not crack and will sustain until the end of the Puja, as the the lead *Karigor* explained to us,

> *"As I keep mentioning to you that the Pals are trained for it, let me give you an example why. We need 11 different samples of clay and mud for God. And these 11 samples has to be mixed with the other mud following the appropriate ratio. If the ratio is disregarded then there will be a crack on God and such a crack will bring back luck for the people- this is how it is interpreted. You just can't take risk with people's sentiment." (P31)*

The lead *Karigor* also mentioned to us that he buys the mud and clay by himself. Also, he makes sure the *Bena* and frames of the *Thakur-stage* are all brand new to minimize the risk of hurting public sentiment through use of a poor medium. The ratios themselves, complicated by the need to include multiple materials, are part of the craftsperson's practice and must adapt to changing climate and seasonal factors. Good use of materials provides additional evidence of the *Karigor's* skill.

5.1.3 Gendered Aspects of Medium Use. Gender can also place demands on a practitioner's choice of medium for spells and other artifacts. For example, refer to the image of a spelled ring in Fig-5(a). This ring from a collection of spelled rings was shown by a witch and given to a client during a witchcraft therapy session. During that session, the witch was helping a male who was consistently failing in his business and facing a huge monetary loss right at that moment. The witch explained to the man:

> *"This ring is special because of the Jantra written on it, this Jantra is going the lead you economic success in your business, always keep this put on your finger and show off this in front of the people, so they will know you are using proper spell. Only you can use it, not your wife since this is written on brass-metal ring, that means it will only work for a*

Fig. 5. A witch showing her collection of *Jantra* (religious scriptures used in witchcraft practice) to explain the use of metals: (a) brass ring with *Jantra* scripts on it supposed to help economic success. (b) silver *Tabiz* that women should use instead of brass rings for the same purpose.

> *male, not female, even though she sometimes sits in the shop, don't share the ring with her..." (P5)*

Showing her collection of *Tabizs* (the local name of specific spelled amulets provided only by witches; see Fig-5(b)), the same witch later explained to us that the Jantra on these *Tabizs* are supposed to be written only on silver but no other metal and put on only as necklaces and no other way. She also emphasized that if the brass ring or the silver Tabizs are used some other way then the spell will be ineffective. In this case not only does the message conveyed change in response to medium of transmission, but also its efficacy.

5.2 Abstraction, Concreteness, and Connotation

One key element of communicating about data (both digitally and in analog form) is the use of abstract marks to represent data entities. In some cases, single marks can represent collections or even entire datasets. This provides an immense amount of expressability- more data can be shown on a screen and it's easier to present aggregated information. On the other hand, abstraction requires effort on the part of the viewer. They must interpret the use of marks and make sense of how they map back to data entities. While conventions might make it easy for those with experience to interpret a chart (e.g. circles on a scatterplot), that may not be the case among individuals who do not regularly make use of modern information visualizations. In our field studies we noted a difference in how entities were conventionally encoded when storing information for later presentation. The traditional practices we observed tend to make use of concrete representations. The visual designers we studied used representations that were as close as possible to the meaning they intended to convey, avoiding a high degree of abstraction. The graphic and visual objects used in rural Bangladeshi traditional presentations of information often appeared as the closest related physical form the practitioner could employ.

5.2.1 Abstract Geometry vs. Mundane Objects. The forms and shapes of the entities in rural traditional visuals are often borrowed from the forms and shapes of designers' and users' known world and renowned myths. If rural traditional practitioners in Jessore intended to convey the concept *human*, they used an iconic representation of a human as the visual form; when they intended to mean wealth, they used gold, jewelry, and money; and to signal any association with music, they used musical instruments. For example, Goddess Laxmi carries a lot full of wealth. Generally, the idol makers portray a pot of money. When we asked them if it is possible to replace

it with another mundane object and convey the same message (paper money or a bank cheque for example), a group of focus group discussants explained:

> *"The pot is not only about the money or cash flow. It is about the wealth that will come and sustain, like the way the pot holds the wealth in it ensuring the sustainability... Bank cheques might just fly out, right?" (participants of FGD-4)*

The selection of mundane objects in this cases is strategically performed with careful judgement to connotation and interpretation. One of the lead *Karigor* informed us that once the units are established, they do not generally replace them with something else as the situated meaning is conventionally understood by the community.

5.2.2 Connotation of Signifiers. Our participants informed us that while designing with reuse concerns, the *Karigors* remain careful about not mixing up themes and contexts. The *Karigors* may not use the same object to signify a similar concept if they are rooted in two different contexts. For example, for the Hindu Goddess *'Saraswati'* (renowned for her power of art and music) a guitar-like 'Tanpura' in her hands represents that for craftspeople (See Fig-2(c)). On the other hand, the God *'Krishna'* lives in a rural environment, follows around his lover, the Goddess *Radha*, and plays a flute to seduce her. Although both the God and Goddess are associated with music, we were curious that if the idol makers would still use the exact same instrument as a signifier to indicate that music is involved in the narrative, and whether they would bring about the same connotations. The lead idol-maker explained to us,

> *"Goddess Saraswati's Tanpura is about elegance and God Krishna's flute is about seduction - those are not the same themes. You can't just interchange them or replace them with something else. You have to keep those as they are. Otherwise, the story wont' make any sense." (P40)*

The lead *Karigor* explained to us that such sensitivity to themes and connotations are widely practiced in his field. He also informed us that any replacement of visual objects that are strongly associated with some particular theme might confuse the people and might even risk hurting public sentiment.

5.2.3 Multiple Instantiations of Signifiers. The *Karigors* informed us that they might use the same visual objects for two different contexts if the religion and myth approved of them as connected through an extended version of the narrative. For example, some Hindu myths claim that Goddess *Kali* is renowned for punishing two unbeatable demons namely *Chanda* and *Munda*. She replicated herself into Goddess *Tara* from her third eye to punish and destroy a demon called *Hayagriva* who wrought havoc everywhere, banished the Gods from *'Amaravati'* (their residential city) and robbed their possessions. Both *Kali* and *Tara* put on a garland of skulls, according to the myths. When we asked the idol makers whether the garland on these two Goddesses are the same or somehow different, one of the *Karigors* explained,

> *"In the story, Goddess Tara was born from Goddess Kali, with an approval of Mohadev (one of the leaders of the Gods). And did the same thing as Goddess Kali would have done. And they are avatars of same persona. So, they both have four hands, although they holds different weapons in those. And they both use the garland of skulls but with slight changes in the numbers of skulls in those." (P32)*

A similar observation about multiple instantiations also applies to many of the cases in witchcraft practice. For example, any *Jantra* with human-shape means those apply to a person. Also, any strange shape on *Jantra* means strange activities or diseases. Similarly, a human head with horns in different *Jantra* and *Tantra* generally means an evil entity have been controlling a person to perform

something bad and the spell will chase it out (see Fig-3(a), Fig-7(a), and Fig-7(b) for examples). In sum, while at first it might seem that concrete representations signify directly, in reality there is a rich set of connotations and contextual criteria wielded by practitioners which influence how signifiers are understood.

5.3 Quantities, Order, and Intensification

In information visualization practice there are a number of common approaches for mapping numeric and categorical attributes to visual characteristics (often through *visual channels* such as area or color [105]). As in the previous section where we discussed abstraction and concreteness, this mapping is conventionalized in modern practice and familiar to many consumers of visualizations in the West. On the other hand, repetition, extended size, and color-opacity of entities do not necessary convey the same meaning among our participants. For example, one of the *Thakur-Gorar Karigor*, P32, showed us a different form of *Durga-Thakur* setup designed by and produced under his supervision. He explained how the repetitions of different elements in the *Durga-Thakur* setup should be interpreted, reporting:

> *"Durga-Thakur has ten hands, holding ten different weapons to kill demon Asura. Asura is the buffalo-king, often he hides behind his bull avatar. She rides her tiger 'Somanandin', accompanied by a snake. So, all of these are generally in a Durga-Thakur setup. Sometimes there are repetition of the bull or Asura, to convey how difficult it was to kill the demon, as you can see in these two setups (pointing to the idols). However, this setup with the repetition of the snake, denotes her upward movement from a lower state of consciousness to the higher state of existence experiencing pure bliss." (P32)*

However, variations in frequency, strength, and size are not entirely excluded from the visuals we observed- rather, they often were employed for different purposes.

5.3.1 Frequency and Strength. The practices we observed made use of their own grammar for representing differences in frequencies and strength of particular variables. For example, yearly income was recorded in *Nakshi-Katha* in Fig-6(a) as a red wheel (see Fig-6(b)). The women who owns it now, P11, explained how the designer, her great grandmother, recorded the information and how it should be interpreted:

> *"The wheel has 16 slices, to represent the 16 lunar cycles of 8 months of harvest, she (great grandmother) discarded the other other 4 lazy months. It should be read from the top to right and then down (means clockwise). Although the numbers are strange that I can't read, but I heard from elders that the year was eventful." (P11)*

She explained how it was eventful, pointing to a rat depiction which was bigger than the nearby elephant (see Fig-6(c)). The ratio is at first strange, but she identified that it is an indicator that impact of the rats were significant that year and mentioned that rats spoiled part of the harvest. Thus, the great-grandmother represented the severity of the event through a narrative cue that referenced the viewer's local domain knowledge. As mentioned earlier in Section 4, artists' choice of *'Nakshi-Shelai'* stitches also can encode meaning. In the case of the great-grandmother's *Nakshi-Katha*, the use of broken lines and line weights is employed to indicate distances and intensity in much the same way that line opacity and saturation would be employed in a digital visualization.

5.3.2 Time-indexing Events. We identified some specific ways that the rural traditional visual designs employed to present various events with respect to the time during which those events took place. For example, P11 continued explaining her *Nakshi-Katha*, informing us how her great-grandmother represented the passage of time and specific milestones in it (see Fig-6(d) and Fig-6(e)).

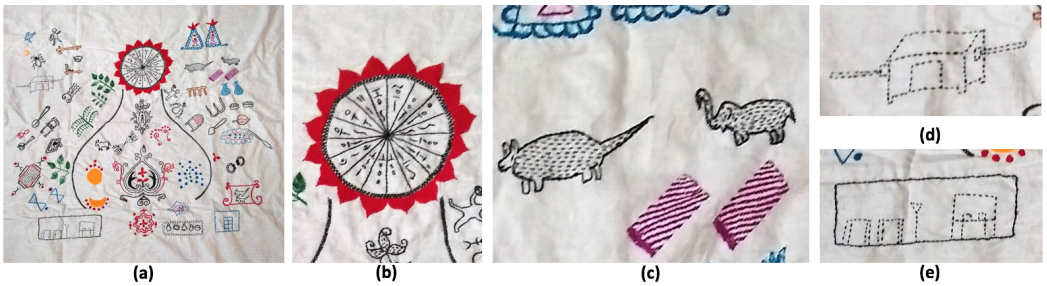

Fig. 6. The great-grandmother's *Nakshi-Katha* that participant P11 showed us: (a) The whole *Nakshi-Katha*, (b) the wheel from the top middle of the main *Nakshi-Katha* what has the monetary records of 16 of the productive lunar cycles (8 months) that year, (c) the rat and the elephant from the right-top of the main *Nakshi-Katha* indicating that there were events related to the elephant and the rat. (d) the palanquin taken from left-top of the main *Nakshi-Katha* made in the broken line stitch which means it is gone, and (e) the two-story building from the bottom-left of the main *Nakshi-Katha* indicated her in-laws house, made in broken lines to indicate that it was not near and cannot be seen from their household.

Here the great-grandmother presented the most memorable events of the year including the marriage of the daughter of the family. As we followed P11, she reported:

> *"Do you see all the marriage related stuff are on the left side of the piece? Most of them are done with solid lines except the palanquin and the two-story building (at the bottom left corner, See Fig-6(d) and Fig-6(e) for a zoomed in view). That means all the things happened here at home and the stuff are still here. But the daughter has left for the two-story building at her in-laws in the palanquin, so these are no longer here, that is why my great grandmother used dotted stitch for those, which mean those exist, those were here and now gone." (P11)*

However, P11 and other *Nakshi-Katha* makers also informed us that the style of presenting cause and effect as well as the passage of time varies from designer to designer. Even so, they report that they should follow general conventions used in the community.

5.4 Storytellers and Provenance

One unique characteristic of digital media is the focus placed on scalability and reproducibility. This reproducibility is seen both in the ability to digitally copy materials and in the way that conventions are regularized across the community to the point that they are almost universal among users of digital systems. Software infrastructure also helps to push modern computing systems to follow a template for usability and scalability reasons. However, there is has long been debate in the arts as to whether reproduction diminishes or enhances the craft of a designer.

In contrast, the traditional practices we observed tended to closely integrate the designer/storyteller into their fabric, potentially to the point that they resist reproduction. Rural practices we observed often surface the designer by emphasizing their individual style. Knowing the storyteller is an important in interpreting the information or narrative conveyed in a representation in Jessore. For example, we refer to Fig-6(a) again, which shows a *Nakshi-Katha* containing a year's worth of significant events as experienced by a housewife. One of our participants, P11 showed it to us, having inherited from their great-grandmother. As the participant explained to us:

> *"In this Nakshi-Katha, she mapped all the significant events happened that year. My cousin has another one that was made by great-grandmother's sister-in-law who lived in the same house. That one had a bull and circus on it. You know, everyone's year is different*

and their choice of motifs are also different. You might need to ask and verify what is it about." (P11)

While continuing the session, the participant informed us that the year would look different in someone else's *Nakshi-Katha* since the relative significance of events, shape and size of objects, and design-sensibility would vary person to person. This makes every *Nakshi-Katha* a unique presentation with an expectation that at points it will drift from established norms in favor of individual style or preferences. Often the *Nakshi-Katha* makers put their signatures in stitches on the *Katha*.

On the other hand, witches in our investigation drew their *Jantras* in such a way that they could recognize their own work later. Such a practice is important for the continuation of their multi-phase therapies as well. They prefer not to interfere with other witches work, making signals of the provenance of their materials crucially important in maintaining consistency of practice. One of the witches explained how this works, reporting:

"I can tell which Jantra was made by me, the threads and the needles I use result into a set of stitches which is different from her (the other witch in the neighborhood). Usually, we do not take each others' clients, let alone interfering the Tantra... (N)o it is not about professional clash, we just don't want to make each others' Jinn mad." (P5)

The witch explained to us that the idea is to keep the scope and significance of the *Jantras* and *Jantras*-driven actions limited and focused within the community for better impact. Tracking their individual actions through unique markers helps to make sure they divide their efforts fairly and minimize existential risk.

The practice of the *Nakshi-Katha* makers and witches suggest that, in order to understand the meaning of traditionally crafted visuals, a viewer ought to understand the culture of the storyteller and share a common ground of social and cultural understanding with the designers. One might need to turn to the designers for further contextual meaning, even sharing a common cultural understanding.

5.5 Situating Readings

Digital information tends not to require specific locations or notions of place in order to be useful. While personalized systems and visualizations are not uncommon, and interactive tools might allow users to explore their locales, it is rarely the case that a visualization is inapplicable or dependent upon a specific real-world context. For example, if someone designs an application to help patients seek information on malaria cures, their design may focus on a specific target population rhetorically but attempt to generalize so that the information could be useful for anyone. Likewise, it is uncommon that a presentations' intended impact is dependent upon shared community or in-group membership.

On the other hand, the traditional practices we observed were often dependent on the physical location of the designer and consumer. This is especially true for visuals in witchcraft therapy. The audience and the consumers have to be physically located in the same locale as the designer. Often *Jantras* are location dependent and thus the therapy and the suggestion by the witches need to be highly contextual to physical location of the household of the person using the *Jantra*. For example, during an observation session at one of our witches' places of business, P6 showed us her witchcraft book. The witchcraft grammar book had a number of *Mantras* accompanied by a set of specific instructions to create useful *Jantra* and *Tantra* for the consumers. However, those instructions are not universalized and ubiquitous. Rather, they are expected to be translated according to the witches (who is the designer in this context). P6 showed us the *Jantras* in Fig-7 as an example from her book and explained how to use those, as we quote from the book,

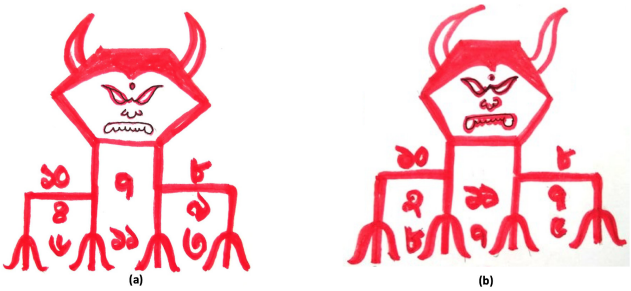

Fig. 7. The versions of *Jantra* that help a consumer if they suspect that some of their neighbors might have placed a bad spell on them. The help-seeker needs to pick a suspect first and tell the witch. The witch will adapt the presentation such that while performing the investigation spell, the tridents point the help-seeker's house and the horns on top of the head point the suspect's house. Here, (a) the suspected neighbor's house is towards 12 o'clock direction and (b) the suspected neighbor's house is towards 3 o'clock direction.

> *"This one helps those help-seeker who suspect that some of their neighbors might have performed any bad spell on them and thus they are in a bad situation. Now, since they do not know who might that be, this spell can find the household where the neighbor lives. The help-seeker needs to pick a suspect first and tell the witch. Following the details, the witch will draw one of the version of these (means Fig-7(a) or Fig-7(b)) or some similar version in a way that while performing the investigation spell, the tridents point the help-seeker's house and the horns on top of the head point the suspect's house. Also, they have to make sure there is no Acacia plant in between these two houses. If the witch doesn't know the mapping of the neighborhood, then performing an investigation spell is quite impossible." (From Fieldnotes, observation with P6)*

The witch also mentioned that if a newcomer in her society seeks help, she would be able to take that case since it is still within the same neighborhood despite their personal unfamiliarity. Thus, for a successful witchcraft therapy using visual *Jantras* and *Tantras*, being a skilled witch and sharing the same cultural grounding as the help-seekers may not be enough. Rather, both the witches and the consumer might need to live in the same physical locations and know the neighborhood well.

A similar observation was also made with the *Thakur-Gora Karigors*. One of the lead *Karigors* explained to us how the location of the commissioner who ordered the *Thakur* is carefully investigated by before accepting the request, mentioning:

> *"If they come from Tetulia (a district in the far north) and asks for a Thakur, I am afraid I would not do it. Not that I can't, but because their Thakurs' attire have some significance followed than that we our Thakur follows here. I learned that their Goddess Durga follows purely Vedic protocol(one of the Hindu sub-practice), our one is a mixture of Vedic-Tantric-Pouranic (all are Hindu sub-practices). I know some stuff from the Shastro (religious books) and some from stories, but what if I miss something? Then the people over there might accept their Thakur will less respect and that would be a problem. However, if someone form north come to our area, we never block them to pray to our Thakur. But Thakur travelling to north generally does not happen." (P40)*

Thus, the usefulness and impact of a rural traditional visualization depend on the designers' physical location along with their expertise and skill and sharing same cultural grounding with the

people who will use the visualization. These factors are an important element for consideration by the practitioners we observed.

6 DISCUSSION

In this paper we have described three rural Bangladeshi cultural practices, namely *Nakshi-Katha* art, Hindu-idol crafting, and witchcraft practices where information is conveyed through traditional practices in arts, crafts, and symbols. From our observations we identified how these practices use visuals as means of record-keeping, as media for storytelling and education, and as tools to guide decision-making in rural life in Bangladesh. We have also explored how these local practices seek to meet a broader goal of storing, representing, and transmitting information through artifacts in ways which do not necessarily align with modern information communication practices. Approaching our findings from the scope of CSCW, social computing, information visualization, and HCI, we see in these practices hints of novel design dilemmas for both designers and theoreticians working with stakeholders in the global south.

6.1 Implications for Design

Through the comparative discussion of modern visualization and rural Bangladeshi traditional visualization, our work points to several design challenges:

6.1.1 Standardized versus 'Situated' Visualization Literacy. One common theme in information visualization and communication theory is the practice of studying individuals through observation and controlled experiments in order to create generally applicable standards. These range from studies of visual mappings [67] to best discernible differences in colors [101] to semiotics for conveying uncertainty [66]. While a great deal of this work is generally applicable across all humans, as they measure generalizable physiological or cognitive factors, investigations that venture into expertise, semiology, cultural conventions, many-to-one relations, interaction modalities, and more risk encoding values and assumptions from prevailing norms resulting from scientific rationality. Thus, while work may in fact result in generally applicable findings, they may only generalize to what might in fact be a narrow audience that is already familiar with existing practices for working with information. Further, this narrowness may be hard to disentangle as a result of the deeply embedded assumptions. As our work as well as a number of past case studies and comparisons have illustrated [73], these assumptions can have particularly acute impacts on the usability of data technologies in low-literacy communities.

In this project we sought to observe the narratives and data practices that individuals in rural Bangladesh employ as a way to understand how traditional practices might differ from current assumptions in the digital communication of information. Through our investigations we uncovered a rich set of practices for producing, managing, communicating, and storing information in individuals' daily activities. We find that, while there are many commonalities with existing practices in research (e.g. tabular representations, using color and pattern to indicate attributes), the bricolage [64] of practices developed by individuals is deeply situated in their cultural and spiritual practices, as propagated to the next generation through oral history and heritage. This leads us to conclude that the people we investigated in rural Jessore are not lacking in 'visualization literacy' per se, rather they are experts in a particular kind of *'situated visualization literacy'* that relies on local, in-group, or familial practices. Such expertise, while effective in the community, may not provide the necessary set of tools to help individuals access tools created following standard best practices (e.g visual channels, rhetorical structures). We posit that this disconnect is a major challenge for the CSCW, visualization, and HCI communities to overcome as researchers attempt to broaden access to data resources. While training might well help to overcome gaps in expertise

vis a vis standard practices, it might neglect the situated practices in a community that could be employed to design more accessible and culturally appropriate tools. This challenge is both theoretical and operational. Not only do we need to continue to develop an understanding of the different ways information is communicated, but also do we need new methodologies for evoking and understanding these practices.

6.1.2 Preservation, Sustainability, and Medium. The rural practitioners we followed each considered the medium through which information was transmitted as a part of their information communication practice. Media encoded different features and were a key factor in some of their decisions. Our findings showed that any sign and icon on a particular medium might encode significant meaning which may not be present on another medium. We also noticed how media are chosen from locally available objects and products such as textiles, clay, and plants (among others) and integrate some of the situated practices mentioned in the previous section. Interestingly, many of the media we saw employed also degrade or decay over time, which also was a consideration for the individual when attempting to store information for long periods. On the other hand, as we noted earlier in this paper, much of digital information dissemination attempts to operate agnostic of the particular device on which it is displayed/used (the exception often being interaction affordances and hardware limitations). The ability to support multiple media and device scales has long been a subject of research [23, 44]. Likewise, value is placed on the permanence of data entities and their relative immutability, though recent research has explored how incorporating slowness and decay can change how individuals relate to digital artifacts [36, 80].

ICTD researchers have made contributions to data preservation problems in marginalized and low-resource spaces. One common solution to the problem of degrading media is to copy the information into another more stable medium (often an electronic one). For example, Open Data Kit [15, 41] and digitized medical data from paper copies in Africa for storage and later use. However, these practices neglect to consider how medium might also shape the kind of information and meaning being communicated through artifacts. Using a different medium with participants in rural Bangladesh may not be appropriate as changing the medium would change the valuation and significance of the information, especially for the practitioners we observed. This poses another standing challenge for the research community: how can we design systems and artifacts that work within familiar, local media and take advantage of their unique situated meanings? How do we still go about providing the kinds of scale, permanence, and transportability guarantees that we regularly employ?

6.1.3 Conflicting Moral Values. Our study also highlights the absolute importance of shared cultural grounding between user and designer so that information can be conveyed successfully and individual values are fully accounted. This calls for consideration of cultural understanding and moral values while designing information presentations for marginalized or low-resource communities. Yet, careless integration of such values might also introduce imbalances. For example, Jessore is a Muslim majority region with a significant number or Hindu residents. If a designer wants to integrate religious and spiritual values in their artifacts so that they could be useful for this group of people, then they must consider how to effectively balance between these two separate (and possibly competing) ideologies so that their innate conflicts may not be exaggerated or worsened. In cases of witchcraft practice in rural Jessore, recent research has shown how local witches learn specialized therapy in both Muslim and Hindu traditions, offering treatment to the clients based on their choices [97]. Furthermore, the local witches avoided providing suggestions and treatment to women that directly conflicted with values of their patriarchal society – rather they often found alternative ways to help the women gain more agency. Similarly, Bidwell et al. established a handshaking of local traditional medicine practices and indigenous knowledge

with ICT for improving wellbeing in Africa [76, 91]. We suggest that careful attention must be paid in how best to address coexisting and conflicting values in information visualization and communication systems which leverage local practices or knowledge.

6.2 Broader Implications

Along with pointing to some design challenges for visualization research in this domain, our work also joins two broader agendas in CSCW, social computing, and HCI research: postcolonial computing and feminist design.

6.2.1 Postcolonial Values in Information Visualization. Our study contributes to the growing body of literature on postcolonial computing within the CSCW and HCI communities [5, 51, 72]. Building on long-standing, influential work by historians, philosophers, and social scientists, postcolonial computing criticizes the mismatch between the values that are embedded in technology by western designers and local values and practices in the Global South. Such technologies do not only fail to capture the the problem from the ground-reality and hence fail to respond accordingly, but also produce a problematic power relationship with the West that perpetuates through various aspects of postcolonial societies [56]. One root cause of such power-laden transfer of values through technology can be found in the modernist practice of universalizing knowledge [97]. Postcolonial literature has long been critical to such 'universalizing' and exercising politics through and over them [92, 93]. This problematic practice is often evident in medicine, agriculture, architecture, and technology that is embedded in the computing practices in those disciplines - as scholars of postcolonial computing reveal [8, 9].

This paper joins this growing body of work in CSCW and related literature and shows how the practice of information visualization over computing embodies Western scientific values that are often not compatible with local traditions and cultures of rural Bangladesh. Our study shows how the rural Bangladeshi communities have a long and rich traditions of storing and communicating information that are strongly connected to the local art, culture, people, history, materials, and environment. We thus show how the local practices are fundamentally different from a modern scientific practice that risks alienating data from material, designers, and context. We argue that having more knowledge about people's lives, communities, values, practices, religion and spirituality through long-term ethnographic engagement and participatory studies will lead to more effective information communication techniques for this and similar marginalized population.

6.2.2 Women Empowerment Agenda and Information Access. Our study also joins a major ongoing discussion in CSCW and HCI on feminism and women empowerment. In many cases designers have tried to empower the women in patriarchal societies by assuming that women having more access to information and technologies would automatically provide benefits. However, in a patriarchal society like Bangladesh, women's access to information and communication technologies has reportedly been limited by patriarchal practices along with other reasons [98, 100]. While many researchers see this as a roadblock to empower these group of women, often they develop their own ways of information exchange and record-keeping (e.g. employing them for communication over the generations through their *Nakshi-Katha* and witchcraft practice). Previous works by Medhi et al. has showed the potential of using iconography as tool granting access to marginalized people [24, 71] and Kumar et al. showed how rural Indian women come up with their situated solutions while accessing and managing their information [57]. In their work with rural women in Bangladesh, Sultana et al. called for enabling situated tactics through design for rural women's empowerment [99]. Our work responds to that call, informing the domain about women's practice of using different local objects, crafts, and symbols in developing situated contextual visuals for mundane purpose, and arguing that an integration of this practice in feminist HCI design could be a

possible avenue for culturally appropriate and acceptable design for the rural women in Bangladesh and women in other similar places.

6.3 Limitations

Our work has several limitations which might influence how our implications and broader considerations ought to be interpreted. First, our work is not free from participation bias and selection bias. We had the opportunity to engage with a total of 220 villagers from the ten villages through a snowball sampling process. While we can assume that opinions and arguments represent the collective view of the residents of the whole geographic area, this may not actually be the case. Second, our interaction with the participants could also have suffered from experimental and methodological flaws. Question-order bias, self-presentation maintenance, and power imbalances all might influence the kinds of things we observed.

7 CONCLUSION

In this paper we explored how modern practices of information visualization in human-computer interaction risk sidelining marginalized communities due to prioritization of scientific rationality and modernity. Through a six-month long ethnographic study with *Nakshi-Katha* makers, Hindu Idol makers, and witchcraft practitioners, we investigated how rural practitioners use their own forms of representation and narrative in record keeping, social and religious storytelling, and information-mediated decision-making. We found that traditionally developed approaches towards presenting information often made use of concrete units to represent entities and connect to designers' cultural practices and the physical location. Further, we identified how medium had a significant influence in individuals' meaning-making and how strategies and conventions are passed down through generations within the community. We discussed how the rural traditions we observed differ from the modern information visualization practices, exploring how an understanding of traditional practices for representing information might be useful in developing more accessible, and culturally appropriate modern tools and technologies for the people of rural Bangladesh and similar communities. We hope that our findings might offer additional insight for researchers and practitioners investigating ways to broaden the impact of information and collaborative technologies.

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