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WIRELESS DEVICES FOR HUMANITARIAN DATA COLLECTION

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WIRELESS DEVICES FOR HUMANITARIAN DATA COLLECTION

The socio-technical implications for multi-level organizational change

We apply socio-technical theories to explain and predict technological choices and use by humanitarian relief and development organizations. This research examines the organizational context of using a personal digital assistant (PDA) in the field to collect data. We identify organizational factors at multiple levels that are likely to influence a field-based PDA data collection initiative in the context of a large, international non-governmental organization. This research differs from existing studies that have documented different effects of information and communication technology on various organization levels when information technology (IT) is deployed throughout the organization. The research suggests that despite being motivated by upper levels of the organization, the middle levels of the organization (the country offices) are most affected by the IT implementation. We assert that the motivations for changes made to the technological systems and/or devices used by a multi-level organization will produce significant social/organizational changes at each level of the organization. We also claim that the motivations for technological change in organizations that stem from the top layers of that organization are likely to produce beneficial changes for the top layers of that organization. Intermediate and bottom layers will experience a mix of changes, with some being negative and some unintended for the respective layers.

Keywords socio-technical theory; organizational theory; humanitarian relief; accountability; wireless devices

Introduction

The intent of this article is the application of socio-technical theories to explain and predict technological choices and use by humanitarian relief and development

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organizations, an understudied arena. Within this intent, we make two specific theoretical claims. First, we assert that the motivations for changes made to the technological systems or devices used by a multi-level organization will produce significant social and organizational changes at each level of the organization. Second, we assert that the motivations for technological change in organizations that stem from the top layers of that organization are likely to produce beneficial changes for the top layers of that organization. Intermediate and bottom layers will experience a mix of changes, with some being negative and some unintended for the respective layers.

The unit of analysis for this research is a non-governmental organization (NGO) that delivers food, clothing, and health services to beneficiaries in the world's most impoverished areas. Despite these remote areas being far from the power and telecommunications infrastructure often associated with information and communication technology (ICT) use, NGOs are beginning to deploy wireless devices through field staff, primarily for the benefit of data collection.

These deployments are due in part to a trend toward increased accountability for NGOs, which have created a data collection imperative and part of advances in wireless technologies that have enabled NGOs to attempt to push technology, along with its costs and benefits, further into the field. These advances do not, however, guarantee acceptance by field personnel or that value is generated for the wide variety of stakeholders.

One area in which wireless technologies, and in particular personal digital assistant (PDAs), are beginning to be used is to replace or supplement existing pen-and-paper data collection systems established for donor-specified monitoring and evaluation programs. These data include information such as the identity of beneficiaries, demographic characteristics, health conditions, and services provided. They are typically analyzed in country offices or at international NGO headquarters. It is in these locations that the need for the data, as well as its content and structure, are often defined. However, once collected, these data are also used to help improve current and subsequent program implementations and designs.

Thus, the arrival of ICTs in these remote and impoverished areas is both driven by, and has subsequent implications, for the organizational processes of NGOs. This research examines the organizational context of a field-based PDA pilot implementation for data collection about beneficiaries (the clients served). We seek to identify organizational factors at multiple levels that are likely to influence a field-based PDA data collection initiative in the context of a large, international NGO. In five countries, the program introduced PDAs into pen-and-paper intensive data collection processes that support programs in Food Security, Maternal and Child Health and Community Development programs. The data presented here were collected during feasibility assessments and field testing in one of those programs.

Our findings suggest that PDA use brings about significant organizational changes, and that the higher levels accrue benefits while lower levels have mixed results. PDAs, as with all information technologies (IT), demonstrate the characteristic of dual potentiality: the same technology, depending on the purpose to which it is applied, can increase organizational power and control or instead empower users.

Theoretical approach

During the past two decades, research on ICTs has demonstrated that the benefits of advanced technologies do not necessarily accrue to the organizations that adopt them. Further, it has increasingly been recognized that technological development occurs within organizational contexts and that these two entities, technology and organizations, have complex interactions. This perspective, as articulated by socio-technical systems (STS) scholars, provides a framework for identifying the organizational issues that will likely influence field-based PDA use.

The STS theory approach argues that any design/redesign of work system must deal jointly with the technical and social systems – two independent, but correlated systems that make up a 'work system' (Cherns 1987; Eijnatten 1994). In terms of stretching STS to study the role of ICTs in development efforts by NGOs, we make two key assertions drawn from the theory.

First, we assert that the motivations for changes made to the technological systems or devices used by a multi-level organization will produce significant organizational changes at each level of the organization. This claim is built on work that demonstrated IT applications introduced throughout an organization were used differently and impacted each level of the organization differently (Davenport *et al.* 1992; Orlikowski 1992). Further, across comparable organizations Robey and Sahay (1996, p. 108) show that 'nearly identical technologies occasioned quite different social meanings and consequences'. The findings of these studies suggest that IT have differential effects as opposed to a single fixed effect (Kling 1999). Further support for this theoretical argument is offered by Leonardi and Barley (2008) in which they argue three key points concerning the introduction of new ICTs into a multi-faceted organizational setting: '(1) that the outcomes of adopting an IT will reflect unique social processes that transpire in the immediate context of the technology's use, (2) that IT and an organization's social structure merge in idiosyncratic ways, and (3) that people often use technologies in ways other than managers or designers intend'.

Second, we assert that motivations for technological change in organizations that stem from the top layers of that organization are likely to produce beneficial changes for the top layers of that organization. Intermediate and bottom layers

will experience a mix of changes, with some being negative and some unintended. This theoretical assertion is drawn from STS research that focused on the differential adoption of technologies according to hierarchy, rank, or power within organizations. These perspectives are particularly adept at exposing the governance, control, and political motivations behind technological choice and development, critically exposing privilege and power (see among others, Law & Bijker 1992; Williams & Edge 1996; Winner 1997). This orientation is not satisfied with merely identifying differentiated use among organizational units, but relates that differentiated use and adoption to relative positions within the organization and the ability of units to make decisions and control resources (Kvasny & Keil 2006; Tapia 2004) (Figure 1).

STS theory seeks to understand the *influence and interdependence* of organizational and technical characteristics for the effective design, development, implementation, and use of information systems (Lyytinen & Yoo 2002). In the case analyzed here, the organization can be treated as a set of levels, with the domain of IT use being the lower level, influenced by successive organizational and sectoral levels. Further, international NGOs are embedded in contexts that range from rural areas in developing countries, with all the accompanying challenges for ICT implementation, to the power centers of the world, including London, Washington, and Tokyo.

There is mutual influence between the ICTs and the organizations. The organization influences the design and use of ICT and subsequently, ICT use affects the organization, creating pressures for structural changes, redefining roles, and changing the nature of work. In examining the influence and

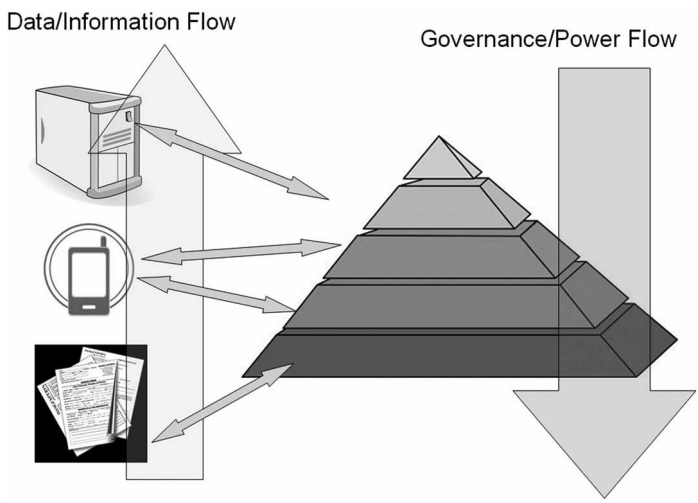

FIGURE 1 Differentiated ICT use and adoption based on differentiated organizational units.

interdependence, this research will both define the stakeholders to the wireless device implementation and assess the potential costs and benefits.

Context: humanitarian information collection

The international humanitarian aid sector consists of a very large number of small agencies that are predominantly local, as well as a small number of large, multi-continental agencies. These large agencies typically have their headquarters in so-called western (and northern) countries from which large numbers of country or field offices are supported. Some of these larger agencies, such as CARE, the Red Cross/Red Crescent, and Save the Children, are organized as federations in which national offices have high levels of autonomy (Brown & Moore 2001).

The revenues of these large NGOs are generated from a variety of sources, including charitable contributions from individuals and firms, as well as through contracts and grants from government and NGOs. In many cases, a large portion of these revenues come from the development agencies of western governments (Edwards & Hulme 1996).

As recipients of government contracts or grants, international NGOs are expected to report on project progress and outcomes that in turn generate demand for, and stipulate the structure of, data collected from beneficiaries. While data can be put to many uses, and the primary motivation for data collection may be donor reports, data collected from and about beneficiaries also enable (1) program evaluation, management, and organizational learning, (2) education of beneficiaries and their further engagement in their own development (Buckmaster 1999; Ebrahim 2002, 2005; Lewis & Madon 2004), and (3) establishment of baselines against which development programs may be planned, assessed, and marketed (Murray & Carter 2005).

The primary accountability reason is part of a larger trend that is also affecting governments and the private sector (Brown & Moore 2001; Ebrahim 2003a; Gray *et al.* 2006). Despite the difficulties associated with measuring for accountability, NGOs typically employ a variety of accountability mechanisms, roughly divided into tools and processes (Ebrahim 2003a). While *tools*, such as reports, disclosure statements, and performance assessments, emphasize easily measurable and quantifiable results, *processes* are more broad and multi-faceted, and emphasize a course of action and include participatory methods, self-regulation, and social audits (Ebrahim 2003a). While both require data collection in both quantitative and qualitative forms, bilateral donor agencies increasingly require quantifiable measures of performance.

NGOs have both downward accountability to beneficiaries, staff, and supporters, and upward accountability to donors (Edwards & Hulme 1996) and host governments. Additionally, an NGO might also consider accountability to itself, its mission, and its goals (Ebrahim 2003a). As with all organizations

that must meet the needs of a wide range of stakeholders, these multiple accountabilities can create tensions (Ebrahim 2003b). For example, an NGO may feel greater accountability to a cause rather than to a donor (Brown & Moore 2001). Further, the balance between upward over downward accountability may be influenced by the extent to which an NGO relies on powerful government donors (Edwards & Hulme 1996).

The increased demands for accountability-related, and hence typically quantitative, data have generated criticism of measurement as well as of donor power. The primary criticism is of their requirements for detailed, typically quantitative, outcome measures, which is seen as an attempt to turn a highly uncertain and complex activity (development) into a linear and certain process. NGOs and academics that argue against performance measures cite the complex nature of the relationship between service providers and beneficiaries, which includes, for example, trust, emotion, conscience, social contracts, and mutuality, as one that cannot be reduced to simplified and quantitative measures (Gray *et al.* 2006). However, NGOs are often constrained in their choices due to the power of bilateral donors (Bornstein 2006).

Hence, given these requirements we seek to answer the following questions:

1. Given donor power and increasing importance of accountability for NGOs, how are these demands translated into organizational action at the level of the beneficiary? How do different levels of the organization interpret these demands?
2. When ICTs are used to meet these demands, what are the likely outcomes for the different levels of the organization as well as for beneficiaries?

Methods

We employ a case study approach (Yin 2003) as it allows for capturing holistic detail in natural settings (Benbasat *et al.* 1987; Yin 2003). Other advantages of the case study method for this investigation include its appropriateness for research engaged in: studying phenomena that cannot easily be distinguished from their context; theory development and extension (Benbasat *et al.* 1987; Darke *et al.* 1998); studying areas that are underdeveloped in the literature (Benbasat *et al.* 1987); and studying ICTs in organizational contexts (Darke *et al.* 1998).

Our case study examines a pilot ICT implementation in a large multinational development NGO. This NGO is generally similar to its peers in its organizational structure, the size and structure of its ICT staff, and in the development programs it operates. Trade press and study participants suggest that PDA-based beneficiary data collection is currently spreading, or soon will spread, across all organizations engaged in humanitarian relief and development. Thus, this IT implementation is unlikely to be idiosyncratic to this organization.

Following the standard protocol for conducting case studies (Benbasat *et al.* 1987; Yin 2003), this research relies on multiple sources of evidence and analysis

techniques. We used three forms of data: interview data with organizational representatives, official policy documents, and other forms of internal and external textual communications. Our data comes from a large, international NGO, which provides humanitarian relief to developing nations through continuing development programs. This NGO placed approximately 200 PDA devices in the field in five countries, principally in their child and maternal health programs. The data presented below are primarily from Bangladesh, the first country to fully develop the PDA program, although where appropriate we supplement with data from other countries. The data were collected via interviews with NGO representatives from headquarters and with the wireless device program manager. In addition, we present secondary data from feasibility and field tests in Bangladesh. Fieldwork was carried out in October 2005 (feasibility assessment), March 2006 (proof of concept), and June 2007 (implementation).

Case study

The overall goals of the Bangladesh programs are to promote household food production, improved access to, and quality of, basic health and nutrition services, as well as improving families' resilience to shocks as they are under constant threat of natural disasters. Within this multi-agency program, the PDA project targeted the NGO's integrated Mother Child Health and Nutrition (MCHN) and Food Security (FS) programs. Together these programs seek to improve the nutrition of children under the age of two through well-established healthcare mechanisms. In these integrated programs, if a pregnant mother, or mother with a child under two years of age, registers for maternal/child health services at a health center, she then qualifies for a ration at a food distribution center. This program design thereby requires transfers of information about beneficiaries between the health and food distribution operations.

These operations provide services to approximately 190,000 registrants (estimated March 2007) in an area with a population of approximately 2.8 million inhabitants. These services are provided through 87 field officers who support a total of 2,637 health centers. At the health centers, and supervised by the field officers, are 3,154 community health volunteers. The volunteers are typically women from a local village who are familiar with the local environment and know families in the area. Similarly, the food distribution program is run by 43 food commodity field officers who oversee 336 commodity distribution centers providing service to over 160,000 beneficiaries. In the following, we describe the traditional beneficiary data collection processes and then the integration of the PDAs into these processes.

The beneficiary data collection system

Within the Dhaka Country Office Food Security Department, Bangladesh, management information services has developed an SQL Server-based database

application. The database serves as a secure data repository that exchanges data and enables the printing of lists of beneficiaries (in support of the paper-based process), as well as commodity distribution management utilizing bar code technology (in support of IT-based processes). The database also enables monthly reporting to all stakeholders, both within the NGO and at other agencies.

In the field, the process of data collection and distribution begins when child health volunteers collect data from new program participants by recording data on forms that are then sent to Dhaka to be entered into the database. At the next visit to the health center, the beneficiary is allocated a tri-fold laminated document containing their registrant data and a pre-printed bar code that corresponds to a unique identifier in the central database. Subsequently, at the food distribution center information is taken from the card and matched to records distributed from Dhaka (either by barcode scanner and automatic lookup or via manual lookup on paper). Food distribution is used as an incentive for encouraging consistent health center visits, and therefore, data on health center attendance should be continually transferred to the food distribution program. The food distribution program also relies on the MCHN program to estimate the amount and location of food distribution.

The food distribution data collection process uses 11 laptops assigned to the district offices for each of the commodity distribution points. Using a virtual private network link to the central database in the Dhaka Country Office, the laptops are pre-loaded with the MIS (management of information systems) application and its associated database, including data on the number of registrants and their health center attendance. After updates are loaded, the field officers then return to the commodity distribution points with the laptops where the rations are delivered from the centralized warehouse according to the pre-determined number of registrants.

The database application for food distribution can only be used consistently wherever electrical power is available. In the absence of a power infrastructure, or when laptop batteries are drained of power, the manual paper-based system must be used for registrant validation and accounting of commodity distribution. Given that electricity is available at only 13 percent (43 of 336) of the distribution points, the large majority of the data collection process is carried out manually, including identity validation and recording of benefits, as well as transcription of the data into the district office laptop for uploading to the central database. The resulting problems of incorrect or missing data cause inaccurate program evaluation and commodity management along the entire supply chain, thereby limiting program effectiveness.

A change of data collection devices: the move to PDAs

The PDAs shown in Figure 2 presented several advantages to help overcome the above-mentioned challenges and through their introduction into the health and

FIGURE 2 Databases as used on the PDAs.

food distribution centers they were put to several uses. They were deemed appropriate due to the mobility of field staff, which excluded desktops, their cost advantages relative to laptops, and the ease with which they could be carried and used during the data collection process.

Therefore, PDAs have several uses, including (1) data input, (2) identity validation, and (3) data delivery. Using PDAs, data input occurs through several methods including writing, drawing, typing, and audio recording. Although this is not being done now, if augmented, PDAs could also capture barcode data (when attached to a barcode scanner) and location data (when attached to a GPS receiver). Further, specialized software made it relatively easy to design surveys and load them on the PDA. Data input proceeded via drop down menus and other means that make it easy to use a stylus or pen, thereby minimizing the need to type.

PDAs also enabled identity validation by storing, retrieving, and matching data. Beneficiary profiles, identity numbers, and photos are stored in the PDA and used to validate identity at the time of service delivery. Identity validation is particularly important in programs such as food distribution to prevent people from trying to get food more than once. Validation also ensured beneficiaries complied with service conditions, such as attending nutrition consultations before receiving food.

Finally, PDAs also enabled delivery of data both from the field to headquarters as well as back to the field again. While the normal flow of data is typically from the

field to headquarters, PDAs also enabled the download of data to PDAs. Thus, field staff had potentially both beneficiary histories and other important information to help pre-populate forms to speed data collection, as well as the latest results of analyses for their area or program or other programs. The PDAs were also loaded with training materials that could be presented to beneficiaries or volunteers.

Discussion

The above case indicates the complex and multi-level organizational context within which PDA use in beneficiary data collection programs was undertaken. The levels consist of a sectoral component, a headquarters component, a program/country office component, and finally, the context of data collection itself. As suggested in Figure 3, each level has its own unique and interconnected influence on PDA use. But does PDA use bring about significant organizational changes, and do higher levels accrue benefits while lower levels have mixed results? This analysis examines motivations for program support and organizational process changes, as well as their implications for information flows and governance/power at each level.

In brief, we found that significant changes occurred in the country office. Mixed results were experienced by volunteer field workers and beneficiaries.

Sectoral component

Accountability has become a significant organizational obligation for NGOs with the consequent translation into established processes and procedures and

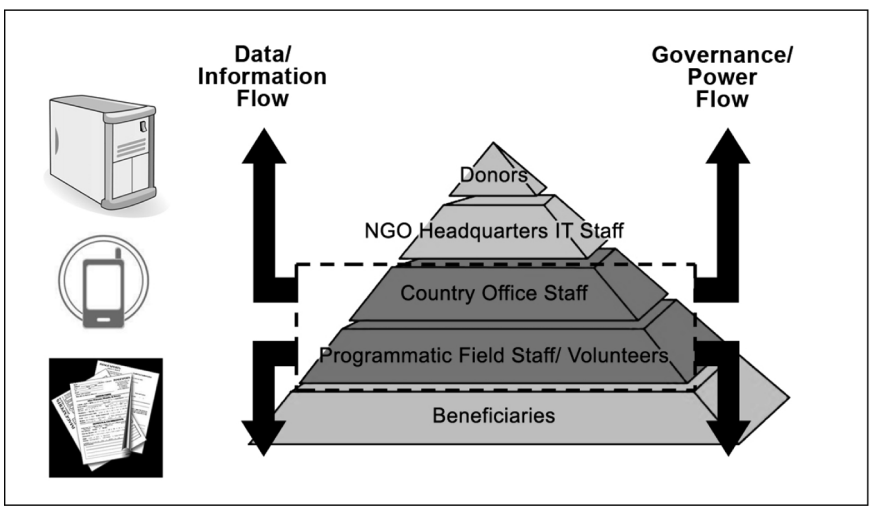

FIGURE 3 PDA implementation for beneficiary data collection: differentiated adoption and use.

increasingly dedicated information systems. As indicated by the data from these programs, the PDA use is targeted primarily toward quantitative data collection activities. These activities fit in well with the dominant sectoral paradigm for evaluation, and as such, should provide benefits for the organization in relation to its donor commitments and upward accountability. Principally, the primary advantages for upward accountability are likely to include more timely data and the potential for fewer errors. It is unlikely that comments scribbled in margins or in drawings in pen-and-paper data collection systems make their way to headquarters. Hence, the potential limitation of a PDA – that it does not collect comments – has negligible implications for upward accountability.

Over time upward accountability programs may benefit through increased standardization and stabilization of data collection processes. The increased formalization of the data collection process resulting from the introduction of PDAs may improve the quality of the data. For organizations, however, this increased formalization of processes that serve upward accountability may make it costly to eschew such programs at a later date. Hence, the introduction of PDAs may further institutionalize programs of upward accountability at the expense of improvements in downward accountability, particularly to beneficiaries. Hence at the sectoral level that is concerned with accountability, changes to the information flows are likely to be increases in quality. In terms of changes in power, increases are likely to occur through the institutionalization of upward accountability programs that will accompany more extensive use of IT. However, because these effects will accrue slowly, we consider them secondary.

NGO headquarters

IT staff at the NGO headquarters served as the organizational enabler of the PDA data collection system, driving the IT implementation through their influence on the technical choices made by all parts of the organization. Hence, the types of wireless devices, databases, and software used to support the program are influenced by choices made at headquarters. In addition to these choices, there are several ways in which the headquarters IT department also influences PDA implementation, including strategy, funding, and personnel.

For example, subsequent to a change in leadership in 2000, the IT department sought to change its strategy from a focus predominantly concerned with issues at its headquarters to one with a greater field orientation. This was in part a response to the increasing sophistication of field office IT staff and demands for greater IT use arising from greater demands for data, reductions in the cost of IT, and wider recognition of its benefits.

The second mechanism of influence over the PDA program was funding. Typically such a project would require external donor funds or full funding by the country offices. However, neither was likely in this case because previous generations of PDAs had failed in the field and therefore new implementations

required field tests to demonstrate their potential. Given this climate and the strategic orientation of the headquarters IT group, they decided to provide seed funding for the project.

The third issue influencing the project was personnel. Headquarters-led IT projects typically require headquarters-field interaction, which can be handled by telephone or email interactions. However, the use of PDAs in the field required IT personnel who were flexible enough to travel to remote places in multiple countries where beneficiary data collection occurred. Further, as the limited seed funding meant a successful project would require ongoing support from the country offices, it had to be 'sold' to them. The solution was to use a consultant with the ability to work independently.

From a headquarters perspective, the PDA project used a technology that is mobile, flexible in its application (can be used in many programs and across countries), and relatively easy to support. The project helped headquarters fulfill its desire to get closer to the field without figuratively getting stuck in the country office. Further, the modest cost of the PDA system meant that with a relatively small amount of start-up funds the project could demonstrate adequate benefits so as to become relatively low cost. Thus, strategic fit, cost, and flexibility were crucial organizational requirements for the launch of the PDA program. In terms of the implications for information flows and power, the likely benefits enjoyed by IT staff included a more centrally located position within the organizational hierarchy, as well as the funding, staff, and decision rights that accompany such an increase in status. These benefits derive from the data collection processes becoming simultaneously more technologically dependent and central to the organization as a whole.

Program/country office

Perhaps the most important and interesting level of the organization is the country office, which typically manage field-based data collection about beneficiaries. These country offices receive some degree of headquarters support in areas such as human resources, program management, and IT, and in turn are likely to support a number of sub-offices or field offices. The country offices, staffed mostly with host country professionals, are typically used for administrative purposes with programming activities being carried out through the dispersed network of field offices. Beneficiary data collection programs are managed at the country office level, involving program, monitoring, and evaluation as well as IT staff.

The Dhaka Country Office was the level of the organization in which there was the greatest amount of organizational change as a result of the PDA system implementation. Indeed, the greatest beneficiaries of PDA use are likely the mid-level staff for whom they are likely to bring increased satisfaction with work (due to the reduction of tedious tasks), more pleasant working environments

(once paper is cleaned away from offices), and increased stature attributed to mobile device use. The costs for mid-level staff are the responsibility for safeguarding the device and the potential frustrations that technology can bring, as well as possibly increasing the social distance between technology wielding PDA users and beneficiaries. For country office managers, the technology was only valuable in cases where business processes were such that individuals had data collection as such a significant part of their tasks that the expense of the PDA, the software, and accompanying accessories could be justified.

According to one interview, the organizational employees who received the most benefit from the PDA system were the 'country office workers, the M&E [monitoring and evaluation] managers and program managers' because they were receiving cleaner data faster. The same interviewee stated that the country office staff was also the most likely to have to change and to resist that change. Concerning the country office IT staff he stated, '[the new PDA system] it makes in harder for them because they have a new process to support and now they have to support database software rather than just spreadsheets. Moreover, they need more bandwidth for their VSAT (satellite) connections' for data collection.

In another interview the subject stated that, 'the middle tier, the ones who use the data, being the country office workers' receive the most benefit from the PDA data collection system. However, simultaneously, '[speaking about] the resident IT support group at the country office level – I get resistance from them because all they want to do is keep the email and web servers running and don't want to deal with something different'. However, the country office program staff enjoyed many benefits of the PDA system, especially in accuracy of data. The entry forms on the PDA only allowed for certain values of data and are self-checked in the field, making data cleaning in the field office less burdensome. One participant stated, 'Yes, the PDA can check the validity of the input data. Usually they have to do a two-step data cleanup but now they've eliminated that. They'd usually do an analysis of completeness, but that's done locally because the form software prompts [the user]'.

Another subject described the time consuming, complex and difficult tasks of converting the old paper surveys into databases and PDA forms, which took place in the country office. This was further evidence of the amount of work and organizational change experienced at the middle level. He stated, '... we spent 2.5 hours on three questions but we could not get the group to agree on what the questions meant. The paper forms cannot be directly translated into a (PDA) data model – the format, the wording, the response categories, the flow logic etc'.

According to secondary data from a PDA program in Bolivia, 'Historically this program was tracked by collecting paper forms in El Alto, traveling an hour back to the country office in La Paz and taking 17 days per month to transcribe data into a database and report on results'. By applying PDAs to this work flow, they were able to reduce data collection and reporting from 17 days per months to just over 7 days, a gain of 57 percent.

Clearly, the country office experienced several organizational process changes, which have implications for information flows and power. Similar to the headquarters IT staff, the increased use of IT in the data collection process is likely to increase the power of the country office IT staff. Also, the improved information flows into the program and M&E operations, giving them control over a more valuable asset, are likely to increase their power vis-à-vis their relationship with headquarters.

Field staff and volunteers

Across all of our interviews it was clear that the jobs of the hundreds of field workers, the primary users of the PDAs, and thousands of volunteers were significantly affected. These staff were confronted with a complete change in their daily work and informational processes (Figure 4). In most cases their use of the PDA was their first use of a handheld device and they required significant levels of education, training, and confidence building. Often field workers refused to use the PDAs or developed side-by-side paper systems to accompany them. Oftentimes the PDA was used to collect data in the country office while the old paper system remained in place to collect data for the local volunteers and beneficiaries.

As one of the field workers said: 'I think it's created a burden that they have to keep track of the PDA, but the value of it is the onsite analysis and then back in

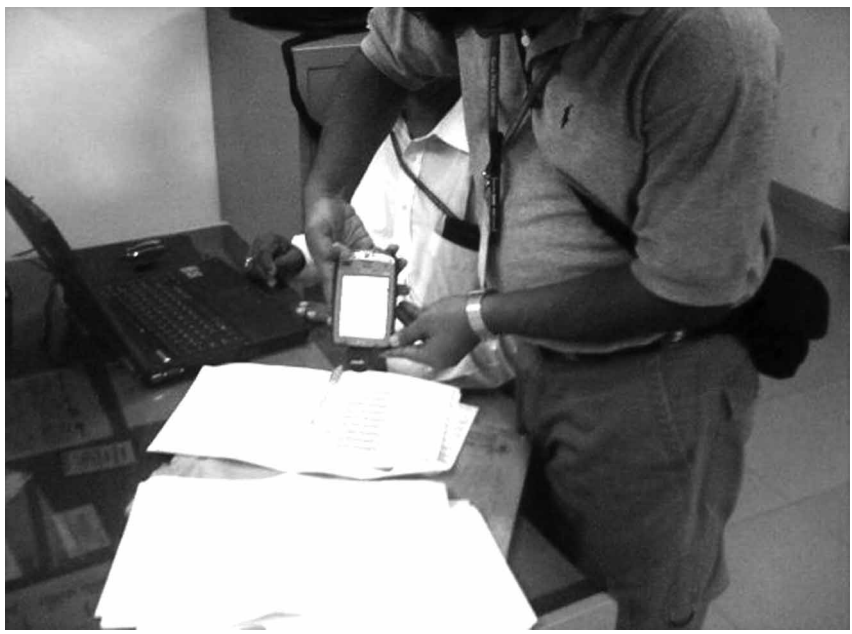

FIGURE 4 Country office staff with PDAs learning to scan barcodes.

the office to not have to transcribe'. He went on to state that the PDAs also helped speed up the data collection for the field workers. 'For example, I might have 6 different sets of paper interviews and then write on it; with the PDA you have it all there and then the form can hide all the irrelevant questions and move through them quickly'. In another interview, an official spoke about how the field workers could now also bring information and tools back to the villages with them on the PDAs. He stated, 'Now they can provide power point slides and training videos (reverse information flow) . . . and results of statistical analysis'. Later the same interviewee stated, 'In Haiti they carried pharmacologic data with them that reduced the need to travel . . . In Bolivia they carried the entire census of the country on the PDA'.

Another subject talked about how the PDAs were used by fieldworkers in unanticipated ways, 'Yes, but they'll hide it; it depends on the level . . . as long as the [NGO] people get their data that's the important part; it doesn't matter so much what happens in the field. You also might not have all people in the field using the PDAs. Thus, only the information is captured that the program managers want'.

For volunteer staff the benefits were fewer as they were less likely to use the devices. For example, in Bangladesh the PDAs were used predominantly by the field officers and not the volunteers. There are many reasons for this, including the large number of volunteers and their generally low level of education and IT familiarity that would make PDA use and training challenging.

At this level there were significant organizational process changes but their effects are unevenly distributed across the staff. Whereas the use of the PDAs and the associated responsibility will increase their power, there were few changes seen in the nature of the information flows.

Beneficiaries

PDAs can represent a variety of likely costs and benefits for individual beneficiaries. The costs are mainly those associated with discomfort associated with having their data recorded via this medium and the potential loss of information they deem important, but not recorded via the PDA. The observed benefits from the Bangladesh program include reduced queuing time for food distribution and reduced errors in the data used to validate identities and track their progress (Figure 5).

According to one of our subjects, the number of beneficiaries increased directly because of the PDA program in Bangladesh. He stated, '. . . they've been able to significantly increase the number because it was limited to 300,000 because of computers, and now with PDAs they can serve almost 600,000 people'. He went on to explain that, 'The physical extent of the program area was limited because mothers had to walk to these few places to collect food. [The NGO] they could not extend the program because they used

FIGURE 5 Food and medicine distribution center in Bangladesh: mothers with new scan cards.

a bar code system and laptops to register people. They couldn't expand it because the paperwork process was killing them. So they went from laptops to PDAs.'

One report suggested, 'porting the tracking application to PDAs which with maximum battery packs could last ten hours, translated into a 39 percent savings in data entry time. Lest anyone think this is merely a data efficiency gain, being able to handle 39 percent more transactions per day could mean the difference between life and death for women and children who walked kilometers to the food distribution center and who are waiting in line in 90°F and 90 percent humidity weather for food rations'.

An interviewee echoes this data, stating that in a PDA program in another country evidence exists that the PDA program is saving lives, 'Yes, they're saving lives; in El Salvador instead of taking two months getting the data analyzed they got the data in two days. The data scared the local mayor who was hoarding food and selling it on the black market. The data on the poor nutrition compelled him to release the food'.

In another interview one subject worried that the PDA program might actually be harming beneficiaries in some ways. He stated, 'Yes, I worry about bias, that the clipboard is accepted and the PDA may not – are you recording, is that information going to go to the government, why are you asking me that question? [I see the PDA as] both positive and negative . . . It can break down barriers that the clipboard creates but creates the fears'.

It appears that PDAs will have some direct implications for beneficiaries. Data collected for downward accountability to beneficiaries are typically communicated in graphical form through simple charts that are readable and visible to all. The analyses are basic and thereby do not require a computer nor a PDA. However, if data from other programs or from other regions is delivered to field offices via the PDAs (e.g. charts and pictures that could be copied onto posters by hand), the use of the PDA as a data delivery tool could be of value.

Implications

As stated above, the overarching goal of this research is to extend socio-technical theories to the technological motivations and choices of humanitarian relief and development organizations. Because of the unique nature of humanitarian/development organizations in terms of structure, function, and context, we anticipated that we would find unique patterns of technological choices and actions. We anticipated that due to its structure, each level of the organization would express different motivations and different likely outcomes about the decision to move to a PDA-based data collection system.

This is exactly what we found. Donors were primarily motivated by the need for transparency, accountability, and efficiency. Headquarters were primarily motivated by the desire to align their actions with strategy and to contribute to meeting donors' data requirements. Country offices were motivated by the desire to fulfill the data demands of those higher-up in the hierarchy, but also to reduce their workload, increase funding, and meet the needs of their beneficiaries. Field staff and volunteers were often motivated by the desire for more efficient use of their data collection efforts, the desire to serve more beneficiaries, and the desire that more timely data flow back into the villages.

Our second goal was to seek evidence supporting the claim that technological change that stems from the top layers of the organization is likely to produce beneficial changes for the top layers, while intermediate and bottom layers will experience a likely mix of changes. This claim was also supported, but not nearly as clearly as the first.

While each level of the NGO hierarchy experienced some degree of organizational change, the change itself was not equal in terms of amount or intensity as well as being qualitatively different. Those at the top of the hierarchy, while having initiated, funded and staffed the program, did not experience significant organizational change.

This can be contrasted with our most important and unexpected finding, namely that the middle of the hierarchy experienced the most organizational and technological change, the most potential benefits, the most resistance, and the most impacts on work and information flows. The country level staff and the paid field workers were the primary developers of the PDA system and its

technological supports. They developed the transition between paper to PDA with accompanying workarounds and side-by-side systems. They developed the PDA training modules and the delicate methods by which they would be exposed to the beneficiaries. They were the daily users of the PDAs in the field and became part of the information conduit in both directions.

We anticipated that the beneficiaries, being at the bottom of the hierarchy, would experience a form of 'data imperialism' (as one of our subjects called it) in that data would be taken from them, quantified, and sent up the hierarchy without any direct benefits accruing to them. However, while we found this to be true, we also found the PDA-based system to have significant potential to positively affect beneficiaries if used to bring back useful data and information to the village.

These findings contribute additional nuance to STS theories, as well as contribute to the literature on accountability. Namely, they provide evidence of the dual nature of organizational and technological change in a context in which IT implementation, while motivated by higher levels of the organization, has its most significant implications for IT use and organizational processes at the middle levels. Further, these changes are likely to result in modified information flows and power structures, as IT use is likely to further institutionalize quantitative upward accountability programs.

Conclusions

NGOs are operating in a context that is generating greater demands for accountability. While donors are primarily concerned with upward accountability, participative development programs also generate demands for higher levels of downward accountability. These sometimes competing demands suggest that IT need to be deployed in ways that supports both forms of accountability.

The likely benefits to the overall humanitarian relief sector, should this form of data collection continue and spread across organizations, are more data, better quality data, and the ability to use these data to benchmark program success, become more efficient with current funding, and secure more funding. In addition, this form of data collection may increase data sharing across organizational boundaries facilitating further coordination of humanitarian efforts.

PDAs may also play an important role in participatory development. In a pencil-and-paper world, it is likely that large volumes of rich data are stored in villages and in the minds of local health and development workers. This information is shared neither with the broader community nor with country office program managers because the cost of copying and distribution is too high. PDAs enable broader distribution of information, and if used creatively, may foster greater participation in development planning, implementation, and evaluation.

The introduction of PDAs also has the potential to generate costs and risks associated with any transition away from a paper-based environment. Potentially significant is the risk that PDA use will limit the amount and type of information recorded due to the relative complexity of PDA use, both because of its complexity and because of difficulties with recording information that is not associated with a particular field on the survey. The change in medium may also be intimidating to beneficiaries.

Thus, PDAs as with all IT demonstrate the characteristic of dual potentiality, that the same technology, depending on the purpose to which it is applied, can increase organizational power and control or instead empower users. However, the control/empowerment dichotomy is an oversimplification. As the above discussion suggests, while the PDAs are being deployed in processes designed to serve demands for upward accountability, they also have positive implications for downward accountability at the same time.

Indeed, this is the case with PDA deployments in data collection processes. As described above, we have found that it is likely that the new generation of PDAs can provide benefits for both upward and downward accountability. However, for NGOs opposed to quantitative measures, for which PDAs are ideally suited, they may find that the use of such devices may further entrench upward accountability into their organization. Nevertheless, survey-based data collection is just one use of a PDA. The wide variety of ways that PDAs can be put to use in the service of development has yet to be seen. Given their ability to be used in places that lack electricity and their fundamental design for information transfer, they may also hold great promise for promoting further programs of participatory development. Critical to the success of such endeavors are the organizational processes through which analyses are fed back to beneficiaries, helping them become more involved in their own development. Future research is needed to shed light on the ways in which PDA use influence information flows as well as influence their power in the development process.

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