Current Practices in Field Force Automation: Decision Support and Information Management for the Field Force

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Abstract

In the past, field operations have mostly been a stepchild of information and communication technology (ICT) enabled organizational overhaul and process re-design. Recently, increased technological (mobile wirelessly connected) capability, economic necessity, and new external factors (such as the higher frequency of large-scale emergencies, for example, of the magnitude of hurricanes Katrina and Rita in the US) have raised interest in and commitment to on-site information management and to a drastically improved in-situ decision making capacity of field operations. Field force automation (FFA) techniques and process changes have been introduced in field operations of organizations in both the private and public sectors. This study seeks to establish a baseline of current FFA practices in both sectors. Among other areas, we explore, what the work-related and organizational specifics of field operations are, also with respect to ICTs, how process completion and efficiency are measured, and how effective FFA is with regard to information management. FFA, it appears is still in its infancy, and the full extent of potential efficiency and productivity gains might need more time to emerge.

Introduction

Over the past decades, ICT has been utilized in back offices, front offices, and on the shop floor to improve process efficiencies and decision-making capabilities across all sectors and industries. Field operations, however, has remained far less ICT-enabled than those other three areas. This area has only recently gained more attention regarding its potential for streamlining and decision support based on mobile ICT. FFA projects have been launched within field operations of organizations in various sectors.

Primary drivers for launching FFA projects seem to fall into three categories: (1) curiosity regarding the promises of novel technology leading to experimentation with fully mobile wirelessly connected (FMWC) technologies and applications [12, 15, 35], (2) economic pressures to reduce field operations cost, drastically increase field force productivity, and better manage assets in the field [8], and (3) the vocal criticism of insufficient and ineffective management practices in response to major natural and man-made disasters [24], for example, the 9/11 attack or the hurricanes Katrina and Rita in the US. Field work and field operations it appears have much room left for significant improvements along almost all lines, that is, streamlining of long-evolved and cumbersome business processes and workflows [33], cutting costs, providing new location-based services [10], increasing productivity [19], improving service quality [14], increasing the quality of decisions made in the field, and managing assets with increased sophistication [39]. While in principle FFA appears capable of closing the ICT support gap for field operations, the different nature of field operations and, hence, FFA is not well understood. Quite a few early FFA projects seem to struggle or yield fewer gains than anticipated. Effective (mobile) ICT support for field operations might prove more challenging to design and implement than that for other (more structured) areas.

In this paper, we explore the specific challenges found in and posed by field operations and seek to establish characteristics and metrics for successful FFA. We first establish an account of what is known about field operations, their specific ICT support needs, and existing FFA projects in the academic literature. Based on the literature, we identify several gaps in the academic knowledge of field operations and FFA-related. Third, we pose five research questions, which help increase our understanding of the subject. Fourth, we present the methodology and a research design addressing those research questions. Fifth, we report on the results of our study derived from ten cases and discuss the findings. Finally and in conclusion, we summarize the major insights from this study and propose future research based on these.

Literature Related to Field Force Automation

Field Work and Field Operations

The definition of fieldwork in academia refers to an individual who studies phenomena out in the work

environment to find trends and build scholarly knowledge. In this study we do not use the terms fieldwork, or fieldworker, in this sense. In this study, we rather use the terms fieldwork, field force work, and field operations interchangeably as a broad term that includes many types of workers and industries performing their work away from their offices and shops (cf. also [32]). Fieldworkers, or the field force, have a wide range of skills and work objectives. Field forces include such diverse populations as doctors, nurses, reporters, journalists, salespeople, maintenance and repair workers, field service personnel (from cleaning to towing), construction workers, movers, inspectors, spotters, assessors, investigators, the police, the fireguard, the military, the coast guard, and emergency/disaster responders [1]. In field operations, stationary, semi-mobile and fully mobile actors can be distinguished: [27]. Fieldwork and tasks performed in the field can be distinguished as falling into dynamic and static categories [29], which lead to widely differing needs of the field forces in terms of the information involved and required to perform the work or task at hand [28].

We found no comprehensive academic account, in which the wide variety of field operations and field forces has ever been systematically studied (we were not able to fill this gap with this study; however, we have been attempting a first step). Little is known about the specifics of work and tasks in the field [4, 38, 9], and how decisions are made in that context. It has remained unknown, which information has to be available in the field decision-making process. In summary, the characteristics as well as the similarities and differences between those various field workers and those diverse field operations remain unclear.

Organizational Characteristics of Field Operations and Field Force Automation

Work orders, asset descriptions, maps, directions, and building diagrams would exemplify static information needs, while tracking inventory, time entry, and staff location would represent dynamic information needs. As opposed to other work areas such as the back office, the front office, or the shop floor, field operations have been found as far less structured (or even structurable) [18, 6, 41, 44]. Field operations such as maintenance and repair work as well as emergency response operations also entail a high detail complexity. The combination of high degrees of unstructuredness along with high detail complexity makes fieldworkers the holders of asset-, location-, ambience-, and task-specific tacit knowing [36, 43]. Field Force Automation systems it was found mainly supported the structured or semi-structured elements of the work and tasks at hand.

In summary, the specific challenges and characteristics of work in the field as well as the various kinds of field operations have not been sufficiently studied and understood from an organizational point of view. For developing streamlined, mobile ICT-enabled business processes and workflows for field operations, the organizational nature of fieldwork needs to be better understood.

Research Questions

Given the small base of academic knowledge on the subject, on the one hand, and the wide variety of field forces and field operations, on the other hand, we propose to establish a baseline of characteristics of fieldwork and fieldworkers in the first place. We further propose to conduct such an exploration from a work and task-centric perspective, which we believe will provide a solid foundation for future research on the subject. The work-centric perspective we hold particularly has the capacity to cover the technological and human-actor-related requirements. We break down this broader research area into five more specific research questions (R1) through (R5):

(R1) What are characteristics of the field force (across various contexts)?
(R2) What are characteristics of work and tasks in field operations (across various contexts)?
(R3) What decisions are involved in performing work and tasks in the field?
(R4) What are measures of success (failure) in completing work and tasks in the field?
(R5) What are organizational characteristics of field operations?

Method

Analytical Framework and Instrument

The nature of this study was exploratory aiming at establishing descriptive accounts of field force characteristics and field operations across sectors and industries, on which a theory-building process on field force automation can be grounded. Hence, the study makes no claim to generalizability of its findings. We employed a case study approach [46, 16], within which we adapted elements of Cognitive Work Analysis (CWA) as our analytical lens. CWA "is a work-centered conceptual framework developed by Rasmussen, Pejtersen & Goodstein (1994) to analyze cognitive work" [17]. We used the CWA framework in our analysis for systematically establishing the characteristics of field operations and field crews across industries from a work-centric

perspective. The framework uses seven cascading layers of analysis, which are geared to uncover the constraints involved in the work and task at hand. Those layers encompass (a) an environmental analysis ("What elements outside the organization affect its work? What are the boundaries for the work environment?"), (b) a work domain analysis ("What are the goals, priorities, and constraints of the work domain? What are the functions and physical processes? What tools are employed?"), (c) an organizational analysis ("How is work divided among teams? What criteria are used? What is the nature of the organization? What are the organizational values? How is work divided among team members?"), an activity analysis (d) in work domain terms ("What are the current tasks? What are the goals of the fieldwork activities? Constraints? The functions involved? The technology used?"), (e) in decision-making terms ("What decisions are made? What information is required? What information sources are useful? What information is used? What information is created? What information is shared? Among whom? What information in disseminated?"), and (f) in terms of strategies that can be used ("What strategies are possible (e.g., browsing, the analytical strategy)? What strategies does the actor prefer? What type of information is needed? What information sources does the actor prefer?"), and finally an analysis of actor's resources and values ("What is the formal training of the actor? Area of expertise? Experience with the subject domain and the work domain? Personal priorities? Personal values?") Based on this analytical framework we developed a questionnaire with 24 semi-structured and open-ended questions, which covered the five research questions outlined before.

Sampling and Data Collection

We employed a purposive sampling [31] and identified ten cases of field operations from various areas and industries in the private and public sectors. Since the sampled cases were diverse on purpose, we refrained from developing a formative model of field operations specifying strategic choices as done in other CWA-inspired studies. Interviews were taken in person and over the phone. The interviews lasted up to two hours. We distinguished two primary categories of fieldworkers: (a) emergency and disasters responders as main purpose and (b) fieldworkers involved in routines mainly other than emergency and disaster response (for short, we will in the following refer to these two worker categories as (a) disaster responders and (b) field service workers. We took five cases from each category. Six different work areas and industries in two sectors (private and public) were represented. Interviewees held positions in an electrical utility, a cable TV business, an electrical bus trolley, underground utilities, natural gas providers, emergency medicine, and federal government.

Data were collected via the aforementioned semi-structured interview format, which allowed for additional probing on the basis of a fixed structure of uniform statements (cf., [2, 13]. Detailed notes were recorded during the interviews. The notes were transcribed and summarized based on the two fieldworker categories. In an open coding process [42], the transcripts were coded, where each unit of data was assigned to a preliminary category or sub-category whose dimensions and properties were developed from the data. New categories and sub-categories were introduced, in case existing categories did not apply [21]. In an axial coding process was applied, during which the converged categories and subcategories were analyzed regarding their inherent structures and processes leading to paradigms, whose internal relationships were identified wherever possible [42]. Finally, a selective coding process was performed, in which the resulting current practices concepts and theories were related to each other.

Results

(R1) What are characteristics of the field force (across various contexts)?

As desired, we were able to derive a profile of the disaster responders and field service workers with regard to their level of experience, their training, and the factors, which the workers perceived made them successful in their jobs.

Experience

Interviewees in both field service and disaster response represented three different levels of experience. In two cases the field workers had less than five years of experience in their jobs; three workers had between five and ten years of experience; and five workers had tenures of more than ten years in their jobs. In other words, four fifths of the interviewees were either experienced or very experienced. Most of the workers with more than ten years of experience were near age 40 and beyond.

Training

Field service workers in our sample learned their jobs to a lesser degree via formal training-center-type educational programs but rather through apprenticeship and mentoring programs as well as through years of accumulating own experience. Many

procedures they used were adopted in the course of personal experiences on the job. In the words of one interviewee, "We match wits with the job to be done." Overall, field service workers were proud of what they perceived as their accomplishments; they communicated a great willingness to share their experiences (also with peers), they firmly believed that they worked in a smart way, and they were highly interested in making the ultimate beneficiary of their services (customer, client, taxpayer, or citizen) feel well served and satisfied. Disaster responders had formal and mentoring training. Disaster and emergency management follows clear procedures and drills, which were practiced in the training programs.

Fieldworkers' Perceived Critical Success Factors

Flexibility was the most important success factor mentioned by disaster responders, while field service workers gave more diverse responses, with an emphasis on a desire to learn, communication skills, and conscientiousness towards quality. Other important success factors included: The ability to follow procedures, intimate job knowledge, a disposition towards mechanical workings and processes, an ability to simplify, skillful decision-making under uncertainty, that is, with incomplete information, an awareness of co-workers, customers, and other stakeholders involved, an ability to deal with and meaningfully fill spare time, and finally a solid background in emergency response procedures. Disaster responders were typically more "matter- of-fact" and "down-to-earth" with their reasoning. One interviewee described that frame of mind as an "ability to make decisions in a high pressure situation with incomplete analysis." They also discussed situations of involvement, where human life or major economic assets were at stake.

Summary

Fieldworkers seemingly liked their jobs and showed a strong esprit-de-corps. Disaster responders were apparently much more willing to accept and align under a chain of command for their tasks, while field service workers would insist on maintaining a high level of self-determination in the way they handle a given assignment or work order. Experience on the job was the foremost factor mentioned guaranteeing success for both field service workers and disaster responders. Both groups of workers were used to and had to make critical decisions on the spot with incomplete information at hand.

(R2) What are characteristics of work and tasks in field operations (across various contexts)?

Structure, Focal Areas, and Responsibilities

Field service workers mentioned the following tasks as their focal areas of responsibility: Repairing access to cable TV, repairing and maintaining electrical meter hook-ups, bringing bus trolleys back online, (re-)connecting homes with water, sewer, cable TV and electrical. In the following, a few examples of tasks illustrate the wide range and variability of tasks performed, for example, (1) pulling wire to place in a dirt trench with proper depth that varies according to the topography; (2) using experience and training protocol as guide to assess the impact of a gas meter damaged by a car accident and safely evacuating people; (3) supporting lineman working on live trolley wires through traffic re-direction and bus re-routing, (4) comforting panicking callers requesting evacuation assistance before the arrival of another hurricane, (5) leveraging medical knowledge and awareness of a patient's symptoms to judge proper medical treatment during transport to a medical facility, and (6) understanding diverse local building codes for underground utility installations.

Although workflows and tasks reportedly follow certain pre-determined sequences, those sequential structures may vary significantly depending on asset characteristics, repairs, or treatments needed. Unlike, for example, fully structured manufacturing workflows, field workflows and tasks were found semi-structured at best and defied detail preplanning from start to finish. Field service workflows could also be interrupted, halted, or delayed due to missing equipment or material, or due to higher-priority tasks, to which the field service crew had been reassigned.

Disaster responders' work responsibilities comprised emergency medical response, ambulance dispatch for patient evacuation, clearing ports for large vessel transport, repairing electrical wiring in flooded homes, rescuing people trapped in homes, repairing broken service lines with natural gas escaping. Disaster responders also dealt with tasks having a direct impact on the quality and sustainability of human life. As one interviewees put it, "We were (working) under the impression death would occur." Most disaster responders were involved in and spoke to tasks performed while responding to the disaster caused by hurricanes Katrina and Rita in the US Gulf Coast region. The phenomenon of workflow interruptions and delays due to missing equipment or parts, or higher priorities was even more prevalent in disaster response than in field service work.

Dependency on Outside Resources

Both field service workers and disaster responders required the use of outside resources to complete their tasks. For field service work, police frequently provides traffic control, for example, for busses that encounter problems with the trolley system on major city streets, or in case oversized equipment had to be moved in and out of a job site. Contact with material suppliers was reported essential to secure mission-critical deliveries. Further, external expertise was required to accomplish a task working with specialized tools or original documentation.

The field service workers also utilized services provided by the Post Office, their own main office, for example, for accessing information such as blue prints, a specialty tool warehouse for tooling, an equipment trainer for expert advice on using the specialty tools, and suppliers for information on the specifics of materials delivered.

The disaster responders also utilized the police, fire departments, road crews for traffic direction, helicopter services, the emergency operations center for communication and coordination, government agencies such as FEMA, the Army Corp of Engineers, Army, Navy, Air Force, Marines, and also individual government officials. When responding to emergencies or disasters, responder crews access resources from all levels of government at the same time. However, the coordination of a multitude of external resources can become a challenge. During the aforementioned hurricane response, for example, human resources, sent to participate in rescues, cleanups, repairs, and inspections, arrived at the US Gulf Coast in such numbers that the coordination task for the disaster response managers became overwhelming. Additional time and effort had to be spent on integrating and aligning the additional resources for effective use.

Summary

Across various contexts, field service work and tasks were found to have less predefined start-to-end structure than known from other work domains. Both field service work and disaster response were said to have a high variation in work and task flows, partly due to interruptions. Both field service workers and disaster responders relied on collaborating with external actors and depend on external resources to varying degrees. In disaster responses, the coordination of external resources had been found a major challenge.

(R3) What decisions are involved in performing work and tasks in the field?

Field force workers in both field service and disaster response make many decisions affecting the outcome of their work and task assignments. Across the various areas and industries in our sample, workers' reported that their decision-making had to take into account a fairly diverse set of considerations and variables. In other words, in both field service and disaster response decisions involved relatively high degrees of detail and dynamic complexity. The information needs of workers in the decision-making process, hence, varied considerably from one task to the other. Typical decisions encountered by field force operations included the delegation of work (delegate/do it yourself), the selection of the particular approach to solving the problem in a given situation, the notification of stakeholders on the state of the problem and the progress of the effort made, the appropriate next steps after an equipment failure, the management of a broader scope of work than originally expected, the verification of the problem description, and handling material needs. Disaster responders typically make decisions regarding evacuation requirements, shutdowns of gas, water, power, and other feeder lines, road closures, resource needs, task sequencing, type of treatment after diagnosing a patient, choice of hospitals for emergency treatments, extent of site survey when working, for example, on river beds, appropriateness of equipment relative to the task at hand, search needs, and effective resource allocation.

Information Needs and Gatekeepers

Based on this wide variety and the sheer extent of decisions with at times far-reaching consequences, field service workers and disaster responders alike reported on their need for highly specific and relevant information pertaining to the decision at hand. Disaster responders identified two common needs: (1) knowing who holds local knowledge, and (2) the name and address of those in need. The diversity of information required in field force decision making presents a major challenge with regard to the information access and information quality. Other information needs in support of field crew decision making included service beneficiary-related information, nature of work task, due date, availability of required equipment, task priority, problem description, results of site walk-through, travel and accommodation-related information, scope of a search and rescue area, demographics, topographies, and time estimates.

The information required for decision making in field operations is not only diverse, but frequently also resides under the jurisdiction of various

information providers. Those information providers can assume the roles of information gatekeepers who (among other activities) select, manipulate, integrate, withhold, present, and channel required information [5]. Typical information gatekeepers for the field force are the dispatchers, the supervisors, and other functions at the head office. Disaster responders most commonly receive detailed information from radio dispatchers, while field service workers receive the relevant information from a supervisor. Other information providers and gatekeepers include diverse players such as head office managers, passers-by, 911 phone callers, aircraft and satellite surveillance, (other) government agencies, incident commanders, local navigation managers, field crews, and emergency services such as coast guard or fire departments.

Communication Procedures and Tools

Electric utility workers said that they seek information by contacting individuals in the main office or from other organizations via their cell phone receiving sometimes information of low quality. Dispatchers might also issue jobs that can be returned by the worker for re-assignment to other workers if not completed. When incident responders first arrive on a scene the field operator is put in control of operations using their interpretation of known procedures in managing the response and communication protocol. When passers-by provide information to work crews regarding potential problems, this information is reported back to a dispatcher or supervisor. Interestingly, during disaster responses, roles are learned, as the event unfolds, and rules of engagement for communication are developed as part of the response effort. As shown in chart 1, field operations primarily use cell phones and 2-way radios for communicating with information providers/gatekeepers and task authority. Emergency medical responders, for example, reported that they must constantly stay in touch with their dispatcher via radio or pager. Wirelessly connected laptop computers still account for only a small fraction of the communication traffic.

Summary

Field forces were confronted with a wide range of decisions, and they reported to regularly make many if not most decisions pertaining to their work in the field by themselves. Their decisions depended heavily on diverse sets of information controlled by information gatekeepers such as dispatchers and supervisors. Information used in the on-site decision making process was reportedly not always of sufficient quality. Communication procedures varied as much as the work and task varied. The foremost used tools for field force communication were still cell phones and two-way radios.

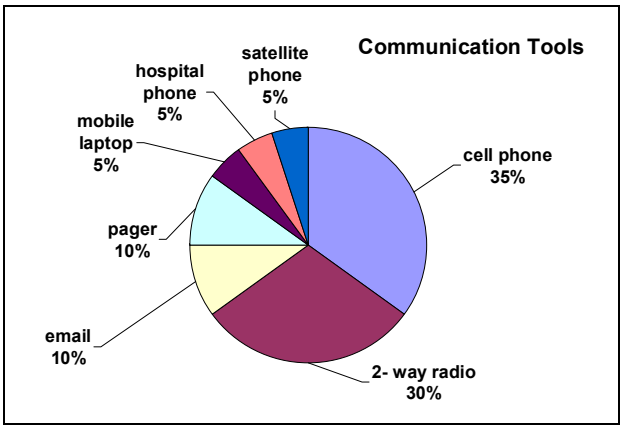

Chart 1 Field Force Communication Tools

(R4) What are measures of success (failure) in completing work and tasks in the field?

Most Frequently Reported Task Inhibitors

A broad range of circumstances can get in the way of mobile fieldworkers when working on their assigned tasks and work orders. The most frequently reported task inhibitors include (1) lack of training, (2) task-to-task monitoring (requiring a check-in before proceeding to the next task), (3) disparate expectations regarding work sequencing and approaches, and (4) lack of rest (see Chart 2). Other challenges in the field included the communication protocol, the environment (extreme temperatures), service level agreements, and logistics (also, see Chart 2).

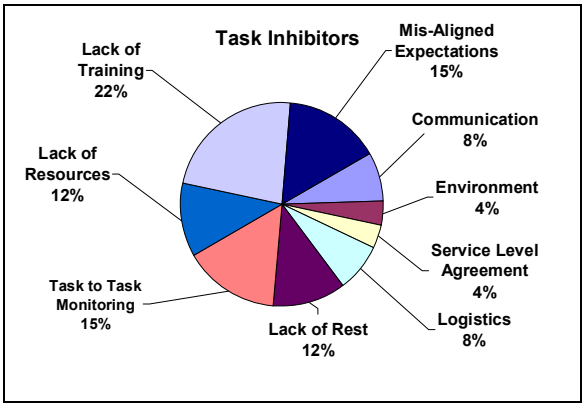

Chart 2 Field Force Task Inhibitors

Success Measures

The most frequently mentioned measures used in field force operations in gauging success were (1) appreciative feedback, for example, from service beneficiaries, and (2) the non-occurrence of a problem situation (see Chart 3) Field force workers

appreciated "a pat on the back for a job well done," or hearing directly from the individual they had served. Favorable public esteem of their services also played a major role as measure of success for field service workers and their feeling of accomplishment. Unlike field service workers, disaster responders mostly lacked that sort of recognition from the ultimate beneficiary, since they had to hand off their patients to another team after rescues or transports to emergency medical facilities. In the rare cases, when disaster responders heard directly from the rescued, they said they had felt great satisfaction worth the personal sacrifice. Other measures mentioned were bonuses, project closure, new work assignments, personal feeling of accomplishment, and the discovery of new information.

Summary

Measures of success were mainly appreciative feedback from individual and public sources and the absence of problems to be solved. According to disaster responders' accounts, affirmative and appreciative feedback was more difficult to receive for them, since the direct connection between service provider and beneficiary would be cut off in the course of the emergency intervention.

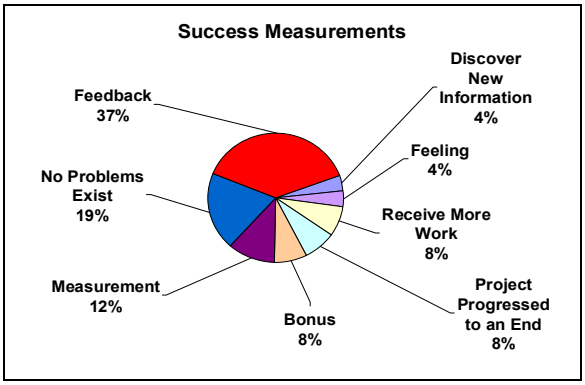

Chart 3 Measures of Success in Field Operations

(R5) What are organizational characteristics of field operation?

Interviewees reported that in most situations the immediate supervisors assigned work orders to the field service worker in their span of control. Disaster responders, in contrast, received work orders from more diverse sources of authority than field service workers, including managers and officials many miles away from the disaster scene, the first to arrive on the scene, or their immediate supervisor. Other authorities involved in work order and task assignments included government leaders, group planners, the worker themselves (self-assignments), schedule planners, and dispatchers.

Cooperation

Different interpretations of a given problem and the difference in approaches to solve that particular problem between the workers in the field and the chain of command reportedly presented a major challenge to the field force. Supervisors and governmental authorities were responsible for assigning tasks to work crews and, finally, supervisors and radio dispatch communicated relevant event information to the workers in the field.

Information about a work crew's experience levels and areas of expertise was said to be the main criterion for task-to-crew assignment in both areas of field operations. However, disconnects between dispatchers and the field force were said to regularly occur causing communication breakdowns. The field force itself tended to rely heavily on their own experience and assessments for making critical decisions out in the field.

Summary

While the field force represents the lowest level of the organizational hierarchy, the scope and the weight of decisions made by individual fieldworkers distinguish them from other individuals situated on lower levels of the organizational pyramid. The nature of fieldwork and the organization's dependency on the proactive engagement of the individual fieldworker it was said required a relatively high degree of autonomy to rest with the field force. That in turn led to certain latent and open tensions between the leadership and the field force.

Discussion

The purpose of our exploration has been to uncover the nature and major characteristics of field operations and field forces across contexts in order to understand the particular challenges both workers and managers face in on-site decision-making and information seeking from a work-centric perspective. With more understanding of the challenges and needs, we assumed, we would also be better able to identify critical characteristics and elements of FFA, that is, the use of fully mobile wirelessly connected information and communication technology in support of field operations and on-site decision-making. In the following we interpret our results and discuss their consequences for building and implementing successful FFA systems

Structure of Fieldwork (Fieldwork Sub-domains)

The work domain of field operations exhibits varying degrees of structure in the way work is organized. While some fieldwork is or can be ***highly structured (sub-domain 1)*** (for example, inspecting (like real estate assessors), or, the police and the fireguard, by mostly relying on standard routines in response to given requests and events, other types of field operations, while they are still ***primarily structured (sub-domain 2)***, possess a lower degree of structure, that is, exceptions to routine may occur more frequently and external influences may force the deviation from pre-programmed routines. Examples for primarily structured field operations can be found in construction work, transportation, gardening, landscaping, hunting, or fishing. A large sub-domain of field operations, that is, field service work as well as emergency and disaster response are ***semi-structured (sub-domain 3***), at best.

For the design of FFA systems, this has immediate consequences: While FFA systems for sub-domains 1 and 2 might share many characteristics of stationary systems used in front and back offices, sub-domain 3 FFA systems would need to possess a different set of characteristics. The latter FFA systems need to be more agile, less structure-oriented, interruptible, easy to override, adjustable to the worker's immediate information and decision-making needs than the former. While many back and front office legacy applications might extend their span of use into field operations in sub-domains 1 and 2, this would work to a much lesser degree in sub-domain 3, it at all.

Stakeholder Involvement

Involving the fieldworkers and other important stakeholders in the planning, design, and implementing phases of FFA system introductions can be considered as critical to the success as in any, even less ambitious ICT projects [11, 34, 22, 20, 30]. Yet, the involvement of workers in field operations in the improvement and redesign process is a necessary prerequisite but alone is still not sufficient to guarantee success. Employing a work-centric perspective lets fieldworkers engage and bring to the table their valuable expertise into the overall process improvement. As we found fieldworkers were highly self-paced and motivated to work "smart." Fieldworkers we met applied highest standards to measure their work. They worked under enormous pressures to complete their work orders in the shortest time possible. Any FFA system, which takes additional time to learn and operate and which delays task completion, will hardly be considered as adding value to field operations. FFA systems, however, which help the field force gain efficiencies and access useful information to improve decisions will be highly welcome. Effective FFA systems would grant fieldworkers timely access to main-office-maintained information. Those systems could also be instrumental in strengthening the formal and informal bind between field force and office staff.

Fostering Team Work

The field force as we found faces numerous communication challenges when following through with their work orders. Emergency medical responders, for example, became confused about the chain of command after a second local command center was established. Or, State Search-and-Rescue units had to quickly learn a new communication protocol when working with Army soldiers. Or, utility workers encountered additional equipment to be serviced when they arrived on-site and had difficulties receiving the necessary details for completing all assigned work orders. FFA systems would have the capacity to help those field force teams quickly retrieve the required information and set up a collaborative and well-informed workspace.

How critical a difference a well-designed team approach, for example, supported by FFA systems could make is illustrated in our next example: One disaster responder who had participated in rebuilding homes damaged by hurricanes Katrina and Rita flooding described such an approach. Highly skilled experts from across the nation were brought together to assist with home repairs. Although those fieldworkers were strangers to each other, they managed to work together as a high functioning team, swiftly completing their assigned projects. Those workers were provided project folders containing detail accounts of repair requirements, homeowner profiles, and supply sheets. Teams would gather for briefings in the morning, meet to discuss work orders, and proceed to go on-site with all required materials awaiting their arrival. FFA systems would be able to even accelerate the described smooth process even further and help bring in resources from anywhere and insert them into a process flow.

Collaboration Between the Field Force, Information Gatekeepers, and Work Order Assigners

The collaborative concept applies also in the relationship between the back office and field operations: In semi-structured workflows, the field force constantly generates new knowledge adding to data received from information providers and work order assigners. FFA systems have the capacity to capture at least the non-tacit portions of new knowledge generated on any completed project. Over time, the knowledge base at both ends broadens and

deepens FFA systems have the capacity to facilitate the forming of mutually beneficial and collaborative work teams of field workers, information gatekeepers, and task assigners, as they have an ability to influence fieldwork decisions. The success of such collaboration, however, depends less on the technological capacity of the FFA systems, but more on the enacted principle of mutual benefit. Using the improved information base for imposing more control and structure over fieldwork is prone to meet the resistance of the field force [18].

Collaboration in Emergency and Disaster Responses

Increased field force effectiveness and efficiency can also be gained through collaboration and scaling efforts sought between players in emergency and disaster response situations. Resources are typically brought in from across the country to assist during those situations. These resources can be used more effectively when smoothly integrated into the existing systems. Knowledge about the locale could be readily shared among interoperable FFA systems. In other words, FFA systems have the capacity to provide the specific contextual knowledge and improve collaboration among field force operations by utilizing context-aware Geographic Information System (GIS) systems [23], or by sharing a common visual space [26], by improving information sharing between emergency responders [37],

Searchable Information

On-site information retrieval for the field force has mostly been targeted information stored in in-house databases. The information residing in these databases is typically derived from proprietary transactional data. While field service workers and disaster responders would benefit from information systems that enable information retrieval from those sources of information, for example, via a data warehouse, vastly more relevant information is readily available from other sources and through other data formats. Information retrieval provided through Internet/Intranet-based search engines has the capacity to greatly enhance the information base of the field force dramatically. This can even be considered a core functionality of an (FMWC) FFA system.

Almost all fieldworkers we interviewed expressed their need to access context-sensitive ad-hoc information, particularly, for unexpected encounters. For example, the clarification of authorized post office addresses, knowledge of local routes for navigating through logistical challenges, location of stocked oil and gas resources or background medical information for patients were all examples of fieldworker information needs brought out during the interviews.

We are aware of a proof of concept exercise [45], which used records from customer calls captured during a disaster incident to perform simulated mobile searches. The results indicate precision could be attained with such a system. The study also suggests mobile implementations of information retrieval should consider providing menu driven or faceted selection for search where information is being delivered on a small screen with limited key functions [25].

Measures of Success of FFA

Field service workers are focused on efficient use of equipment, worker productivity, customer satisfaction, and asset preservation. Disaster responders tally lives saved, fuel requirements, supplies and resources needed. Accountability is important to both fieldwork categories studied. Gaining accurate data for such benchmarks improves decisions made at both the fieldworker and office manager levels.

Obviously, establishing baselines of the ex-ante state along those benchmarks would directly show the impact and degree of efficacy of FFA after some time. This may include the measurement of the mobile system's overall maturity [3]. Establishing metrics for FFA is one of the most powerful managerial tools for influencing behavior. Customer satisfaction, for example, has been proposed as a measure for FFA outcomes [7]. Our data suggested that traditional fieldwork metrics might need to be revisited and re-evaluated before being applied to new FFA contexts. Some currently used fieldwork performance measures might even be outright counterproductive [40]. For example, utility workers were asked to break out three tasks for time entry in fifteen-minute increments when all three were completed in 20 minutes. Particularly, the sheer volume of what is traditionally measured might need a critical review aiming at reducing the amount of measures.

Conclusion and Future Research

Fieldwork, especially if semi-structured (sub-domain 3), presents new frontiers in terms of ICT support. Fully mobile wirelessly connected technology is making possible to support even the remotest worker in the field with up-to-date information on almost any aspect of her work and decision-making. However, the nature of a large sub-domain of fieldwork does not allow for an extrapolated rollout of existing structured

applications into the mobile fieldwork environment. It rather requires radically new methods and applications geared at a far less structured, frequently interrupted, highly variable workflow environment. In this study, we employed a work-centric perspective on fieldwork and FFA. We were interested in the unique characteristics of fieldworkers and field operations, the decision-making process in the field, the success measures in fieldwork, and the organizational context of field operations. We discovered a wide variety and variability of fieldwork and task flows. Decision-making rested more with the fieldworker the less structured the fieldwork task at hand was. In our view, this has far-reaching implications for the design, the functionality, the implementation, and the use profile of FFA systems.

Although not funded under its umbrella, this study has been conducted as an adjunct study to the NSF-funded mCity study (2005-2008), which aims at establishing an in-depth understanding of FFA in a specific context (public utility fieldwork in a major metropolitan area of the USA). Our study complements that study in a number of ways. While the mCity study develops a formative model, which helps identify the strategic choices when organizations advance towards FFA, our study demonstrates (although on the basis of a small sample of ten cases) the common themes in field operations across a wider context. This study has further established three distinct sub-domains of fieldwork along the lines of work-inherent structure.

In future research, which builds on this study, we intend to explore the similarities and differences of fieldwork within the three work sub-domains. We also intend to take account of FFA initiatives and projects in all fieldwork sub-domains. When tracking such projects we would be highly interested in learning how the relationships between fieldworkers, information gatekeepers, and task authority develop over time. Our research has identified specific decisions and efficiencies that could be gained by improving the information sharing among these three groups. We would also be inclined to more deeply study motivational factors of human actors in field operations. Such research would further help understand the drivers and inhibitors of FFA-mediated collaborative approaches between fieldworkers, information gatekeepers, and the fieldwork task authority.

Finally, we see a particularly high potential for FFA systems in the emergency and disaster response area.

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