Making Technology Fit: Designing an Information Management System for Monitoring Social Protection Programmes in St. Kitts

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Abstract

This paper reports on the development of an Information Management System to monitor and plan social protection programmes for the St. Kitts' Department of Social Work. Best practices for the design of such technologies require special consideration of users' needs; in the case of St. Kitts, this included meeting the constraints of the small island environment. The collaborative process between the software developers and users, wherein users explain what they need and the software is designed accordingly, was complicated by the existence of a disconnect between users' work practices and those supported by the proposed system. The challenge was thus to design a viable and sustainable information management system (IMS) relevant to the users' work, and responsive to local constraints.

The project revealed cultural differences between department workers and software developers. It suggested new methodologies for assessing user needs, eliciting their preferences, and building their capacity in electronic recordkeeping. It also highlighted the need to develop communication strategies for both clients and developers of technology. The lessons learnt have implications for improved practice when introducing IMS technologies into work contexts in microstates where they are currently not used.

1. Introduction

In their continuing effort to find innovative strategies to maximize social and human capital, small island developing states (SIDS) have turned to the use of information and communication technology (ICT) to overcome the restraints posed by isolation, diseconomies of scale, and other limited resources (Atchoarena et al., 2008; Hage & Finsterbusch, 1987). Information management systems (IMS) that support the electronic processing of data are an integral part of this strategy. IMS provide an electronic repository that supports timely access to consistent and up-to-date data as well as reporting and query facilities, and constitute the backbone of many organisations in industrialised nations. Seeking the advantages an IMS offers, the St. Christopher and Nevis Department of Social and Community Development decided to replace the existing paper-based record keeping system for social protection programmes with an IMS. At a superficial level, introducing an IMS can be considered as simply changing the manner in which data is stored and viewed, from writing on paper forms to electronic entry and display on a computer screen. This shift from paper to electronic format might appear to be possible without disrupting the existing work practices whereby the data is collected and used. However, at a deeper level, IMS best practices from the industrialised world present information in a way that may be at variance with that of its intended users and bridging this disconnect is crucial if users are to see value in the IMS and fully integrate it in their daily work practices. As outside observers, academic software designers from Canada, we were aware of the possibility that our ideas about IMS design would conflict with those of our friends in the Department of Social and Community Development who use the system. Indeed, we discovered such a disconnect in the course of gathering requirements for the IMS.

Our research objective in undertaking this project was to investigate the various factors that come into play when designing culturally sensitive software applications for small island developing states. Determining the requirements of an IMS involves close collaboration with its intended users. Along with determining what data to store and reports to generate, it is also necessary to understand the contexts in which data is collected and used to ensure that the IMS will fit within the users' work environment and be useful to them. Understanding the perceived shortcomings with the current system is also crucial as these will dictate the improvements the new system should deliver. When we began probing the department's needs, it quickly became apparent that our users, being unfamiliar with information system technology, were not in a position to accurately assess let alone express short and long term needs with respect to an IMS. Whereas the administration was confident that an IMS would provide improvements over their current system, the workers, who would actually use it, were sceptical and resistant. Both situations could jeopardise the project's success—on the one hand, we were concerned that the administration's expectations might exceed what the technology could deliver; on the other, the workers' resistance could result in their refusal to use it. Investigating the reasons for their resistance, we discovered a disconnect between the community oriented worldview that characterises the social workers' practices and the rationalistic worldview embodied by the IMS. We bridged this gap by designing the IMS to be situated with respect to the workers' actuality and by providing training in rhetorical styles that enabled the workers to see the value of the IMS and thus overcome their apprehensions. We subsequently validated our design, set expectations and collected further needs using a high-fidelity prototype.

In the case of this project, the gathering of requirements and prototype development was funded by a research grant. While the methodology we used can be applied in other contexts, the non-trivial effort involved in developing the prototype and the difficulty experienced in transforming the prototype into a production level IMS point to a technological vulnerability that other SIDS are likely to share. While the advantages IMS provide are undisputed, few SIDS have the resources or expertise necessary to undertake such projects on their own. This raises the question of how microstates can cost-effectively introduce IMS technology into work contexts in which they are currently not used, and sustain them over the long term.

Below we first describe what the development of an IMS involves, and some of the challenges with respect to developing countries. We then describe the project context and the gathering of requirements for the proposed IMS. This is followed by a discussion of the constraints SIDS face with regards to IMS technology, and the technological vulnerability this reveals. We then consider how this vulnerability might potentially be addressed before concluding.

2. What it takes to develop an Information Management Systems (IMS)

While the concept of an IMS—namely the storage and retrieval of data—is easy to comprehend, an actual system is a complex set of interworking components. The basic components consist of a database server in which the data is stored, an application server holding the business logic, and a frontend user-interface for entering and viewing the data and generating reports and queries. In the typical case that the components are situated on different physical machines, a properly setup network connection is required as well. These components are available for a range of system platforms, application environments and network protocols. For users of an IMS, the frontend interface is their primary and only view of the system. However, it is the underlying database technology that constitutes the core of the data management system, enabling all the visible capabilities and providing additional functionality to assure efficient handling of large datasets, concurrent access control, security, recovery, and data backup and restore facilities, while the network assures transmission of the data. On-going management of the backend database and network is essential to assure smooth operation of the front-end. The configuration chosen for a

particular IMS application is a function of both user needs and the organisation's infrastructure, with different configurations and settings providing different levels of service. Thus, along with designing a backend database, a frontend user-interface, the application logic and establishing network connectivity, the design of an IMS includes selecting a specific platform, environment and network as well as defining the administrative procedures necessary to provide the desired level of service. Consequently the development of an IMS is non-trivial.

It is estimated that in industrialised countries up to 25% of IMS projects are total failures, while 30-60% fail to attain major goals or have significant undesirable outcomes (Heeks, 2002). Despite advanced development tools and methodologies, IMS projects continue to run into significant cost overruns and fail at alarming rates, often due to stubborn adherence to existing theories despite evidence indicating the need for revision (Lyytinen & Robey, 1999). The failure rate in developing countries is likely to be even higher due to the lack of technical infrastructure and capacity. Heeks attributes this poor success rate to "design-actuality gaps", corresponding to a mismatch between the developer's vision of how the new system should operate and the local actuality of users. These gaps correspond to invalid assumptions on the developer's part regarding the users' context, and are exacerbated when developers apply assumptions from the industrialised world to developing countries. Heeks identifies a design-actuality model with the following seven dimensions to characterise the discrepancies that may exist between the actualities of industrialised and developing countries:

- **Information**: the type of data that is available, where it is located, and how it flows, is transformed and used. Emphasis is often placed on standardised, formal, quantitative information distributed through formal channels
- **Technology**: the technological infrastructure, including (but not limited to) hardware and software, is assumed to be a neutral, enabling mechanism
- **Processes:** the actual activities and workflows of users and others, are assumed to be stable, clear-cut and formalised processes with rational decisions based on logical criteria
- **Objectives and values**: are assumed to be formal organisational objectives
- **Staffing and skills**: staff is viewed as rational entities, in sufficient number and with sufficient competency levels
- **Management systems and structures:** are assumed to operate according to formal, objective processes
- **Other resources:** particularly time and money applied in attaining organisational objectives

With regards to the gap related to resources, the discrepancy in budgets available to organisations is significant. Developing countries must often rely on external funding to finance their projects, and the funding agencies often impose their own decisions with regards to the solution and the progression of the project (Knack & Rahman, 2007). If developing countries wish to benefit from a technology, they are obliged to follow along and invest their time and money in the proposed solutions, locking them in and potentially leaving them with a hodgepodge of different platforms and application environments to sustain once the project is delivered.

Technologies in themselves also embody assumptions that engender design-actuality gaps. In the case of database technology, it has its own internal logic based on mathematical models that assures properties such as data consistency, integrity, and reliability. Realising these properties requires structuring the data in prescribed forms that satisfy that logic. While much of this

complexity is transparent to users, certain restrictions are imposed on the nature of the data and how it is entered. In the industrialised world this underlying logic, which requires people to have a unique identifier, to spell names and other attribute values consistently, to enter data in a prescribed order, etc. generally goes unquestioned as it is an integral part of the work practices and of the larger social setting. However, such restrictions directly tie in to the design-actuality gaps described above. In developing countries, people may not have official papers, a social insurance number or know their exact date of birth or spelling of their name, and addresses do not follow predefined formats while strict adherence to prescribed procedure is not always possible or the norm. Many of the assumptions embedded in the database are reflected in the tools for designing user interfaces, the visible part of the system, and carry through to the approaches conventionally applied for IMS development, with practitioners applying best practices drawn from conceptual frameworks and normative models without regard to contextual particularities (Avgerou, 2001). When design-actuality gaps are identified, these are often in conflict with established norms, and it becomes necessary to devise workarounds, resulting in less technically elegant solutions.

Design-actuality gaps are not restricted to developing countries, as witnessed by the high failure rates noted by Heeks (2002). The recently announced (and still contested) failure of a $1.3 billion welfare modernisation project undertaken on behalf of the state of Indiana, USA, is a case in point (Hoover, 2009). Here the intention was to revamp welfare case management by replacing a slow, paper-based system with an IMS that required "less face-to-face work and more computerised processes". Instead, the introduction of the new IMS resulted in more incomplete application forms and processing delays, attributed to the fact that "welfare needs more substantive conversations than the system allowed" (Hoover, 2009, pp. 18). The cause of failure is at the heart of the legal dispute between the state and contractor.

3. The Project Context

St. Kitts, one of two islands in the Federation of St. Christopher and Nevis, has a land area of approximately 68 square kilometres and a population of approximately 35,000, putting it well within the thresholds for classification as a Small Island Developing State (SIDS). SIDS are independent island states with land masses of less than 10,000 square kilometres and resident populations of 500,000 or fewer. Along with the classic development problems, SIDS face additional vulnerabilities arising from their geographic constraints (Turvey, 2007). Among others, these include more limited infrastructure, capacity, and resources due to their small size and populations. As a result, the available pool of expertise is smaller and less diverse, and economies of scale are difficult to realise. Government institutions are likewise affected in terms of staffing, budgets and infrastructure.

St. Kitts' information technology (IT) infrastructure is managed by the National Information and Communication Technology Centre (NICTC) with a staff of approximately 10 people. The centre oversees the various international initiatives for introducing IT to the island, manages the island's IT infrastructure, runs general IT literacy skills training programmes, and develops and maintains the software applications used by many of the governmental agencies. While certain larger ministries and private organisations (such as those in the banking sector) may have their own IT department, the majority of governmental offices, being too small to have dedicated IT personnel, rely on the NICTC to introduce, maintain and support their IT services.

The Department of Social and Community Development is one such office that benefits from the NICTC's services. The director of the Department manages social protection programmes with the assistance of a supervisor, who runs daily operations with five officers reporting to her, and eighteen homecare workers reporting to the officers. Each officer handles approximately thirty

clients, and manages three or four homecare workers, who each assist approximately ten clients. The department's operation is entirely paper-based, with the paper-trail embedded in its work processes. Officers are responsible for processing requests for assistance and reviewing ongoing cases, both duly tracked on paper forms, and for writing quarterly reports on their activities. The officers primarily work in the communities, visiting clients in their homes to assess their situation. Once a week, they make the trip to the central office to discuss their cases with the supervisor and deal with paperwork. This involves completing the appropriate form for each case with a description of the problem, their assessment and recommendations. This form is then reviewed by the supervisor before being passed on to the director for approval.

While the academically trained director and supervisor can be considered "professionals," the social assistance officers are lay practitioners. They have completed high school but have no formal social work training beyond what they have learnt in departmental workshops and experience in the field. Nevertheless they are dedicated to their work and well-respected in the community. None of the homecare workers have completed high-school. Computers are available in the department office and used daily, primarily for email and word processing, and some internet use. The social assistance officers share two or three computers in the office, but have no access when in the field. Overall, department personnel have limited experience with computers and no exposure to electronic record keeping applications.

4. Gathering requirements

In March 2008 we were approached about the possibility of designing an IMS for client records. The expressed goal was to improve access to client information for the preparation of reports and external funding requests. The administration was confident that an IMS could provide the necessary information in a timely and comprehensive manner. We were provided with a set of blank forms used in the department and central to its work practices, to familiarise us with the type of information collected.

Working together with the director and supervisor, we began eliciting and documenting requirements through telephone interviews and email over a 3 month period. We identified the departmental problems to be addressed, the system goals, the stakeholders and end-users, and the system features, capabilities and constraints. In elaborating the system features, we began investigating the types of reports to generate, the data required to generate them, and where that data would be obtained. We analysed the paper forms and noted that some of the attributes, for example, the names of a client's friends and extended family members or religious affiliation, were not typical of the type of data associated with an IMS, but were advised that the information was important and could not be omitted. All this information was documented in a preliminary *software vision document* detailing the nature of the problem and scope of the potential solution.

In June 2008, we made a one week on-site visit to elaborate the requirements, investigate the work context and conduct interviews with all the users. For two days we met with the users, both individually and with the officers as a group, to discuss the IMS and elicit their input. This was followed by three days of observations in the office and field. We clarified that the IMS would primarily be used by the officers, who would update the IMS with information about departmental clients, and also use the data to draft quarterly reports. These reports would be used by the director to compose her own reports to departmental administrators, government officials and granting agencies. The director was largely able to tell us about her IMS needs, however the officers were unable to discuss them in terms amenable to the construction of an IMS that would collect and organise the information.

Describing a social work client in terms of community and family relationships is quite different from describing him or her in terms of statistical data, a crucial distinction that arose in designing a culturally appropriate IMS. The scientific and objective position an IMS assumes with respect to data was in direct conflict with the community oriented discourse that characterised social work practice. While an IMS could fulfill the objective of storing department data electronically, the officers did not view this as the primary objective of their social work practice. Realising the nature of the disconnect, we revised our requirements gathering strategy accordingly. Our original plan called for developing a preliminary working prototype IMS based on the requirements we had gathered, and to use this as the basis for validating the requirements and eliciting further input from users. We now decided that prior to presenting the prototype to the officers we would first provide them with training in rhetorical styles that would assist them in seeing the connection between the goals of their practice and the logic of the IMS technology With regards to the prototype itself, while the database component and application logic were designed according to established norms in order to leverage the underlying properties and functionalities of such systems, the visible user-interface would be designed to reflect the officers' local context.

After the site visit, we developed the prototype IMS with a simplified dataset and a user interface that is "situated" with respect to the paper files and work processes to which the officers are accustomed. While a full discussion is out-of-scope, we briefly explain. In designing the interface, the paper form was the guiding metaphor. The data-entry screens and available actions match the various forms in current use and associated activities, and are situated in operational frames of reference (i.e., fill out blank forms, submit forms, review client files, etc.). Clients are referred to by name and abstract concepts are presented in concrete terms (e.g., the concept "type of assistance" is realised by completing a particular form rather than selecting a value from a drop down menu classifying the different types available). Entries can be made in any order, and forms completed at later times. The resulting interface mirrors their current work practices more closely, but is less "technically elegant" than if the interface were structured around the underlying database structure with entry order dictated by the internal logic.

On our return in September 2008, prior to presenting the IMS, we organized a 2-day workshop on report writing, focusing on the new IMS as a source for supporting the officers' recommendations. Directly following the writing workshop, the officers were presented the prototype IMS. The effect of the writing workshop was immediately evident. Whereas before the officers only saw the IMS as an alternative way for storing data already available on paper forms, they now perceived it as a tool with the potential to facilitate and improve their work. They mastered its operation quickly and immediately began proposing modifications and additional functionality to improve not only its information content, but also its integration within their work processes and the processes themselves. Their enthusiastic and eager engagement was a stunning reversal to their initial reticence and apprehension, reflected in these comments and requests: "*We need this now!*", "*Why didn't you tell us this was what you wanted to do the first time you were here? We could have told you then and not wasted all this time!*"

5. The disconnect between IMS technology and SIDS local actualities

Our intention in undertaking this project was to investigate the factors involved in elaborating requirements for software applications so that they are appropriate for local actualities of non-industrialised countries. The purpose of any information system is to collect data about some topic of interest with the goal of providing useful information about that topic. In order to design an IMS it is necessary to understand what constitutes 'useful information' to its users, and this understanding must be bidirectional. In other words, users must understand what kind of 'useful information' the IMS technology can provide, and developers must understand what constitutes 'useful information' to the users so that the resulting design reflects the users' worldview rather

than that of the developers. In the case of our study, we discovered significant design-actuality gaps between the social workers' mindset and that embodied by the IMS. These were manifest along the information, objectives and values, processes and staffing and skills dimensions of Heeks' (2002) design-actuality gaps model. The informal, qualitative and highly personal information in circulation, the community based values and the nature of the work processes, typical of the mode of discourse that characterised the officers' social work practices, were at variance with the formal, quantitative and rational perspective privileged by the IMS. Because of their circumstances, these characteristics are likely to exemplify many SIDS work contexts, making such design-actuality gaps a given when introducing IMS technology. Another characteristic SIDS share are their small resident populations and office staff. The size of the data sets and number of users that IMS must deal with will be consequently small.

At the same time that addressing incongruence in mental models is of vital importance, it is also necessary to consider the technical practicalities of introducing a new software application into an environment with limited IT infrastructure, capacity and resources. SIDS face additional constraints in this respect due to their smaller budgets, staff and available pools of expertise as well as technological infrastructures. Here we touch upon the other dimensions in Heeks' model, namely technology, staffing and skills, management systems and structures, and other resources. In a SIDS context, existing infrastructure may well consist of a miscellany of devices, platforms, application environments and networks obtained from external funders. Limited budgets will directly affect what technologies can be acquired, with unlicensed open source software often favoured due to its low cost (i.e. none), even though development support is limited or non-existent. Many institutions will have minimal staffing and skills with respect to IT, and no dedicated personnel to support what IT services they have. As is the case in St. Kitts, a central organisation, itself limited in terms of staff and resources, may be responsible for overseeing the provision of IT services to a wide range of government institutions and offices. Supporting the various applications in use as well as catering to the diverse set of user needs may seriously stretch its abilities. The provisioning process itself will not be guided by strictly "rational" decisions, but rather driven by factors such as external funders and political demands. All of these give rise to a highly dynamic IT environment in which systems that require continuous hand-holding rapidly become non-functional.

Given that on-going management of the IMS backend is essential to its operation, the long term sustainability of such a system will largely depend on how easily its management requirements can be met. Here the actualities of the SIDS context must be taken into account. With regards to technology, the choice of IMS components (i.e. platform, application environment, and network) should be made in function of the technologies with which IT personnel are proficient as this can considerably reduce the burden of support and maintenance. Given the IT staffing and skills constraints, administrative functions should be simplified and automated to the extent possible while end-use should be "intuitive" to minimise training requirements. A further aspect to consider is the on-going evolution of the IMS. Once users have become familiar with IMS technology, their needs as well as the organisation's are likely to evolve. Being able to modify the IMS easily to address evolving requirements is essential to keep the system relevant. Here again, choosing environments with which the IT staff is proficient and designs that are easily updated is important. Unfortunately, all too often decisions pertaining to the underlying IMS components and administrative functions are made without adequate consultation, leading to design actuality gaps that jeopardise the system's sustainability.

6. Technological vulnerability of Small Island Developing States

Whereas the requirements of the department's IMS have been established and validated with users by means of a high-fidelity prototype. Although the implementation of an IMS is

considered standard practice and relatively straightforward, development of even a simple IMS is non-trivial and requires specialised skills in database systems and user-interface design. Here the conundrum arises. While the development of a process for gathering requirements related to introducing IMS technologies into developing countries can be considered a valid research problem, the implementation of an IMS is not, and the lack of technological innovation makes it difficult to claim as Computer Science research (Dias & Brewer, 2009). Additionally, the non-trivial effort involved in developing a prototype, not to mention a production level IMS, stretches the capabilities of most research departments and requires a level of experience and time commitment beyond that of a student course project. Nor can research departments assume support and maintenance of delivered systems, let alone assure their financial and operational sustainability in the host country once a system is deployed. At the same time, most developing countries have limited resources and expertise to undertake such development on their own while the cost of contracting development out is prohibitive with no guarantee that external developers, imbued in the rationalistic viewpoint of their technologies and applying conventional approaches, will be sensitive to local actualities and willing to compromise their technically elegant solutions to provide an appropriate match.

This situation highlights a technological vulnerability that assails SIDS from two directions. On the one hand, the limited IT infrastructure, resources, and capacity of the individual nations make the development of custom IMS solutions impractical. Most SIDS have neither the resources nor capacity to undertake such projects on their own, nor could they do so cost-effectively. The alternative would be to develop a generic IMS solution to be shared by SIDS. While this approach realises economies of scale, it has serious drawbacks and is unlikely to be successful. A one-size-fits-all solution introduced from outside will present numerous design-actuality gaps even if a generic developing country context is assumed. The administrative processes of the various SIDS reflect a rich and diverse historical background that is not amenable to a single interpretation, and attempting to impose one is likely to bring strong opposition as it directly undermines national identity. SIDS therefore face the conundrum of how to cost-effectively introduce and sustain IMS technology without undermining their cultural identity.

7. Towards resolving the conundrum

Addressing SIDS technological vulnerability poses a conundrum for which no ready solution exists. On the one hand, custom IMS solutions are both impractical and cost-ineffective, while on the other, a generic IMS solution is destined to fail. A possible solution is a mid-ground whereby a generic framework is provided that can be customised to satisfy local actualities. This situation also highlights a significant shortcoming with current IMS development environments. Although IMS are extremely powerful and flexible (in terms of their ability to deal with large and complex data sets providing alternative views accessed by multiple concurrent users), the tradeoff is simplicity. Current development environments and tools are oriented towards the needs of large industrial organisations and embody best practices that are geared towards those needs. Much of the complexity these environments support is not required in a SIDS context. Additionally, the best practices they incorporate may be in conflict with local needs, requiring workarounds that contribute to implementation complexity. Furthermore, the wide choice of IMS configurations adds to this complexity. All these factors conspire to make the implementation of even a simple IMS non-trivial.

We contend that one aspect of resolving the conundrum requires an IMS research focus on technical simplicity. From a technological perspective, this can be achieved by establishing:

- a set of IMS best practices appropriate for SIDS contexts

- an integrated IMS development environment supporting a simplified feature set appropriate for SIDS
- a generic IMS framework that can be customised to satisfy a given nation's local actuality
- support for incremental, component-based IMS evolution

Such an environment would assist in significantly reducing the initial start-up costs involved in introducing IMS, and allow the evolution of home-grown solutions that reflect the diversity of the different islands. Such systems would provide a platform for investigating whether the quantitative, objective viewpoint that IMS inject is, in effect, an intrinsic quality of IMS as opposed to a value built-in for historical reasons. They would also provide a context for exploring how such a viewpoint can be integrated in a small island context where many people know each other personally and would consider an objective stance on the part of an interlocutor unacceptable. In this regard, the small island nations could provide valuable lessons to the industrialised world regarding information systems that support human values.

8. Conclusion

Understanding user needs is a necessary condition for designing a system that users can integrate in their work, and is essential to a project's ultimate success. In the course of eliciting user needs, we discovered a significant disconnect between the mental models of the intended users and those embedded in the IMS in terms of how information is perceived and used. The social workers, whose work was grounded in the "telling" paradigm, viewed the IMS, with its perspective geared towards "showing", as a disruption of their cultural practices and were resistant to it. This disconnect could not be bridged by reworking the internal data structure, application logic or user-interface, but instead was addressed by providing the workers with training in rhetorical styles that allowed them to reformulate their discourse into a form more appropriate to the mode of communication favoured by the IMS technology. In this way the workers were able to see value in the IMS and express needs with respect to it. In parallel, care was taken in designing the IMS user-interface to ensure that the resulting system is "situated" with respect to the users' current practices and worldview.

Our case study clearly demonstrates the need for software developers to be sensitive to the users' mindset in order to understand their needs and produce a design that reflects their worldview. At the same time it reveals that IMS technology, design tools and practices embody a worldview that may be at odds with that of users, and developers must be sensitive to this if the design is to fit the users' actuality. The non-trivial effort involved in developing both a prototype and production level system reveals a technological vulnerability on the part of SIDS with regards to introducing IMS. This vulnerability can potentially be addressed through research to establish IMS best practices for SIDS contexts, an integrated and simplified IMS development environment, and a generic, customisable IMS framework that supports incremental evolution.

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