TDT4900

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Abstract

Acknowledgments

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List of Abbreviations

AD Anno Domini. 10

ANC Antenatal Care. 19

BC Before Christ. 10

CHD Community Help Desk. 17, 20

CHW Community Health Worker. 4, 17–20

CoIA Commission on Information and Accountability. 12

DHIS2 District Health Information System 2. 12

DOT directly observed treatment. 18

GNI Gross National Income. 9, 10

HC Health Center. 19

HISP Health Information System Program. 11, 12

ICT information and communication technology. 12

MOH Ministry of Health. 17

NCD non-communicable disease. 18

RPF Rwandan Patriotic Front. 10, 11

TB tuberculosis. 18

UiO University of Oslo. 12

Chapter 1

Literature Review

1.1 Information and Communication Technologies in Developing Countries

It is important to take notice of what kind of development information and communication technology (ICT)'s are supposed to support. And in this notion make conclusions and measures based on that. Like increase a countries competitiveness in the global free market.

Common problems that concerns the Information Systems (IS) in developing countries are:

- Scarce resourses
- Little technology
- Missing skills

1.1.1 Discourses

- The pace and direction is set by the advanced economies in the world, North America and Europe. [1]
- An increasing number of studies in developing countries in Africa, Asia and Latin America.
- Developing countries are highlighting new topics like national culture, global politics, provision of ICT resources for a community.
-

Transfer and Diffusion Discourse The Transfer and Diffusion discourse assumes that IS-innovations in developing countries are achieved by transferring technology and organizational structure from more advanced countries. Much like, "if it works here, it should work there". In order to succeed the receiving part should try to emulate what is being done in the more developed countries. Of course IS these ideas of best practice are somewhat adapted to fit their new context, but the underlying assumption is that the transferred methods result in the same outcomes.

Social Embeddednes Discourse This discourse assumes that IS innovation is about creating new techno-organizational structures given a local social context. The new structures are built on the already existing structures and are a locally socially constructed course of action. The problems are seen from a local perspective and hence the solutions has to be an integrated part.

Transformative Discourse The last discourse is mostly concerned with creating possibilities for improvement of life conditions. It focuses on how IS can be used to facilitate deep socio-economic change. The social embeddednes discourse takes the local context into consideration, but the transformative takes it one step further and includes politics, economics and social conditions.

The transformative discourse raises more explicitly the strategic issues in the development struggle.

A distinctive feature of IS research in developing countries is that it puts focus on e-governments, free and open software and the development of community resources intended to overcome the digital divide.

Issues that received attention in Information Systems in Developing Countries (ISDC).

- IS-failure
- Outsourcing
- The strategic role of ICT

[1]

1.1.2 Success and Failure of ISDC

Are there any evidence suggesting that there are more IS-failures in developing countries?

In the ISDC literature the is an anxiety about failure, and not without reason. Compared to other settings there are additional pressures. The need to catch up with the rest of the world, high opportunity costs and over optimistic expectations.

Categories of failure:

- Scalability failure because of waning political support, technological complexity, human resource capacity.
- Sustainability failure because of starvation of IS resource, loose political commitment, poorly maintained. This could be tracked down to foreign aid-donors that neglected the development of local technological capabilities. The remedy is of course to look at IS as the socially embedded instead of transfer and diffusion. The IS project needs to be an integrated part of organizational practices, secure the required financial and knowledge based resources and political commitment in order to succeed.
- Assimilation in dysfunctional organizational processes, meaning that an already broken system cannot be fixed with facilitating the broken system with IS.

Total Failure An initiative that never is implemented or abandoned immediately after implementation.

Partial Failure An initiative where major goals are unattained or where there are significant undesirable outcomes.

Success An initiative where major goals are attained for most stakeholders and there are no significant undesirable outcomes.

In industrialized countries there is an estimate of $\frac{12}{60}$ to $\frac{15}{60}$ fall into the category of total failure; something like $\frac{20}{60}$ to $\frac{36}{60}$ fall in the partial failure category; and lastly the $\frac{9}{60}$ to $\frac{28}{60}$ are successes. See figure 1.1.

For practical reasons like lack of technical and human infrastructure developing countries should be performing worse than industrialized countries. The evidence base is not that strong due to lack of literature in general, evaluation and focus on case studies, but it generally points in one direction. High rates of IS-failure.

Failure can be viewed as something positive. Like in a learning process, but it cannot be overlooked that continually failing keeps the under developed countries on the wrong side of the digital divide.

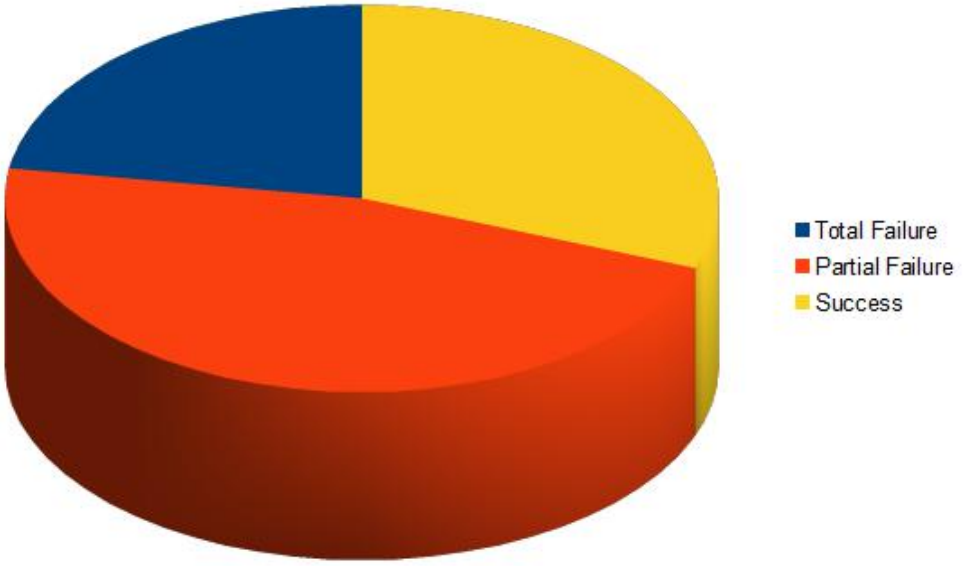

Figure 1.1: Diagram of Success and Failures in Industrialized Countries

Organizational change can be viewed as a process between two states. The current system and the future. The future system would represent the design of a IS system that are to be implemented. And the current system as a description of how the system is. Between these models there will need to be some change in several dimensions like processes, people, structure and technology in order to reach the a state of the future system. This design-actuality gap usually represents how much risk are involved from moving to a design.

The actuality of the industialized countries and developing countries have in themselves gaps. The design-actuality gap might not be the same for the solutions used in industrialized countries and developing countries.

[5] [1]

1.2 Outsourcing

A number of developing countries have nurtured software and ICT services industries able to compete in the global market, India being the most successful. Factors that account for success in the global market include technology and project management skills, copyright legislation and government industrial policy. By making an effort to outsource, there may be also be an increase to services offered to the domestic organizations. This in turn will

have an impact on the overall developments of the country or region. It is hard to imagine that there are little technological use in a place that are among the top exporters of software. The spill over effect may results in local organizations running better, and this way offering better possibilities in the other fields as well.

[1]

1.3 Digital Divide

1.4 E-Health

E-health is defined as:

> Use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research.

E-health has many areas of application. Studies have shown that in by using electronic health records it is possible to improve staff productivity, reducing patient wait times, increase staff satisfaction and providing higher quality of data to relevant personnel. Laboratory information managements systems have decreased the time for communicating results and improved the productivity of the laboratory. Pharmacy information systems reduces time to order medications and provides easy access to past information. This is useful for forecasting medication requirements in order to get it at a lower price. Particularly relevant for drug resistant tuberculosis (TB) medications. Also reducing the number of errors. Fingerprint scanners reduced the time to locate records with 74% and barcode scanners reduced the time by 97%. The time to track patients lost to follow-up could with patient tracker systems be reduced by 20–50%. And patient reminder systems can increase attendance with up to 21%. A cost analysis of data collection systems show that it is possible to save 91% over a paper based system.

These findings clearly argue for the implementation and commitment of e-health in developing countries.

Challenges include:

- physical environment
- power
- networking

- availabillity of technical staff

Further there is a rapid development in the m-health area. Cellphones and tablets are making the networks previously accessable only to computers available on the move. In health this means that it is easier to response to crisis, talk to health personell, both as a coleage and patient and generally making health services more available through electronic channels. The idea of mhealth is not something completely new. Just think about the primary way of responding to an accident as a citizen. Nevertheless, the way software are being integrated with health services today are innovative and needs attention in order to succeed. Even in the more developed countries of the world there are histories that exemplifies the difficulty of integrating health services with ICT's.

[4]

1.5 Transition Strategy

With a transition I talk about taking the system as it is and change it to something new. It's the process from old to new. The process of transforming systems or system migration if you will.

Making a transition involves a switch from the old system to the new. There is the source system, also referred to as the legacy system and the target system. At one end of the specter we have the Big Bang strategy, were we taken on an revolutionary approach. A complete new system is developed, supporting all the required functionality. Then one decideds a time when all of those involved switches to the new system. This way usually has a high risk of failure. On the other end of the spectrum we have the evolutionary approach. Gradually one introduces new functionality, or the same with a new system, then after the legacy system is not used anymore, one turns off the switch.

1.5.1 Planning and Conducting a Transition Strategy

There are some predefined methods for conducting a system migration which also could be used in a transition strategy plan. Remembering that one moves from a source system into a target system. As mentioned, solutions to transition problems could be characterized by how revolutionary it is. The most revolutionary would be redevelopment, followed by migration, maintenance and finally wrapping. One would choose the most appropriate strategy based on the level of risk. Like wrapping, one takes almost no risk, since it requires no real change to the system, but instead provides an updated interface for

the source system. Although this way is low risk, this could complicate things later on. Making use of wrapping not only slows down the system, but also makes maintenance more complicated. The most appropriate use of wrapping is when one wants to make a new Graphical User Interface (GUI). Like when moving from a text based front-end to a graphical based front-end. With redevelopment on one end and wrapping on the other, in the middle we have system migration. This technique allows for a smoother approach while being able to have control.

1.5.2 Migration

When redevelopment is to risky and wrapping is unsuitable, migration usually is the best way to go. This allows for both systems to co-exist while making the transition from one to the other. Migration usually involves moving an existing system to a new platform. Before making the transition one has to decide on some basics. Like how one would like to migrate to the new system. Much of the time is spent on testing the target system. Therefore it is good practice to not introduce new functionality while migrating to a new platform. It also makes the testing easier since one could compare with the old system for output results. New functionality should be introduced afters the old ones are supported.

The Cutover

The cutover is the last step in the migration process. Here are three main approaches.

The cut and run This is the most revolutionary way of migrating. It is much like redevelopment and seldom used alone. Once the target system is ready on turns of the source system and enable a new feature rich system.

Phased interoperability In this strategy incremental steps towards the target system is used. Replacing functionality over time and slowly moving towards target system until all functionality is replaced. The last part of the cutover would be cut and run to some degree.

Parallell operations In this strategy both systems are running at the same time. Both source and target system is operational. The target system is continually tested and only when it's fully trusted, the source system is disabled.

The cut and run is very simple, but usaually involves high risk. Parallell operations usually become quite complex, but are fairly safe. Phased interoperability is somewhere in the middle.
[13]

1.6 Groupware

Groupware development is found among the developers. When the purchasers buy visible and expensive systems organizational change is likely. Upper managements is thus likely to commit to helping the system succeed. Social and political factors that affect the introduction of a system.

- job redesign
- job creation
- providing training
- restructuring to work around individuals who will not use the system
- positive leadership

Management is less committed to the less expensive applications or features. An organization will not restructure itself for each new application the way it does around a major new system. Therefore these systems must adapt to the organization and be fitted into existing work patterns and appealing to everyone who must support it.

1.7 Information systems in the learning economy

Research in developed countries has shown that learning is a critical factor for economic success. This is not just critical for firms and industries, but also for regions and countries. This makes learning a crucial factor for developing countries. Learning, being an interactive socially embedded process, are facilitated through the institutional setup or the national innovation system. It's efficiency very much depends on the circumstances. By making the environment facilitate learning one has the opportunity to increase learning, and in turn, better the economy and technology, making living conditions better. Through ICT, knowledge can be spread from one individual to another. By actively making ICT's available we also are making knowledge

available and facilitating the learning process. So with efforts focused on ICT's, developing countries are able to learn faster by having greater access to knowledge and as a result having a better economy. This would actually just take the developing countries to a level already reached by the developing countries. So in order to really have an impact, they would need to have an advantage. Japan and United States of America (USA) have two very successful, but different approaches to learning. The one from USA has a focus on explicit knowledge. Here the focus is on reducing tacit knowledge into information with clearly defined processes and facts. A good example at this would be a step-by-step guide in order to learn something new. On the other hand Japan has more focus on making tacit knowledge. This is the knowledge that is almost subconscious. You don't necessarily know it as a set of instructions. This learning strategy are often built on the master-apprentice scheme focusing on co-operation, social cohesion and long-term social relationships. By acknowledging that there are two types of strategies, there must be a third that combines the best from both. Now, since success in the global economy are based on learning there are an opportunity here for the developing countries to not only advance to the level of the developed, but also have an advantage.

[17]

1.8 Outsourcing

Offshoring has it's spring from:

- globalization of trade in services
- Software commoditization
- Wage differentials
- Business friendly climate
- Growth of offshore labor pool
- Drop in telecom costs

China graduates four times more engineers than the USA pr. year. Before there were a differance in the quality of the engineering program, but the gap has narrowed. The talent was always there, but before those with talent would emigrate to industrialized countries. With globalization of trade in services we can tap into their services from anywhere. With low telecom

prizes, low wages and software commoditization industrialized countries are able to offshore their software activities more or less.

The wage factor are the most dominant factor for off-shoring. The global software work phenomenon is not the first of it's kind, but it differs in that it delivers a service rather than a specific product. It is well known that manufactoring and production are often moved to other low-wage countries. Parts of software development has now become such a commodity that firms from industrialized countries are able to outsource these tasks and keep the more high-level activity for themselves.

A useful way of understanding this context is via Vernon's *international product cycle*.

Stage 1: A new product begin with highly skilled entrepreneural activities, typically in industrialized nations.

Stage 2: Production begin to shift offshore via investments in low-wage nations.

Stage 3: As the product standardizes, it is mass produced with cheap, low-skilled labor.

Software has areas in all three stages. The high-level activities stay in stage 1 while being prepared as routine tasks of best practice, then moved towards stage 3 through stage 2.

Global Software Work opens up a market that are very different from others. The developing countries are here able compete under very different circumstances. Were the developed countries has to deal with high salaries the developing countries can benefit from having lower salaries and compete on cost. This makes the market highly dependent on the knowledge competencies. As discussed in section 1.7 a countries ability to learn has a great impact for developing the economy. Access to knowledge intuitively has a way of speeding up the learning process. And the most efficient way of getting to knowledge is through ICT's. Having the opportunity to compete on knowledge competencies can pace the way for developing countries. By focusing on learning the developing countries of the world are able to enter the market of ICT's with an advantage. Policy makers in charge of economic growth and infrastructure should therefore recognize this and facilitate both the learning process and the exportation of services. By focusing on this area of expertise development in other areas of industry are likely. Having a highly developed ICT infrastructure is likely to have spillover effects on the domestic services and production. Making opportunities for even new innovations. History has shown that there is a link between fortunes of the developed countries

and the developing. Rapid upgrades in ICT's have reduced the costs and increased the scope of operations all over the world.

[22] [2]

1.9 ICT4D

Giving attention to ICT's in the developing countries are both rewarding and useful. The potential impact ICT's have in developing countries are much greater than in the industrialized countries. An innovative ICT's step in the industrialized countries may lead to some improvemnt in productivity, but focusing our efforts in the developing countries has the potential of a much bigger impact. The world problems of conflict, desease and resource depletion are first met by the poor. Although the more advanced economies of the world are not primary victims, it is beneficial to give these problems some attention. These problems may someday reach the industrialized countries someday through terror, desease epedemics and migration. There is also the case that if the poor get richer, they buy more products.

In the 21st century economic, social and political life are increasingly becoming more digital. This is also the case for the developng countries. An estimate from 2012 shows that 34.3% of the global population has internet access. The computers entered the developing countries in 1954, Kolkata India. Initially computing was used in the developng countries in the public sectors for adminastrive tasks, but in the 1980's some saw ICT's potential for economic growth in the private sectior. With the internet really catching on in the 1990's, giving much attention to ICT's and the political focusing on the international development, gave rise to Information and Communication Technology for Development (ICT4D) Initially computing was used in the developng countries in the public sectors for adminastrive tasks, but in the 1980's some saw ICT's potential for economic growth in the private sectior. The internet really grew during the the 1990's, giving much attention to ICT's. At the same time international development was moving up on the political agenda. Combines these two subjects gave rise the the concept of ICT4D. As a result, initiatives like telecenter was taken place. These were buildings housing computers giving people access to the world wide web. The initiative had some problems succeeding, but brought with them important lessons that are still challenges we are facing today. Sustainability, scalability and evaluation of systems in the developing countries are important topics to consider. The systems of the past had a tendency to fail to deliver, have a limited reach and was generally talked about as better outcomes than it in reality was.

The main goal of the future should be to give internet access to the remaining 65.7% of the population. With this goal in mind there are two ways to go. Either lean on existing technologies or wait for the technological innovations. Here it is possible to go both ways.

Introducing ICT's can done in three different ways. One could just set up an environment and make the users adapt to existing processes, work with the users and continually innovate making locally appropriate solutions or lastly just introduce the technology and have the users innovate on their own.

[12] [**?**]

Chapter 2

Discussion

2.1 Evaluation

In terms of meeting the objectives described in **??** there are still some work to do. In the time frame of this case we did not manage to make a system that was operable in a real scenario. This was largely due to delays in the system of bureaucracy. It cannot be stated clearly enough how this effects the development cycle of this project. This system has been planned for a long time. The first time we initiated the request for the Short Message Peer to Peer (SMPP) protocol was at least 4 months prior to this particular case study. Adding 2 months during the case study we end up at 6 months of waiting. I will not go into details about the political decision making, but in order to explain why the project was mainly realized in a test environment is because of one signature that never made it to the paper. Because of this fact, I will continue to evaluate the project based on what we where able to realize in the test environment.

2.1.1 Objectives

The first objective (see **??**) was clearly over simplified in the beginning. District Health Information System 2 (DHIS2) supports both sending notifications based on rules. The main problem was to generate the values the rules should use as thresholds autocratically. So the objective should rather have stated that we should be able to integrate a customized algorithm that could use data from DHIS2 as input. The output should then be available in DHIS2 for presentation and further use. With "The Essential Predictore" we were able to do just this. The plan was to then use DHIS2 to send notifications based on a functionality called validation rules. We did not have the time to

figure out if this was possible, but was told by the support team that it was very likely.

The second objective (section **??**) was to send a reminder if a Simple Message Service (SMS) report was late. Our initial idea was to use the validation rules in order to check if the report was sent. Like the first objective, we did not get the time to work on the validation rules and therefore were not able to implement this functionality.

The third and fourth objectives (section **?? ??**) were realized in DHIS2. After configuring DHIS2 we were able to both send and receive SMS in the test environment. This functionality was also presented to the Community Help Desk (CHD).

In terms of success and failure as discussed in 1.1.2 we can categorize the objectives. Assuming that the test environment is suitable to simulate reality, we have; Objectve 1 classified as partial failure. We did not meet the main objective, but did clear out much of the work in order to meet the objective in the future; Objective 2 was total failure. We did not meet the main objective in the time frame set for the case; Objective 3 and 4 could be classified as a success. The main objectives were met, although only in the test environment.

2.2 Reflection

The Health Management Information Systems (HMIS) team had not only mmunity Logistics Management Information System) to consider during the case study. Several projects including data quality, malaria, moving servers to the national cloud were running alongside the Community Logistics Management Information System-project. This resulted in divided attention of the team. Having a positive impact on the collective productivity, the divided attention also results in having to continually update team members. As a result, more meetings are needed and more presentations and more time spent.

2.2.1 Language

Language barriers are common when collaborating across borders. But in this study we found that there are also symbol barriers. Common misspellings were between the symbol for the letter 'l' and the number '1'. Also, between the letter 'o' and number '0'. These were pitfalls easy to avoid, but hard to take notice of. This was mainly resulted by the lack of schooling of the Community Health Worker (CHW)'s. In Rwanda there are currently three

languages being spoken. English, French and Kinyarwanda. English is the working language, but both one cannot take for granted that everybody speaks it. This makes automatic feedback an issue. Developers may not be aware that the official spoken language is are not spoken by all inhabitants. DHIS2 has taken some actions to make all their messages customizable and support for customized feedback messages are just around the corner.

2.2.2 Programming

I took notice of the convenience of being able to program the software that we used. DHIS2 is an open source software with frameworks based on JAVA. Being able to customize DHIS2 on this level is essential to meet the clients and users needs. For now Health Information System Program (HISP) has a developer team located in Oslo that is supporting the users requirements. DHIS2 is active in over forty countries. Clearly some local customization is in order. I would propose that every team that are using DHIS2 had some employee that are able make DHIS2 applications.

2.2.3 Power supply and Internet

Often taken for granted in the developed countries are stable internet and power supply. Every other day one could experience power cuts that lasted between 5 and 10 minutes. While not being a critical issue in these short terms, it did affect the productivity. Routers rebooting and interconnections resulting in downtime on servers are not easy to work with.

2.2.4 Creative Use of DHIS2

DHIS2 is developed to be used a certain way. All data should be located in the same database basicly being manipulated through the user interface. Our solutions to our problems did in some way circumvent this. By connecting directly to the database we were able to implement the algorithm and create bulk users. This may create some issues in the future. Like when creating bulk users, the CHW's are not being part of the process. This may lead to unwanted outcomes on bigger perspective. The DHIS2 protocol for doing this is that someone in charge will register users in their area of responsibility. By bypassing the user involvement we are loosing the HISP characteristic of social-embeddednes.

Another example of creative use of DHIS2 is that instead of using one database several are used for different topics. Then, in order to have inter-

operability between instances, certain dataelements are transferred between the servers.

2.3 Rwandas ICT Transformation

The government of Rwanda has lately been wanting to become a knowledge based economy. This means that they want to trade knowledge for other kind of resources. The topic of interest is ICT's. In section 1.1.1 we talked about how ICT could be categorized into three different discourses of seeing Information Technology (IT)-innovations. The Rwandans perspective clearly have some similarities with the third discourse, *transformative ISDC*. Since Rwanda mainly exports coffee and tea there will be some significant changes in the way the country is both social and economical. With the goal of becoming the IT capital of Africa raises issues including social, political and economic issues. There are about 90% of the population that works in the agricultural sector where their main export are tea and coffee. Switching from agricultural to an ICT based economy will call for a large scale deep socioeconomic change.

Into this vision of Rwanda becoming a ICT/knowledge based economy, HISP fits right in. HISP's view of IT innovation is more like the social embeddedness discourse. Since these two discourses are much alike they also can co-exist. While the government is focusing the the socio-economic process the country needs to go through, it makes room for organizations like HISP to focus on the social-embeddedness of ICT innovations.

[16] [6]

2.4 ICT to Facilitate Health Services

The motivation for ICT's in health systems are to take advantage of the possibility to increase efficiency, scale up treatment and improve patient outcome. In a Logistics Management Information System (LMIS) context the primary objective would be to reduce errors and increase efficiency. Studies have shown that a reduction in errors Pharmacy Information Systems when using information systems.

[4]

2.5 Discuss action research the overall action research case

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