

Smart Collaborating Hubs and a Smart Global Village – An Alternative Perspective on Smart Cities

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Abstract—Most of the prevalent smart city solutions that focus on large metropolitan areas are irrelevant to almost half of the world population that lives in rural areas, small towns, islands and isolated communities. This paper presents an alternate perspective that is based on Smart Collaborating Hubs and a Smart Global Village to serve smaller communities. These hubs provide inexpensive and highly specialized services in health, education, public safety, public welfare and other vital sectors for the underserved populations around the globe. An extensive computer aided methodology is presented that is being used to plan, engineer and manage the smart collaborating hubs for a United Nations Partnership. Key results and examples are used to illustrate the main points.

Keywords—Computer Aided Strategic Planning, Smart Cities, Smart Enterprises, Small Islands, UN SDGs

I. INTRODUCTION AND THE CHALLENGE

Most smart cities projects at present are focusing on large metropolitan areas in developed countries. However, roughly half of the world population lives in rural areas, small towns, isolated communities and small islands. Due to the small fragments of widely distributed populations and weak communications technologies, planning and engineering/management of such populations involves difficult decisions that require people, processes and technologies tradeoffs. For example, the Solomon Islands is interested in a “Smart Solomons” vision. However:

- Solomon Islands has a population of 0.6 million people that is spread around 900 small islands in a 10,000 square mile (roughly 100 mile x 100 mile) geographical area in the vicinity of Indonesia.
- The populations in the small islands are so small that most of them do not have schools beyond primary education and virtually no healthcare facilities.
- The population is generally poor, with many people living with less than USD 100 per month. The working professionals make between USD500-600 per month.
- The telecommunications costs are extremely high (around USD1200 per month) for a 1Mbps line.
- The capital city, Honiara, is the only “developed” city with decent schools and healthcare facilities. But Honiara has only 15% of the Solomons population – 85% of the population lives in the 900 islands.

- The islands are between 20 to 50 miles away from each other. It may take between 3 to 5 hours to transport a patient from an island to a hospital in Honiara.

A quick glance at this example makes it clear that most of the prevalent smart city solutions are completely irrelevant to this situation. However, almost half of the world population that lives in small islands, rural areas, small towns and isolated communities are facing challenges somewhat similar to the Solomon Islands.

Instead of focusing on large scale smarter cities, we are proposing smart hubs located in small towns and isolated communities that provide location specific services to reduce global urbanization trends complicating current smart city solutions. Our hypothesis is that people living in rural areas would prefer not to move to the expensive, congested and crime ridden cities if local smart hubs could provide high quality services to people living in more sustainable local environments. In addition, smart collaborating hubs can be used to provide needed services to few neighborhoods of a large city and can also be used to gradually implement a large smart city plan instead of a centralized “one size fits all” solution.

This paper concentrates on smart hubs being developed by the United Nations ICT4SIDS (Information & Communication Technologies for Small Island & Developing States) Partnership. The lessons learned based on implementing more than 30 hubs located in 10 countries are highlighted and future research plans are outlined. An attempt is made to answer the following questions:

- What exactly are smart hubs and how can these hubs collaborate with each other to form a smart global village for the benefit of underserved populations as defined by the United Nations SDGS (Sustainable Development Goals) [1]
- What are the key challenges faced in planning and operating smart collaborating hubs and what is the methodology adopted to overcome these challenges
- What are the results so far to demonstrate the value of smart collaborating hubs to form a smart global village
- What is the expected contribution and what are the future areas of research and development

II. THE OVERALL VISION AND BASIC DEFINITIONS

Our vision is a *Smart Global Village for the Underserved Populations* that consists of smart collaborating hubs located in small islands, small towns and isolated communities, as shown in Figure 1. The basic definition of a smart hub is that it must provide most appropriate location specific services of high value to its users. Specifically, a smart hub must:

- Provide highly specialized region and population specific low cost and high impact services in health, education, public safety and public welfare (for example provide a hypertension telemedicine clinic in areas with high incidents of hypertension and offer adult job training and micro-entrepreneurship training in areas with high unemployment).
- Collaborate with each other for a region wide impact through information exchange and cooperation between various smart hubs (for example, a hypertension hub collaborates with another specializing in diabetes).
- Be aware of the local information technology and energy constraints and be customized accordingly (for example, do not offer cloud-based services to small islands that do not have access to the cloud).
- Be supported by a powerful portal that has prefabricated plug-ins for collaboration, business intelligence, decision support, and security so that a smart hub located in the remotest possible locations can equally participate in the government decision making and citizen engagement processes.
- Provide a pathway to add cognitive services as local capacities of populations improve accordingly.
- Support a systematic methodology that significantly reduces the time and the cost of implementing the hubs and thus partially address the financial crisis faced by the small islands and developing countries [3].

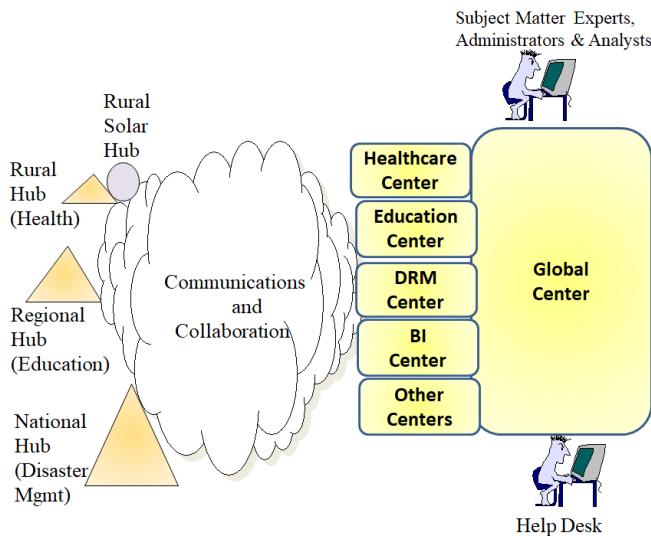


Figure 1: Overall architectural vision for Smart Hubs and the Smart Global Village

Due to our experience so far, we strongly believe that this *distributed collaboration* approach is very effective for rapid implementation of the 17 SDGs that span health, education, public safety, public welfare, energy, agriculture, food safety, and other vital areas [1,2].

III. CHALLENGES FACED AND THE METHODOLOGY ADOPTED TO OVERCOME THE CHALLENGES

Given the massive scale and the ambitious vision presented in Figure 1, our major challenge is how to materialize this vision quickly, economically, and globally so that no one is literally left behind. *Our main objective is to quickly identify and launch low cost but high impact services in health, education, public safety and other vital sectors for any location anywhere in the world.* Specifically:

- Where exactly should a hub be located?
- What type of service(s) should be provided for the area?
- What type of energy and communications will be needed?
- What type of ICT infrastructure will be needed?
- What are the security, privacy and policy issues?
- How can the funding and capacity building issues be handled?
- How can the skill shortages in remote areas be addressed?
- What are the project management and governance issues?

Due to these and other complex issues repeatedly mentioned in extensive studies [3, 4], the failure rates of ICT projects of this nature are very high – around 80% in developing countries [12, 13]. To address these challenges, we used the computer aided methodology displayed in Figure 2. This methodology relies heavily on a powerful computer aided planning and decision support environment, called SPACE (Strategic Planning, Architecture, Controls and Education) and other tools.

The SPACE environment [7] addresses the aforementioned challenges and produces a highly customized portal to support different smart hub configurations within an hour. Most importantly, SPACE supports individual services that can be combined into complex “service bundles” to represent offices, clinics, community centers, corporations, neighborhoods, and even cities. This allows us to plan and architect very simple to very large and complex scenarios for smart hubs. This methodology is based on the insights gained by implementing more than 30 smart hubs in pilot projects that span more than 10 countries. The pilot projects have been launched and managed by the United Nations ICT4SIDS Partnership [6]. The recent version of the methodology, displayed in Figure 2, consists of the following phases:

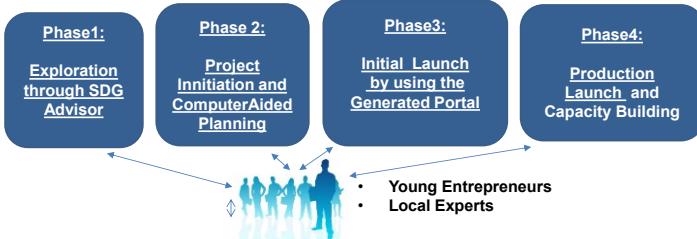


Figure 2: Computer Aided Planning and Implementation Methodology for Launching Pilot Projects

- **Phase 1:** We invite potential users to join a smart pilot project that implements smart hubs to support health, education, public safety, public welfare, and other SDGs for the community. We ask the interested users to use the SDG Advisor tool (part of SPACE) to help them assess their needs and determine which SDGs should be addressed in the pilot project.
- **Phase 2:** A hub vision is proposed and a pilot project is initiated by a user and a *Point of Contact (POC)* is appointed by the target community. The POC is trained to use the SPACE Extensive Planner to conduct an extensive feasibility study and produce a strategic plan, a funding proposal and a working prototype of the selected smart hub(s) – all within 2-3 hours.
- **Phase 3:** The results of the feasibility study are analyzed/revised and a final smart hub is created in collaboration with the POC and local experts. The final hub is “registered” in the Collaboration Matrix and also in the appropriate Global Center (e.g., a hypertension hub is registered in the World Hypertension Center). The POC goes through intensive training, available through SPACE, and is responsible for refining and expanding the hub portal based on local needs.
- **Phase 4:** The produced portal is refined for a production version and is added to the collaboration matrix of the Global Village – this makes the new hub a collaborating hub. The new hub is also published in a Donor Portal for attracting funding sources and business partners. Funding models accessible by this process include public, private, or even “crowd sourcing” which allows individuals to contribute to specific projects. The Donor Portal also serves as a connector hub for micro financing. A production version of the smart hub is launched at the end of this phase.

It can be seen that SPACE is at the heart of this methodology. Initially developed as a computer aided planning tool for small businesses, SPACE has now matured into a powerful computer aided planning, engineering and management environment due to repetitive use and research since 2010 [9, 10, 11]. Figure 3 shows a conceptual model of SPACE as it exists at the time of this writing. As shown, SPACE covers the entire Learn-Plan-Do-Check cycle to address the aforementioned challenges. SPACE uses an extensive array of capabilities that include patterns, games, decision support and planning tools, and specialized tools that invoke different capabilities for different types of

situations. Specifically, SPACE consists of the following capabilities [7]:

- *Patterns and Knowledge Repositories* (the innermost circle) contain an extensive library of business and technology patterns and expose the users to educational materials, case studies, and examples needed throughout the cycle. These patterns and case studies span 11 sectors that include agriculture, education, health, public safety, public welfare and other vital sectors and are used throughout the aforementioned methodology. For example, healthcare patterns are used to create healthcare hubs.
- *Games and Simulations* (the next circle) that support decisions in strategic analysis, mobile services planning, interagency integrations and health exchanges, application migration versus integration tradeoffs, risks and failure management, and quality assurance. For example, disaster recovery (DR) games are used to populate DR hubs.
- *Decision Support Tools* (the outer circles) contain strategic and detailed planning tools that systematically guide the users through various decisions in strategic planning, architectures, integration, acquisition, security, controls and project management activities. An example is the Extensive Planner (ePlanner) that is used in Phase2 of the aforementioned methodology to produce a strategic plan, a funding proposal and a working prototype of the selected smart hub(s).
- *Specialized Tools* (the outermost circle) that present and customize special views of the inner capabilities for specific large scale projects. An example is the SDG Advisor that is used in Phase1 of the aforementioned methodology.

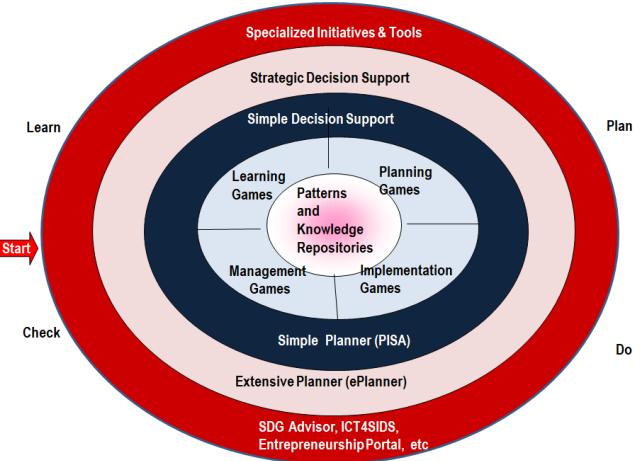


Figure 3: Conceptual Model of SPACE Capabilities

All SPACE capabilities are integrated with each other and collectively support numerous practical planning scenarios. For example, a health clinic for Haiti is first created by customizing the health clinic pattern for Haiti (the innermost circle) and then uses the higher level planning capabilities (the outer circles) that leverage other capabilities to build a smart collaborating clinic for Haiti. Big data, deep learning, and ontologies may also be used to launch a final hub.

IV. MAIN RESULTS AND LESSONS LEARNED

We are implementing our vision of a Smart Global Village through pilot projects that have deployed several smart hubs for underserved populations in Small Islands, Africa, Asia, South America and the United States. A snapshot of our projects at the time of this writing is displayed in Table 1. This sample table displays how different hubs (columns) are being implemented in different countries (rows). Community Centers provide multiple services to a small population. The cells of the table show the specific topics being addressed and illustrate the diversity of our approach. The computer aided methodology, explained previously, is being used to implement this plan by employing local youth and other individuals as Point of Contacts (POCs) who are given tangible entrepreneurship opportunities in different rural and urban areas. For example, young nursing school graduates in some developing countries are running Hypertension Telemedicine Centers as “Hub Masters”.

To operate these hubs, we are partnering with social enterprises such as Ikdar.org, UN agencies such as UNESCAP, healthcare organizations such as the World Hypertension League, and local agencies such as the Sri Lanka ICT Authority. We have learned the following key lessons so far:

- The approach of highly focused pilot projects (about 3 months) works very well -- we quickly learn what really works and also provide educational and entrepreneurship opportunities for the youth. For example, young entrepreneurs in Maldives, Rwanda and Pakistan have developed business opportunities in health informatics by working on telemedicine hubs.
- In Tanzania, we launched an educational hub for educating high school teachers in ICT (a highly valued skill in extremely short supply). This hub exceeded our

expectations by becoming financially independent in just 2 months because of much higher than expected enrollments (we were expecting 20 students, we enrolled 120 students). This hub has now started collaborating with nursing education that is supporting telemedicine hubs.

- The POCs of each hub are *required* to communicate and collaborate with at least 3 other hubs as part of the training program. They initially exchange educational materials and lessons learned but later start exchanging other vital information such as evacuation procedures in case of a disaster and digital marketing approaches and experiences for cottage industries.
- Even in its formative stages, the collaboration matrix in Table 1 is an extremely interesting playground for horizontal collaborations between different hubs in the same country (e.g., all hubs of the Solomons), vertical collaborations between different countries but on the same topic (e.g., telemedicine hub in Haiti collaborating with the one in Peru), and diagonally (e.g., micro-entrepreneurship and micro financing in Pakistan and Sri Lanka serving as connector hubs for each other).
- The collaboration matrix in Table 1 is a realization of the Smart Global Village for underserved populations vision. This is giving us unprecedented opportunities to collect, combine, and analyze highly valuable data from very diverse populations from different sectors living in different parts of the world. For example, we have combined hypertension data from Seat Pleasant, a small town in Maryland (USA), with data from Haiti, Peru, and Jamaica. According to the World Hypertension League such data has *never* been collected before.
- The Global Center of the Village, located in USA, can remotely monitor the disaster resilience capabilities of smart hubs located anywhere in the world.

Table 1: Snapshot of implementation plan of the Smart Hubs and the Evolving Smart Global Village

	Health (Telemed Hubs)	Education & Capacity Building Hubs	Entrepreneur- ship & eCommerce	Food and Agriculture Services Hubs	Business Intelligence (BI) Hubs	Disaster Resilience Hubs	Community Centers
Haiti	General						
Jamaica	Hyper- tension		Tech- Preneurship		Data Mining		Health and Agriculture
Solomon Island		Business Management	Digital Marketing		Data Mining	Storms	Health and Education
Tanzania		ICT4Teachers	Tech- Preneurship				
Nigeria	General	ICT4Teachers					
Rwanda	General		eConsulting				
Maldives	Hyper- tension			Food Distribution			
Sri Lanka	General Telemed		Digital Marketing	Farming & Fisheries	BI4Small Firms	Storms	Plastic Waste
Pakistan	General		eConsulting		BI4Health	Floods	Education
Peru	General						
USA	Hyper- tension	Entrepreneur- ship Education	Tech- Preneurship		BI and Analytics	Remote Monitoring	Smart Town

V. OPERATION OF THE SMART GLOBAL VILLAGE

Figure 4 shows the Global Operations Center that supports the Smart Global Village presented in Figure 1 and the implementation plan shown in Table 1. This Center, located at the Harrisburg University, serves as the collaboration and control site between all smart hubs, and provides the following capabilities:

- *Collaboration Matrix (Table 1)* that supports various collaboration scenarios between different hubs and global centers. For example, telemedicine centers in Samoa and Solomon Islands can exchange information with each other and also with a nursing education center located in Aruba.
- *World Hypertension Center* located in Harrisburg can be used to store hypertension data from Haiti, Jamaica, El Salvador, Peru, Tanzania, and other countries for across-country analysis and advice to populations in these islands. This center is currently operated by the World Hypertension League, part of the World Health Organization (WHO), and a partner healthcare NGO (Colleagues in Care) addressing non-communicable diseases world-wide [4].
- *Education Center* is available as the central repository of education and training for capacity building of different regions. We are currently working with Tanzania to educate local teachers for effective use of computers in classrooms.
- *Business Intelligence Center* is a new capability that will be used by any of the hubs for analytics so that even the remotest villages can also participate and benefit from

simple analytics to promote local economic activities in the global marketplace

- *Smart SIDS* is a new initiative that is using the SDG Advisor and Computer Aided Planning to develop smarter SIDS. We are currently working with Solomon Islands on a Smart Samoa Pilot Project. This concept is also being expanded to smart towns and isolated communities.
- *Entrepreneurship Portal* initiative is primarily focusing on micro-entrepreneurship through microfinancing. This portal is providing resources for education, social networking, digital marketing and e-commerce as the basic tools for young entrepreneurs.
- *Smart Agriculture Portal* is a new initiative that is extensively based on using IoTs and embedded systems for monitoring the growth of crops and food security as the key areas of focus at present.
- *Disaster Recovery Center* reduces risk from disaster situations such as climate change and earthquakes, and to accelerate recoveries of economic activities thereby reducing risks to public and private sector investors
- Additional centers on food safety, micro-grids, AI applications, and Internet of Things (IoT) solutions are also under investigation at present.

The global decision support center located at Harrisburg University is giving us tremendous opportunities to conduct research on collaboration on different topics at global level. For example, we have collected a great deal of data on hypertension statistics from different population segments with different life styles, social status and diets.

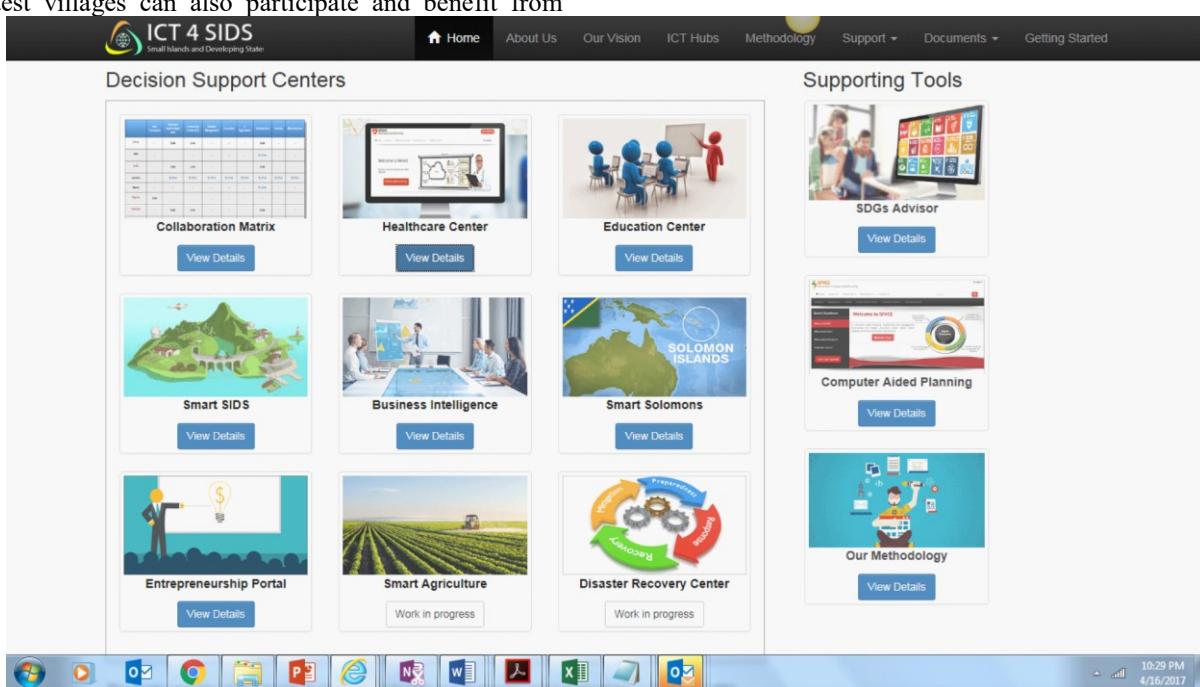


Figure 4: Screenshot of the Global Operation Center for the Smart Global Village

VI. EXPECTED CONTRIBUTION AND FUTURE DIRECTIONS

Under the umbrella of the UN ICT4SIDS Partnership, a small team of 5 people in a startup, with some help from advisors from the UN and other agencies, has launched more than 30 smart collaborating hubs that involve more than 10 countries. We have learned that this approach can directly help the underserved populations around the globe and can significantly reduce expensive retries, errors and failures that plague ICT projects. Smart hubs improve decision-making, harness innovation to improve outcomes, and engage young entrepreneurs to meet evolving needs. Based on the insights gained through the hands-on pilot projects, we feel that significant improvements in rural/urban transformations can be achieved through a set of collaborative smart hubs as a possible alternative to large scale smart cities initiatives.

We are far from done and intend to pursue several areas of practical research and development to further improve the computer aided planning, architecture, integration, implementation, operation and management aspects of the smart global village (SGV) concept. Specific areas of future research are:

- What would be the exact tradeoffs between smart city solutions based on gradual implementation of smart hubs in selected neighborhoods versus large centralized solutions for the entire city.
- How can the success rate of pilot projects be further improved. Almost 80% of our projects are successful – the main failures happen in the last phase due to the lack of financial resources to the young entrepreneurs who want to be hub masters. We are seeking innovative models to fund \$10k per hub.
- How can the Enterprise Architecture Frameworks such as TOGAF [15] be extended to improve the business, applications, platforms, governance, security, business continuity and risk management aspects of SGVs.
- What type of unique B2B scenarios will be needed to capture the global collaborations possible in an SGV and what type of workflows and B2B protocols will be needed for such scenarios. For example, will a light weight NIEM (National Information Exchange Model) will be needed for developing countries.
- How can the SPACE Environment be further improved to take advantage of the latest advances in deep learning, AI, block chains, IoTs, cloud computing, drones, and distributed intelligence. The objective of SPACE is to recommend low cost but high impact digital innovations for the poorest populations.

VII. CONCLUDING REMARKS AND ACKNOWLEDGEMENTS

We have presented an architectural vision of a smart global village that is based on smart collaborating hubs to serve smaller communities. These hubs provide inexpensive and

highly specialized services in health, education, public safety, public welfare and other vital sectors for the populations that are being left out of the smart city initiatives. A smart global village consisting of several smart hubs is currently operational and is actually being used to help developing countries and small to medium businesses to plan and engineer their systems. In addition, this village is being used extensively to support graduate courses and professional education in strategic planning and enterprise architectures and integration. Based on the lessons learned, we strongly feel that this approach could also provide a possible alternative to large scale centralized smart city solutions and can in fact be used to gradually introduce smart city solutions by offering urgently needed services first through highly specialized smart hubs and then implementing others on an as needed basis.

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