Spatial Data Infrastructure Funding Models: A necessity for the success of SDIs in Emerging Countries

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Key words: SDI, Funding Models, Factors Affecting Models, Models for Emerging Nations.

ABSTRACT

The early nineteen nineties saw an explosion in the interest of Spatial Data Infrastructure (SDI) spearheaded by the Clinton Executive Order 12906 of 1994 (Groot, 2001). This resulted in a number of research projects and publications on SDIs, the need for SDIs, SDI components and techniques for standardizing existing ad hoc spatial data related infrastructures. However, cursory reviews of SDI publications revealed limited in-depth studies and publications on the economic issues of SDI, especially in the area of financing (Rhind, 1999) (Groot, 2001)(Giff, 2000).

This area of SDI is extremely important and should not be ignored if SDI implementation is to be successful. Studies of the economic issues of SDIs would answer such questions as, what are the cost associated with the building of a SDI, cost vs benefits issues and where will the resources come from to fund the development and maintenance of a SDI, to name a few. The need to know the answers to these types of questions is even more important in emerging countries where resources are limited.

The condition of the economic environment of emerging countries makes it impossible for them to totally finance their SDIs. Therefore, additional funding must be obtained externally. The nature of the economies of emerging countries will eventually force SDI specialists to develop models capable of the following:

(a) Promoting the benefits of a SDI to cash strap governments and funding agencies who requires tangible returns on their investment. These models should provide SDIs with the capabilities necessary to compete for funds against preferred areas such as health and education; and
(b) Identifying resources for the implementation and maintenance of SDIs. Funding models for the implementation and maintenance of SDIs will differ from country to country base on Government Structure (Federal vs Centralized), the economic climate, prevailing legislation, predominant technologies, culture, maturity of available datasets and the size of the country to name a few. However, conceptual funding models can provide the framework from which individual countries can build specialized models.

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1. INTRODUCTION

Spatial Data Infrastructure (SDI) is now widely recognized as an important spoke in the wheel known as the Information Society. It provides the tools for continents, countries, regions and local governments to better organize, plan and manage their natural, cultural and economic resources (Sorensen, 1999). The recognition of SDIs' importance to the information society has resulted in a significant number of research and initiatives in this area. However, publications generated from these research and initiatives have done very little to address the economic issues associated with the development, implementation and maintenance of a SDI (Groot, 2001) and (OMB, 2001). Most authors who have examined the economic issues of SDIs have concluded that the least addressed economic issue so far is, that of finance (Giff, 2001), (Groot, 2001), (Rhind, 2000) and (Rhind, 1999). That is, the development of long term capital financing models for SDIs.

The concept of SDI financing models is even more important to emerging and transition countries that have very limited financial resources which must be shared amongst other projects that have more tangible and short term benefits. Therefore, SDI program managers need to go the extra mile in order to secure funds for the development and implementation of their SDIs. In order to assist these program managers in fighting the odds the authors intend to propose conceptual funding models that will provide SDI program managers with methodologies for identifying and sourcing funds for SDI development.

This paper is the result of early research carried out to address the deficiencies in research on the economic issues of SDIs particularly that of financing. The paper does not intend to propose funding models for individual SDIs but instead to provide conceptual models for SDI financing with the hope of stimulating additional interest in this area of SDI implementation.

The paper will open with a brief review of SDI and its economic issues. The authors will then propose a number of funding models and analyze how different environments affect these models (in particular government structure). The paper will then review the application of these funding models to emerging nations and conclude with a brief review of research done to date and the next phase of the research.

2. SDI DEFINED THROUGH INITIATIVES

Most nations have by now recognized the importance of a spatial data infrastructure to their economic, environmental, political and social prosperity and thus, have taken steps to build or formalize their existing SDIs (ANZLIC, 1996). An important step in the development of a SDI is the definition of the concept of a SDI. Three of the most active nations in SDI

formalization the United States, Australia and Canada define their SDIs in the following manner:

2.1 United States of America

The Clinton Executive Order 12906 was one of the earlier definitions of the United States National Spatial Data Infrastructure initiatives. The Clinton Executive Order 12906 set out to define a national spatial data infrastructure as the:
"*…technology, policies, standards and human resources necessary to acquire, process, store, distribute and improve utilization of geospatial data*" (Clinton, 1994).
The USA's Spatial Data Infrastructure program has been the most widely documented effort to date. Readers are encouraged to consult http://www.fgdc.gov for a wide collection of articles, reports and tools related to this initiative.

2.2 Australia

The Australian and New Zealand Information Council (ANZLIC, 1996) defined the Australian Spatial Data Infrastructure (ASDI) as comprising four main components. They are:

1. An institutional framework;
2. Technical standards;
3. Fundamental dataset and;
4. Clearinghouse networks.

These components will be used to facilitate the identification, sharing and usage of spatial data across Australia and New Zealand in both the public and private sector arenas. The ANZLIC view their SDI as being similar to any other infrastructure and thus, should be funded by the government. It is the ANZLIC's view that one of the functions of government is "*…to provide* a *common, consistent infrastructure upon which a variety of government, private sector and community activities can take place*." This concept that an SDI is a necessary infrastructure for the public good is held by the majority of public and private sector managers.

2.3 Canada

The Canadians describe a SDI as an integrated on-line mechanism to deliver geospatial data, services and information for applications, better business and policy decision-making and value-added commercial activities (GeoConnections Secretariat, 1999). The Canadians on the other hand support more private sector involvement in the development, implementation and maintenance of their SDI. This concept will require more private sector contribution to the funding of the SDI. It is the Canadians opinion that a SDI should be funded by a joint private sector and government partnership (Labonte et. al 1998). Labonte et. al (1998) describes the Canadian Geospatial Data Infrastructure (CGDI) as having five main thrusts. They are:

1. Access (nation wide electronic access);
2. Data Framework (common national framework);

3. Standards;
4. Partnership and;
5. Supportive Policy Environment (promoting broader information usage).

Readers are encouraged to consult the GeoConnections web site at http://www.geoconnections.org for more information on the CGDI.

A more comprehensive list of current SDI initiatives around the world may be found at http://www.spatial.maine.edu/~onsrud/GSDI.htm.

The above definitions do have common components with each country emphasizing the components that the authors believe are most important in delivering the concept of a SDI to the general society. The definition of a SDI is also important in an economic sense since, it will provide a guideline of the different components that are included in the SDI and thus a cost can be estimated based on the relevant components. It also provides information on the different parties that are likely to be involved in the creation of the SDI and contributes financially (Rhind, 2000). Therefore, a clearly defined SDI can assist enormously in the costing and identification of possible source of funding.

3. THE ECONOMICS OF SDIs

The economic issues involved in implementing a SDI are covered by both strategic and operational management principles. The issues related to strategic management are the more complex and interesting of the two. Some of the more challenging issues that must be addressed by SDI program managers are:

- The economic viability of a SDI (Benefit Cost Analysis)
- Strategic Planning
  - Funding Models
  - Pricing Policies
  - The role of a SDI in the global market
- The economic issues associated with day to day operations.

The first phase of implementing a SDI involves the determination of whether or not the SDI is economically viable. This is usually achieved through a benefit cost analysis and is the economic issue of SDIs that has been explored most (Rhind, 1999). A number of research have been carried out in this area to determine the value of SDIs and GISs (NASA, 1995; Korte, 1996; Silva, 1998). However, researchers in general are still ignoring the next phase of the implementation (i.e. strategic planning) especially the area of funding (Groot, 2001) (Rhind, 1999).

Preliminary research carried out by the authors revealed only a hand full of researchers actively working in this area. The review indicated that very few researchers have spent any significant amount of time on developing mechanisms to source and identify possible resources for the financing of SDIs. These findings were also supported by most of the authors performing research in this area example (Groot, 2001), (OMB, 2001) and (Rhind 2000). Some of the more prominent work on funding models for SDI implementation can be

found in (Obermeyer and Pinto, 1995), (Rhind, 1999), (Rhind, 2000), (Urban Logic, 2000), (Groot, 2001) and (Giff, 2001).

If we are to proceed on the tenet that a SDI is an essential part of a nation's capital infrastructure and thus, economic development, then there should be in place funding models for SDIs just as how funding models exist for other capital infrastructure development.

3.1 The Concept of SDI Funding Models

The main purpose of a SDI funding model is to act as a guideline for SDI program managers on how to formalize and source financing for the implementation and maintenance of a SDI. Funding models are not universal since; the implementation environment of individual SDI may differ thus, requiring adjustment to the models. However, conceptual funding models can become very important to SDI development since, they can provide SDI program manager with answers to such questions as:

- Where and how to seek out funds?
- Over what period will the funds be disbursed? and
- What are the effects of funding on pricing policies?

The answers to the above questions are even more significant to emerging nations and nations in transition. This is true since, these nations are usually affected by very limited financial resources, poor capital markets and inadequate political structures (IIPF, 2001). These and other factors will make infrastructure financing which on its own is a formidable task an even more complex problem. Emerging nations and nations in transition cannot afford to totally finance their SDIs from their local budgets thus, additional funds must be obtained externally. Long term capital financing models for SDIs as the potential of becoming an important tool for assisting SDI program managers of these nations in sourcing, structuring and formalizing of funding for SDI implementation.

3.2 Funding Models of the Generation of SDIs

The majority of today's existing SDIs evolved from National Mapping Agencies. Thus, a significant proportion of their funding was derived from the budgets of national mapping agencies. From the previous statements it is reasonable to conclude that the funding models of the majority of today's existing SDIs are very similar to that of their national mapping agencies. That is, they were mostly a combination of Government Funding (derived from taxation and external funds) and to a lesser extent Private/Public Sector Funding (derived from fees charged to customers). Although the level of government and private/public sector contributions differ from country to country the above argument was found to be true in both first world nations and emerging nations, and in free market as well as centralized economies.

Rhind (2000) expanded on the above concept and concluded that there are at least four different models today that could be ascribed to SDI funding. They are:

1. Government Funding (Funds derived from taxation);
2. Private Sector Funding (Derived from fees charged to customers);
3. Public Sector Funding (Derived from fees charged to customers); and
4. The Indirect Method (Funds derived from advertising, sponsorship and other indirect methods).

Preliminary research indicates that the application of these models varies from 'stand alone' to a combination of one or more or all of the above models.
Research on infrastructure development carried out so far by the authors suggests that the first model was and still is the most widely used. In the past, government made the most significant contribution to infrastructure development; for example, the US Highway Network (Sorensen, 1999). However, since governments are now moving away from investing heavily in infrastructure, alternative sources must be sought.

Income generated from the usage of the infrastructure ranked next (e.g. income from fix-lines and cellular networks). In the context of a SDI the sale of spatial data/information is on the increase and is viewed by many as one such source of alternative funding to government. To this end a number of spatial data producing organizations around the world are in the process of putting in place, policies aimed at making them more self-sufficient. That is, satisfying all their expenditure through income generated from the sale or provision of spatial data/information. Success stories can be seen in some European Countries, for example the Ordnance Survey of Great Britain (William and Gartner, 1996; Ordnance Survey, 1999) and the Dutch Kadastre (Bing, 1998) (de Jong, 1998)(Kok and van Loenen, 2000). These organizations are now aiming at producing and marketing their goods (spatial data/information) and services more efficiently.

Based on the above factors and also comparison with the Internet, Crandall (1996) in his review on infrastructure funding concluded that an increase in the supply of affordable spatial data in the format required by the consumers may in the long-term result in an increase in demand. This increase in demand may lead to increase revenue thus, the possibility of funding a SDI through fees derived by Statutory Bodies (Government owned companies) and the private sector.

Crandall's (1996) review also covered the indirect method and concluded that this method of generating revenue is on the rise but the environment is still risky. That is, the expected returns from advertising in the spatial data environment are low since advertisers are not yet convinced of the volume of traffic a spatial data/information site will command. Thus, an influx of investment in this area is not expected in the near future. However, there is light at the end of the tunnel as success in this area can be seen in companies such as MapQuest™ and Microsoft's TerraServer™ to a lesser extent. These companies are presently generating steady revenue from advertising on their spatial data/information related sites.

Although there are some success stories, the latter two models are in their infancy stage and are yet to be tested on a broad scale in a spatial data environment. However, the likelihood of

using these models along with other models seems plausible and will be closely watched by the authors.

3.3 Key Factors Affecting Funding Models

The design and usage of funding models are affected by a number of issues associated with the SDI implementation environment. Some of the most significant factors are:

- Government Structure - The level of government responsible for SDI implementation;
- Government Policies – SDI classification (Classic Infrastructure [public good] or Network Infrastructure [capacity based]), is there a need for earn returns on investment?
- Capital market – The availability of local capital for investment ;
- Social and Political Culture – The society's views on infrastructure financing;
- Private Sector Activities- The level of private sector involvement in SDI implementation; and
- Legislation – The different laws that affects infrastructure financing in general and SDI pricing policies.

Factors	Effects		Level of Adjustment to Models
	Positive	**Negative**	
Government Structure			
Clear policy on the role of each level of Govt.	✔		Low
Local Govt.	✔	✔	Low
Central Govt.	✔	✔	Low
Both levels of Govt	✔	✔	High
No clear policy		✔	Very High
Government Policies: SDI Classification:			
Public Good	✔	✔	Low
Network Infrastructure	✔		Medium
Return on investment	✔	✔	Medium
Capital Market Activities			
High	✔		Low
Low		✔	Very High
Private Sector Activities			
High	✔		Very Low
Low		✔	High
Legislation			
Impeding/constraining		✔	High
Non-constraining	✔		Low
Social and Political Culture	✔	✔	Varies for low to high

Table 1: An illustration of the effects of some key factors on the models proposed by Rhind (2000)

The implementation environment of individual nation will have different combination of the above factors associated with it and thus, the conceptual models to be recommended by this paper will have to undergo some level of adjustment to satisfy each environment. However, the models to be proposed in this paper have factored in the effects of each factor and were designed in such a manner that only significant movement from the norm will require high levels of adjustment.

4. FUNDING MODELS BASED ON GOVERNMENT STRUCTURE

Government structure in today's information society varies from nation to nation. These varying government structure will significantly affect infrastructure financing as the responsibility of infrastructure development thus, financing will vary with varying government structure. In classifying government structure in terms of how they affect infrastructure financing (particularly SDI) the logical classification would be to narrow them down into two categories. They are:

- A Central Government Structure and
- A federal Government Structure.

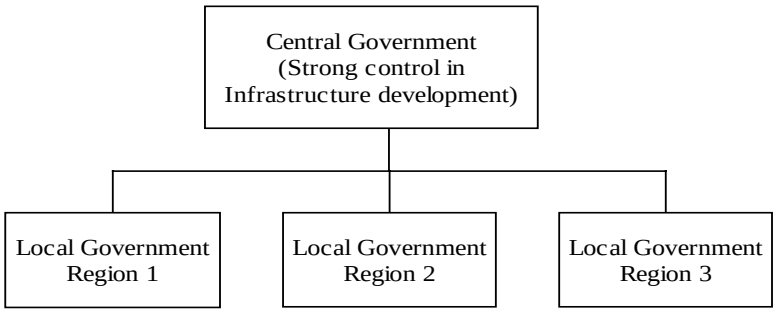

Figure 1. Central Government Structure

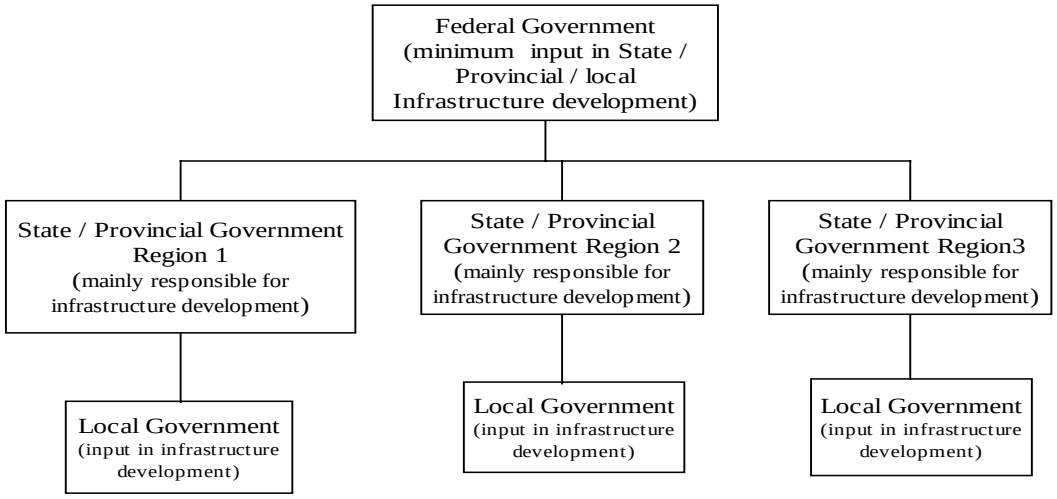

Figure 2. Federal Government Structure

In the case of a central government structure the highest level of government is mainly responsible for infrastructure development with minimum input from local government. While in a federal government environment the different levels of government will be either totally responsible for infrastructure development or bear the majority of the responsibility. The federal government will be responsible for infrastructure considered as national while the other level of government will have the majority of the responsible for regional and local infrastructure.

5. FUNDING MODELS FOR CENTRAL GOVERNMENT STRUCTURE

All levels of government are intimately involved in SDI whether as users, landlords, regulators, economic developers and or providers. In a central government structure however, it is the central government that bears most of the responsible for SDI development and maintenance. In light of the fact that governments throughout the information society are reducing their level of contribution to infrastructure development alternative funding models had to be created. One plausible alternative is for the private sector step up to fill the void left by the reduction in government spending. This can best be achieved through joint government-private sector initiatives. This is the policy adopted by both Canada and the United State for the implementation of their SDI (FGDC, 1997), (Labonte et al., 1998) and (Masser, 2000) (Giff, 2001A). Funding models that may be applicable for financing SDI implementation under a centralized government structure are:

1. Funding of a SDI through government financing (that is, from taxation). An example of a SDI created from centralized government funding is the Portuguese National SDI [Sistema Nacional de Informacao Geografica {SNIG}] (Nebert, 2001).

2. The establishment of special banks or financial institutions to underwrite low interest loans for the investment in SDIs. These institutions can have a similar structure to Agriculture Credit Banks established in Europe to support the growth of agriculture. The Federal Geographic Data Committee (FGDC) is presently carrying out research in this direction (Urban Logic, 2000).

3. SDI funding can also be generated through the issuing of medium and long term tax-free bonds specially targeted at large spatial data user (public and private) and spatial data software developers for example. The issuing of bonds however, is very dependent on market conditions and thus, research in present and future market conditions should be undertaken before applying this option.

4. Private sector capital investment in SDI based on expected returns on investment through value added products.

5. The creation of the SDI as a service bureau or consortium. Shares in this new organization can then be issued on the stock exchange or through private subscriptions (Urban Logic, 2000);

6. Through accessing of capital markets by the consortium for financial assistance such as revolving loans and other similar debt structures; and

7. Large users of spatial data should be asked to pay a membership fee to the consortium (Urban Logic, 2000);

8. The financing of a SDI through the sale of spatial data/spatial information by government and private sector partners.

9. In some cases depending on the implementation environment the models proposed above might fall short of raising the complete capital investment required for a SDI implementation. A solution to this problem could be a combination of the models listed above. Combining the models would not only depend on government structure but also financial markets and the political climate to name a few.

6. FUNDING MODELS FOR FEDERAL GOVERNMENT STRUCTURE

The responsibility for infrastructure development under this type of government structure lies mainly in the hands of the regional governments, but may vary in some cases from total responsibility by regional governments to a joint partnership with the federal government. For example in Australia each individual state is required to develop their own portion of the Australian SDI (Nebert, 2001). However, since the industrial revolution regional governments have been fighting with federal government to make a fair contribution to infrastructure financing (Harris, 2000). Again one solution to the lack of federal funding would be partnerships with private sector investors. Funding models more appropriate for this type of government structure are:

1. Funding through regional government budgets.
2. The application of incentives such as matching ratios to stimulate investment. Under this type of arrangement the federal government would match (according to the specified ratio) the amount of funds invested into the SDI by a state. Matching ratios could also be applied to private sector partners in the form of tax breaks.
3. Partnership with the local private sector not only in the form of capital investment but also in the usage of their resources (e.g. data collection and consultation).

All the models are applicable in either category however; some models are more tailored for a particular category (Figure 3.). In addition to models 1 to 3 above, models 2-9 under the category of centralized government structure are also applicable here in a more localized format (smaller scale).

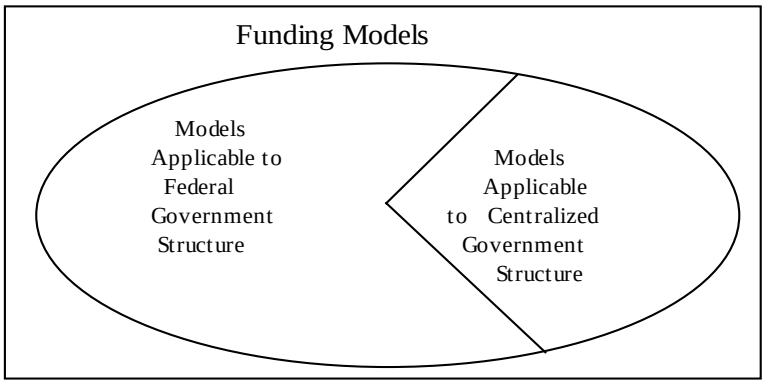

Figure 3. The application of the models between the categories

7. FUNDING MODELS FOR EMERGING NATIONS

SDI implementation in emerging nations will differ from that of developed countries mainly because of the differences in the legislative and regulatory systems; the lack of political and economic security; the culture and usually highly centralized infrastructure system (IIPF, 2001). Therefore, the models identified by Rhind (1999) and those proposed in the previous paragraphs will not be applicable in their current form in emerging nations and nations in transition. However, with in-depth analysis of the environment of these nations and drawing on the lessons learnt in the application of the models in developed countries it will be possible to modify the models to suite the environments of emerging nations. Preliminary analysis of the environment of emerging nations have revealed the following results:

- Infrastructure financing was done through government budgets and foreign donor agencies. However, with the constraints on both local and foreign government budgets, these models are becoming less effective.

- Emerging nations lack the necessary creditworthiness required to access funding from international credit agencies (IIPF, 2001).

- Capital market and private sector activities in these countries are very weak.

- A lack of political and economic security (IIPF, 2001)

Based on the above factors the authors suggest the following range of potential funding models for SDI implementation and maintenance in emerging nations:

1. Funding from Government budget
2. Funding through International Donor Agencies
3. A Government and International Donor Agencies partnership
4. International Donor Agencies and Private Sector (local and international) partnership
5. Government Private Sector partnership
6. The creation of a Government, Donor Agencies and Private Sector partnership

7. The creation of a donor pool. That is, a partnership amongst different donor agencies with each agency responsible for different aspects of the SDI (Nebert, 2000). This donor pool should be organized in such a manner that it will ensure there is sufficient funds to sustain the SDI until it becomes self-sufficient or other methods of funding are secured.
8. Non-monetary Private Sector contributions (e.g. data collection, database management)
9. The establishment of special banks or financial institutions to underwrite low interest loans for the investment in SDIs. This can be done in conjunction with international lending agencies.
10. Matching ratios with the Private Sector (local and international) based on tax incentives

The difficult environment of emerging nations coupled with the present constraints of most donor agencies forces the authors to conclude that no single model will be capable of financing a SDI. Therefore, the best possible solution would be the creation of a pool of funds to be access for SDI financing when necessary (figure 4).

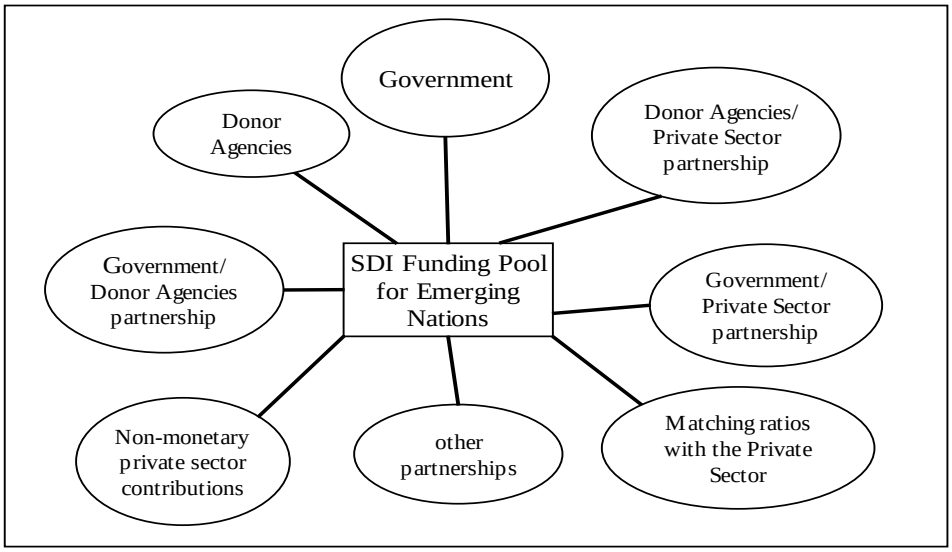

Figure 4. SDI Funding Pool for Emerging Nations and Nations in Transition

The above models are the results of preliminary research on the environment of emerging countries and thus, do not represent a comprehensive list of all the possible models. If the models are to be effective the legislative and regulatory system of these nations and donor agencies to a lesser extent will have to be modified. For example, these countries may have to put in place systems to address such matters as lenders and equity investors' ownership in SDI, taxation on profit and repatriation of profits. In the case of the donor agencies they may have to modify their regulations in terms of funding private sector development of SDIs.

8. CONCLUSION

This paper discussed the importance of having in place funding models for the efficient implementation of a SDI. These models will serve as a guide to SDI program managers on how to identify and secure the finance necessary for SDI implementation. This concept is even more important to emerging nations because of their very limited ability to generate financial resources for infrastructure development. They are also important to countries with

SDI initiatives in progress since the allotted funding for the first generation of SDIs are now almost depleted or totally depleted.

The paper categorized the proposed models based on their suitability to different government structures. This was done since government structure and government in general will have enormous influence on the implementation of a SDI.

Initial investigation into the environment of emerging nations revealed that the models proposed for the second generation of SDIs of developed nation would not be applicable in their current form thus, the proposal of the models for emerging nations.

The models proposed for emerging nations still require further research since they ignored a number of variables associated with these environments that might have some level of effects on the models.

The initial results of the research (proposed models) are presented here by the authors with aim of attracting and generating more interest in the economic issues of SDI implementation. These issues have so far played a minor role in the first generation of SDI initiative. However, if second generation of SDIs and SDIs of emerging countries are to be successful then the financing of SDIs must be addressed.

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BIOGRAPHICAL NOTES

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David Coleman Ph.D. is Chairman of the Department of Geodesy and Geomatics Engineering at the University of New Brunswick in Canada. Prior to joining UNB, Prof. Coleman spent 15 years in industry as a project engineer, senior manager, and consultant. His research deals with land information policy, geomatics operations management, and emerging national and global spatial data infrastructures. Dr. Coleman is currently President of the Canadian Institute of Geomatics.