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A Geo-Spatial Information Model for Rurban Planning

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1 ABSTRACT

The Indian context of planning primarily focuses on urban settlements comprising approximately 30% of our land area. The rest two-thirds are composed of spatially isolated rural communities which lack access to adequate infrastructure, services and connectivity for which the absence of a standardized planning methodology is a pertinent reason. Since a spatial entity is never disconnected from its context, planning is most effective when undertaken in the context of a region, joining settlements in need of physical, economic and social connectivity. Within a region, the availability of a multihierarchical geo-spatial database is fundamental to spatial planning, and research identifies that it requires conspicuous attention in our rural planning strategy.

The proposed paper addresses this lacuna of data infrastructure at the micro-regional level. An example of micro-region is the rurban cluster, comprising several village settlements around a central town, displaying potential for spatially integrated development. The rurban cluster is in compliance with the Shyama Prasad Mukherji National Rurban Mission (SPMNRM), a flagship programme initiated by the Ministry of Rural Development (Government of India) in 2016. The planning, implementation and execution of this scheme also sufferes due to the lack of geo-spatial database management. Borrowing from past experiences in the country and abroad, this paper constructs a model for geo-spatial planning of rurban clusters. The model takes care of all the stages of rurban cluster planning such as delineation of the micro-region, database design and management, analysis, evolution of alternative scenarios and finally implementation and monitoring through geo-spatial information systems. Once developed and applied, it objectively evaluates the corresponding stages of the SPMNRM (non-spatial) and the new model (geo-spatial), to demonstrate how the latter adds value to the planning process and produces superior results on ground.

Keywords: Khunti, India, Geospatial Information, Rurban Clusters, Planning

2 INTRODUCTION

In India, spatial planning suffers widely in the urban, rural and regional context due to unavailability of spatial data. The absence of spatial planning is reflected in the inequitable distribution of finances and facilities in the country (Banerjee and Mahavir, 2018). The unavailability of data or the lack of utilization of spatial data in the creation of plans signals towards a major defect in the paradigm of Indian planning. This defect is centred around understanding the fundamental needs of physical planning, which are, data and information. Planning, being a participatory method of rational decision making is incomplete and indequate without an understanding of the present scenario. Another important aspect, currently suffering in the Indian planning scenario, is the region. The ideal management of data and information for planning must occur at a regional level, borrowing from multiple hierarchies of administrative units and integrating them into a unified and holistic framework for planning.

While looking at the availability of spatial data vis-a-vis the practises of successful planning in India, a positive bias towards the urban is observed (Banerjee, 2018). It was thus realized that if the problem of geo-spatial planning needs to be solved, the idea must emanate from, and act towards the upliftment of rural India. Introducing a geo-spatial approach to just rural planning involved the erstwhile problem of piecemeal planning and lack of an integrated multi-hirarchical planning methodology that would bring together a system of urban and rural settlements as a well-connected and interlinked region. Therefore, the model was developed for a rurban cluster, which is essentially a mix of both urban and rural areas, with a special focus on the rural. The first part of the paper elaborates on the concept of the rurban, where and how it emanated and how it has evolved over the years in the international and the Indian context, while simultaneously plotting the growth and development of geo-spatial planning information systems. The second part of the paper tries to tie these concepts together into a geo-spatial model for planning. The third part looks at an

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analysis of the application of the model on Khunti district of Jharkhand. Finally the model is re-evaluated, modified and improvised while different challenges are looked upon to come up with a way forward for rurban cluster planning in the country.

3 UNDERSTANDING THE CONCEPTS

3.1 The Rurban Cluster

The theoretical roots of the rurban cluster can be traced back to 1826, when Von Thunen proposed his "Centre Periphery Model". It represented a well-defined causal relationship between the town and its surroundings which was carried forward by Walter Christaller in his theory of Central Places, measuring spatial arrangements of settlements in a region in terms of population size, functions and distances. A layer of depth was added to these ideas such as driving area and driven area within a region by Myrdal and Friedmann's "Core Periphery Linkage" theory. The stage-wise emergence of an urban system across the pre-industrial, transitional, industrial and post industrial stages was also introduced. Complemented by Vance's theory of "Urban Realms", these earlier studies laid the basic foundation of the rurban concept as a regional, hierarchical, functionally classifiable and transitional concept of space.

The evolution of the concept from its theoretical roots began in 1966 when Kingsley coined the term "rurban" to define developed villages dispersed in a vast rurality (Banerjee, 2018). Then Disckinson gave his definition of rurban as smaller urban areas, with a higher functional status than villages (Adell, 1999). In 1970, Lefebvre used the term "rurban" to indicate the rural-urban merge, just like Pryor and Johnson in 1968.Cater defined this rural-urban fringe as a space in which the town extends into the village, but the assimilation of the rual into the urban is accomplished only partially (Adell 1999). In "Scattered City", Bauer and Roux employ the term rurbanization to define it as the dissemination of urban activities into the rural. From studies, it became clear that the rurban is a space beyond the physical boundaries of a settlement and comprising a region, rather a micro-region, with distinct densities, activities and socio-economic character, characterized as niether urban, nor rural.

Indian studies on similar concepts were few and rarely used the term "rurban" initially. Srivastav and Ramachandran in 1974 discussed the stage-wise transformation of a village into an urban area while discussing the "Rural Urban Fringe". The Punjab New Periphery Control Act of 1966, discussed "Controlled Areas" within 10 miles from the city, into which the city might expand in the future. It wasn't until 1989, that Mandal used the term "rurban centres" to depict large rural areas or small towns of fuctional hierarchies higher than the surrounding settlements. In 2014, Chatterjee used the term rurban to define Census Towns (towns with population greater than 5000, yet governed by rural authorities) as rurban areas.

In 2001, the Planning Commission of India, first started using the term rurban in a manner that was inclusive of its distinct regional character (Sharma, 2016). In a centralized scheme of the Ministry of Rural Development, Government of India (GoI) called Provision of Urban Amenities in Rural Areas (PURA), the government used the word rurban to talk about a cluster of villages, delineated for integrated development. In the Vibrant Gujarat Summit of 2012, this concept was taken ahead and used as a means to reduce the rural-urban disparity in terms of infrastructure, services and connectivity in India through the Shyama Prasad Mukherji National Rurban Mission (SPMNRM) 2016. It redefined the rurban cluster as a micro-region comprising of a central town and a few surrounding villages.

The concept of rurban defined in this paper tries to look at the historical context of the concept and tries to relate it to its current application in the country. It can be defined as "a spatially contiguous cluster of villages around a central town, each unique in their demographic and socioeconomic identities, but intimately related to one another through rural-urban linkages which can be developed to bridge the rural urban divide and foster an integrated development for both" (Banerjee, 2018).

3.2 The Geo-Spatial Information Systems in Planning

When it comes to a well-defined and systematic methodology for planning, the system's view of planning provides a comprehensive solution. It concieves settlements as systems and sub-systems, each consisting of a set of components working together to achieve the same common objective. The system's view of planning is multi-layered and has complex processes of data collection, storage, analysis, manipulation. Ian McHarg,

in his iconic Design with Nature talked about a multi-layered analysis of both physical as well as socio-economic attributes of an area with a geo-spatial outlook.

The concept of geo-spatial information systems have evolved from geographic information systems, which in turn are a specialized branch of information systems. At first, information systems were viewed as a system for transmitting and receiving messages, then as a chain of operations dealing with mapping and cartography only (Banerjee, 2018). In 1996, Mahavir bridged this gap by defining GIS as a blend of hardware, software, humanware and orgware. The paper adds another layer to the existing conversation, by talking about geo-spatial information systems which also take care of the collection of data with the use of remote sensing. It is defined as "a combination of dataware, hardware, software and networks of humans and organizations that work together collect, process, store, retrieve, manipulate and disseminate information to support decision making, coordination, control, analysis, and visualization of geo-spatial data" (Banerjee, 2018). In further sections we will integrate the concept of rurban clusters with geo-spatial information systems, in an attempt to create a geo-spatial planning model for rurban clusters.

4 BACKGROUND STUDIES FOR A GEO-SPATIAL MODEL FOR RURBAN PLANNING

The model derives itself from earlier models of rurban cluster planning as well as geo-spatial information systems, concieved either theoretically or in practice in the country. It also tries to look at the existing legislative and institutional framework in India within the model shall be defined.

4.1 Approaches for Planning of Rurban Clusters

The concept of rurban clusters is relatively new, in both India as well as abroad, and therefore specific instances of rurban cluster planning were not discovered. There were a number of neighbouring concepts which were looked at different components of rurban planning were adopted for different stages of the planning methodology. Mandal defined large rural settlements and small towns (the interface between the urban and rural) as rurban centres with important features like delineation of rurban centres based on a rurban index and functional classification of settlements (1989). The Food and Agricultural Organization (FAO) gave a bottom up methodology for planning of micro-regions in 2005 where planning was divided into analysis, scenario-writing, sectoral strategy and project profiling phases. Along with that, the FAO model also stressed on the need for a participatory, bottom up approach to planning, which motivated us to facilitate public participation during most stages of our model.

In the seventh semester studio exercise of the Bachelor of Planning Course at the School of Planning and Architecture, New Delhi, an attempt was made to mitigate the limitations of the cluster development plan proposed under the SPMNRM, through the rural and rurban development chapter of the District Development Plan for Kurukshetra, 2035. The methodology for planning of rurban clusters was divided into five parts comprising a district level overview of rural development through Composite Rural Development Index (CRDI), identification of poorly developed block within the district, delineation of the rurban, a 4-stage analysis, projections of future growth and projectization (Banerjee and Agrawal, 2017). In the model that will be created, all the important stages derived from different background studies will be reflected in detail.

4.2 Geo-spatial Information Systems in India

A study of different information systems in the country was conducted in order to design the geo-spatial information support to the planning methodology. The planning methodology in compendium with the geo-spatial information support system will together define the geo-spatial model for rurban planning. The District Informatics Programme of the National Informatics Centre (DISNIC) was the first spatial database at the village level in India. National Urban Information System (NUIS) contains spatial and attribute data useful for master plan preparation, at scales of 1:1,000 or more, updated every five years. Environmental Information System, or ENVIS is a national level spatial environmental information system with maps of scale 1:250,000 or above, which are irregularly updated and incompatible for rural or rurban planning. Others include Bhuvan-Panchayat (scale of 1:10,000, village level data) and the spatial database proposed for GIS-based master planning for cities selected under the Atal Mission for Urban Rejuvenation and Transformation Mission (AMRUT). It was observed that most of them suffer from improper mantainance and lack of data updation. The number of functional information systems were positively biased towards the

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urban; those which had data applicable to rural or rurban planning were present on scales incompatible with the needs of rurban cluster planning.

4.3 Institutional and Legislative Frameworks for Rurban Cluster Planning in India

Under the 73rd Constitutional Amendment Acts of India, provisions were made for local authorities at the town and village level, but no provision was made for the governance of village or rurban clusters (**, 1992). Under the SPMNRM, rurban clusters are administered at the district level. There is no definite authority for data collection, storage, analysis or dissemination of clusters even within the Census of India. Rural and rurban areas find mention in the urban, rural and regional planning legislations in different parts of the country. West Bengal Town and Country (Planning and Development) Act of 1979, attributes the development of village clusters to development authorities of the nearest urban area. Karnataka Town and Country Planning Act, 1961, physical (or spatial) planning of urban and rural areas take precedence over economic planning. The Kerala Town and Country Planning Act, 2016, demonstrates a clearly defined focus on “scientific spatial planning”, stressing on the need for a geo-spatial database management intervention at the rural level.

4.4 Adopted Model for Rurban Cluster Planning

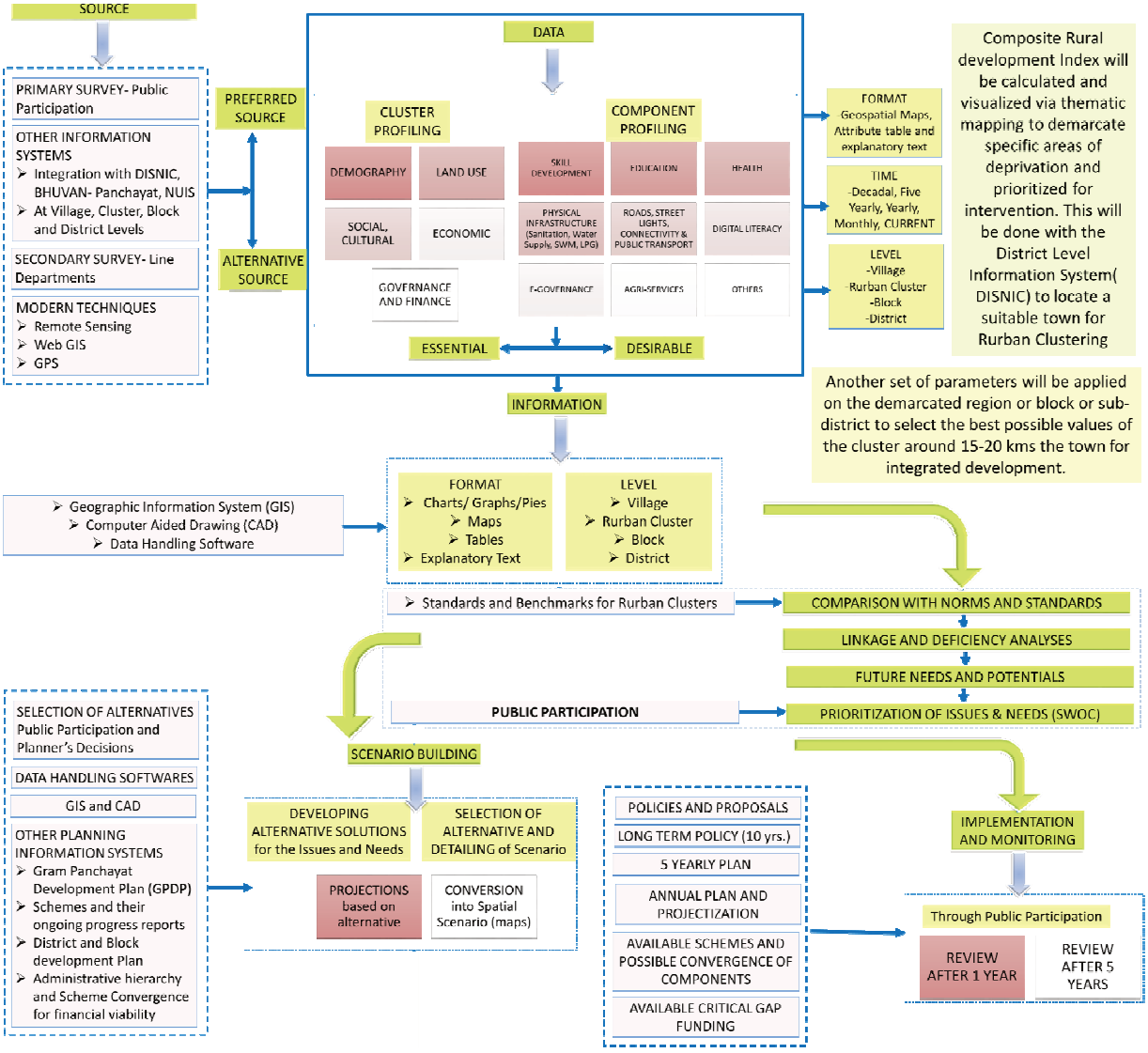

Fig. 1: Geo-spatial Information Model for Rurban Planning.

After looking at the different approaches for rurban cluster planning, available spatial databases, their limitations and institutional frameworks, a conceptual geo-spatial model for rurban cluster planning is laid down. The model effectively consists of a 10 stage methodology for planning, based on the systems view of

planning, along with a geo-spatial information support system to assist at every stage of the methodology. (Figure 1).

4.4.1 Stage 1: Overview of Rural Development in the District

A state is divided into administrative units called districts, which are further subdivided into towns and villages. This stage is a pre-requisite for rurban cluster delineation in districts with multiple urban centres only. It attempts to delineate the urban centre in a district most suitable for rurban cluster planning (rurban centre). Here a Composite Rural Development Index is formulated as the final outcome of 10 indicators comprising population density, decadal growth in population, sex ratio, literacy rate, percentage of Scheduled Caste and Scheduled Tribes (SC/ST) population, accessibility through roads, worker's participation rate, proportion of non-agricultural workers, percentage of irrigated area and provision of educational and health facilities. Each of the criteria is mapped for individual villages on a district level map and layered one over the other in GIS to create the composite rural development map, to delineate the rurban centre.

4.4.2 Stage 2: Spatial Delineation of the Rurban Cluster

A set of spatially identifiable parameters is applied on all villages within a 15 km radius (termed as the rurban radius) of the rurban centre delineated in Stage 1. The delineation criteria shall be compared with the values of the district average and each village must be weighed on a well-defined scale of weights to yield their total values. The total population of the delineated cluster should remain between 50,000 to 25,000 in case of a non-tribal cluster, and 5,000 to 15,000 for a non-tribal cluster.

4.4.3 Stage 3: Formulation of Goals and Objectives for the Cluster

The objectives of the scheme at the national level for all rurban clusters are considered at this stage. The intervention of the geo-spatial system of the rurban cluster, requires inputs from the goals and objectives which are prioritized at the village, city, block and district levels as well, to facilitate multihierarchical planning. Public participation has been deemed mandatory during the formulation of objectives for the cluster action plan, and will be incorporated using Participatory GIS techniques.

4.4.4 Stage 4: Database Design and Generation

The aim of this stage is to address geo-spatial data gaps in rurban clusters and cater to the needs of integrated planning. Data shall be collected under two segments, cluster profiling (demography, socio-cultural aspects, economy, land use, governance and finance) and component profiling (skill development, education, health, physical infrastructure, digital literacy, e-governance, agri-services, etc.). The database is designed on the basis of the type of information that is to be derived, format, scale, periodicity of updation and source (preferred and alternative). The data is divided into spatial (S), spatially representable (C) and non-spatial (NS) with a critical focus on S and C. Further data is categorized as essential (critical to plan-making) and desirable (can be added later), in an attempt to cut down on the excesses of data collection which delay and impede plan making. Public participation consists of cooperation during primary survey, participation in meetings, workshops, etc.

4.4.5 Stage 5: Conversion of Database into Information-base

This stage converts the database generated in stage 4, into an information base with the help of geo-spatial information handling softwares. It involves generation of inventories and maps by condensing the database to extract information relevant to decision making. It is designed as per the analysis predicted on the information, the format in which it must be retained (tables/maps/charts, etc.) and the level of information (i.e. village, rurban cluster, town, block or district level) relevant to rurbancluster planning.

4.4.6 Stage 6: Analysis

At this stage the information base will be utilized to participate in four different kinds of analysis, namely a Component-wise Deficiency Analysis, Rural-Urban Linkage Analysis, Strengths-Weaknesses-Opportunities-Challenges (SWOC) Analysis and finally an analysis of Issues and Potentials. The findings would be supported by relevant data from the information base, projections and forecasting of the future needs of the

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rurban cluster within a predetermined time frame. This stage expects participation of the people in trying to bring out their unique needs, problems, issues and priorities.

4.4.7 Stage 7: Evolution of Alternatives

This stage tries to delineate possible options for the future of the rurban cluster. The planning team shall utilize the geo-spatial information system at this stage to generate two or more alternative scenarios by analysing the trends and projections, and assist the people in visualizing their future needs and growth potentials. The feasibility of every alternative, their resource requirements, impacts and roles in fulfilling the priorities of the people must be clearly represented before the people.

4.4.8 Stage 8: Selection of Suitable Alternative

This stage judges the feasibility of each alternative generated in the previous stage and upholds it before the public for their consideration, suggestions, objections and feedback. The final selection of the alternative is based on the information released to the public by the geo-spatial information system, and a clear and transparent dialogue between the authority and the representatives of the rurban cluster to fulfil the goals and objectives initially set for the cluster.

4.4.9 Stage 9: Proposals

The selection of alternative is succeeded by the proposal stage which includes long term policy guidelines and proposals for the rurban cluster to finalize the Integrated Cluster Development Plan (ICAP). It is supported by maps, projections, etc. derived from the analysis stage. The proposals must be represented spatially with their locations referenced. This shall be translated into individual projects for different durations of time which are to be detailed out on the base map of the cluster and forwarded for implementation.

4.4.10 Stage 10: Implementation

The individual projects formulated in stage 9, will be subjected to implementation, control, qualitative and quantitative monitoring and evaluation, to enable periodic revisions of the geo-spatial cluster development plan. At this stage the information support system shall behave like a geo-spatial MIS aiding in the implementation strategy, operation and Mantainance and revision of plans based on yearly approval of projects and available funding mechanisms.

5 APPLICATION OF THE MODEL: A COMPARISON WITH SPMNRM

The 10 stage model discussed above is applied, partly on a non-tribal, and partly on a tribal cluster, stage. As mentioned earlier, the idea for the model was borne out of an academic planning studio exercise, in Kurukshetra district of Haryana, India by the Department of Physical Planning, School of Planning and Architecture (SPA) , New Delhi. Therefore, the district of Kurukshetra (non-tribal cluster) forms a basic case study for the creation of the model. Post creation, the holistic and full-fledged application of the model was done on a tribal cluster in the Khunti District of Jharkhand, India. It was deemed that the application of this conceptual model would provide valuable leads for the forthcoming work in tribal clusters for the SPMNRM Cell at SPA, working under the Ministry of Rural Development, GoI. In this paper, the application of the model is be compared with a cluster development plan prepared under the SPMNRM. Table 1 gives a comparative analysis of the stagewise application of the model in terms of the input at each stage, the processing or analysis, and the output at each stage of the proposed geo-spatial model and the SPMNRM. It goes on to also show the earlier gaps in the SPMNRM that are addressed through the new model, new gaps which were discovered and finally the value addition at ech stage due to the model.

While applying the model on the tribal cluster of Khunti (India), it was very well received by the public as well as the representative of the government, as a step in the direction of enabling e-governance and e-planning. It was observed that some of the stages in the model received feedback. The most important feedback was received for Stage 2, the formulation of goals and objectives. This stage was then divided into two parts, namely “Stage 2: Broad Goals and Objectives” and “Stage 9: Specific Goals and Objectives. The feedback mechanism visualized earlier connected the implementation of proposals to the formulation of goals and objectives phase only. This was refined, and three levels of the intensity of feedback were discovered (Figure 2).

Stages	Overview of Rural Develop-ment & Delineation of Cluster	Formulation of Goals	Database Design and Generation	Conversion of database into information	Analysis	Alternative Scenario Building and Selection	Proposals	Implementation
Existing SPMNRM Model (EM) Input	Non Spatial, Aspatial	N/A	N/A	Cluster profiling and Component profiling (Aspatial and Non-Spatial)	Aspatial, Non-Spatial	No such exercise	Deficiency analysis(Aspatial, Non-Spatial)	Aspatial, Non-Spatial
Proposed Geo-spatial Information Model (GM) Inputs	Spatial, Attribute, Non-Spatial, Aspatial	2 stage process (Spatial, Aspatial, Non-Spatial)	Spatial, Aspatial ad Non-Spatial data divided into essential and desirable items	As per database design (forcus on Spaial and Attribute data)	Spatial and Attribute (data format as per information base)	Gaps, Linkages, SWOC, Issues and Potentials (Spatial)	Analysis+ Selected Scenario (Spatial)	Projects from final cluster developemnt plan (geo-spatial)
EM Process/ Approach/ Analysis	Imperfect criteria (65% inputs were difficult to find)	N/A	Cluster profiling (tables) and subjective profiling of Components	N/A	Finding Gaps by comparison with the standards across the country	N/A	Projects to fulfill the existing gaps within a year	5 yearly iteration to ICAP (updation) + Yearly Revision
GM Process/ Approach/ Analysis	Easily available input parameters, well-defined evaluation criteria	National level goals + goals of higher and lower hierarchies of plans	Based on analysis, source, data type, time, format, level of information	Information converted as per specified format in the database, in-depth analysis possible	Gaps by comparison with formulated goals, objectives, standards, understanding linkages, SWOC	Presenting alternate scenarios to the people for their choice and feasibility analysis	Selection of alternative through public and stakeholder participation for a specific future vision, phased projects based on it	Specific Details regarding updation of every data item/ information specified in the database
EM Product/ Output	Politically biased, Inaccurate	N/A	Inadequate, Considers 1/6 of the required data	Non-spatial textual in nature, does not provide for further analysis	Only gives an absolute figure for gap in supply	N/A	Component based projects for a year only	A list of Projects instead of a proper cluster development plan
Existing Gaps Addressed	Evaluation Criteria, objective delienation	Setting of goals and objectives	No database design, inadequate number of areas addressed	Component Profiling subjectively based	No understanding of gaps wrt context	No formulation of possible future options	No spatio-temporal approach, no sustainability of cluster	Spatial Approach to M&E
New Gaps Discovered and Addressed	Output Parameters used for delineation which were difficult to find and not spatial	Analysis done against the same standards for every cluster	No division into essential/ desirable, No consideration for goals and objectives	Cluster Profiling inadequate, aspatial, does not lead to further analysis	No linkages analyisl, SWOC, issues and potentials analysis	only 1 set of standards for all areas without enabling different options based on resources	Strengths, weaknesses, opportunities , challenges and resources other than the financial were ignored	Geo-spatial MIS to maintain a constant record of all projects on an online platform for the public to see
Value Addition	Objective and Logical, spatially verifiable, equitable	Vision of the Cluster taking people's participation ;.	Clarity in data collection, source, updation and what is to be done in the upcoming step	Standardized format (data standardization and multi-hierarchical planning options), Critical thinking	Unique reasons behind the deficiencies, their potentials and alternative scenarios	Participatory, democratic process enabling accountability	Transparency, accountability, better distribution of resources, vision for the future, more efficient management of finances.	Spatio-temporal vision, transparency, accountability to the people and higher authorities

Table 1: Stage wise Comparison between the Existing Model (EM) of the SPMNRM and the Proposed Geo-Spatial Information Model (GM) for Rurban Cluster Planning.

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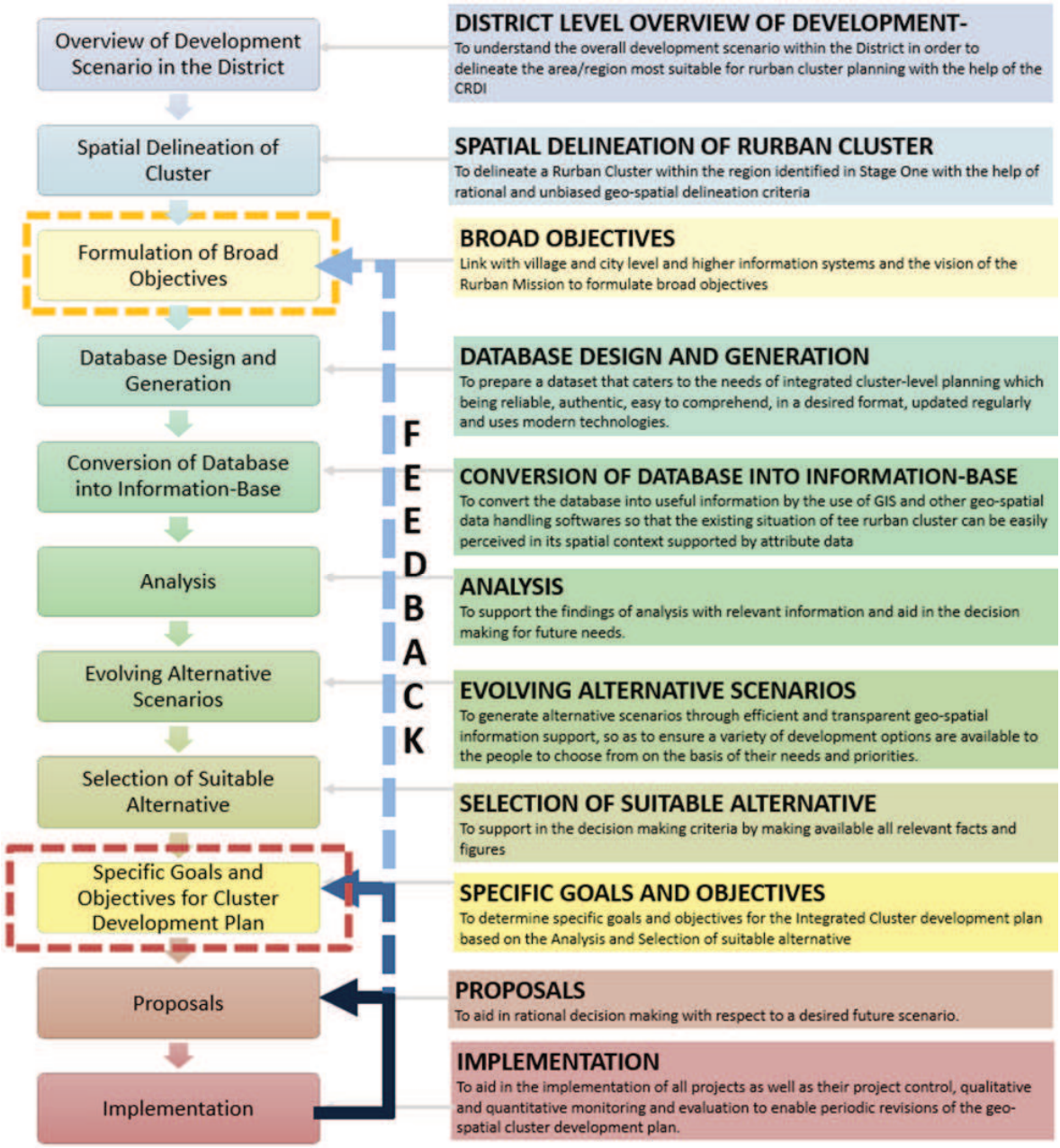

Figure 2: Final Proposed Geo-Spatial Information Model (GM) for Rurban Cluster Planning.

6 CONCLUSIONS, CHALLENGES & THE WAY FORWARD

When it comes to a geo-spatial model for rurban planning, it requires a process and a system to facilitate that process. The theoretical conception of the model and its limited academically oriented application, as described in this paper, simply signals towards a beginning. The real task of applying the model within a multihierarchical system of similar models at each level of planning, gathering the requisite resources, knowledge, skill and man-power is where the real challenge of the task lies. It is envisaged that the model would perform best when accomodated within a hierarchy of geo-spatial information systems at the district, block, rurban cluster, town and village level, with accompanying technical assisstance and administrative bodies at all the levels.

There are several challenges in the proposed geo-spatial approach to rurban cluster planning, which must be resolved for its successful functioning. Data standardization demands a strict adherance to the formats and design present in the database and information base design, constant updation of data and its proper maintenance. This must be facilitated in a manner that evolves with the needs of the area, accomodates adequate stakeholder participation and creates an integrated scheme for planning from the distict to the

village level. It requires an effort in collaboration of individuals, groups and organizations comprising actors and stakeholders from the public, private and administrative spheres. The model defines a pathway for delivering faster, more efficient and effective plans whose implementation is responsible, transparent and accountable to its beneficiaries. They are non-negotiable values currently missing from the Indian scenario of planning at the national, state and local levels.

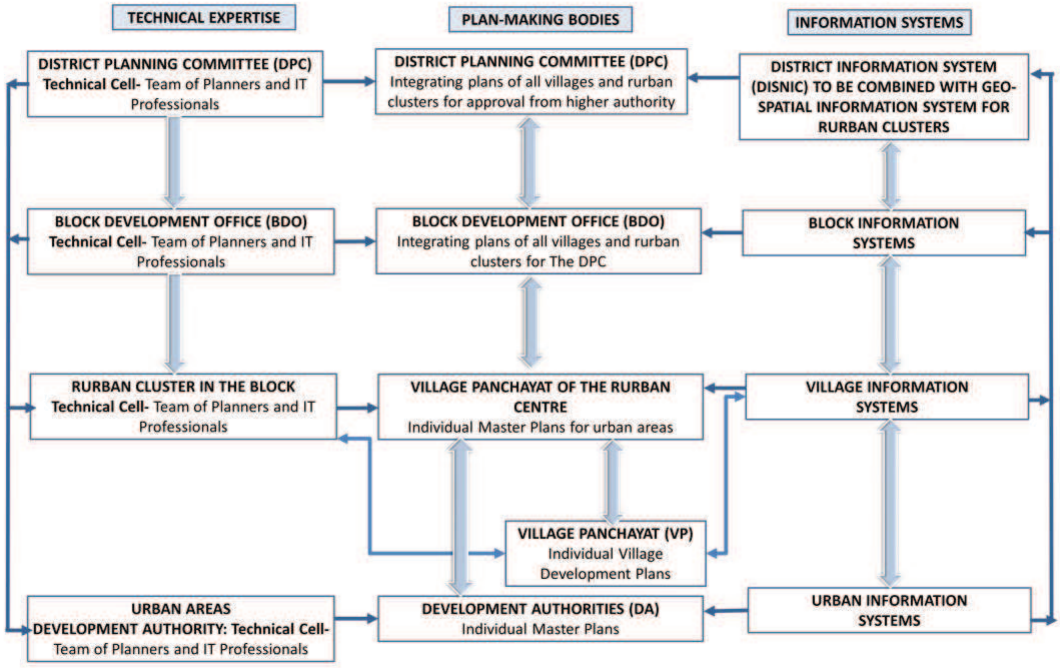

Figure 3: Suggested institutional framework to support the proposed model

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