Use of Bayesian networks for monitoring total sanitation campaign projects, India

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Introduction
Bayesian Network (BN) is Decision Support System, which can be used for analysis of complex systems having wide range of inter-connected variables. It can be effectively used for analysis of community managed water supply and sanitation systems especially Sector Reforms and Total Sanitation Campaign projects launched by RGNDWM.

Bayesian network is composed of three basic elements:
I. A set of nodes representing management system variables, each with a finite set of mutually exclusive states (the terms “node” and “variable” are used to mean the same thing)*1. Variables can either be discrete or continuous. A discrete variable is one with a well-defined finite set of possible values, e.g. the number of wells in a village; whether a crop is wheat, cotton or sorghum; whether a statement is true or false. In a BN, each of these values becomes a state of the node. A continuous variable is one that can take on a value between any other two values: Examples include rainfall depth, groundwater level, crop yield and price. When represented in a BN, the full range of values taken by a continuous variable must generally be broken down into sub-ranges, with each sub-range becoming a state of the node.

II. A set of links represents causal relationships between these nodes. Links, therefore, have direction - from cause to effect. If there is link from node A to node B, B is described as a child of A, and A as a parent of B.

III. A set of probabilities, one for each node, specifying the belief that a node will be in a particular state given the states of those nodes that affect it directly (its parents). These are called conditional probability tables (CPTs) and can be used to express how the relationships between the nodes operate.

The Bayesian networks are usually able to represent the most important factors in the system effectively. Since the networks are diagrammatically based, it is relatively easier for users to understand how those factors interact and, as a result, how the DSS produces its outputs. For the same reason, it is also fairly easy to communicate the information on which you have based represents simple concepts of cause and effect. Again, tests have shown that most people are able to express their ideas using such concepts. This means that information elicited from stakeholders can be used directly within the BN. Finally, BNs explicitly represent uncertainty in a way that can be clearly understood.

Development of Bayesian Network for monitoring of TSC Programme
There are a large number of softwares, which can be used to develop Bayesian Networks: Softwares called “Netica” or MSBNx can be used for developing the Bayesian networks on the computers. Firstly based on common sense and experience a network on paper was developed for effective implementation of community managed sanitation projects. The cause and effect relationship between different factors were defined. After the identification of the key factors and relationships between them, this was put on the computers using “Netica” software. In this software, each node of the network with, which is assigned a value. This value can be assigned based on actual field survey results or experience. The conditional probability tables were filled up for the network. After that, network is compiled and run. The network developed for monitoring of the TSC projects is enclosed as Annexure I.

Once this network is developed, values of each independent node (key factors) is assigned based on the experience of monitoring the implementation of the TSC projects in India. The values assigned to each of the independent key factors of the Total Sanitation Campaign Programme in India are given in table I.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Key factors</th>
<th>Values assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>External resource</td>
<td>0.8</td>
</tr>
<tr>
<td>2.</td>
<td>Ability to pay</td>
<td>0.6</td>
</tr>
<tr>
<td>3.</td>
<td>Demand/Need</td>
<td>0.4</td>
</tr>
<tr>
<td>4.</td>
<td>Policy</td>
<td>0.7</td>
</tr>
<tr>
<td>5.</td>
<td>Management friendly technology</td>
<td>0.8</td>
</tr>
<tr>
<td>6.</td>
<td>Legislation</td>
<td>0.9</td>
</tr>
<tr>
<td>7.</td>
<td>Enabling environment for sustainability</td>
<td>0.5</td>
</tr>
<tr>
<td>8.</td>
<td>Construction capacity</td>
<td>0.7</td>
</tr>
<tr>
<td>9.</td>
<td>Supervisor capacity</td>
<td>0.5</td>
</tr>
<tr>
<td>10.</td>
<td>Advisor capacity</td>
<td>0.7</td>
</tr>
<tr>
<td>11.</td>
<td>Availability community skills</td>
<td>0.7</td>
</tr>
<tr>
<td>12.</td>
<td>Training capacity</td>
<td>0.6</td>
</tr>
<tr>
<td>13.</td>
<td>Community capacity</td>
<td>0.6</td>
</tr>
<tr>
<td>14.</td>
<td>Community capacity</td>
<td>0.6</td>
</tr>
<tr>
<td>15.</td>
<td>Technical solution properly implemented</td>
<td>0.47</td>
</tr>
</tbody>
</table>

TABLE I
After assigning these values, the network is compiled and run on the computer which gave the probability of successful implementation as well as probability of sustainable community participation. In order to identify the main factors, which influence the result different values were assigned to each independent node and the result is tabulated. This exercise gave a good idea of understanding how a particular node (key factor) influences the network. The study of the network revealed the key factors for effective implementation as well as for sustainable community management.

**Finding**

The three most important key factors, which emerged, are: (i) **Enabling Environment**: This includes various issues namely political will at various levels, level of awareness among different stakeholders and attitude of administrative and technical officers and other line departments towards community management of projects. (ii) **Demand with willingness to pay**: The demand with willingness to pay leads to ownership of the projects, which is an important factor for successful implementation of community, managed projects. This demand can be generated through intensive IEC activities. (iii) **Community Management Capacity**: The community must have good management capacity and for this purpose, the community should have the authority as well as technical and managerial capacity. This capacity should be at the Panchayat level.

**Recommendation**

Based on the analysis of the key factors mentioned above the major recommendations made in Indian scenario are as follows:

i) **Efforts to create awareness to bring in favourable attitudinal change**: In order to make conducive environment for community managed projects, adequate awareness must be created among the political, administrative and technical support systems' level so that a positive approach is developed among these institutions towards community management of projects.

ii) **Capacity building of community, local bodies and intermediates level institutions**: There is necessity for capacity building of the community as well as local bodies especially at the Panchayat and Block level so that they can effectively implement and manage the community projects.

iii) **Create awareness to manage and pay for quality services for better implementation and sustainability**: In order to have better implementation and sustainability of projects, people must develop a sense of ownership which is a function of the level of awareness people have as well as their willingness to pay for the quality service. Hence for this purpose, social mobilization to generate awareness is to be initiated.

iv) **Community friendly technology options**: It has been noticed that in many parts of the country, technology options are really not available with the community. The community is given very little technology options. Most of the time, projects involve huge technical expertise as a result it becomes difficult for the community to manage them. However, such technology options, which are community friendly are easier to maintain and manage. So there is necessity for development of such community friendly technologies.

**Conclusion**

For promoting decentralized community managed sanitation projects in India the following factors are of highest important:

(a) **Enabling Environment**

- Create policy and legislative framework for community management.
- Facilitate attitudinal change for better linkage and coordination among community, government and other stakeholders.
- Define role for NGOs/Private Sector.

(b) **Capacity Building**

- Administrative, financial and technical capacity of the communities should be built. The capacity of institutions at the intermediate level must be developed with high priority, which will support the community efforts.
- For better participation and management, capacity at community level should be developed.

(c) **Develop Appropriate Technology**

- Community management friendly technology options must be developed and given to the community.
- There should be replicable models for wider coverage and sustainable community management.

It is clear that there cannot be any fixed model for scaling up community management initiatives. However, there are similar key factors which influence community management globally and those key factors should be addressed to.

**Reference**


The views expressed by SRI KUMAR ALOK, Deputy Secretary, Department of Drinking Water Supply, GOI and SRI K. MAZUMDAR, Sr. Consultant, Unicef, India Country Office, New Delhi are their own and does not reflect the views of the Organization they work for.