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DESIGNING A MODEL DRIVEN DECISION SUPPORT SYSTEM FOR PRIMARY HEALTH CARE MANAGERS

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Abstract

Delhi is the capital city of India but is administered by multiple government agencies. Each agency has its own network of health centers to cater to different segments of society. There is a need to define these health facilities in terms of a region or District, so that the facilities within the region are strengthened by facilitating collaboration, which can be achieved by load transfer between centers. There is also a need to decongest secondary care by shifting patient load to primary care and also to minimize referral of patients from primary care to secondary care.

At the primary level, all health centers of government have the same number of doctors, irrespective of the patient load on the center. This research paper describes a model driven Decision support system, that facilitates load balancing and decentralization. This model can be used by health care planners in strengthening primary health care services within a geographical region or district, and in manpower and equipment requirement planning, based on patient load, instead of fixed administrative guide lines.

***Keywords**:* Model driven Decision support system; load balancing; primary health care services; health care planning.

1. Background

The culture of governance in India is has been characterized by secrecy, seniority and corruption (Sharma, 2002). An online DSS can remove this malady.

All countries should progressively and continuously reorder health expenditure priorities, leading to the most cost effective actions relating to health centers.(M.Akbar Ali Khan, 2001). The DSS can do this by redirecting patients to their nearest region, thereby improving accessibility of health centers.

The decentralization of out patient health services at the primary health care level can be achieved through the Hub and Spoke model, which facilitates dynamic load balancing and planning deployment of manpower and equipment (Vohra, 2007).

The use of Call centers using this DSS, can redirect patient flow to the nearest region (Vohra, 2007).

A key reason for the failure of the public health care system in India, is because of a gap between expected and actual number of health centers, as also between expected

and actual strength of doctors and consultants. (Singh J. P., 2002). The DSS proposes to bridge this gap information. The shortage of medicines and specialists is responsible for the failure of the health care delivery system at the primary level. (Planning Commission, 2001). A DSS can facilitate planning of doctors deployment, according to the health care needs of the region.

Information kiosks have potential value to provide citizens convenient access to information and bridge the digital gap in society. (Nia and Ho, 2005). The model DSS uses information kiosks placed in the districts to facilitate redirection of patient flow.

The WHO has promoted a decentralized approach based on the concept of a district as a self contained and geographical entity, to better integrate multiple health programs and providers. (WHO, 1994). In the model DSS, a district is treated as a single collective entity, to plan regionalizing services within it.

A WHO and UNICEF stressed the importance of primary health centers in Alma Ata declaration in 1978 (WHO, 1978), in which PHC is the first contact with the health system for an individual or family. The DSS aims to minimize referrals to secondary care and decentralize primary services through Hub and Spoke model.

As such Delhi is administered by many government agencies. In this research paper, we begin by describing the Hub and spoke model, which is a model driven Decision support system (DSS). This model facilitates decentralized planning and load balancing. By Load, we mean the number of patients visiting a primary health center (PHC). This constitutes the load on the center. Delhi is chosen for this study, as it is the capital city of India, and has multiple governing agencies in the public sector. The scope is restricted to the health agency of the state government of Delhi.

2 HUB AND SPOKE MODEL

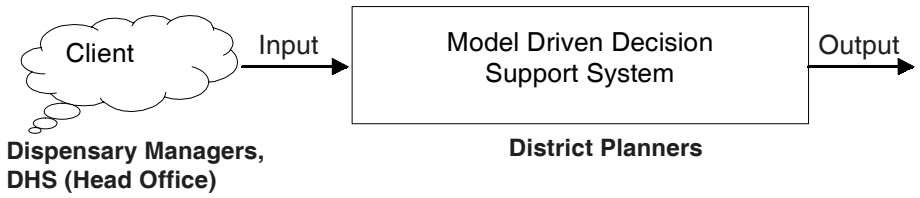

Figure 1: Decision Support System

Input: District Primary Health Centres (Flat Structure)
Output: Hub and Spoke Structure (for the District)

In effect this categorization produces a hub and spoke model in each district at the primary level. This model can be used in:

- Load balancing: Redirection of patient flow to balance patient loads within a district.
- Manpower planning: Plan deployment of medical staff for Hub and for spokes.
- Equipment planning: Plan deployment of medical equipment like x-ray machines in hub and spokes.

As an example we can show how load balancing can be achieved.

Table 1
Hub and Spoke Model Input

Name of dispensary	*No of Doctors*	*Present load/day*	*Capacity of dispensary*	*Excess load*
A	2	200	144	56
B	1	150	72	78
C	2	250	144	106
D	1	300	72	228
E	2	400	144	256

We assume a OPD slot of 6 hours per day and 5 minutes per patient per doctor. Therefore a dispensary with 1 doctor has a capacity of 12 patients per hour or 72 patients per day for a slot of 6 hours. Excess load for a dispensary is Present load – Capacity. Then total excess load in the network can be calculated as 724.

The Hub is selected to absorb all excess load transferred from the spokes while by design the spokes are constrained to their capacity. The Hub is selected according to load (volume). So the center with the highest load i.e. dispensary e is the hub. This results in a hub and spoke model.

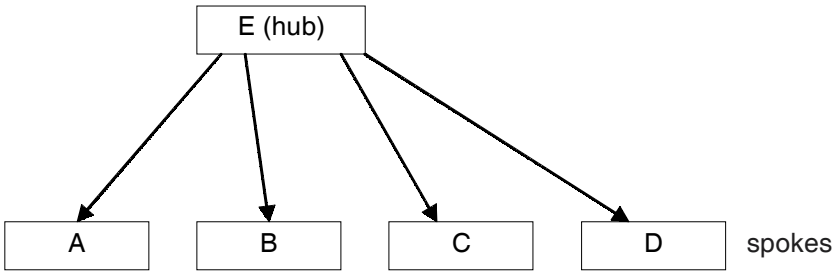

Figure 2: Hub and Spoke Model Output

The new load distribution can now be calculated as follows :

Table 2
Hub and Spoke Model New Load Distribution

Name of dispensary	*New loads on dispensary*	*Number of Doctors*
A	144	2
B	72	1
C	144	2
D	72	1
E	724+144 = 868	12

The number of Doctors needed in Hub (E) is therefore 12. The health care managers can also choose 2 hubs for a district, in which case the dispensary with second highest load i.e. D (300) becomes the second hub. In this case both hubs share the total excess load transferred from the spokes equally. The hubs can also be chosen according to the distances between the dispensaries. The Decision support system is thus model driven and must have the capability of performing this load balancing analysis along with manpower and equipment planning using the same hub and spoke model. The Hub and spoke model facilitates the following:

- Decentralization of health care services by forming hub and spoke models in the districts.
- Regionalisation of health care services : This is done by directing patients to the nearest region (district).
- Minimizing referral to secondary care services in the district: This is done by strengthening the hubs by providing more manpower and equipment at the hubs.

Once a hub and spoke model is created, further requests for patient servicing can be satisfied by: The present hub or its spokes(if they have free capacity). However if the present network is full, the requests for patient servicing must be redirected to the nearest hub and spoke network. Again search is performed in that network to verify if the request can be satisfied by the hub or by its spokes.

3. THE DECISION SUPPORT ALGORITHM

The Algorithm for the model driven decision support system can be written in the following steps:

(1) For 1 to *n* (there are *n* health centers), accept for each center, as input : center name, no of doctors, patient load/ day.

(2) Calculate the capacity of each center, according to the number of doctors, as explained in the hub and spoke model description.

(3) For each center from 1 to *n*, calculate excess load, given by Excess load = Patient load/ day – Capacity of center.

(4) Sum each centers excess load to get Total excess load.

(5) Select the Hub as the center with the maximum patient load/ day. In this case, the hub selection is done on the basis of load (patient load) at a center.

(6) The remaining centers are spokes, in the case of selecting one hub for analysis.

(7) Compute the New loads on the spokes as explained in the hub and spoke model analysis.

(8) Compute the new load on the Hub by adding total excess load to its capacity.

(9) Display the new load distribution on the centers and the new deployment of doctors at the centers.

After the algorithm generates the Hub and spoke model, for a given input data, queries can be executed for giving answers to different aspects of the Decision support model. These queries and the program implementation of this algorithm can be done in any Programming language.

4. CONCLUSIONS

This research paper describes a health care management planning tool in the form of a model driven decision support system. This system can be used to implement decentralization of health care services, strengthening of primary health care services within a region or district, deployment of manpower and equipment. In this context, the Hub and spoke model was described. The hub and spoke model algorithm was also written. The hub selection was done on the basis of patient load, with the health center having maximum patient load, within a district being selected as the hub. The philosophy of this model was to constrain spokes to their capacity, while simultaneously transferring all excess load from the spokes to the hub center.

The total free capacity in the hub and spoke network created is got by adding free capacity at spokes to the free capacity available at the hub center. The relationship between the hub and spokes was mainly of load transfer and load balancing. The hub selection and computation of new loads on centers, after creation of hub and spokes in East District was done by the algorithm.

In future extensions of this model, collaboration with another hub and spoke model in terms of load transfer between these two networks can be studied. In addition, spokes can be divided on some basis to be attached to multiple hubs. Also Data mining techniques can be applied to generate a decision tree, which partitions the set of input centers into overloaded and under loaded centers. This has implications for acquiring

decision rules and machine learning applications. Finally, collaboration rules can be written for collaboration between two hub and spoke networks, belonging to different service providers, but located in the same region or district. The selection of the hub can be done by different criterion like Distance between the centers, services provided, population of a region etc. The hub and spoke network can be used to redirect patient flow to the nearest hub. This means primary health care facilities within a region are strengthened. Also it recommends deployment of Doctors and manpower/ equipment based on actual patient load at a center as opposed to fixed manpower recruitment and deployment norms. This will also strengthen regional budgetary planning and resource planning and allocation at the regional level. This model has research directions in Data communication, concurrency planning, distributed computing, Data mining, Artificial Intelligence, Expert systems and Machine learning.

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