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Integrated Healthcare Resource Planning and Management

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Abstract—**Management Information Systems (MIS) and Decision Support Systems (DSS), used as part of broader healthcare technology management, are considered to be health technologies. As such, they should meet the criteria of affordability, appropriateness, cost-effectiveness, ease of use and sustainability if they are to be implementable and have a lasting impact on healthcare service delivery. They should also facilitate and support improved quality of healthcare. We have developed a suite of management-support tools around a concept of Integrated Healthcare Resource Planning and Management (iHRPM). We believe that these tools meet the above-mentioned criteria and therefore lend themselves to widespread applicability in diverse healthcare and socio-economic contexts, not least in supporting performance monitoring and benchmarking.**

I. Introduction

The correct type, quantity and mix of healthcare resources[1] necessary in a given service delivery environment has been – and is – a focus of attention for many researchers, health planners, health economists and political players, etc. This intensively debated and still unresolved issue is magnified by the high cost of some health technologies together with the need to provide the best possible quality of care.

This often translates into a tension between those tasked with limiting the escalating cost of healthcare and those providing the prescribed clinical services, further exacerbated by issues of access and equity. There is, therefore, a need to formulate some sort of compromise between competing demands and expectations to assure delivery of healthcare services with the highest quality possible, while ensuring that the cost of its provision is affordable and sustainable.

While conventions and best practice suggest the resource types, quantities and mixes needed for various healthcare delivery contexts, standardisation is difficult due to the large number of resource and service configurations as evidenced, for example, by currently available and emerging clinical procedures and techniques.

The preferred technologies associated with these can and do change and the "one size fits all" approach, as in the case of static essential or standard lists, can lead to underutilisation and wastage of resources on the one hand, or inflexibility in planning and management through over-specification on the other.

While an array of HTM decision support tools are available, it is prudent to apply the criteria of **access**, **appropriateness**, **affordabilit**y and **usability** in assessing what is available, which of these lend themselves to implementation in resource-poor environments and, most importantly, are likely to be sustainable. This also applies to conceptual models, frameworks and even policies used to guide and support HTM-related interventions, processes and activities.

II. The Framework

A. The Concept

For practical purposes, a 'health unit' (whether a primary healthcare centre or a complex tertiary hospital, or even a regional grouping of health facilities) can be considered as a combination of different clinical and supporting departments which in turn can be broken down into 'Service Functional Units' (SFUs).

As an example, at the technology-intensive end of the scale, Radiology (including X-Ray, Ultrasound and CT/MRI devices), Nuclear Medicine (including radio-isotope imaging devices such as Gamma Cameras) and Radiation Therapy (including high-energy X-Ray units, Cobalt units and linear accelerators, say) could be considered as Service Functional Units within a Department of Radiation Medicine.

Each SFU is a self-contained operational entity, with its own combination of health technologies and resources which, in general, are not shared with other SFUs and even less so with another department. A graphical representation of the model is shown in Fig. 1.

The framework is based on the concept of a **Minimum Resource Configuration ($\mathbf{RC}_{min}$)**. Once this minimum configuration is defined, the necessary mix of resources (quantity and type) necessary to perform envisaged clinical and supporting services is then estimated - based on the expected workload - using established techniques. The Minimum Resource Configuration approach is itself derived from the concept of Essential or Standard Equipment Lists, but with important value-added layers. The starting point in developing the $\mathbf{RC}_{min}$ are the 'good-practice' benchmarks – within different environments – resulting from years of experience by multidisciplinary teams of health workers.

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[1] Here defined to include medical devices/equipment, associated consumables, pharmaceuticals, human resources & physical infrastructure.

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This ensures a strong link between strategic/planning activities and operational needs and realities. It also allows for a process of continuous quality improvement [2] to be instituted, with levels of achievement tied to resource availability and management directives.

A. Assumptions and Theoretical Background

Our approach in developing the framework is based on the following assumptions:

Levels of care: There are 4 levels of care, represented by the following health facilities: clinics/health centres, district hospitals, regional/provincial hospitals and tertiary hospitals, respectively. There is another layer of specialized institutions, such as psychiatric hospitals and convalescent homes.

Departments: There are recognised operational entities in health facilities at all levels of care, providing a basket of clinical services and assisted in their service delivery obligations by Supporting Departments.

Service Functional Units (SFUs): There are recognisable operational entities within departments (be they clinical or supporting) providing a specific package of services that can be identified and delineated. Each SFU can be considered as a finite element / "black box" having as inputs:

- **Service Demand Units** (e.g. no. of patients to be seen, no. of specimens received, kg of linen to be cleaned);
- **Resources** needed to provide the required services, and
- **Information** accompanying the patients (and the resources).

The outputs from SFUs are called **Service Delivery Units** or $SU_{delivery}$ and describe the services rendered. The Service Delivery Units include:

Patients (it is assumed that patients enter the health facility in one department and, in general, move through a number of departments prior to discharge);

$SU_{delivery}$ for supporting services such as Laboratory (tests), Radiology (images), etc.;

$SU_{delivery}$ for non-clinical supporting services such as number of bed-sheets to be cleaned, number of items to be sterilized, etc.;

$SU_{delivery}$ for outsourced services such as specialised-nursing, porters, waste removal, etc.

[2] Quality in healthcare is defined as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current knowledge". It is characterised by safety, timeliness, efficiency, effectiveness, patient-centredness and equity (Institute of Medicine, 2001).

The defined resources for an SFU cannot, in general, be used by other SFU's. Each resource is characterised by:

- Category/Type *i* (medical device, human resource, drug, consumable, infrastructure)
- Specific Resource *j* (e.g. pulse oximeters, in category "medical device").

The Minimum Resource Configuration is then generated by the sum of the specific types of resource, *j*, across all types, *i*. Different levels of detail can be addressed, in accordance with the needs at any one time, i.e. 'zoom-in / zoom-out' of the operational environment. This applies also to aggregation of services at and across levels of care, which in turn lends itself to exploration of outsourcing options.

The clinical departments fulfil their obligations with the assistance of Supporting Departments, with their own respective SFUs. An important difference for these departments is that their inputs are not patients but requests for services that they provide; the type and quantity of services needed is determined by the clinical departments. However, the framework uses the same building blocks for both types of departments, with **Service Demand Units** (SU_{demand}'s) as inputs to Supporting Departments, thus enabling simplified representation and analysis.

The concept behind the framework is in line with activities-based budgeting in that the SU_{demand}'s are characterised by number (the total of which equates to workload), associated resources and related cost, whether the SU_{demand}'s are patients being admitted, X-ray examinations requested, equipment repair requests or mass of laundry requiring cleaning.

B. The basic concept as a generalization for modeling groups of health facilities

The concept described above can be applied to all levels of a country's healthcare system. Indeed, in moving from hospital level to regional level, the hospital can be seen as an SFU. A set of hospitals at the same level - district hospitals, for example - become an SFU for the region and they exchange services (inputs and outputs) with groups of health facilities at other levels in the same region.

This extension to other service delivery levels leads to the possibility of applying the same concept and derived mathematical/economical models to the entire health system.

C. The minimum data set requirements

The framework, since it works on the concept of Service Functional Units (SFUs) will need from each SFU the following information:

Type of services to be delivered at the SFU (Service Cluster)
Number of patients entering the specific SFU, per type of service
Set/s of Medical Device used
List of Human Resources available
List of the SDU requests to other SFUs
List of SDUs outsourced

D. Efficiency considerations

There are, however, interactions among the SFUs within a department, i.e. some resources could be shared, such as a radiographer in a department of Radiation Medicine. Lack of resource sharing is considered as an inefficiency factor. Minimizing this inefficiency, using business science methods, optimises the overall number/mix of resources to be deployed.

E. Limitations

The concept behind the model has limitations, as does any representation of reality. Some limitations can be described mathematically while others cannot be modelled and therefore cannot be accounted for. These limitations will lead to an approximation in modelling the real situation and can be represented by an error function in the model, which can be minimised through iteration.

A minimization process will attempt to reduce the required number of resources while maintaining the same desired output, thereby increasing the efficiency of the system.
Constraints are associated with the availability of resources at the time needed and for the duration needed. It will be very cumbersome to estimate constraints for each and every resource in a given SFU; however, once the model is applied a qualitative approach could be used to identify the highest constraint and resolve this, then moving to the next highest constraint, etc.

F. Application of the Concept and related tools

The application of the model should follow a series of activities defined in a specific framework of implementation. Tools associated with application of the framework include the following:

A **Healthcare Resource Costing** Tool (this tool classifies medical equipment, for example, into three different levels of complexity in order to estimate costs associated with training and maintenance).

A **generic reduced Asset Nomenclature System** (grANS) covering medical devices/equipment, infrastructure, commonly used consumables and human resources.

A **Human Resource Staffing** Model, based on SFUs, with measures of efficiency and productivity and associated overheads.

A **Human Resource Competency Profiling** Tool, applicable to all health workers.

A **Health Technology Appropriateness** (HTApp) Tool, with 3 levels of implementation (institutional, regional and national) and a methodology for establishing "organizational fit".

An **Efficiency Benchmarking** Tool, based on concepts developed for measurement of health system performance.

A **Service Coverage** Tool; elements of coverage include *access* (comprising availability, accessibility, affordability and acceptability), *utilisation* and *effectiveness*.

An **HTM/Clinical Engineering Impact** Model, showing the link between HTM/CE activities and healthcare service quality indicators.

A comprehensive **Healthcare Technology Management Information System** (HTMIS) with associated indicator sets.

A **Medical Device Regulatory Framework** (MDRF) covering the three GHTF levels of regulation and using a comprehensive HTM system as a vehicle for improved quality of service delivery, with specific attention to safety and risk management.

These tools can be added/introduced as needed and as resources allow to provide additional layers of value and capability.

III. Advantages of the Framework

We believe that the approach adopted (framework and associated tools) offers the following features:

Use of *status quo* as the starting point (thereby ensuring stakeholder buy-in).
Bridging between strategic/planning and operational/ service delivery levels.
Ease of implementation (using widely available and familiar software packages).
Ability to drill down (zoom in) or aggregate (zoom out) as required.
Addressing service-related resource issues and inefficiencies which have the greatest impact on service delivery.
Scalability of implementation, in accordance with needs and/or resources.
Cost-effective and sustainable management interventions.

References

[1] http://www.ghtf.org/ (website of the Global Harmonization Task Force).

[2] Institute of Medicine. "Crossing the Quality Chasm: A New Healthcare System for the 21st Century", 2001.