SYSTEMIC BUDGET ASSESSMENT MODEL OF MEDICAL EQUIPMENTS INSTALLATION AND MAINTENANCE AT CSSS DU LAC-DES-DEUX-MONTAGNES

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ABSTRACT

The arrival of new medical specialists within the CSSS of Lac-des-Deux-Montagnes requires a technological enhancement of its clinical and/or medical departments. On that account, this study gives a brief summary of the key elements to consider when planning for such an upgrade. In regard to the methodology, the medical devices were sorted into ten categories based mainly on their exploitation cost, and, in some cases, on the actual absence of the manufacturer's warranty. In fact, the use of such an approach has enabled the elaboration of a new parametric model for the budget which simplifies the assessment of a new technological development. As a result, a comprehensive analysis of the actual costs over the last ten years has demonstrated that the recurring operating costs of specialized medical equipment is consistent with our model with the following contingency: half of the observed standard deviation. It appears that the real recurring cost remains essentially the same during and after the manufacturer's warranty. In addition, some specialized inputs that could have an impact on operating costs should also be considered: systems installation and integration requirements, electromagnetic compatibility, infection control, water, air and steam quality.

We share this technological management tool whose parameters have significantly influenced the way functional and technical programs are being managed at the CSSS du Lac-des-Deux-Montagnes.

Keywords*: Specialized Medical Equipment, Functional and Technical Program, Strategic Planning, Standardization, Parameterized Capital Cost Budget, Technology Operating Budget.*

INTRODUCTION

Technology deployment is an ongoing challenge in clinical practice. It involves several managers, requires both a lot of planning (holistic) and precision and it especially often tests our coordination skills.

In addition, since technology is constantly evolving, management frameworks regarding the acquisition, implementation, operation and financing of the completion of a major project become quickly obsolete in the evaluation of costs. An urgent ministerial request that plans for the arrival of fifty new specialists in 2015, bringing the number of beds from 261 in 2012 to 314, required a need to develop a rapid method for estimating capital costs to absorb this development. It was therefore necessary to develop management tools that can provide preliminary data for parameterized first line estimation of the project cost or impact of a medical decision that may have unsuspected significant technological spillovers. To do this, we based our analysis on the actual cost of projects already completed in CSSS LDDM to determine the parameterized budgetary cost of upgrading devices in medical or clinical units for critical care, hospitalization or consultation.

OBJECTIVES

The objective is to obtain the relevant data of a functional parameterization directly related to patient / bed / stretcher and make accessible these parameters which influence the planning strategy medical technology with the experience of managers consulted at CSSS du Lac-des-Deux-Montagnes (CSSS LDDM) and in some public hospitals in Quebec. This would quickly establish the cost of a project based on the number of beds required and on the type of unit.

In this sense, this paper will discuss the parameters to be considered in a technology upgrade, replacement or consolidation, as well as the development of new technologies.

The aim is to make available a tool whose parameters have influenced the way of managing functional and technical programs (FTP) at CSSS

LDDM. Technology management mechanisms are put in place for the following specific objectives:
1. Make more evident the need for the operating costs of EMS from capital (replacement / enhancement, consolidation, development, special projects);
1.1. Make accessible to all CSSS LDDM clinical and medical managers the official information from the MSSS (Actif+ / APIBQ nomenclature, ART cost, useful operating life): Actif+ is a Management System for the equipment Quebec MSSS; ART is the cost After Return of Taxes.
1.2. Promote the use of MSSS terminology in the FTP to be submitted to the regional Health Agency;
2. Categorize EMS depending on the operating expenditure;
3. Facilitate the realization of 'Equipment' component of FTP;
4. Identify requirements for information technology, and permanent or temporary functional renovations, if applicable;
5. Consider whether or not the manufacturer's warranty exists after the first clinical use;
6. Consider the impact of the type of service contract on recurrent costs;
7. Facilitate the management of medical technology in the Quebec health care system.

MATERIALS AND METHODS

1. Parameterization based on historical data

Reference costs used for the parameterization come from the expansion project completed in 2010 that led to the creation of D wing. It has 7 new operating rooms, a new recovery room of 10 beds, an intensive care unit of 12 rooms including 10 fully equipped, 3 new clinical units of thirty beds each.

2. Predicting changes in the level of equipments for a typical room / unit in 2015

Equipment choice reflects the settings of the technological configuration proposed for CSSS LDDM in 2015 (wireless integration, pharmacy networked, electronic patient record, cardiac telemetry without extinguishing zone, traceability of instruments / medical equipments). In an Excel file developed for this purpose, exhaustive lists of medical equipments are set up, taking care to distribute them per bed / stretcher or per units of N beds (N being the number established by the MSSS via Actif+). We then deduce the cost per functional unit or per bed / stretcher / patient.

3. Prediction of recurrent costs in a budget planning or project management

In terms of assets maintenance, the MSSS modified on September 30, 2011 the snapshot of the list of medical equipments, based on the APIBQ nomenclature and the average life cycle established in 2009, adjusted according to the most recent prices from regrouped provincial calls for tenders. Actif+ is not accessible to all personal of the CSSS LDDM. Therefore we developed with Microsoft Excel a nomenclature based on APIBQ's and July 23, 2012 snapshot of Actif+. Costs and useful life cycle of assets are taken directly from Actif+. Items without information are mostly APIBQ terminology not yet directly correlated to Actif+'s.

4. Classification of equipment according to the recurring cost

As a first step, we established the recurrence according to the values generally accepted by the MSSS or those published in the current management guidelines (msssa4.msss.gouv.qc.ca). Then, based on the actual values of recurrences in 2003-2012 periods at CSSS LDDM, we have established more accurately acceptable ranges of operating costs for equipment or medical devices. For any equipment purchased before 2003, the actual recurring cost is calculated from the first clinical use until the end of service.

5. Instruments / equipment without warranty after the first clinical use

So far, we have always believed that all equipments / new instruments come with a manufacturer's warranty covering its damages during a minimum period of twelve months. However, almost all of the nature of the failure of certain equipment / instruments is not covered by this warranty. We will therefore consider no guarantee for such instruments / equipments.

6. Computerized equipments, networked or not

The recurrence of the informatics component of instruments / medical devices is more complex, but it is better to provide a percentage to not omit this aspect which is as important as the equipment itself. Three aspects were considered in this classification: hardware, medical or clinical application and connectivity.

Only computers operating a medical equipment or a clinical / medical application are involved with the study.

RESULTS

Capital cost per functional unit

Based on the actual costs of recent development projects sheltered by the new wing D and considering the projected complexity of equipment in 2015, we obtained budget estimates in critical care (Table 1) as well as general care and outpatient units (Table 2).

The last line of Table 1 and 2 will be completed in a later release when the other consulted health care facilities in Quebec provide data from their most recent achievements in the covered departments / services.

Following the capital budget estimated macroscopically (Tables 1 and 2), recurrent costs have been established according to the type of equipment and rates traditionally used (Table 3). These data are listed according to the traditional classification developed during spring 2012 and finalized in summer 2012.

To determine the actual values of the recurrent budgets of EMS, we have compiled the operating expenses of 265 instruments / medical devices, over the last ten years (Table 4).

Care Unit	Intensive Care Unit	Operating Room Endoscopy	Emergency Room	Nursery
Measurement Unit	- Room	- Operating Room - Recovery Bed - Numbrer of Surgeries./year	- Level 2 - # Ambulances / year - Choc Stretcher - Monitorized Stretcher - non Monitorized Stretcher	- Incubators - Phototherapy
Reference Unit	***Room***	***Operation Room Endoscopy Room***	***Stetcher***	***Room***
Estimated average $/Ref. Unit	200 000$	260 000$ 250 000$	150 000$	70 000$
$/Ref. Unit MSSS	***Not available***	***Not available***	***Not available***	***Not available***

Table 1: Estimated Capital Cost for critical care units, based on the experience of CSSS LDDM.

Care Unit	Medicine Hospitalization	Surgery Hospitalization	Birthing unit	Outpatient	Day medicine	Psychiatry	Long Term Hebergement
Measurement Unit	- Double room - Private room	- Double room - Private room	- # Births / year - # High risk pregnancies - Single room - Double room - Room for four	- Examination Room - Treatment Room - Specialties - # Doctors simultaneously	- # Family Medicine Group - Examination Room - Treatment Room (transfusion, chemotherapy) - Specialties - General Care - # Clinical Nurse simultaneously	- Outpatient - Monitoring at Home - Double room - Private room	- Double room - Private room - #Bed purchased at private
Ref. Unit	***Bed***	***Bed***	***(Exam) Room***	***Examination Room***	***Patient / Day***	***Bed***	***Bed***
Estimated average $/Ref. Unit	15 000$	15 000$	60 000$ 200 000$ (High Risk Preg. Unit)	15 000$ + specialities	15 000$	15 000$	10 000$
$/Ref. Unit MSSS	***Not available***	***Not available***	***Not available***	***Not available***	***Not available***	***Not available***	***Not available***

Table 2: Estimated Capital Cost for non-critical care units, based on the experience of CSSS LDDM.

Type of Equipment	Estimated biomed %	Description
EMS0	0%	Non-medical Equipment
EMS1	2%	Mechanical Equipment (non-electrical)
EMS2	5%	Simple electrical medical Equipment
EMS3	10%	(Non)Networked medical Equipment
EMS4-g	10%	Small surgical Instruments of less than 10000$ per unit
EMS5-g	15%	Flexible Endoscopes
EMS6-g	20%	(Semi-)rigid Endoscopes, surgical drills, laparoscopes
EMS-TI7	20%	Clinical and medical servers and computers
EMS-TI8	25%	Clinical and medical Application, medico-administrative Interface
EMS-TI9	2%	Wire(less) cabling
-g		No guaranty (the recurrence starts at the 1st clinical use)

Table 3: Classification of medical devices based on their operating recurrence - data estimated on a traditional basis

Type of Equipment	Description	Nbre of compiled items	Real biomed %
EMS0	Non-medical Equipment		
EMS2	Simple electrical medical Equipment	139	1,7 % ± 2,1 %
EMS3	(Non)Networked medical Equipment	99	6,2 % ± 8,5 %
EMS5-g	Flexible Endoscopes	39	22,2 % ± 18,0 %

Table 4: Operating recurrence according to the actual data observed at the CSSS LDDM from 2003 to 2012

Impact of the guarantee over maintenance cost

Many EMS3 are traditionally covered by service contracts. The recurrence rate reached 11.9 ± 10.1% when considering only the 40 EMS3 among 90 for which a maximum annual value of contract service has been identified. EMS2 and EMS3 categories include instruments with an average guarantee of 0.83 ± 0.98 and 0.93 ± 1.42 years respectively. Recurrence rates associated with years with or without guarantee are presented in Table 5.

Type of EMS	% biomed recurrence	
	Years under guarantee	Years without guarantee
EMS2	1,0 % ±1,4 % (N=71)	1,8% ±2,4 % (N=68)
EMS3	3,9 % ±4,9 % (N=50)	2,7 % ± 3,5 % (N=49)

Table 5: Actual operation recurrence of EMS at CSSS du Lac-des-Deux-Montagnes according to the guarantee status from 2003 to 2012

The application of our methodology for clinical / medical projects analysis gave the following result in four recent FTPs (Table 6).

Project #	Designation	$ART EMS	$ Mean Recur. Biomed	%Mean Recur. Biomed
04	Oncology	574 711	36 824	6,41%
06	Nuclear Medicine	1 738 566	230 542	13,26%
18	Ophtalmology	2 977 729	284 738	9,56%
30	Psychiatric unit	380 450	4 666	1,23%

Table 6: Operating recurrence requested in four recent FTPs

Theoretical versus real lifecycle comparison

Among the inactive medical devices, we found that EMS1 lasted 20,11 years more than the theoretical value. EMS3 lasted 8.58 more years and EMS5-g 6 more years. New generations are more sophisticated with a large component of microelectronics and informatics.

DISCUSSION AND RECOMMANDATIONS

It should be noted that the objectives of this project can be summarized in the sharing of our tools to facilitate the management of technology in the context of adding medical equipments as well as their replacement or consolidation. We have already successfully implemented these management tools to the impact of the arrival of 50 new physicians to estimate the macroscopic aspect of EMS (Tables 1 and 2) and more specifically to three PFTs (Table 6).

The establishment of this model also confirmed the feasibility of establishing a parameterization of capital costs of new care units based on distinct factors (bed / stretcher, room). From the obtained approximated cost of this single parameter, it is possible to obtain an order of magnitude for a project. It may be more detailed in terms of secondary parameters as more data are collected.

From this macroscopic model coupled with a more specific analysis of actual recurrence rates, percentages allocated to each of the EMS types can be refined and, some nuances can be considered to improve this new classification.

According to the costs associated with EMS of LDDM CSSS, the recurrence rate (1.7 ± 2.1%) for EMS2 is lower than the estimate of 5%. Regarding the EMS3 and EMS5-g, the rate obtained by experience 6.2 ± 8.5% and 22.2 ± 18.0%, respectively are statistically consistent with the estimates of 10% and 15% according to the large standard deviation. However, to avoid cost overruns, it would be wise to consider a recurrence rate being the sum of the calculated average and a contingency equal to half the standard deviation.

Thus, CSSS LDDM, recurrence rate would be as presented in Table 7.

Type of EMS	Description	% GBM (Table 3)	% GBM (real)	% GBM (w/ contingency)
EMS2	Simple electrical medical Equipment	5%	1,7 % ± 2,1 %	2,75 %
EMS3	(Non)Networked medical Equipment	10%	6,2 % ± 8,5 %	10,45 %
EMS5-g	Flexible endoscopes	15%	22,2 % ± 18,0	31,2 %

Table 7 : Recurrence rate with contingency at CSSS LDDM

Considering that the MSSS provides in general an average GBM recurrence of 6%, our study could presage of underfunding maintenance of EMS with most of actual management frameworks in place in Quebec (Table 6).

Given that there are significant standard deviations for the recurrence values for all types of EMS analyzed, our model could be perfected by creating more specific classes of equipment. In particular, there is a need to distinguish between devices with and without a service contract. For example, medical imaging rooms (EMS3) and their accessories should be classified in a category of EMS with service contract (EMS3c) because of the exorbitant costs of flat detectors and X-ray tubes.

Cost analysis of recurrence for years without and under warranties (Table 5) did not reveal a significant reduction in costs when the equipment is under warranty. Thus, the warranty does not cover the most likely additional costs to incur (extended range of hours, parts, misuse). Table 5 shows especially that the maintenance cost of a medical device seems indifferent to its warranty period. The EMS management process must remain alert during and outside of the manufacturer's warranty period.

Moreover, according to the learning curve of users, the adaptation period during the first year of use of a technology is subject to imply more failures due to human error, therefore not covered by the manufacturer's warranty. This is usually the case for complex equipment (see eg EMS 3 in Table 5).

Other aspects to consider when developing a biomedical technology FTP

It is easy to see the rehabilitation of an existing building when replacing medical equipment. By cons, as part of new construction, renovations must provide office space for the 'musical chairs' helping to ensure continuity of services during construction. These forecasts should include the coordination component for physical facilities, furniture and computers.

In order to optimize the arrival of a new technology, it is also important to analyze more specifically the medical equipment that require some specialized inputs that could have an impact on operating costs: softened water, deionized or reverse osmosis, medical air, steam, or rectified power supply (Table 8). Also to be considered, compatibility to electromagnetic interferences and to disinfection and sterilization procedures approved at LDDM CSSS.

Recommended technology should contribute to a more effective infection control when medical devices are used on an outbreak unit.

Designation	Related requirements
Electromagnetic Interferences	Establish and update the EMI spectrum in the presence of EMS
Disinfection	List of disinfectant allowed
Sterilization	Compliance with sterilization procedures in force
Water treatment	Required water quality vs. available
Air quality	Required Air quality
Positive/negative pressure	Requirements relating to the pressurization of rooms
Electricity	Uninterruptible or rectified power supply
Steam	Requirement for steam quality : pressure, and saturation

Table 8: Considerations taken into account in the development of the CSSS LDDM FTP

Finally, it might be interesting to distinguish, in the recurring maintenance costs, the components of curative and preventive. Benchmarking could validate the need for preventive maintenance or for spacing their frequency according to the category of EMS.

CONCLUSION

Our budget planning model during acquisition projects (EMS replacement, enhancement, consolidation and development) will reduce the response time during future projects. It is a systemic model that is a first effort to consolidate data on the maintenance of specialized medical equipment. These tools, developed at the CSSS LDDM have been designed with a view to be easily adaptable to the business models of other health care facilities in Quebec.

Exchanges with the MSSS will be facilitated by this type of tool that is a predetermined scale of unit costs adjusted according to inflation, technological developments and good clinical practice.

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ABBREVIATIONS

ACTIF+: MSSS web based assets Management Tools
APIBQ: Association of Physicists and Biomedical Engineers of Quebec (www.APIBQ.org)
ART: Cost after taxes return
CSSS: Centre for Health and Social Services
DMR: Reusable medical device
EMS: Specialized medical equipment
GARE: High-risk pregnancy
GBM: Biomedical engineering
GMF: Family Medicine Group
LDDM: Lac-des-Deux-Montagnes
MSSS: Ministry of Health and Social Services
PCEM: Conservation plan for medical equipment
FTP: Functional and technical program
SAD: Home Care
UPS: Uninterruptible power supply