

Evaluation of a Regional Computerized Maintenance Management Systems (CMMS)

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Abstract— Computerized Maintenance Management Systems (CMMS) are essential for tracking medical equipment and managing preventive and corrective maintenance in clinical engineering operations. The Children's Hospital of Eastern Ontario (CHEO) uses E-Automate as its CMMS to support both internal operations and a Regional Program serving multiple hospitals. However, the system has notable limitations, particularly for regional use. This study aimed to identify these gaps and define the specifications required for a CMMS suitable for multi-hospital programs. A literature review, market assessment of available CMMS solutions, and stakeholder surveys were conducted to assess user needs. The findings highlighted deficiencies in reporting capabilities, dashboard visibility, interoperability, and adaptability across multiple sites. Stakeholders emphasized the importance of user-friendly interfaces and scalable solutions. Based on these results, a set of specifications was developed as a novice method to assess CMMS compatibility to a Regional Program. While focused on CHEO, these findings may also guide other healthcare organizations managing regional multi-site biomedical engineering programs.

Keywords— *CMMS, Asset Management, Regional Program, Healthcare equipment management*

I. INTRODUCTION

The Children's Hospital of Eastern Ontario (CHEO) is unique among hospitals because it leads a Regional Program created to provide services to 20+ hospitals in the Eastern Region of Ontario. As a result, a Computerized Maintenance Management System (CMMS) is used to keep track of assets, maintenance schedules, preventive and corrective maintenance work orders, equipment and parts inventory, and the management of all contracts to provide service to the hospitals participating in the Regional Program [1]. Most of these services are Preventive Maintenance (PM) contracts. Essentially, 2 full-time equivalent (FTE) techs are hired by the hospital to handle all work: PMs, repairs, incoming inspections, etc. There are also specialized contracts for specific device categories, such as radiology, Waste Anaesthetic Gas System monitoring, and lab equipment. For this project, the main stakeholders are Queensway Carleton (QCH) and Bruyère (BH), as they have the largest medical device inventories, which consequently increases the value of the contract.

The current CMMS used at CHEO is called E-Automate (Fort Worth, USA, 1999). It is an enterprise resource planning (ERP) and field-service management software that supports asset tracking, inventory management, dispatching work orders, contract administration, and reporting [2]. While it has been adapted for clinical engineering use, it was not originally designed for healthcare environment. E-Automate has been used by CHEO since 2011. The idea to replace the software emerged in 2020, mainly due to complaints from hospitals in the Regional Program. Since then, the regional program has been in a stalemate, no budget has been approved to proceed with replacing the current CMMS because of the perceived high cost; The goal herein is to define the requirements to assist moving this initiative forward.

The problem addressed in this project is that the current CMMS used in the Regional Program offered by CHEO does not include specifications that reflect the common needs of the hospitals involved. As a result, dashboards and progress reports do not accurately represent operational performance or stakeholder expectations. This matters to CHEO because it affects their ability to deliver high-quality services across participating organizations.

The objective of this paper is to present a comprehensive list of CMMS software specifications and to conduct market research that reflects the common needs of the main hospitals participating in the Regional Program, based on their input. A novel approach was developed to evaluate the CMMS, and its following findings are summarized.

II. BACKGROUND

This project referenced the World Health Organization (WHO) guidelines on *Computerized Maintenance Management Systems* for developing the evaluation criteria for the CMMS market research. According to the WHO, an effective CMMS supports equipment inventory, maintenance tracking, human resources, financial monitoring, and regulatory reporting [1]. The main feature of the CMMS is to track equipment history, including inventory and work order details, along with associated costs and recall information. Generating reports through the CMMS is essential, as it supports the monitoring and management of medical equipment data.

Since CHEO provide services to 20+ hospitals, the CMMS in use needs to be compatible with multiple locations and include features that would be unnecessary for a stand-alone CMMS. In a recent WHO publication, the networking and integration section outlines the critical distinctions between a stand-alone and a network CMMS [3]. Here is a reproduction of the comparison table from the document in Table 1 below.

TABLE 1. COMPARISON BETWEEN STAND-ALONE AND NETWORK CMMS

Feature	Stand-alone CMMS	Network CMMS
Accessibility	Single location	Many locations
Data storage	On local servers	Cloud or centralized database
Integration capacity	Limited integration with other systems	Seamless integration with EHR, enterprise resource planning, IoT and others
Real-time monitoring	None	Real-time equipment tracking and alerts
Scalability	Difficult to scale up	Readily updates managed by provider
Cost	Higher initial investment, lower long-term costs	Subscription model, lower upfront cost
Maintenance and updates	Manual updates required	Automatic updates managed by provider
Security	Greater control but risk of data loss if not backed up	Stronger cybersecurity measures and encryption
Collaboration	Internal teams only	Among many departments and locations
PdM	Rarely supported	Supports AI-based PdM
Complexity	Simpler	More complex

Note: EHR = Electronic Health Record, PdM = predictive maintenance

The focus will be on a few of the features shown in Table 1: accessibility, integration capacity, real-time monitoring, maintenance and collaboration. With multiple locations managing healthcare equipment, it is important to ensure the CMMS is easily accessible to all locations, through a simple web browser. In fact, during the CMMS implementation for the Lower Mainland Biomedical Engineering (LMBME) consolidated program, they have identified web-based functionality as a mandatory criterion for the CMMS [4]. This characteristic should also be extended to integration capacity, as not all hospitals use the same Electronic Health Record (EHR) platform. Additionally, real-time monitoring is essential for tracking the location of each device across multiple sites.

While both WHO documents provide a well-rounded framework of the composition of a CMMS and features to be used throughout multiple locations, there is limited published research on their implementation in a regional program. The lack of documentation for this literature review emphasized the need for a comprehensive list of specifications for a regional CMMS.

III. METHODOLOGY

A. Surveys on the Current CMMS – E-Automate

A survey was completed to evaluate stakeholders' satisfaction and the operational effectiveness of the existing CMMS (E-Automate) in regional hospitals. Two groups of participants were targeted: hospital supervisors and Biomedical Engineering Technologist (BMETs), both from Queensway Carleton and Bruyère. The survey tool used for both participants was Google Forms. Each also included a 5-point Likert scales (excluding the N/A option) to quantify the satisfaction or usability of the E-Automate features, along with open-ended questions. Here is a summary of the survey focus areas for both participant groups in Table 2.

TABLE 2. SUMMARY OF THE FOCUS AREAS OF BOTH SURVEYS

Survey target	Main Focus Areas
Hospital Supervisors	Report usefulness Integration needs Access features
BMETs	Usability System performance Feature usage Overall satisfaction

B. Market Research and CMMS Evaluation

Market research evaluated existing CMMS available to determine their suitability for the Regional Program at CHEO. The evaluation criteria were developed based on the report type from the WHO *Computerized Maintenance Management System (CMMS)* document. Furthermore, additional regional considerations were also included, such as sub-account access control, inter-hospital reporting, and IT system compatibility. They were inspired by the features listed in Table 1 for a network CMMS. As shown in Table 3 below, the criteria have been separated into two main categories: standard specifications and regional specifications.

TABLE 3. CMMS EVALUATION CRITERIA

No.	Specifications	Weight
	<i>Standard Specifications</i>	40
1	Pre-built reports available (work orders, downtime, costs)	
2	Reports can be scheduled and automatically generated	
3	Users can generate custom reports directly in the software	
4	Reports are filterable by department, asset ID, and time range	
5	Dashboards display real-time KPIs (downtime, response time)	
6	Reports and dashboards can be exported (PDF, Excel, CSV)	
7	Equipment-specific history available (maintenance, incidents, downtime)	
8	System supports custom fields for equipment tracking (manufacturer, warranty, software version)	

No.	Specifications	Weight
	<i>Standard Specifications</i>	<i>40</i>
9	Preventive maintenance schedules are auto-generated and visible	
10	Documentation, images and manuals can be attached to work orders	
11	Work order lifecycle fully tracked (open, assigned, in progress, completed)	
12	Role-based access methods (admin vs technician)	
13	Mobile access available	
14	Maintenance costs tracked by device, category or department	
15	Regulatory events (recalls, incident reports) can be logged and tracked	
16	Tickets can be filtered by department, urgency, technician, etc.	
17	Ticket input can be customized (external or internal requests)	
18	The IT department can use the same system for its own tickets	
19	Software/operating system details can be input and tracked	
	<i>Regional Specifications</i>	<i>60</i>
20	Sub-accounts' access restricted to their hospital/site only	
21	Regional admin can generate reports across multiple hospitals	
22	Reports filterable by hospital/site	
23	Reports can be automatically distributed to external stakeholders	
24	Sub-accounts can design and save dashboards and report templates	
	<i>TOTAL</i>	<i>100</i>

The specifications shown in the table above were developed using multi-criteria decision-making (MCDM) principles [5]. With this method, assigning weights to evaluation criteria is essential because the relative importance of each criterion directly influences the decision outcome. Recent research emphasizes that criteria weights should reflect their role in meeting the objective of the analysis, and that unequal weight distributions are common when certain categories are more critical to the decision context than others. Since the objective of this paper is to evaluate CMMS suitability for a Regional Program, regional specifications were assigned a higher weight (60%) than standard specifications (40%), reflecting their greater relevance to multi-hospital operations. For this survey evaluation, “sub-accounts” refer to hospital supervisors within regional partner hospitals (e.g., Queensway Carleton and Bruyère), while “users” represent CHEO Biomedical Engineering staff with administrative access.

The CMMS selected for evaluation were the most frequently mentioned and advertised as healthcare-specific CMMS solutions in the market research results. MaintainX (San Francisco, USA, 2018), eWorkOrders (Phoenix, USA, 2001), eMaint (Charlotte, USA, 1999), ClickMaint (Toronto, Canada, 2018), and Limble CMMS (Lehi, USA, 2016) were selected for

evaluation. All selected systems included a full web-based accessibility through a standard browser. Each CMMS identified during the market research phase was evaluated against these criteria using a qualitative scoring approach based on feature availability and implementation feasibility.

C. Peer Hospital Survey

This last section was aimed at understanding how other hospitals outside the regional program operate their assets. Additionally, it would allow a comparative analysis of system features and satisfaction levels across these hospitals. This survey, unlike the one created for E-Automate, was targeted only to Clinical Engineers and supervisors from the following hospitals: the University of Ottawa Heart Institute (UOHI), the Ottawa Hospital (TOH), and Lower Mainland Biomedical Engineering in Vancouver (LMBME). Just like the previous questionnaires, it included Likert and open-ended questions. The main themes are the selection of the CMMS and certain features deemed important for a Regional Program.

IV. RESULTS

The following sections summarize the survey findings for supervisors, BMETs, and peer hospitals.

A. Key findings from the E-Automate Surveys

1) Survey with Supervisors

Table 4 summarizes ratings of usefulness for each monthly report from 2 supervisors: one from QCH and the other, BH.

TABLE 4. REPORT USEFULNESS RATINGS FROM QCH AND BH

Questions	Average score
Metrics Corrective and PM Maintenance	2.5
Metrics PM Summary Completion	3
Metrics Monthly Maintenance Chart	2
Metrics PM Non-Complete	2.5
Equipment List	N/A
New Equipment PM Review	3
History	N/A
Invoiced Service Calls	N/A
Outstanding PM	N/A
PM vs Repair Comparison	N/A
<i>Total</i>	<i>2.6</i>

The scoring metric is as follows: 1 = not useful, 5 = very useful. N/A indicates that the supervisors do not receive the report and, therefore, are excluded from the average and total calculations.

Both supervisors have indicated that limited CMMS access to view equipment details would be desirable. While QCH has a ticket system, and BH does not, they are both in favour in this feature in the software. In addition, BH reported having an external database they would like to interface with the CMMS, whereas QCH did not.

2) Survey with BMETs

Table 5 presents ratings converted into proportional percentages for comparison. These ratings were obtained from 6 BMETs in total from QCH and BH.

TABLE 5. BMET CMMS RATINGS FROM QCH AND BH

Questions	Average
Is the software intuitive to navigate as a new user?	36.6%
How would you rate the system speed and responsiveness?	53.4%
How would you rate the CMMS overall?	36.7%

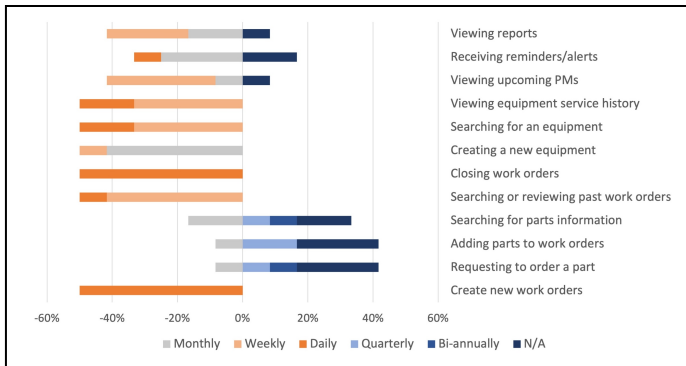


Fig. 1. Frequency of CMMS Feature Use

As shown in Fig. 1, BMETs most frequently use features to create and close work orders and to view equipment service history. Some functions, such as requesting new parts and searching for parts information, were used far less often.

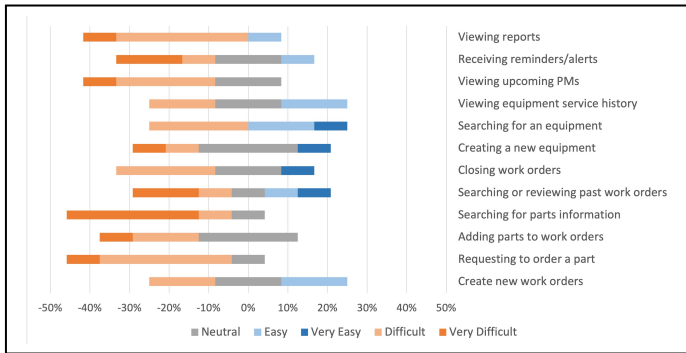


Fig. 2. Usability Ratings for CMMS Features

As shown in Fig. 2, BMETs reported a wide range of usability levels across CMMS functions. Features such as searching for equipment and reviewing past work orders were generally rated as easier to use, while actions like searching for parts and requesting to order parts were rated as more difficult.

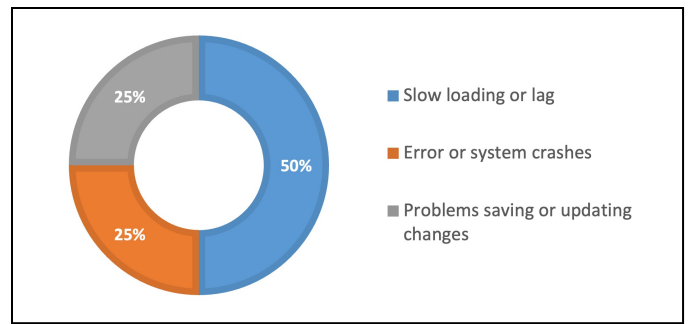


Fig. 3. Usability Ratings for CMMS Features

As shown in Fig. 3, the most reported technical issue was slow loading or system lag, followed by system errors or crashes and problems saving or updating information.

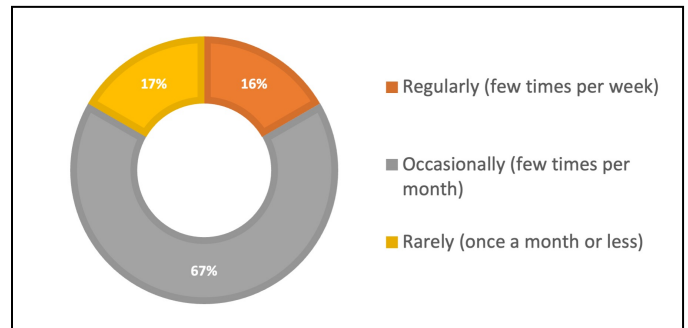


Fig. 4. Frequency of Technical Issues

As shown in Fig. 4, the majority of BMETs reported encountering technical issues a few times per month, with fewer participants experiencing them a few times a week or only monthly.

B. Key Findings from the Market Research

Table 6 summarizes the results of the CMMS evaluation grid.

TABLE 6. SUMMARY OF THE CMMS EVALUATION RESULTS

No.	E-Automate	MaintainX	eWorkOrders	eMaint	ClickMaint	Limble CMMS
S	53%	100%	100%	100%	74%	100%
R	40%	60%	60%	100%	40%	100%
Total	45%	76%	76%	100%	54%	100%

S = Standard Specifications, R = Regional Specifications

The percentage given to each CMMS represents the number of specifications available in each section, standard and regional. The total is calculated by multiplying the sub-total percentage by the assigned weight: 40% for standard and 60% for regional specifications.

Table 7 summarizes the comparison of quote estimates from all five selected CMMS.

TABLE 7. QUOTE ESTIMATE COMPARISON

Costs	MaintainX	eWorkOrders	eMaint	ClickMaint	Limble CMMS
One-Time Cost	\$35k	\$1.2k	\$40.5k	\$1.7k	\$0
Flat Subscription Plan	\$140	\$65	\$1.3k	\$48	\$0
Admin	\$0	\$0	\$0	\$0	\$80
Operator	\$0	\$0	\$0	\$0	\$30
Mobile	\$0	\$0	\$600	\$0	\$0
Dashboard	\$0	\$0	\$682	\$0	\$0
Total Subscription	\$8k	\$3.7k	\$83.6k	\$2.7k	\$2.3k
Total Annually	\$95.8k	\$44.5k	\$1,003.6k	\$32.8k	\$27.7k
First Year Total	\$130.8k	\$45.7k	\$1,044.1k	\$34.5k	\$27.7k

The One-Time Cost is the implementation fee paid in a single lump sum. This includes data conversion, training and configuration support with an implementation manager. The Flat Subscription Plan is the fee per user. For specific user types, the pricing may be different, the admin and operator users for Limble CMMS cost \$80 and \$30, respectively. Total subscription is the fee multiplied by the number of users CHEO needs for each type: 12 admins, 45 BMETs, 10 mobile (regional BMETs) and 3 Dashboard (3 stakeholders). The annual total is the subscription price multiplied by 12 for the whole year, and the first-year total is the latter amount plus the one-time cost.

C. Key findings from the Peer Hospitals Survey

Table 8 includes only the quantitative responses from the three peer hospitals. The qualitative themes are addressed in the Discussion section.

TABLE 8. QUANTITATIVE SUMMARY OF PEER HOSPITALS' CMMS EVALUATION RESULTS

Questions	Metric	Average
Implementation process rating	1-5 score	4.5
Multiple hospital support	1-5 score	5
Intuitiveness for staff	1-5 score	5
Vendors Support	1-5 score	5
Integration with other hospitals	Yes/No	67% = Yes
Generate standardized reports	Yes/No	100% = Yes

V. DISCUSSION

A. Analysis of the QCH and BH Survey Results

Starting with Table 4, which summarizes the ratings of all monthly reports, their average across both QCH and BH of 2.6/5, representing 52%, indicating that significant changes are needed to improve satisfaction. To summarize the comments in

each rating, they are as follows: data accuracy, different summary systems, and requesting additional data. QCH mentioned that, for the Metrics Corrective and PM Maintenance Report for August 2025, they only saw 12 service calls completed, even though at least 120 were completed. There were other mentions that the report was not relevant because of data inaccuracies. BH preferred a fiscal system showing progress from April 1st to March 31st.

While these comments are not directly linked to the software's features, they provide insights into areas that can be improved in the current CMMS before replacing it. If adjusting a few things, such as better accuracy of the data, fiscal year-based reports, and additional data, is feasible, they would significantly increase the ratings of the monthly reports.

From the survey sent out to managers of QCH and BH, they have mentioned to be in favour of limited access to the software to avoid having to ask Clinical Engineers at CHEO for data. Furthermore, they would also like a ticket system as an additional feature of the software. QCH does not have a database to interface with E-Automate, as they do not have a CMMS. However, they have evaluated ServiceNow (Santa Clara, USA, 2003) as a near-future solution for their CMMS, mainly because it is compatible with Biomedical, Facilities, and IT departments. BH, on the other hand, does have a database from the Facilities department documenting corrective maintenance performed on beds and minor medical devices.

Moving on to the summary from the BMETs from QCH and BH in Table 5, most of them say that the system is not intuitive to use, with an average score of 36.6%. The system's speed and responsiveness have scored higher, with an average of 53.4%. As shown in Fig. 3 and Fig. 4, most technical issues were related to slow loading (50%) and were experienced mostly a few times a month (87%). Technical issues were identified as a major contributor to dissatisfaction with E-Automate.

Looking at the results from BMETs in Fig. 1, we can see that they regularly perform tasks such as creating/closing work orders, viewing equipment history, and searching for equipment. When comparing the task complexity in Fig. 2, we can see that at least 2-3 of the 6 BMETs have selected 'Difficult' for the daily tasks mentioned above. The tasks that have scored the worst are searching for parts information, viewing reports, and requesting to order a part. The two main comments about these tasks were that too many tabs or windows had to be opened to complete them and there are multiple ways to complete the same tasks. Overall, the CMMS received an average score of 36.7%, which is low.

B. Analysis of the Market Research

Table 6 summarizes the results of each CMMS against all the specifications previously listed in Table 3. For the Standard specifications, we can see that MaintainX, eWorkOrders, eMaint, and Limble all have a score of 100%. ClickMaint scored 74%, lacking features such as scheduled reports and automatic generation and the ability to create custom fields for equipment tracking. In the regional specification, only eMaint and Limble CMMS have scored 100%. Both MaintainX and eWorkOrders, scoring 60%, were unable to restrict access from one sub-account (supervisors) to data for their hospitals only

and to design and save their own dashboards. ClickMaint, with a score of 40%, lacks these features and cannot automatically distribute reports to external individuals who are not users. E-Automate has scored lowest in both categories, with 53% and 40% in the standard and regional specifications, respectively. The low scores are mainly because CHEO's CMMS requires a third-party software called Crystal Reports which requires to learn a programming language to generate and send reports. This additional step makes it incomparable to the seamless reports builders in the 5 CMMS evaluated. It is important to note that the assessment made by the regional BMETs was on the cloud platform of E-Automate and is not the same as the one used in-house.

C. Analysis of the Peer Hospitals Survey Results

Looking at the results from the peer hospitals summarized in Table 8 we can see that the overall experience with their CMMS from the three institutions has been favourable.

To summarize, most scores given in the survey were all very high. Both LMBME and TOH had a smooth deployment of their CMMS and were satisfied with the support given throughout the implementation process. Furthermore, their CMMS was also competent in multi-hospital support especially with standardized reports.

Intuitiveness received the strongest results, with all three hospitals rating their systems 5/5. This contrasts with the results from QCH and BH BMETs in Table 5, where intuitiveness scored significantly lower, reinforcing that the current CMMS falls short in usability compared to peer hospitals. Vendor Support also showed positive results, averaging 5/5, although UOHI scored N/A, as they would be rating themselves for vendor support because they have built their CMMS in-house and run it on MS Access.

Regarding compatibility, 2 out of 3 hospitals confirmed that their CMMS integrates with other hospital systems. This aligns with one of the managers' feedback, who noted that they would like to integrate their technical database with the CMMS, and this would be an essential consideration for future adoption. All three hospitals indicated that their CMMS can generate standardized reports, which is consistent with the ongoing reporting needs identified in the internal surveys.

Overall, these results show that peer hospitals generally operate well-supported CMMS platforms with strong usability and reporting capabilities. This highlights several gaps between their systems and the current E-Automate environment at CHEO.

It is essential to note that the CMMS currently used in hospitals are often not a healthcare-specific system, but rather a general CMMS configured to meet hospital needs. This is the case for ServiceNow at TOH and Nuvolo at LMBME.

D. Analysis of Quote Estimate Comparison

As noted in the market research key findings, both eMaint and Limble CMMS scored highest, meeting all specifications in both the standard and regional categories. After evaluating all the demonstrations for each CMMS, they were asked to provide a quote comparison, summarized in Table 7. Focusing on eMaint and Limble CMMS, we can see that eMaint is the

most expensive, with over \$1M for the first year, whereas Limble CMMS costs roughly \$40k. Unfortunately, the implementation cost for the latter was not obtained. However, for comparison, if we assume both eMaint and Limble CMMS have the same implementation cost, the first-year cost for Limble CMMS will be approximately \$80k. This new price is still more than \$900k cheaper than eMaint. Despite the substantial price difference, these results provide context for the next steps of evaluation during procurement stages, including the development of an RFI and RFP.

VI. FUTURE WORK

It is important to note that there are limitations to the project presented in this paper. The sample size of the survey performed is very small with only two hospitals from the regional program. Additionally, the specifications listed are not as detailed as they would be in a formal RFI or RFP.

The next steps are to first perform the same evaluation with more hospitals participating in CHEO's Regional Program to have a better consensus. This will improve the specifications to better capture the common needs of a multi-hospital program. Ultimately, the list of specifications will provide a more robust assessment that can be applicable for any other network CMMS.

VII. CONCLUSION

This project evaluated the suitability of CHEO's current CMMS for its Regional Program and identified the key specifications required for a multi-hospital system. Through a literature review, stakeholder surveys, market research, and peer hospital input, several gaps were identified between E-Automate and regional program needs, particularly in reporting accuracy, dashboard visibility, usability, and compatibility.

The findings showed that both supervisors and BMETs experience limitations with the current system, affecting efficiency and data reliability. In contrast, several CMMS identified in the market analysis offer features better aligned with regional requirements. Based on the evaluation grid, Limble CMMS and eMaint met all standard and regional specifications, with Limble CMMS being the most cost-effective option.

As next steps, the same methodology could be applied to additional hospitals in the regional program to build greater consensus. These results support future decision-making, including the development of an RFI/RFP. While focused on CHEO, the proposed methodology and specifications may also apply to other Regional Programs.

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