SELECTION OF A COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM FOR MECHANICAL AND INDUSTRIAL LAB EQUIPMENT OF UNIVERSITY OF SOUTH AFRICA

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ABSTRACT

The research on which this article is based, sought a suitable computerized maintenance management system (CMMS) for use in the Mechanical and Industrial Engineering laboratories and workshop at the University of South Africa. The university plans to implement such a computerized maintenance management system, to keep track of past repairs, schedule future maintenance, and maintain a ready list of vendors or sources of parts. Currently, the department does not have a maintenance strategy or equipment history. The price of a product is an important factor when selecting a CMMS program. The recommended software will not place to great a stress on the departmental budget, is user friendly and can be used by two to five users.

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1 INTRODUCTION

Nowadays, maintenance is a strategic factor to guarantee high productivity of industrial systems as well as universities, but the global economic crisis has brought companies to reduce maintenance expenses with critical consequences for long-term reliability [1]. Industrial maintenance has two essential objectives, which are a high availability of production equipment and low maintenance costs [2]. However, a strong factor militating against the achievement of these objectives is the nature and intensity of equipment failures in plants and laboratories [2]. The cost of operations and maintenance can make or break a business, especially with today's increasing demand on productivity, availability, quality, safety and environment, and the decreasing profit margins [3]. A couple of years ago, CMMS was applied for hospital instrument maintenance. Now, CMMS is used by factories and production companies as well [4].Today's computerized maintenance management system (CMMS) can manage all of our possible requirements within the area of maintenance management [5]. The widespread mechanization and automation has reduced the number of production personnel and increased the capital employed in the production equipment and civil structures [6]. In many industries the equipment required to produce goods and services is expensive to own, operate and maintain and faults even in a single piece of equipment can halt an entire production [7].The primary uses of CMMS appear to be as a storehouse for equipment information, as well as a planned maintenance and a work maintenance planning tool [8]. Computerized maintenance management systems (CMMS) are required in order to manage and control assets and help schedule equipment maintenance. A CMMS is much more than merely a way of scheduling preventive maintenance (PM). By using a CMMS, administrators can create equipment logs to record events associated with a piece of equipment; create work orders automatically according to a schedule (or do so manually, from service requests); record the authorized use of equipment; and track scheduled services or PM, training, maintenance history, employee time, the downtime of a device, parts inventories and purchase orders [9]. Equipment should be properly maintained, if it is to fulfil its intended purpose [10]. In a plant, the numbers of pieces of equipment and service events are so large, that keeping and organizing related information can only be done via a computerised system. Thus, a CMMS software tool capable of running on a stand-alone computer – can be very useful for managing a plant and laboratory equipment maintenance programme [11].

CMMS can keep track of past repairs, schedule future maintenance, and provide a ready list of vendors/sources of parts. It can be used to generate detailed work orders for maintenance personnel [12] – orders which contain specific safety precautions and list the specialized tools needed for individual jobs. This system, when installed on a computer network, can further be used to manage the maintenance of several remote facilities from a central location [12]. CMMS programs thus offer a wide range of features, and it is up to the manager to decide which features are compatible with a facility and will generate the most helpful information. Maintenance has a very important role in the life cycle of any item or device, serving to maximize its performance by ensuring that it operates regularly and efficiently, attempting to prevent breakdowns or failures, and minimizing losses incurred through breakdown or failure [13].

Equipment management started with preventive maintenance, before advancing to productive maintenance. Facilities management, which is a strategic function, makes a notable contribution to business growth and company success [14]. The maintenance function has become increasingly important, due to its role in maintaining and improving availability, product quality, safety requirements and plant cost-effectiveness levels [15].

Machines must be maintained to ensure adequate levels of safety and quality. There should, similarly, be a regular maintenance and testing program for labs and workshop equipment. A qualified person (e.g., an artisan, technician, engineer or other maintenance person) must monitor, test, calibrate and maintain the equipment regularly, in accordance with the

manufacturer's specifications and recommendations. Equipment maintenance may be done by in-house staff, contract workers or a combination of both.

Maintenance is not an expense, but an investment in improved organization. The aim of maintenance is to maximize machine availability under operating conditions, to obtain the desired quantity and quality output. Maintenance should be performed in a cost-effective way, to set safety and environmental standards. The performance of maintenance management is dependent on the proper distribution of resources (spare parts and other maintenance materials, the workforce, the necessary tools and instruments), for achieving life cycle profit for the organization [16]. Effective Computerized Maintenance Management Software (CMMS) that schedules preventive maintenance work orders on the equipment is an integral component of any efficient maintenance department [5]. Far too often organizations will purchase CMMS or EAM software with the expectation that their maintenance business will instantly operate more efficiently. As with everything else in life, CMMS can only provide to you what you put into it [17]. The aim of this study is to select the suitable computerized maintenance management system which will assist mechanical and industrial practice effective preventative maintenance on laboratories and workshop equipment.

2 METHODOLOGY

For the purposes of this research study, qualitative method in the form of interview was used to gather the necessary information. This method of data collection was utilised in order to overcome issues of cost and time. Several key questions were put to the three lab technicians employed in the Mechanical and Industrial Engineering department as well as six academic staff who utilize the equipment for teaching and research purposes, to determine the need for a CMMS. The technicians and academic staff assessed the current mode of operation in their labs and workshop and were subsequently interviewed. The questions posed, and members of staff's responses, are presented in table 1. Next, the authors studied the manufacturers' product maintenance recommendations, and took note of problems in the department with respect to equipment and machine usage. After discovering maintenance challenges, the department is facing, authors visited seven universities to find out if they are managing their lab equipment using CMMS. It was found that none of those universities use maintenance management system. Decision was made to look for the software that will suit our need. After considering 125 top CMMS programs for 2019, for the purposes of this study Capterra – a web service that helps businesses find software solutions – was chosen as a tool for selecting the best option. To this end, the authors considered the following features when selecting the best CMMS deployment, asset tracking, calibration management, inventory control, key & lock management, mobile access, PM, purchasing, scheduling, service history tracking, technician management and work order management. Thereafter, the software was further evaluated based on features, industry, size, price and ratings. The final stage involved contacting the suppliers of the top four products for prices and full details of each product. Apart from not depleting the department's budget, the product had to be manufactured by a reputable company that has been in business for a while and have all feature mentioned above.

3 RESULTS AND DISCUSSION

Table 1: Key Questions to Determine the Need for CMMS.

Key questions posed to members of staff in Mechanical and Industrial Engineering department	**Responses**
Do you have an effective way to generate and track work orders? How do you verify whether the work was done efficiently and correctly?	Do not have such a tracking system

What is the notification function upon completion?	
Are you able to access historical information on the last time a system was serviced, by whom, and for what condition?	No
How are your spare-parts inventories managed and controlled? Do you have either excess inventories or are you consistently waiting for parts to arrive?	Do not have spare-parts inventory
Do you have an organized system for storing documents (electronically) related to operation and maintenance (O&M) procedures, equipment manuals and warranty information?	We do not have such a system
When service staff are in the field, what assurances do you have that they are compliant with all life, health and safety-related issues (e.g., lock and tag) and are using the right tools/equipment for the task?	None
How are your assets, i.e., equipment and systems, tracked for reporting and planning?	No maintenance plan, equipment is reported only when broken

The responses from the three lab technicians employed in the Mechanical and Industrial Engineering labs, as presented in table 1, illustrate that the department does not have an effective way of generating and tracking work orders, therefore it is difficult to verify whether work has indeed been done efficiently and correctly. The lab technicians do not have access to equipment history either. There is no spare-parts inventory or organized system for storing electronic documents (related to operations and maintenance procedures around equipment in the labs and workshop). When maintenance personnel are working on the machine, the lab technicians do not have the assurance that such maintenance complies with all life, health and safety-related specifications, or that those personnel are using the right tools for the job. There is no maintenance plan, and no equipment tracking, or reporting is done. Based on these responses, there is a need to select and implement a CMMS in this department's labs and workshop.

Table 2: List of Best computerized maintenance management systems CMMSs Software.

Products	Recommendations	Size
eMaint CMMS	184	2 to 5 users
FT Maintenance	100	2 to 5 users
Hippo CMMS	70	2 to 5 users
agilit	10	2 to 5 users
eSpace	0	2 to 5 users
ss-CMMS	0	2 to 5 users
Maxpanda work order	0	2 to 5 users
manwinwin	0	2 to 5 users
Fixd	0	2 to 5 users
corrigo	0	2 to 5 users
Fleet maintenance pro	0	2 to 5 users
Maintenance coordinator	0	2 to 5 users
EZmaintain	0	2 to 5 users
I'monit	0	2 to 5 users
MASTIS	0	2 to 5 users

When the 125 products were evaluated for the second time, based on the features, industry, size, price and rating, only 15 products met the criteria. The industry chosen for this study

was education, because the software will be used to track university equipment. Based on the number of technical officers in the department, the product size needed to be such that it could be used by two to five users. Given budgetary constraints, the cheapest software had to be chosen, with the price of the product including software licences, maintenance and support, installation, customization, data migration and training. Of the 15 products shown in Table 2, only four met the criteria and thus made the short-list.

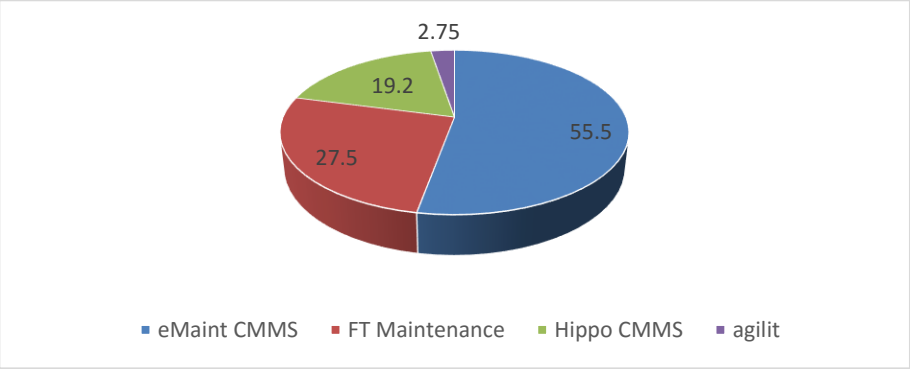

Figure 1: Recommended Software's

Figure 1 indicates that eMaint CMMS came highly recommended at 55.5%, followed by FT Maintenance with 27.5% and agilit with the lowest number of recommendations at 2.75%. Based on the highly recommended products percentages, eMaint CMMS was deemed the most appropriate maintenance software for use with educational equipment. Therefore, eMaint maintenance software is recommended for the Mechanical and Industrial Engineering labs and workshop of the University of South Africa.

Table 3: Software Review Based on the Product Establishment, Number of Customers, Deployment Mode, Location and Price.

Product	Est.	Customers	Deployment model	Free trial	Headquarters	Price (per month)
eMaint	1986	4,000+	Cloud, on premises	Yes	Bonita Springs, FL	$85 for 3 users min.
FT Maintenance	1989	20,000+	Cloud locally installed		Wisconsin, USA	$40 per user
Hippo CMMS	2001	55,000+	Web-based	Yes	Winnipeg, Canada	$ 125 for 3 users

The findings in table 3 shows that eMaint software is cheaper than the other products, despite its smaller customer base. eMaint software company was founded in 1986, which indicates that it has survived for more than 30 years in the game of selling CMMS – this implies that its software can be trusted. Hippo CMMS has a high number of customers but is more expensive than the other two products. Based on the price, deployment model and existence of the company, eMaint is thus deemed best suited for use in Unisa's Mechanical and Industrial Engineering labs and workshop. (Agilit software was not included in table 3, as the product did not come highly recommended).

4 CONCLUSION AND RECOMMENDATIONS

The selection of suitable, cost-effective software was achieved, as the proposed product will not break the bank and can be used by a minimum of three users at the same price. The

selected software program will help the department access important information regarding the lab and workshop equipment, help in planning maintenance activities and make lecturers aware of the availability of machines, thus enabling them to schedule practical sessions timeously. Reports will be generated from the system to assist the department in reaching decisions relating to the lab and workshop equipment. By implementing this CMMS, the department will be able to keep track of virtually everything that happens in its labs and to its workshop equipment. Also, it will enable the department to move away from keeping paper records of service reports. The department will be able to determine how much time is spent on certain tasks, will have a record of maintenance activities and any materials purchased, and will be able to manage the lab technicians' time more effectively. Also, it will afford the latter an opportunity to create work orders for the equipment via the web when maintenance is needed and allow them to respond to these orders more efficiently. Extensive and targeted training is recommended, as it will be key to a smooth transition – it will prove to be well worth the expense. It is also recommended that trainees be given time to absorb the information and apply the skills/use the features they learn during one training session, before proceeding to the next. Also, the spacing between training sessions will be important, so as not to overburden trainees.

5 REFERENCES

[1] M. Faccio, A. Persona, F. Sgarbossa, and G. Zanin, "Industrial maintenance policy development: A quantitative framework," *Int. J. Prod. Econ.*, vol. 147, no. PART A, pp. 85–93, 2014.

[2] W. H. Wan Mahmood, M. N. Ab Rahman, B. M. Deros, and H. Mazli, "Maintenance management system for upstream operations in oil and gas industry: A case study," *Int. J. Ind. Syst. Eng.*, vol. 9, no. 3, pp. 317–329, 2011.

[3] G. Waeyenbergh and L. Pintelon, "Maintenance concept development: A case study," *Int. J. Prod. Econ.*, vol. 89, no. 3, pp. 395–405, 2004.

[4] R. R. INDARYANTO, "Implementation of Computerized Maintenance Management System (Cmms) for Medium Transport Aircraft," no. June, 2013.

[5] A. A. M. Ali, "Application of computerized maintenance mangement system in industry," *37th Int. Conf. Comput. Ind. Eng. 2007*, vol. 1, pp. 33–44, 2007.

[6] A. Garg and S. G. Deshmukh, "Maintenance management: Literature review and directions," *J. Qual. Maint. Eng.*, vol. 12, no. 3, pp. 205–238, 2006.

[7] J. Laurila, "Developing Computerized Maintenance Management System," no. December, 2017.

[8] A. Labib, "Complex System Maintenance Handbook," *Complex Syst. Maint. Handb.*, no. January 2008, 2008.

[9] Kulolli, "Selecting a Computerized maintenance management system," no. August, 2008.

[10] H. H. Osman, M. A. Hassan, N. M. Elhady, and R. M. Elrasheed, "Computerized Preventive Maintenance Management System (CPMMS) for Haematology Department Equipments," *Int. J. Comput. Appl.*, vol. 109, no. 16, pp. 9–12, 2015.

[11] world health organization, "Computerized maintenance management system Open Rubric WHO MEDICAL DEVICE TECHNICAL SERIES : TO ENSURE IMPROVED ACCESS , QUALITY AND USE OF MEDICAL DEVICES DEVELOPMENT OF MEDICAL DEVICE POLICIES WHO MEDICAL DEVICE TECHNICAL SERIES FOR MEDICAL DEVICES INNO," *Comput.*

Maint. Manag. Syst., 2011.

[12] A. Crespo Marquez and J. N. D. Gupta, "Contemporary maintenance management: Process, framework and supporting pillars," *Omega*, vol. 34, no. 3, pp. 313–326, 2006.

[13] R. H. Fouad, M. Rawashdeh, A. Albashir, and B. Al-sharif, "Designing a Computerized Maintenance Management System for Medical Devices in Royal Medical Services," vol. 10, no. January, pp. 115–118, 2012.

[14] D. Mutia, J. Kihiu, and S.M. Maranga, "Maintenance Management of Hospital Equipment: a Case Study of Public Hospital in Kenya," *Mech. Eng. confrance Sustain. Res. Inov.*, vol. 4, pp. 85–89, 2012.

[15] B. Al-Najjar and I. Alsyouf, "Selecting the most efficient maintenance approach using fuzzy multiple criteria decision making," *Int. J. Prod. Econ.*, vol. 84, pp. 85–100, 2003.

[16] D. Sherwin, *A review of overall models for maintenance management*, vol. 6, no. 3. 2000.

[17] M. Crain, "The Role of CMMS," *Ind. Technol. North. Digit.*, pp. 1–6, 2003.