Industrial Engineering Letters
ISSN 2224-6096 (print) ISSN 2225-0581 (online)
Vol 2, No.3, 2012

Developing an In-house Computerized Maintenance Management System for Hospitals

David Mutia [1, 2*] John Kihiu [1] Stephen Maranga [1]

1. Department of Mechanical Engineering, Jomo Kenyatta University of Agriculture & Technology
   PO Box 62000-00200, Nairobi, Kenya
2. Department of Medical Engineering, Mombasa Polytechnic University College
   PO Box 90420-80100, Mombasa, Kenya

* E-mail of the corresponding author: davi2malombe@yahoo.com

Abstract

The safety and reliability of medical equipment is mandatory. Equipment may be used on the patients who are unconscious. Other types of medical equipment function as life support and their failure may result in the patient's death when the machine is in use. The maintenance program developed in the research determined the possible remedies for the respective faults and the personnel to rectify the problems. The system was developed to enable the existing facility maintenance managers in major hospitals in Kenya to improve on their maintenance management of the medical equipment. The equipment is initially identified in its category by the program and guides the user to identify the causes of the medical equipment faults and the possible personnel to handle the fault in the equipment. The system would enable the hospitals achieve optimum utilization of hospital equipment and improve the management of medical equipment through a proper time management.

Keywords: Health facilities, Maintenance, Medical equipment

1. Introduction

Hospital and health care facilities are among the most complex, costly and challenging equipments to manage. One of the main challenges of managing hospital facilities is the highly diverse network and range of functions that are needed to maintain operations of the medical equipment and the complexity of services which are required to support them (Loose more, 2001). The maintenance facilities managers ensures that medical equipment are well calibrated and in proper operational condition. They are expected to have the ability to maintain the medical equipment to comply with standard performance characteristic set by the hospitals policies, the manufacturer's specification and the clinical requirement. A major breakdown signifies that the maintenance and servicing program have failed. Productivity is a concept which is defined as a state of efficiency or the rate and quality of output based on the rate and quality of input (Kirkland, 1985). As it relates to hospital facilities management, higher productivity can mean safer and more reliable equipment, less service cost, less equipment downtime, more revenue and more effective use of man power (Hashem, 1986).

Hospitals have been faced with a competitive environment which has resulted in the need for increasing high levels of capital investment to support facilities and equipment perceived necessary to retain top quality physicians. Hospitals have continued to invest capital in tangible, and hopefully billable, equipment in order to retain a public image of being a "State-of-the-art" facility and attract and retain the needed physicians who in turn funnel their patients to the hospital that is best equipped (Kerry, 1995). When medical equipment does not work properly, blame for the resulting complication is always directed at clinicians, as the manufacturer and the technical support personnel are at least equally responsible. The extensive utilization of complex and sophisticated electromedical equipment by facility maintenance managers who have little technical background, however, has not only facilitated physicians in diagnosis, prognosis and treatment of disease, but has also caused problems that are new to the world of medicine

(F.P.Branca,1993). In a Harvard study, nearly four percent of hospitalized patients sustained medical treatment-related disabling injury. Technical causes were the third most common type of adverse events (Leape, L.L, 1997).

2. Literature Review

Figure 1 shows a flow chart of the Planned Preventive Maintenance (PPM), its concept of Monitoring and Evaluation system in major Kenya hospitals. The system is used to reduce and eliminate unpredicted malfunctions of the equipments. These are problems that occur suddenly and therefore cannot be detected or prevented by PPM measures. However, many problems occur because of the deterioration of equipment caused by normal use and can be detected prior to their causing of a malfunction to the equipment.

The Planned Preventive Maintenance system involves several essential elements which includes; inventory system which is used to provide consistent, accurate and up-to-date information on the hospital equipment/biomedical equipment's description. Maintenance schedule, procedures and label medical equipment etc. In monitoring and evaluation of medical equipment in the Kenyan major hospitals a variety of documentation would be used; Equipment record sheet, Request sheet, Job card, History card, Inspection and service forms etc. The development of in-house computerized maintenance management system eliminates accumulation of folders and files thus improving space utilization in the maintenance department. The system improves the swiftness of accessing the technical data for the equipment and stores the current updated information.

The different approach being used by a number of healthcare facilities includes use of maintenance 'insurance' to minimize costs. The insurance program operates in a simple manner, almost the same way as a service contract. Instead of paying the service contract costs to the manufacturer, to have the same coverage, the hospital now pays the insurance company a premium. During the period of insurance, any expenses resulting from equipment corrective maintenance, preventive maintenance, replacement or loss will be refunded by the insurance company. The biggest disadvantage of this approach is the amount of time spent in management intervention. The maintenance teams from the hospitals are required to coordinate with the vendors, supervise field service monitoring, claim processing and reimbursements monitoring and adding or removing equipment from program (Thai G. Tran, 1994). The in-house computerized maintenance management system reduces the time spent by the equipment being idle as the hospital waits compensation by the insurance company. The computerized maintenance system enables the maintenance department to acquire a reliable inventory of the medical equipment therefore able to determine new technology in the market.

Commercial computerized maintenance management system are used by clinical engineering departments in European hospitals to collect, store, analyze and report data on the repair and maintenance. The systems have become complex database management tools that, for most clinical engineering departments, are too costly and time-consuming to internally develop, update and maintain (Ted Cohen, 1995). FastMaint maintenance management software is a type of commercial computerized maintenance management software. FastMaint can create different calendars that can be used to help manage maintenance schedule. For example the engineer could have two different maintenance teams - one that works at night and the other by day. In the night team's calendar, the night team may start work at 8 pm every night and finish the next day early in the morning at 5 am. The systems deals mostly with the work plan in the maintenance department. The task involves planned preventive and unplanned task.

In contrarily to the FastMaint program, the maintenance program developed in the research determines the possible remedy of the respective fault in medical equipment, and possible personnel to rectify the problem.

In 1992, the Clinical Engineering Service (CES) at the Children's Hospital "Bambino Gesu" of Rome, Italy (an approximately 700 bed medical facility) chose to develop its own computerized electromedical equipment management system (F.P.Branca, 1993). This was a tool for decision making in electromedical equipment acquisition strategies, with the aims of minimizing the cost/benefit ratios, and assuring safe and calibrated device. The program output evaluated maintenance costs and workload increase from new

equipment installation and compared similar equipment from different manufacturers during pre-purchase evaluation. The study on developing an in-house computerized maintenance management system for hospitals develops a computer program which assists not only on inventory of medical equipment but also determines the possible causes of the medical equipment faults. It also determines the possible personnel in maintenance management team to handle the faults in the equipment.

3. Programme Development

The major hospitals in Kenya use the Planned Preventive Maintenance (PPM). It's concept of Monitoring and Evaluation system reduces and eliminates unpredicted malfunctions of the equipments. The development of a prototype of a computer program assists in the management of hospital facilities. Figure 2 shows the flow chart which describes the program development beginning from identification of the equipment. The survey conducted focused on four groups each group represented by two types of equipment

- Laboratory equipment; Blood gas and Bacterial incubators
- Diagnostic equipment; Diagnostic X-ray machine, Ultra-sound machine
- Therapeutic equipment; Dialysis Machines, Short-wave machine
- Hospital equipment; Oxygen plant, Autoclaves

The maintenance program is written in a C++ program. The program indicates the flow of the equipment maintenance management by the three facility managers. It restricts the operator to enter only valid data by checking the validity of data code and data format. The program development begins from identification of the category in which the equipment is categorized. The equipment is identified in terms of its category and whether the equipment is in the inventory. This approach reduces accumulation of paper work in the office and proper monitoring of the equipment.

4. Results

The development of the computerized maintenance management system for the Kenyan's hospital was successful. The program was designed through C++ programming because it is user friendly. The greatest number of facility maintenance managers working in the Kenyan hospitals is diploma holders. It is easier for them to use the in-house computerized maintenance management system. The use of complicated program will prove a great challenge on the implementation of the maintenance system to the hospitals. Figure 3 and 4 shows the output from the maintenance program of a faulty Blood gas analyzer and Autoclave machine supplied in the Kenyan hospital. The process reduces the time allocated for the repair of equipment because the information required is accessed immediately. The Life Cycle Cost (LCC) of the equipment and the quality of patient care will be improved to a better standard. The equipment which exists in the institutions are classified to their respective groups and whether they are under warrant. The process helps to improve the inventory system and also reduce the paper work and loss of data in the maintenance management.

5. Conclusion

The hospitals in Kenya have no quality control system for the repair and preventive maintenance. Technical manuals are not fully utilized when repairs are made as maintenance on the medical equipments is not done on the stipulated time frame. Most of the hospitals have personal computers in the maintenance departments. The implementation of the computer program improves the maintenance practices by solving the faults in the shortest duration. The program also reports the possible personnel to handle the fault in the equipment.

References

F.P.Branca, P.Cappa. (1993), "Development of a Computerized Equipment Management Program at Children's Hospital "Bambino Gesu" of Rome, Italy," *Journal of Clinical Engineering,* vol. 18, pp.519-527

Hashem O.Al-Fadel. (1986), "Productivity Improvement," *Journal of Clinical Engineering*, vol.11, pp.355-359

Kerry S., Thomas W., Sharon O. (1995). "Adapting a strategic management model to hospital operating strategies," *Journal of Management in Medicine*. vol. 9, pp.34-47.

Kirkland, D.L. (1985). "Turning Productivity into Profit," *Journal of Micro service management.* pp.18.

Leape, L.L. (1997). "A systems analysis approach to medical error," *Journal of Evaluation in Clinical Practice.* vol.3, pp. 213-222.

Loose more, M., Hsin, Y.Y. (2001). "Customer-focused benchmarking for facilities management," *Journal of Facilities,* vol. 19, pp. 464-475

Thai G. Tran, B.S.E.E., CBET. (1994). "Use of Maintenance Insurance to minimize costs," *Journal of Clinical Engineering,* vol. 19, pp. 143-147

Ted Cohen, M.S., C.C.E. (1995). "Computerized Maintenance Management Systems; How to match your Department's need with Commercially Available Products," *Journal of Clinical Engineering,* vol.20. pp.457-461.

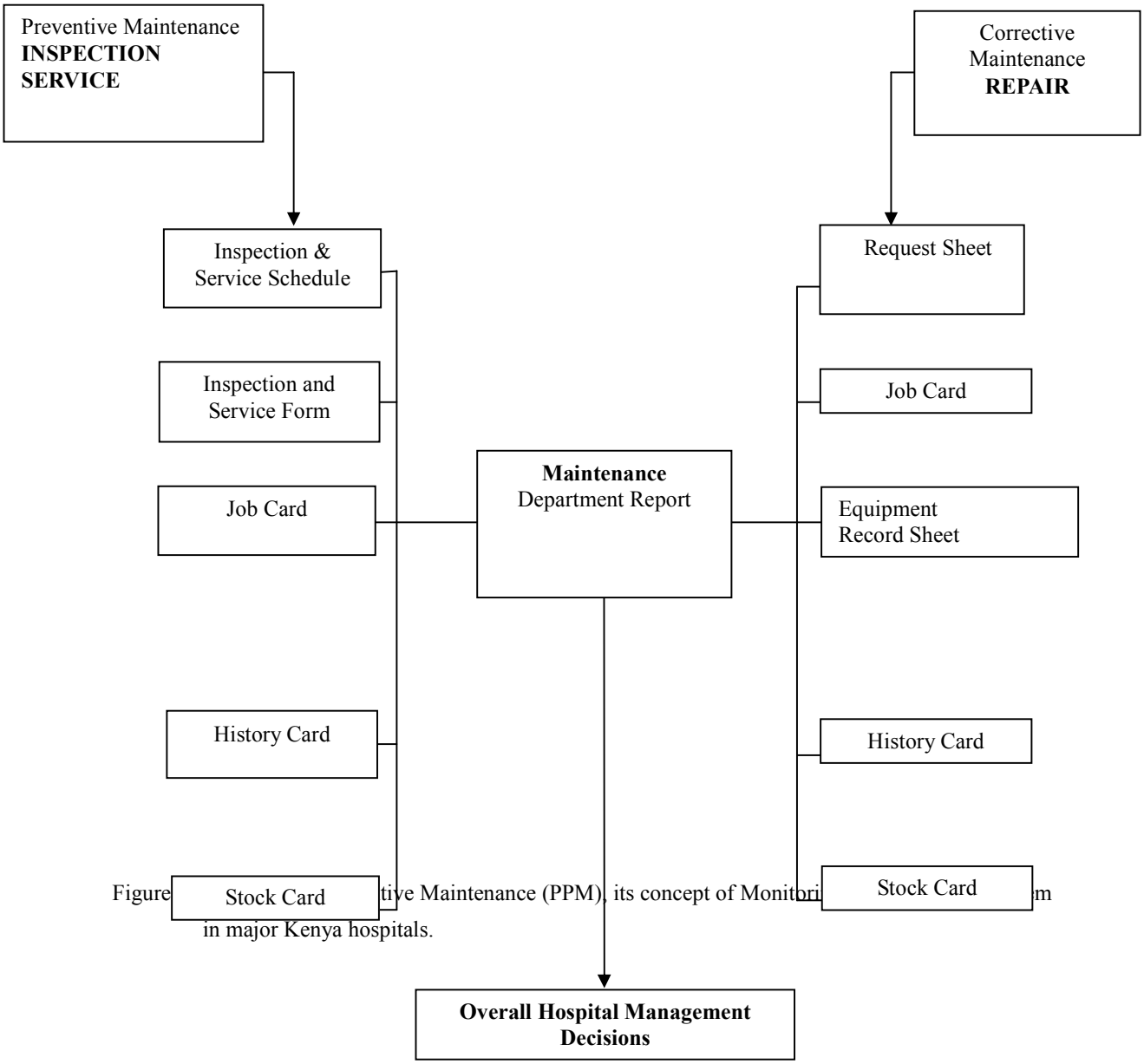

Figure tive Maintenance (PPM), its concept of Monitori m in major Kenya hospitals.

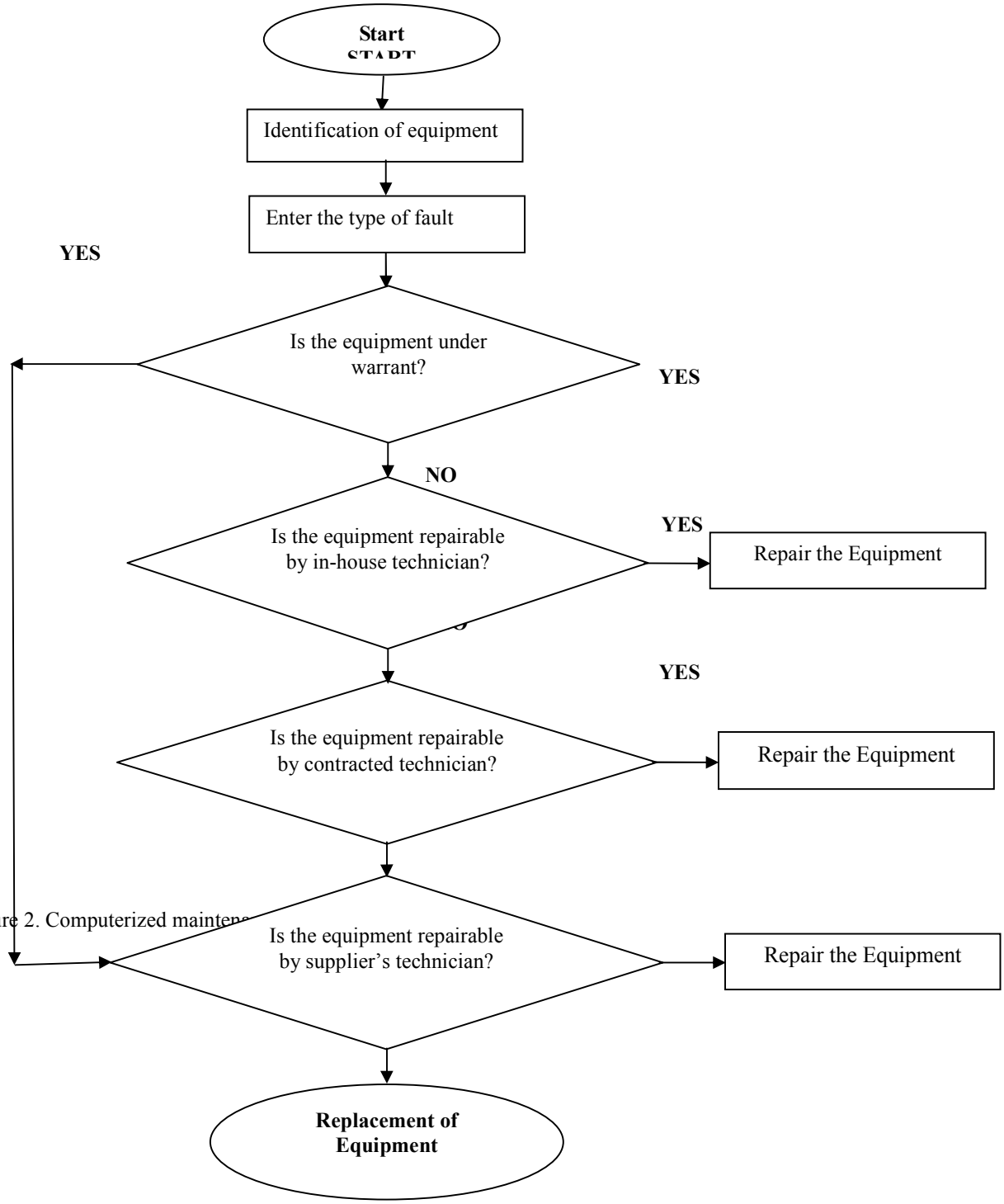

Figure 2. Computerized maintenance

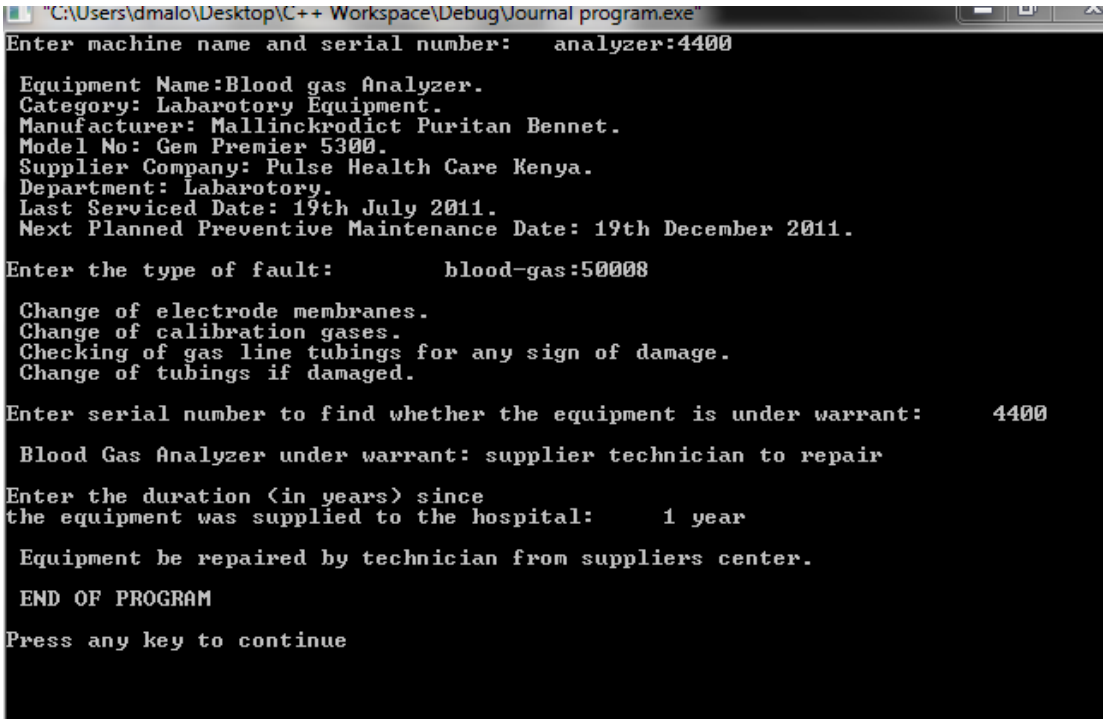

Figure 3. Maintenance program output

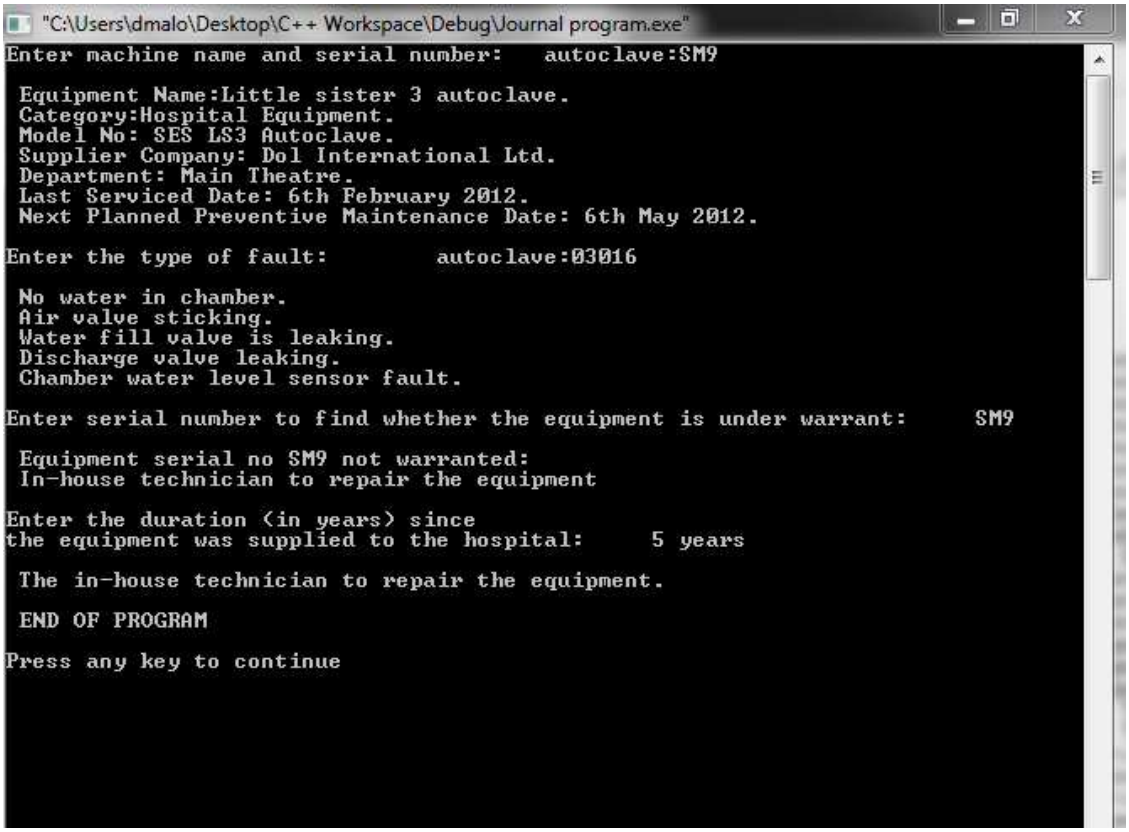

Figure 4. Maintenance program output