

# Electronic Application Development for the Biomedical Department of Honduras Medical Center

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**Abstract-** The order entry process in the Biomedical Department becomes a problem due to the high consumption of time and paper it requires. Using databases, official documents, questionnaires and interviews, information was gathered about the reasons why an optimization of this process was necessary. Using PowerApps and OneDrive tools, an application was implemented with which the department's work orders could be filled out and documented digitally. For this, the formats already established within the department were adapted, defining processes before and after the application, and time measurements were taken. The time invested in the new order entry process was measured. A time reduction of 67% was observed, proving the effectiveness of the application by streamlining the order entry process.

**Keywords-** Work Order, Application, medical equipment, PowerApps, database, document, biomedical department

## Introduction

The biomedical department in a hospital oversees performing different tasks related to multiple areas of the hospital, especially with the maintenance, management, and administration of medical devices [1].

Honduras Medical Center is one of the most prestigious private hospitals in Honduras and has its own biomedical department. It performs medical equipment maintenance activities and uses printed cards that vary in quantity depending on the equipment and type of work.

Due to the high amount of medical equipment in inventory, the department invests a large amount of time and material resources (paper, pencils, folders, among others) to carry out its activities [2].

Nowadays, humanity is adapted to live around technology. Advances and new technological opportunities provide ways to optimize activities and resources invested in different establishments.

For the same reason, it was decided to develop an application to be implemented in the department and considerably reduce the use of paper, printing time and the time to file physical documents [3].

For the creation of the application, the Microsoft applications with their online services and the PowerApps tool will be used to enter the necessary information and keep it on file in the Microsoft databases.

In this research the information of the processes carried out in the department will be compiled. The material resources and time invested in maintenance activities will be calculated.

Based on the data obtained, the application will be designed to update the work methodology used by the department.

Once the application has been implemented, we will proceed to analyze the new resources that will be invested. With the results, the effectiveness will be concluded by comparing the values obtained to the initial ones before using the application.

The Honduras Medical Center (HMC) is a private hospital located in Tegucigalpa. For 18 years, this health center has served the population with its various areas and specialties [4].

Currently, biomedical engineers fulfill the role of providing maintenance of medical equipment and administrative tasks such as filing documents and service reports.

These reports have always been generated in physical form using a printer and sheets of paper and in digital form using the MEDITECH database. Over the years, the use of the DocuWare database was added to further adapt to the digital era.

Despite the advances that have been made, it has not been possible to reduce or eliminate physical service files and reports. This not only results in a large consumption of resources such as paper and printer ink, but also requires an investment of time on the part of department members [5].

The biomedical engineering department of a hospital must be available to respond immediately to any need that may arise. When performing maintenance work, whether corrective or preventive, the work performed must be documented and important data such as date, time, and personnel in charge of this work must be recorded.

## Methodology

The project is based on a mixed approach. The main objective is to reduce the material resources used in the biomedical department focused on a quantitative study. To reach the objective it is required to analyze the state of the processes and the department based on a qualitative study. The material resources were quantified in situations before and after having implemented the application. Procedures and activities were analyzed to determine the current state of the department and how the application would improve the situation [2].

Data obtained before and after implementation were used to determine the outcome and effectiveness. The procedures and status of the activities before and after the implementation of the application were also compared. In addition to the data obtained by the authors, feedback from the users of the department was used to determine the result.

Measuring instruments such as counting, stopwatches and a meter were used to obtain numerical data of the required values.

Through observation and questionnaires applied within the biomedical department, the state of the department was known in more detail. The employees' opinions and comments were the most valuable since they have the greatest influence on the application decisions.

The book on Hospital Standards written by Joint Commission International and the book on medical device maintenance procedures written by the World Health Organization (WHO) were consulted. The books were used to understand in more detail the processes and activities within the department. The department uses these books as references for the elaboration of the activities that the application directly affects [9].

The validation of the project is supported by the results obtained, showing the effectiveness of the application. In addition, studies conducted by third parties that support the validity of the application are also considered.

The first research is conducted by Forrester and determines the effectiveness of using PowerApps as a solution for the elaboration of office activities.

The research found key points that are in line with what this project aims to find. First, it was concluded that four salespeople were able to reduce survey application times by 50%. This reduction is related to this project because applying a survey and filling out tokens digitally have similar writing processes [7].

It was found that, due to the digitization of processes, the collection of physical forms was eliminated. The research also found that productivity on the part of line-of-business employees improved by 3.2 hours per week. User satisfaction was found to be highly positive due to the large number of improvements that a PowerApps application can generate [7].

The second study was conducted by Coleman Parkes Research and funded by Xerox in 2017. The research is about applied trends to improve workflows in small and medium-sized businesses. These activities specifically use paper intensively [8].

The study showed that, of the respondents, when using a Managed Print Service (used to optimize printing processes) there were improvements in:

- Cost Reduction (48%)
- Reduction of paper consumption (47%)
- Improved document workflow (41%)

#### *Obtaining initial process data*

In this section, data was obtained prior to the development and implementation of the application. The information obtained in this section functions as a basis for the decisions that will be made when developing the application.

Here we measured the time currently taken by the department's employees to prepare and store work sheets. The

amount of paper used in all processes was measured and the physical space required to file the sheets of paper was measured.

A questionnaire was prepared with information and opinions from employees about how they feel about the processes they currently work with and how an application can improve their activities. A diagram of the main process that will be affected by the application was drawn up.

#### *Evaluation of application adaptation*

The activities included in the work process diagram will be directly affected after the application has been implemented. In the diagram there are processes that remain the same even after using the application. In this section we determined which of these processes will not be affected and determined the features that can be implemented in the application to have the best time reduction.

#### *Application development*

Once the initial data were obtained and an overview of the department and the activities, specifically those of the work process, was obtained, we proceeded to develop the application. The PowerApps and Power Automate platform was used for the development.

#### *Initial Tests*

Once the previous steps were completed, the application was subjected to initial tests and its behavior was observed. A brief analysis was made to determine the next steps to be taken. The initial tests were performed together with the biomedical technician in charge of performing maintenance activities and inspections of the hospital's equipment. The technician was the main source of feedback.

#### *User feedback*

The authors of the application kept a log of problems that needed to be fixed. Features that could be implemented to improve the user experience were also determined. Problems were fixed and improvements were implemented. The changes were reflected in different versions of the application recorded as a history of changes made.

The application was tested at the same time as the department's activities in response to the hospital's needs. The application was used to generate technical service reports for maintenance and inspections. The biomedical technician in charge used the application on a tablet to fill out the report format, where he also asked the department managers to sign the document digitally.

Once the biomedical technician had tested the application, the questionnaire defined for the end of the day was completed. The technician commented his opinions and observations about what could be improved in the application. The comments from the questionnaire were tabulated in a table to review the information and then proceed to the solutions.

Once feedback was obtained from the users through comments that were submitted, we proceeded to state which improvements were to be made and which bugs were fixed. We started by fixing bugs that considerably affected the performance of the application and directly affected the activities within the department.

*Implementation*

Once all the improvements and bug fixes have been completed, we proceed to define the final version of the application that will be used to measure the new resources. This version was declared when it was considered that the application already has all the necessary components for a correct implementation.

*Obtaining final data and conclusions*

Once the last version of the application was completed, the resources taken in the first step of the study methodology were measured.

After having performed both analyses, the final status was determined and how the application helped in the improvement of the department's procedures and how it would potentially help the entire hospital.

**Results**

Data was collected on the number of documents generated in the biomedical department in approximately one year. For this purpose, the department's indicators for the years 2020 and 2021 were consulted, as well as the DocuWare database to adequately estimate the number of orders generated.

Table I summarizes the number of preventive maintenances performed during each month of 2020. Added to that, the number of sheets of paper associated with each maintenance report was tabulated. The department's Preventive Maintenance form consists of only one sheet of paper, so one sheet per maintenance was used.

Table II shows the number of inspections carried out during 2020. The number of sheets of paper associated with each inspection report was tabulated. The department's Inspection form may have one or two sheets of paper, depending on the equipment. To ensure the highest possible accuracy, each maintenance performed was reviewed for the exact number of sheets of paper. It is important to note that the months of January and June are always free of inspections.

Table III shows the information regarding the number of certifications performed throughout 2020. These certifications were performed using medical equipment analyzers belonging to the hospital. A monthly schedule is in place to cover all the hospital's medical equipment. In the case of certifications, the number of sheets of paper required is variable due to the different tests to be carried out with different equipment.

TABLE I  
Amount of paper used in Preventive Maintenance

Month	Preventive Maintenance	Number of Sheets
January	18	18
February	17	17
March	15	15
April	18	18
May	16	16
June	16	16
July	18	18
August	15	15
September	16	16
October	19	19
November	19	19
December	18	18
<b>Total</b>	<b>205</b>	<b>205</b>

TABLE II  
Amount of paper used in inspections

Month	Inspections	Number of Sheets
January	0	0
February	22	31
March	22	32
April	22	28
May	22	27
June	0	0
July	22	26
August	22	31
September	22	32
October	22	30
November	22	27
December	22	27
<b>Total</b>	<b>220</b>	<b>291</b>

TABLE III  
Quantity of paper used in Certifications

Month	Certifications	Number of Sheets
January	17	36
February	15	37
March	15	31
April	18	36
May	14	23
June	14	25
July	17	37
August	17	28
September	18	26
October	17	29
November	17	41
December	0	0
<b>Total</b>	<b>179</b>	<b>349</b>

Synthesizing the information in the previous tables, a total of 845 sheets of paper used per year in scheduled maintenance within the department is calculated. This number does not include corrective maintenance performed annually. As these are unexpected events, it is difficult to calculate the exact value of work orders dedicated to this type of maintenance. In 2020, a total of 157 corrective maintenances were performed, corresponding to 157 sheets of paper. The amount of paper sheets used in 2020 year in these activities was 1002 sheets. [6].

To execute the time measurements, 10 technical service orders were taken, and the complete order entry process was carried out for each of them.

A total of approximately 294 seconds (4 minutes and 54 seconds) was calculated for each order. The time measured is subject to change due to the difficulty of anticipating the activities to be performed in the department on a day-to-day basis. Table IV shows the average order entry time.

#### Application Development

The application is done in Power Apps because of the ease of use it provides for making applications. PowerApps and Power Automate are included in UNITEC's plans with Office which allows students to use the premium Office online service. PowerApps works like a jigsaw puzzle combined with Excel. The interface and the canvas to make the user interface is used by inserting shapes, buttons and more that allow the application to perform. It was also based on documents mentioning tips to improve an office in terms of paper usage [10].

TABLE IV  
Average Work Order Entry Time

Process	Average Time
Preparation	00:01:11
Label	00:00:05
MEDITECH	00:01:31
DocuWare	00:01:32
Saved	00:00:35
<b>Total</b>	<i>00:04:54</i>

Once objects are placed on the screen canvas, their properties can be accessed. For example, a button is by default made with visual characteristics of a button. The user can modify the properties to perform actions they need. The user can then command a button to perform an action when it is pressed. With these objects the screens are built, using a combination of fields, texts, buttons, shapes, icons, etc.

PowerApps can connect to multiple databases, either by entering a local table or through online databases such as OneDrive, Google Drive, SharePoint, etc.

The application was developed in PowerApps and consists of 3 parts:

#### Authentication

The authentication part is a simple screen where the user will be asked to enter a username and password to proceed to the following screens. This verifies that only registered users (in this case the department's employees) have permission to access the application and generate documents.

The authentication screen includes: the hospital logo, labels to indicate where the username and password should be entered, a button to confirm the login and a message in case the user and/or password have been forgotten.

If they try to log in and the password or user is incorrect, a message will appear indicating that one of the two controls is incorrect, and they must do it again. If the user has

successfully entered the username and password, they can access the main menu.

#### Document Viewing

The second part of the application is the display of the documents included in the application. This part includes the documents that have been generated and have not been deleted from the database. Manuals are also included to support the user in how to use the application if necessary.

The main menu includes the main access to the different parts of the application, in Generate Documents you can access the service reports that have been generated where you can view and/or edit them.

In View Documents you can view the formats established by the hospital. In the help section the user can consult on how to use the application and answers to questions they may have. Finally, a logout button is included to log out of your user and exit the application.

#### Document generation and editing

The document generation section has two options, one section for maintenance and one for inspections. The same format is used for most of the equipment, the details of what specific procedure was done are noted in a section of the format. Regardless of the type of format chosen, the user will enter a screen where a list of the activities performed can be viewed, edited, deleted, or just displayed.

The maintenance and inspections screens, in addition to viewing information saved in the database, also allow the generation of new fields or the deletion of existing ones. These actions are represented respectively by buttons on the "Generate Documents" screen and on the details page. In the details screen there is a button represented by a pencil symbol that allows the user to edit an existing format.

Users have the possibility to save several jobs and return to them in case they need a signature or to generate a MEDITECH number. Once all fields are filled in, the user proceeds to press the generate button to create the document in the cloud. The generate button is linked to a flow in Power Automate that automatically creates a Word and PDF document using the filled fields.

The flow performed in Power Automate starts by linking to the fields in PowerApps, then the flow places the information in a Word format, creates and saves the document with your information in the cloud. It then creates a new file that is a conversion of the Word document into a PDF document. Once the user has access to the PDF document, he can save it in DocuWare or anywhere he needs it.

#### User feedback

The application was presented and implemented during working hours with the biomedical technician in charge of maintenance and inspections. The technician used the application to generate documents of the work performed. The reception was positive with signs of enthusiasm due to all the advantages that the application can bring to the department. At

the end of the day, one was answered as part of the user feedback questionnaire. These comments were considered to improve the application.

The application under development occasionally had bugs or problems that slightly or significantly affected the performance of the application. These bugs were written and then corrected. Each time a bug was known, it was fixed to obtain the best possible version of the application. These comments were written by the authors while the bugs were being detected.

Table V shows a summary of the errors detected by users and the action taken to correct them.

TABLE V  
User feedback log

No.	Error	Correction
1	The flow in Power Automate could not get the signature image in the application and generate it in the document.	Conversion of pencil input to binary language
2	The flow in Power Automate could not get the information from non-text entries, such as calendars and lists.	Input to text conversion
3	A new pencil entry was not generated for each signature resulting in the impossibility of obtaining different signatures without the previous ones being deleted.	Delete location field in the table and condition the display of the image in the application.
4	Some buttons were not navigating to the designated screens.	Alter the position of the buttons creating illusions.
5	Could not save new information when creating a record	Has not been solved

#### Subsequent Analysis

After implementing and testing the application within the department, multiple time measurements were obtained. The order entry process following the use of the application was substantially improved. The generation of the pre-service document is omitted, leading to a fully digital process, and paper consumption is reduced to zero for planned maintenance in the department. The time measurements of this process after the implementation of the application are detailed in Table VI.

There has been a significant reduction in the number of processes for entering documents into MEDITECH and DocuWare. In addition, the process of pre-preparing the document, sticking the label and storing it in the file cabinet is eliminated.

TABLE VI  
Time Comparison

Process	Time Before	Time After
Preparation	00:01:11	00:00:00
Label	00:00:05	00:00:00
MEDITECH Login	00:01:31	00:01:07
DocuWare Login	00:01:32	00:00:30
Storage	00:00:35	00:00:00
<b>Total Time</b>	<i>00:04:54</i>	<i>00:01:37</i>
<b>Time in seconds</b>	294	97
<b>Seconds per leaf per year</b>	294588	97194
<b>Hours per year</b>	81.83	26.99

The pre-service order report preparation step, the process of printing and affixing the label, and the process of storing physical orders in the file cabinet were eliminated. On average, 197 seconds, or 3 minutes and 17 seconds, of the time required to complete the single order entry process was reduced.

Using the information from work orders performed in 2020, this would represent a difference of 54.83 hours between the pre-application process and the process with the use of the application. This represents a 67% reduction in time spent on work order entry.

#### Conclusions

An electronic application was developed that reduced by 67% the time spent in the process of saving work orders generated by the department.

The initial state of the biomedical department prior to the implementation of the application was studied. Using data from 2020, it was calculated that 845 sheets of paper were used in planned maintenance orders and 157 sheets in corrective maintenance. This need for a huge amount of paper is eliminated by digitizing the work orders.

An electronic application was developed using PowerApps where the MEDITECH order number was included in each digital order generated. The digital orders generated in PDF format are entered into DocuWare and the process is linked to the hospital's existing databases.

It was estimated that approximately 80 hours a year are spent in the process of saving work orders into their respective databases. This time could be reduced by 67% with the implementation of an electronic application. This could result in a better workflow due to a reduction in workload and increased time availability within the department.

With the results within the hospital and its biomedical department, the need for continuous improvement to the application and its implementation process arises. It is possible to include reference instructions within the application regarding the development of maintenance activities.

The inclusion of a calendar with which to record the dates on which these activities are carried out provides a versatile way of keeping accurate records of maintenance that has been performed and maintenance that is due to be performed.

In addition to this, the addition of functions for viewing and updating the inventory of medical equipment within the institution provides greater accessibility in terms of controlling the movement, entry and exit of different equipment. The possibility of generating orders without the need for an Internet connection should be studied to avoid setbacks due to failures in the wireless network.

The project was developed in a private hospital in Tegucigalpa, the capital city of Honduras. The workflow within this health center is not representative of the current state of the Honduran health system. Most of the hospitals in the country do not have the necessary technology to be able to modernize the workflow of their biomedical department.

The implementation of this electronic application in other hospitals and health centers should be analyzed. The time reduction that the digitization of work orders can bring to the engineers of the different health centers will have a positive impact on their workflows and the effectiveness of their departments.

Expanding the use of the application can extend its positive impact not only in the biomedical department, but globally within the facility. A cost analysis can provide the facility with the information needed to decide if, in addition to the workflow benefits, this application will have some economic impact for the hospital.

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