

In♥Advance

D7.1 – Mock up dashboard

WP7 – Design of a consolidated standard for appraising PC interventions

| | |
|---------------------|-----------------|
| Submission Date | 31 October 2019 |
| Responsible Partner | UPV-SABIEN |



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825750



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825750

| Project Documentation | |
|---------------------------|---|
| Project Acronym | InAdvance |
| Project Full Title | Patient-centred pathways of early palliative care, supportive ecosystems and appraisal standard |
| Grant Agreement | 825750 |
| Call Identifier | H2020-SC1-2018-Single-Stage-RTD |
| Topic | SC1-BHC-23-2018 |
| Funding Scheme | Research and Innovation action (RIA) |
| Project Duration | 48 months |
| Coordinator | Universitat de València |
| Website | www.inadvanceproject.eu |

| Deliverable Documentation | |
|-------------------------------|---|
| Number | D7.1 |
| Title | Mock up dashboard |
| Related WP | WP7 Design of a consolidated standard for appraising PC interventions |
| Lead Beneficiary | UPV |
| Nature of Deliverable | Report |
| Dissemination Level | Public |
| Submission Due Date | 31/10/2019 |
| Actual Submission Date | 31/10/2019 |

| Quality Control | |
|----------------------------|------------|
| Author(s) | |
| José Luis Bayo | UPV-SABIEN |
| Contributor(s) | |
| M ^a Eugenia Gas | HULAFE |
| Editor(s) | |
| José Luis Bayo | UPV-SABIEN |
| Reviewed by | |
| María Martínez | UPV-SABIEN |
| Carlos Fernández | UPV-SABIEN |
| Ascensión Doñate | UVEG |
| Siok Swan Tan | ERASMUS MC |
| Vania Dimitrova | UNIVLEEDS |
| Approved by | |
| Project Coordinator | UVEG |



| Revision History | | | |
|------------------|------------|--------------------------|------------------|
| Version | Date | Comment | Author(s) |
| V1 | 24/09/2019 | Written first version | José Luis Bayo |
| V1.1 | 30/09/2019 | Contributions | María Martínez |
| V1.2 | 10/10/2019 | Revision first version | Carlos Fernández |
| V1.3 | 16/10/2019 | Revision | Ascensión Doñate |
| V1.4 | 17/10/2019 | Revision | Siok Swan Tan |
| V2 | 25/10/2019 | Modified after revisions | José Luis Bayo |
| V2.1 | 29/10/2019 | Revision | Vania Dimitrova |
| V2.2 | 30/10/2019 | Revision | Ascensión Doñate |
| V3 | 30/10/2019 | Modified after revisions | José Luis Bayo |



Table of Contents

| | |
|---|-----------|
| Table of Contents | 4 |
| List of Acronyms..... | 4 |
| 0. Executive summary | 6 |
| 1. Introduction..... | 7 |
| 1.1 Purpose of this document | 7 |
| 1.2 Who should read this document..... | 7 |
| 1.3 Needed information | 7 |
| 1.4 Structure of this document | 7 |
| 2. What a clinical Dashboard is..... | 8 |
| 3. Introduction to Process Mining | 9 |
| 4. Process Mining Dashboard. User manual..... | 11 |
| 4.1 Zone 1. Main Menu | 12 |
| 4.1.1 Factories..... | 12 |
| 4.2 Filters..... | 13 |
| 4.2.1 Date selector..... | 13 |
| 4.2.2 Pagination Filter | 14 |
| 4.2.3 Clustering..... | 14 |
| 4.2.4 Trace variables | 14 |
| 4.3 Enhancement | 14 |
| 4.4 Traces | 15 |
| 4.5 Statistics..... | 16 |
| 4.6 Workflow Graphic Representation Zone | 18 |
| 5. Use Case | 19 |
| 6. Conclusions | 21 |
| 7. References..... | 22 |
| Annex 1..... | 23 |

List of Acronyms

| | |
|---------------|-----------------|
| HULAFE | Hospital La Fe |
| PC | Palliative Care |
| PM | Process Mining |





0. Executive summary

This deliverable presents the mock-up version of the Process Mining (PM) Dashboard for the InAdvance project. A dashboard is developed to provide a visual display of information. A mock-up is a model of a machine or structure, used for instructional or experimental purposes. Process Mining is a set of techniques that can be applied to data.

Within the InAdvance project, the dashboard aims to provide a global view of all the interventions performed within the project framework, as well as the patient's evolution and their most relevant data and statistics. All this will be shown from the results obtained through the application of process mining to the existing data.

Firstly, the report will describe what a dashboard for a clinical application is and what the dashboard can be used for. Secondly, a brief explanation of what PM is will be presented. Finally, a first version of the user manual will be presented to show the potential functionality and lay the foundations for the future final version of the dashboard.



1. Introduction

The InAdvance project proposes a new model of Palliative Care (PC) based on early integration and personalised pathways addressed specifically to older people with complex chronic conditions.

The dashboard intends to show in a visual way the information of different pathways, from a general level to a patient level.

1.1 Purpose of this document

The objective of this document is to show the potential functionalities that the dashboard will have in its final version at the end of InAdvance project. It is important to develop this deliverable at this earlier time in order to show the clinical partners how the dashboard is planned to be. Thus, partners can have opportunity to provide suggestion to improve the visualisation of the information in the dashboard. These suggestions can be provided now and can inform further improvement to be included in the future versions, when the functionality starts to be developed.

1.2 Who should read this document

This document, in addition to serving as a demonstrator of the work performed during the first period of the project, is intended to provide a first overview to the clinical partners, to show the potential that the dashboard will have at the end of the project.

1.3 Needed information

The information required to develop the mock up of the dashboard was the type of variables that will be acquired from the patients in the different clinical sites. Concretely, for this first version of the dashboard, the information received was from La Fe Hospital (HULAFE). It was used mainly to plan the distribution of the dashboard and the type of filters to be used.

To continue developing the future functionality of the dashboard the type of variables information of the rest of clinical partners will be needed.

1.4 Structure of this document

The document has the following structure. First, an introduction to Process Mining is presented. After that, the data provided by HULAFE is described. Then, a description of the main functionalities of the InAdvance dashboard is shown.



2. What a clinical Dashboard is

Traditional medical records are largely used for storage, and have not been designed with patient care in mind. It is difficult for clinical staff to sort through large amounts of paper work to see what has happened to their patients. Now traditional medical records are becoming increasingly computerised, making them more readable but hardly meaningful anymore for clinicians. Large amounts of data can be captured electronically but information can be just as hard to find [1].

To make electronic records less complex and for health care staff to obtain easy access to timely and meaningful information, there is an increasingly popular move towards integration of patient data. One system that integrates data and is being increasingly used is the clinical dashboard. Clinical dashboards are being implemented in a variety of health care settings to improve workflow by providing graphic visualisations of patient data. Dashboards are seen as relatively cheap to implement.

A clinical dashboard is a visual display of such information developed to provide clinicians with relevant and timely access to the information they need to improve quality of patient care [2]. It provides a visual display of quality or productivity indicators to individual clinicians.

Clinical dashboards offer many key features. They:

- provide better information for clinical teams, presented in an easy to understand format with high visual impact;
- utilise multiple sources of existing data;
- provide clinical information relevant across multidisciplinary teams;
- provide information in “real time” with no delay for data cleaning;
- allow configuration to local requirements and comparison against national and international data sets (where these are available);

Clinical dashboards have evolved and are becoming deployed in real world settings. Feedback indicates that the dashboard technology is allowing clinicians to manage their workload more effectively, increase productivity, manage and monitor performance and streamline the data collection processes.

A clinical dashboard could provide data at the level of the patient (hospital service) or at the level of the healthcare system (hospital managers). In the case of the InAdvance project, the PM dashboard will be applied to hospital service level, using the patient’s data.



3. Introduction to Process Mining

Process Mining (PM) is a set of techniques used to make models understandable by humans that is constructed from event records. An **event** can be considered as an action occurred during a concrete period, i.e. patient is in the waiting room. A set of events, belonging to the same patient, is called **trace** and a set of traces, is called **log**. These models make possible to analyse the processes that exist in an underlying way [3].

In this case, these processes are represented by workflows in which the nodes represent a location, a state or an activity; and the arrows that join them represent the order in which they pass from one node to another. This technology is very useful to highlight outlier cases, which usually are the most interesting.

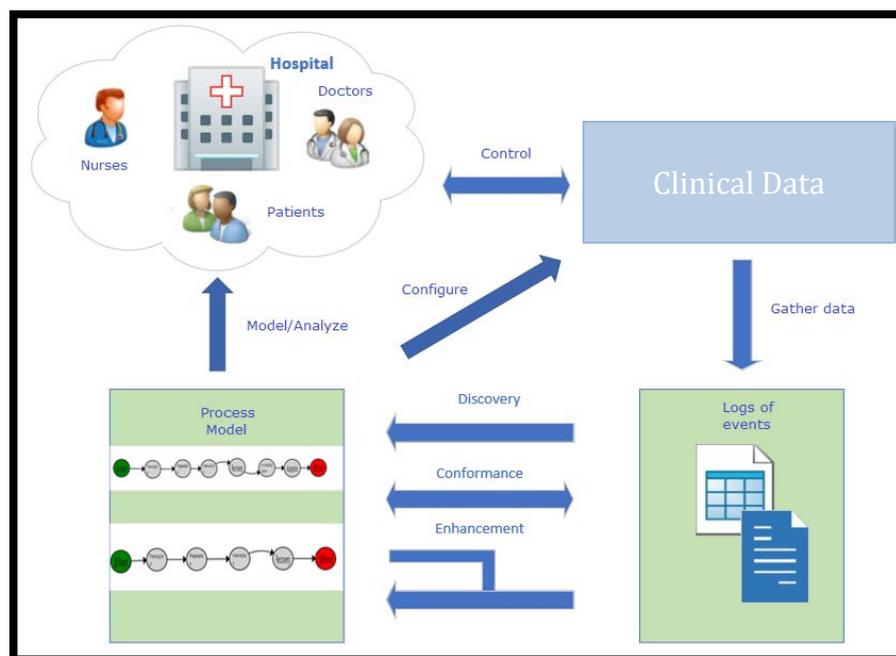


Figure 1. Process mining in Healthcare

There are three different types of PM techniques:

- **Discovery.** It is a technique that allows to discover existing workflows in the data without any prior information. In PC, it allows to characterize the behaviour of individuals under treatment.
- **Conformance.** This technique allows observing how the present data conform to a predefined theoretical model. With this type of technique, it is possible to assess whether patients are following the pathway originally defined by the hospital.
- **Enhancement.** It is a technique that uses the model discovered to improve the theoretical model that should be followed, thus generating a new model that will emphasize differences such as bottlenecks, being able to adopt measures needed to solve them.



One of the limitations of PM is that noisy data will generate a so-called *spaghetti effect* (Figure 2) [4]. It generates incomprehensible models, thus losing one of the main advantages of the PM [5]. Therefore, reducing noise in the database should be one of the first steps to follow before using the PM techniques.

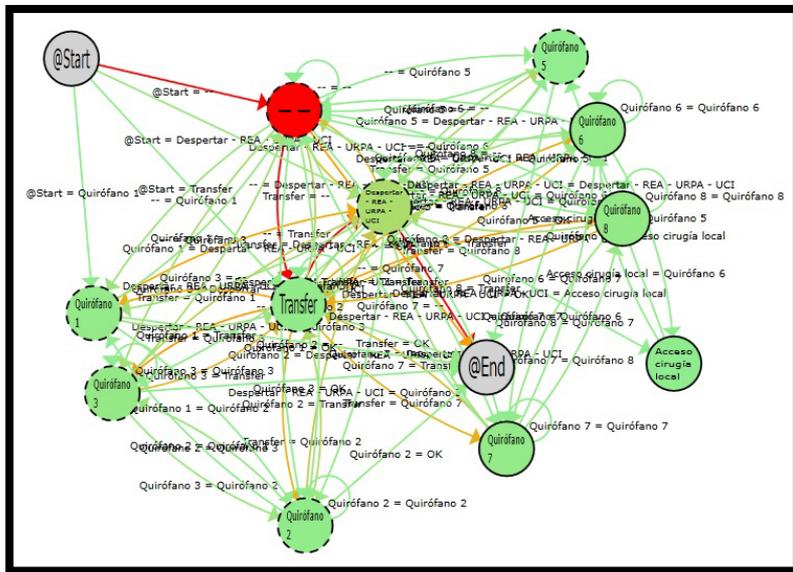


Figure 2. Spaghetti effect example



4. Process Mining Dashboard. User manual

The InAdvance mock-up dashboard is based on PM techniques and based on PALIA Suite [5] algorithm developed at the Polytechnic University of Valencia. This application is customizable according to the problem to be solved. That is, the type of controls that appear in the dashboard will depend on the type of problem to be resolved. An example of the dashboard is presented in the following link, so that the reader could test the different options that are presented in the present document: <https://gofile.me/3YTY9/xyj26LhxU>.

When it is downloaded and extracted, it should be executed the “DashboardInAdvance.exe” file to run the Dashboard application. (If you have problems with windows Defender please see Annex 1)

In this manual, the ideas to provide usable information to the clinical partners of the InAdvance project are presented. In the future developments of the dashboard, it will be developed the functionality of each part, customizing anything when it will be necessary.

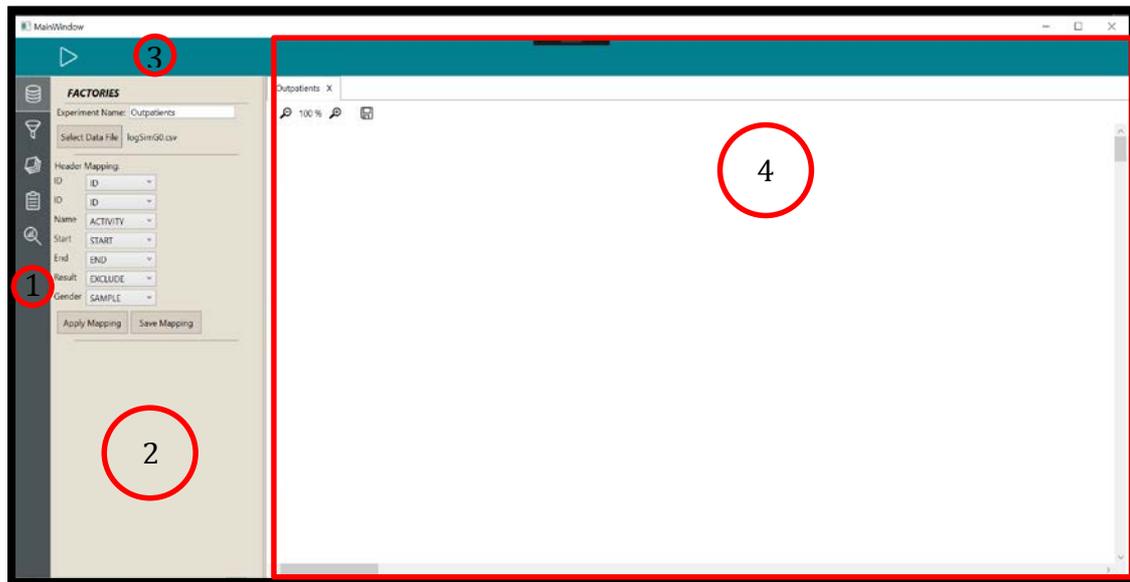


Figure 3. Main screen of the dashboard

As it is shown in Figure 3, the graphical interface of the dashboard is divided into 4 different zones:

- **Zone 1.** This zone presents the **main menu**. It contains the access to the different menus for deepening on the information of each specific process. These are the factory menu, the filters menu, the heat maps menu, one menu for viewing the selected node or transition traces and another with statistics.
- **Zone 2.** This zone is where the **detail** of the selected menu in zone 1 is presented.
- **Zone 3.** This zone is the **top menu** that allows access to common functions of the application and it is intended for specific actions on PM and can be



customizable. i.e. The first of these functions is the start button that allows PM to begin.

- **Zone 4.** It is the zone of **graphic representation** of workflows, where the inferences obtained as a result of applying the PM algorithm is displayed.

To understand a little more how the dashboard is used, we explain below the regular flow of the application:

1. From the main menu (zone 1), in the menu Factories, you can load a log (LoadLog) by selecting the corresponding csv file.
2. Then, click on PLAY button (zone 3) to start the experiment.
3. Once the process has finalized, the result will appear in zone 4.
4. Then, filters, enhancement and statistics (menus in zone 1) can be applied to the obtained workflow, which will help to discover outliers.

In the following sections each of the zones and their utilities will be explained in depth.

4.1 Zone 1. Main Menu

4.1.1 Factories

As it has been said, this option allows searching the file containing the log data. This menu could be selected by clicking in the first button of the main menu (zone 1), as it is shown in Figure 4.

By clicking on Select Data File button (zone 2), an “open” window appears, where the user could select the .csv file to be loaded and click on the “open” button. In the provided example of dashboard, you can select the “mockupdata.csv” file.

Then, the Header mapping section appears, where the different items for each label could be selected. You should select the most appropriate for each one among the drop-down list. Pressing the PLAY button, it will start the data mining process.

ATTENTION!! The .csv file must be closed in order to load it. If it is open, the dashboard does not warn of any type of error. It just does not load it.



Figure 4. Factories



4.2 Filters

In this menu we can find different filters that allow to modify and select what data from the initial log will be used in mining. The filters help to adapt the input log data to the mining module format. This menu could be selected by clicking in the second button of the main menu (zone 1), as it is shown in Figure 5.

In this area the different filters to modify and select which initial log data will be processed in the mining engine can be found. According to the chosen log, only the applicable filters will be loaded.

Each time that a new filter is selected, it is needed to press PLAY button in order to refresh the data mining process.

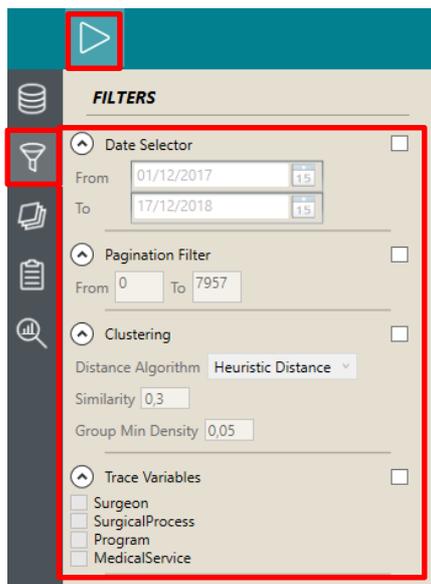


Figure 5. Filters

This area is customizable, but there are 4 basic filters that are available for any data log and will be described below. However, it is important to note that it is possible to create specific filters for different logs.

4.2.1 Date selector

This filter offers the possibility of limiting the log data of a range of specific dates, i.e. if it is a whole year log, the data of a specific month or week can be analysed.

To use this filter, you must select it by clicking on the box that appears on the right of the filter name (“Date Selector”). Once checked, it will be enabled the boxes “From”, where it can be filled in the initial date for which we want to do the analysis, and “To”, in which it will be filled in the final date of the analysis. It should be noted that when the “From” and “To” boxes are enabled, they will contain an initial and final date, which correspond to the first and last date existing in the data log, respectively. These dates will appear only if the analysis has been run at least once before selecting the “Date Selector” filter, with the “play” button in zone 3. When the analysis has not been run, it contains the date of today.



4.2.2 Pagination Filter

This filter allows to work with a subset of data of the log uploaded, i.e. in the case of having a huge quantity of events; it will help to reduce the time of performance of the experiment.

To use this filter, you must select it by clicking on the box that appears on the right of the filter name ("Pagination Filter"). Once checked, it will be enabled the boxes "From", where it can be filled in the initial trace for which we want to do the analysis, and "To", in which it will be filled in the final trace of the analysis. It should be noted that when the "From" and "To" boxes are enabled, they will contain an initial and final trace, which correspond to the first and last trace existing in the data log, respectively. These traces will appear only if the analysis has been run at least once before selecting the "Pagination Filter", with the "play" button in zone 3. When the analysis has not been run, they contain a 0.

4.2.3 Clustering

The activation of this filter intends, after performing the data mining, separate those nodes with behaviour similarities in different workflows. This is useful in some activities such as when locating people, because the same location cannot exist in two places at once, but in other log this can mean distorting reality.

This will be done by selecting the type of distance algorithm that it is wanted to apply, as well as the Similarity and Group Minimum Density desired. By modifying these last two parameters we will get more or less groups and more or less detail (number of nodes) in each one.

To use this filter, you must select it by clicking on the box that appears on the right of the filter name ("Clustering"). Once checked, it will be enabled the boxes "Distance Algorithm", where it can be selected the type of algorithm that we want to apply during the analysis, "Similarity" and "Group Mín Density", in which it will be filled the different criteria to define the type of clustering we want to obtain.

4.2.4 Trace variables

Those variables from the log, labelled as samples, will be available in the trace variables filter. When selecting one the data will split in different workflows according to the number of variables selected. It will allow seeing only the data related with the selected variables and hide the rest of the data. You can choose from one to all variables.

To use this filter, you must select it by clicking on the box that appears on the right of the filter name ("Trace variables"). Once checked, it will be enabled the boxes of the left of each variable and it will be possible to select all those we want.

4.3 Enhancement

This menu allows adding a colour map to a Timed Parallel Automaton (TPA) already drawn in the graphic representation zone (zone 4). This menu could be selected by clicking in the third button of the main menu (zone 1), as it is show in Figure 6.



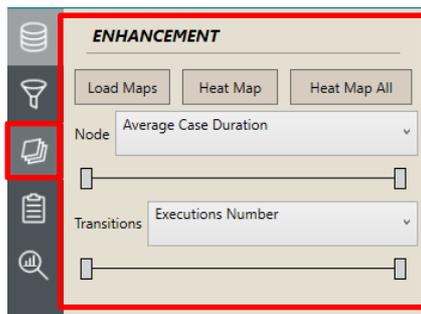


Figure 6. Enhancement

First step is to press Load Maps button. It will bring the maps from the workflows already generated. Then, when we click on Heat Map button, the enhancement will be applied to the workflow that is been shown in the graphic representation zone. If we click on Heat Map All button, the enhancement will be applied to all the workflows (TPAs) loaded. Any of both cases requires to click on PLAY button to apply the heat map.

The heat map represents the time spent in each node or transition. The colours range from green, crossing the range of yellows, to red. In the case of the nodes, green means that people have spent little time on the node while red represents that time has been high. In the case of transitions, green means that few people have gone through this transition, while red indicates a high number of people.

It can be chosen what the colours of each node and transition represent by means of the drop-down that appears at the right of the “Node” and “Transition” labels in zone 2. This drop-down can be seen in Figure 6. All this colour representation makes easier to understand where the bottlenecks are. By default, the Node drop-down contains the options “Average Case Duration”, “Aggregated duration” and “Executions number” and the Transitions drop-down the “Executions number” option.

When one node of the workflow in zone 4 is clicked, a detailed statistical information appears, with information regarding the averages, median, aggregations, numbers... of people going through that state or transition.

With the bar control, we can saturate or modify the maximum and minimum of the colour per node or transition in order to represent more precisely the differences in the workflow. That is, the lower and upper heat map values change, forcing them to be grouped with the maximum or the minimum from a given value.

4.4 Traces

This menu allows knowing the information of each trace. This menu could be selected by clicking in the fourth button of the main menu (zone 1), as it is show in Figure 7.

When a transition (arrow) is selected in a workflow (zone 4), in this section appears the list of traces that has made that path. Each trace belongs to a patient



and is represented by that patient identifier. The number of traces is shown at the top right.

Traces are sorted by number. We can go through the trace pages with the left and right arrow buttons on the top, or write the page we want to go to. The total number of pages is also shown.

By double clicking one of the traces a window will appear that will show the details of the route that the patient has followed (Figure 8).

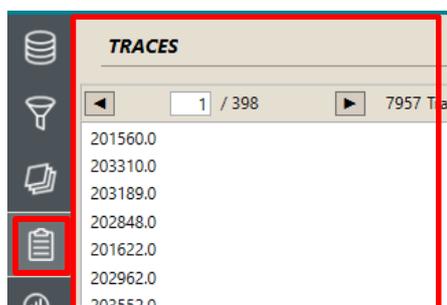


Figure 7. Traces

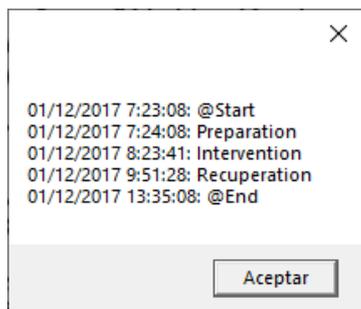


Figure 8. Detail of one trace

4.5 Statistics

This menu allows select and show the statistical information desired. This menu could be selected by clicking in the fifth button of the main menu (zone 1), as it is shown in Figure 9.

Normally, here the fields named as “Sample” appear during the analysis, but it is customizable. When we press the Infer button, it will be brought the metadata stored in the current workflow. Then, clicking on the corresponding fields that we wanted to see and pressing on Show Table button it will be displayed the statistics as is shown in Figure 9, in the table in the right side.

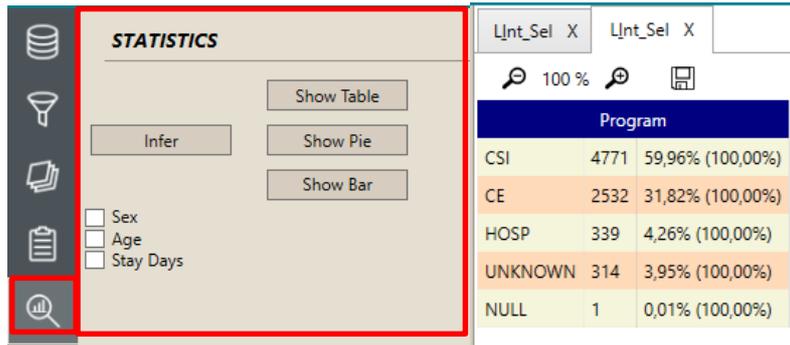


Figure 9. Statistics with table

Likewise, if we press the Show Pie button, it will show the statistics like it is shown in Figure 10 and by pressing in the Show Bar button it will present the data in the format shown in Figure 11.

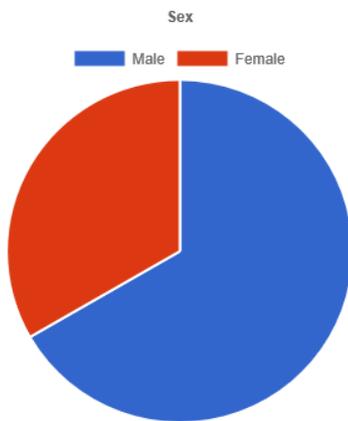


Figure 10. Statistics with Pie chart

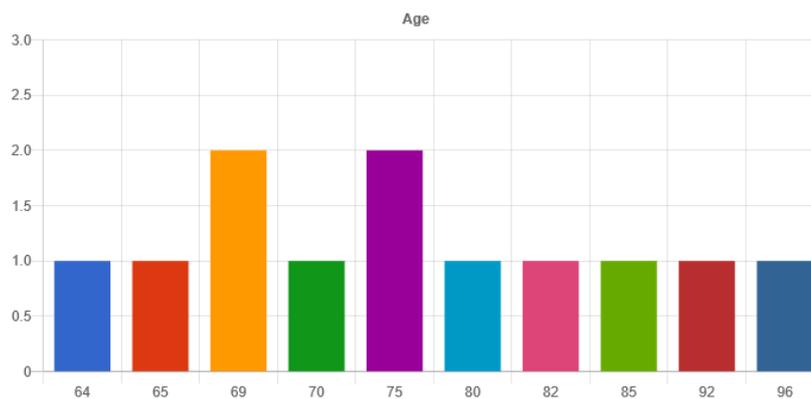


Figure 11. Statistics with Bar chart

This is just a sample of the types of charts that can be shown. During the functional development of the dashboard this visualizations of the statistics can change, having more visualizations or different ones, depending on the data acquired finally for the project.



4.6 Workflow Graphic Representation Zone

In this area the inferences obtained as a result of applying the PM algorithm to the corpus obtained from the filtering are drawn. Here it can be also visualized the enhancement applied to that workflows and the statistics results.

The activities of a log, for example locations, are represented as a node. The nodes have a circular shape and contain the name that represents them inside. There are two special nodes added to all samples, the @Start node indicates the start of any sample/path and the @End node will collect all the end of samples/paths. First, they appear in green and red respectively, and the normal nodes appear in grey. When the enhancement is applied, like in Figure 12, these colours change. The transitions are represented with an arrow from the origin node to the destination node.

The workflow nodes position can be changed by clicking on them with the mouse and dragging them to the desired position, where we will drop the mouse button so that it stays in that position.

In cases where as a result of filtering several workflows are generated, different tabs will appear with each of the workflows, for example when clustering is applied.

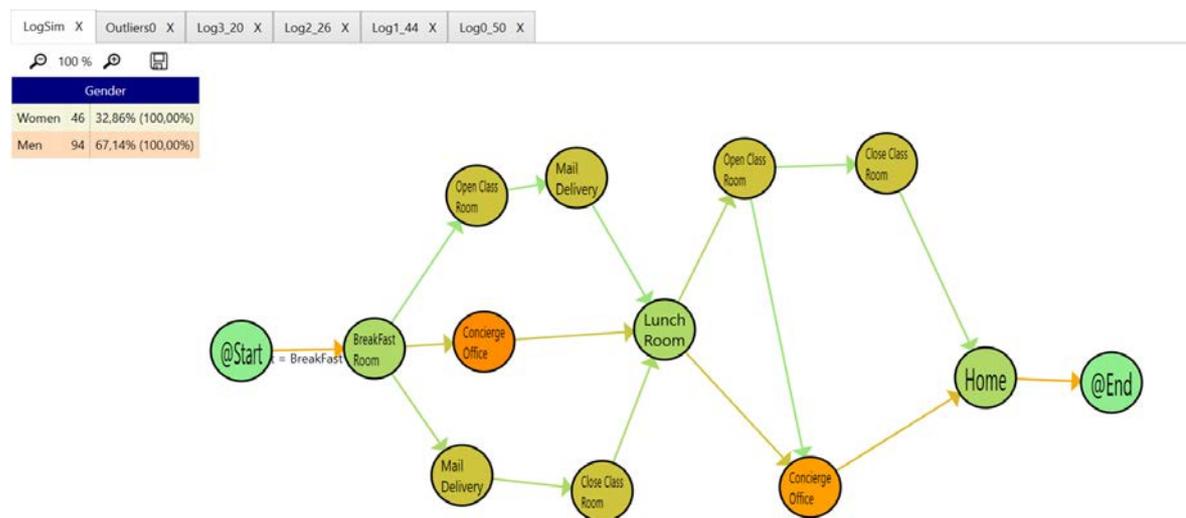


Figure 12. Graphic Representation Zone

5. Use Case

To demonstrate that it is possible to use this mock-up with the data that will be used during the project, the dashboard has been provided with some functionality and data provided by HULAFE in Valencia has been used. These data have been simulated based on the variables that are managed in this hospital so that this test can be useful for the demonstration.

Patients in the home hospitalization area of HULAFE follow the flow shown in Figure 13.

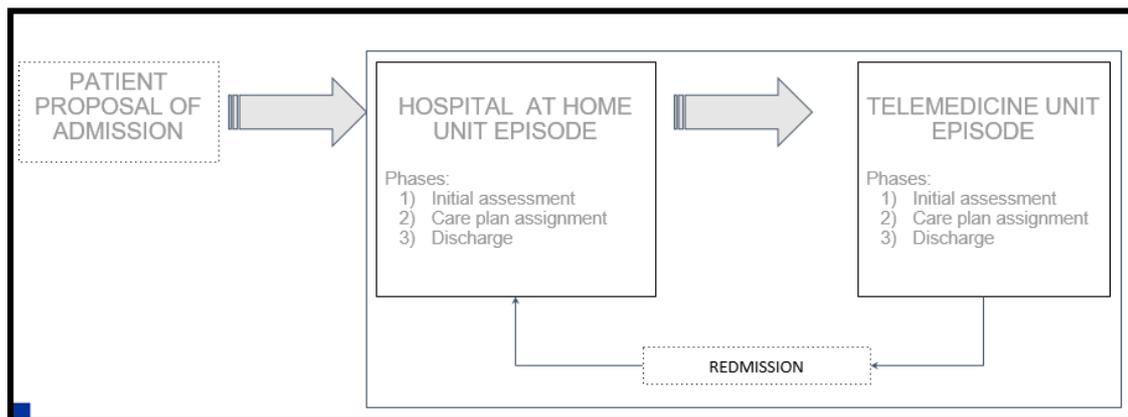


Figure 13. HULAFE's pathways overview

Thus, initially a patient receives a proposal to get in the area. They are visited for the first time in the home hospitalization unit (HH), where they are given an "Initial assessment", a "Care plan assignment" and finally discharged either to the telemedicine unit, where they will be monitored periodically, or to their primary care doctor or other units. In the telemedicine unit (TM) there are 3 types of patients: Chronic, Palliative Care and Oncological Palliative Care. They will remain in this unit until they either fail or their conditions change and they need a new home hospitalization visit (Readmission).

Once the normal flow is known, the dashboard has been used to generate with PM a view of the general operation of the entire home hospitalization area as an example for the present deliverable. In it the flow described above can be observed (see Figure 14).

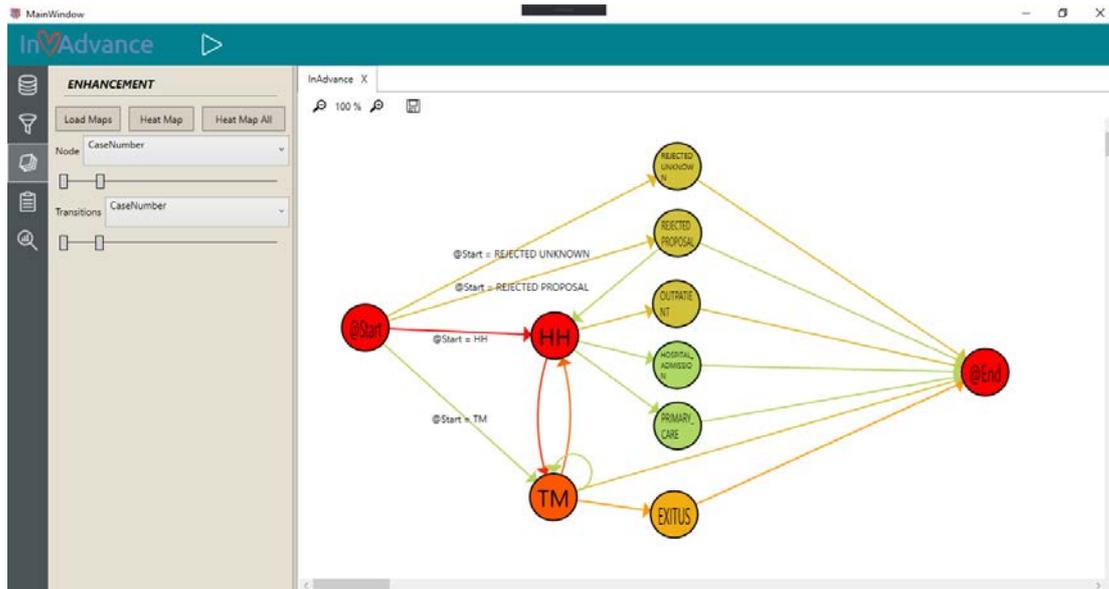


Figure 14. General overview of the HULAFE's home hospitalization area

In Figure 14, the balls indicate the different states in which a patient can be and the arrows the different paths they make. Both the balls and the arrows have a gradient of colour that goes from green to red. If the ball has a greener colour it means that, there are less patients in that ball while more red means that there are more patients in that state. As for the arrows, greener means that this path is made by few patients while redder means that many patients do it.

In this case we highlight, for example, the HH ball, that is the redder one because the most of the patients, and probably all the patients, visit de Hospital at Home unit. Likewise, the colours indicate that the most followed path is HH->TM->Exitus, which means that the most of the patients remain in the unit until they die.

6. Conclusions

A mock up version of the InAdvance dashboard has been developed with some functionality that can be tested by the reader.

The examples presented in the document are very simple, but the main purpose of these examples is to show potential functionality and facilitate feedback gathering from the InAdvance use case partners.

It is envisaged that using real data, provided by dashboard users/clinical partners, the development of the dashboard functionality will be implemented and adapted to use with such data.



7. References

- [1] Henry, S. (2017). "Evaluating the effect of clinical dashboards designed to measure and improve the quality of nursing care and patient safety, in a mental health setting." MSc in Health Informatics. Available in: <https://scss.tcd.ie/publications/theses/diss/2017/TCD-SCSS-DISSERTATION-2017-009.pdf>
- [2] Collins, A. (2010). "Clinical dashboards". HSJ. Available in: <https://www.hsj.co.uk/your-ideas-and-suggestions/clinical-dashboards-/5012508.article>
- [3] van der Aalst, W.M.P., et al. (2010). Lecture Notes in Business Information Processing - IEEE taskforce on process mining.
- [4] Fernandez-Llatas, C., Martinez-Millana, A., Martinez-Romero, A., Benedi, J.M. & Traver, V. (2015). "Diabetes care related process modelling using Process Mining techniques. Lessons learned in the application of Interactive Pattern Recognition: coping with the Spaghetti Effect," in 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp. 2127–2130.
- [5] Fernandez-Llatas, C., Lizondo, A., Monton, E., Benedi, J.M. & Traver, V. (2015). "Process mining methodology for health process tracking using real-time indoor location systems," Sensors (Switzerland), 15(12): 29821–29840.



Annex 1

On some computers the Windows defender may confuse the InAdvance Dashboard software with malicious software that tries to attack the computer. In this case, a window like this will appear.



In order to continue with the execution of the program, follow these steps:

