CA400

Functional Specification

Workload Measurement System for Nurses

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1. Introduction

1.1 Overview

This project is the design and development of a workload measurement system for nurse and nurse management staff in a hospital.
The primary aim of this system is to record the work being done by nurses regarding care for each patient in a hospital and to output information which efficiently reflects the workload recorded. It will provide much needed insight into the amount of work performed in each ward and therefore will allow management within the hospital to ensure they have the correct number of nurses on each ward to accommodate the work to be done.

Due to the already prevalent nursing shortage problem in Ireland, pre-COVID nurse management would have already placed huge importance on the efficiency of work carried out by nurses. With Covid-19 still very much in existence, and the further possible absenteeism of nursing staff having contracted the disease, nurse management and direction is at its most challenging. It is now more important than ever to ensure that nurses are working most efficiently, to be able to immediately identify when nurses may/may not be overwhelmed and to be able to distribute available nurses to where work is needed most.

In 2019, a report titled "Workforce Planning for Nursing and Midwifery" was created by the INMO (Irish Nurses and Midwifery Organisation). [1]
In this report the shortage of nurses and midwives which currently exists in Ireland is discussed. According to the report, the 2019 WTE for nursing and midwifery
"stands at 37,843 (HSE, 2019). This is 1,157 WTE less than the pre-moratorium December 2007 figure, with increased activity and requirements on our public health service during the intervening years."
The article discusses the meaning of these figures and it details that the current situation involves
"a busier and more acute service with fewer staff to deliver it."

In June 2020, the INMO issued a press release which stated that one in ten COVID-19 cases in Ireland were attributed to nurses or midwives. [2]

Our system will be designed and developed to provide a solution to these needs. The system will require nurses to record tasks completed for patients and include the intensity of the labour that was required. This information will be stored and calculated to give an overall workload score or weight. This workload score will be displayed to management in real-time to represent the current workload required and hence help to quickly identify if a ward is overwhelmed and if reallocation of nurses is needed. Additional data analysis

is undertaken to identify any patterns and trends recurring and to create possible predictions for future ward workload.

In a real-world implementation, our app would be integrated with the hospital's IT system as the application will need to use already existing patient and staff records that the hospital's system would have. However, the integration process necessary between both application and hospital IT system is out of scope for this project. Therefore, we are going to work on the assumption that the hospital's IT system has the ability to dump data into text or XML files. Our application will load and read in the data from these files to obtain the patient and staff information needed.

1.2 Business Context

The nurse workload measurement system could be deployed within Irish hospitals where it is believed its functions would be of the most use.

Measuring nursing workload has traditionally been a very subjective exercise. The nature of the work can vary greatly from one specialty to another and while patients may broadly belong to one specialty, they frequently present features of one or more other specialties. Also, a patient's progress may not continue as expected and a sudden change in even one patient's condition can cause a spike in the workload.

In an environment where resources are scarce, and costs are challenging, there is a requirement to provide evidence of the workload driving the demand for additional staff resources. Matching the workload with the required staff resources is very difficult because of the subjectivity of measuring without a common currency. Without a formal workload measurement system, identifying the workload in each area in an effort to resource that workload with additional staff, can be subject to whoever shouts the loudest, so to speak.

Recording workload measurement data often creates an extra burden of work in an already busy environment, and this may cause it to be omitted when it is needed most. There is a need for a standardised system, to measure the workload in a currency, which is also linked to the care-plans to achieve this measurement with absolutely no overhead.

There are various products available for the purpose of measuring nursing workload. Their disadvantages include that they add an extra burden to an already busy environment which makes them likely to fail when they are most needed, and that they are designed to be used only occasionally with the assumption that their findings are representative of the overall time period. These fail to support the unexpected peaks and troughs in the workload, sometimes occurring for brief periods of the day and at other time persisting over a period of days or weeks.

1.3 Glossary

WTE - Whole-time Equivalent

INMO – Irish Nurses and Midwifery Organisation

GUI – Graphical User Interface

2. General Description

2.1 Product / System Functions

Our application will be available in a PC/desktop version and in a mobile/tablet version. These two versions will not have the exact same functionality. The desktop version is intended for use by management staff as they have full access to features and will want a large monitor to configure the primary pie chart and view statistical graphs. The mobile version is intended for use by the nurses on the wards. This will only have the feature to select patients pie charts and log input.

The following is a preliminary list of functions which our system will accomplish to achieve the aim of our application, that of which has been detailed above. Each of these functions will be dissected further in section 3 (Functional Requirements) of this specification.

- o Personalized configuration of primary pie chart
- o Personalized configuration of ward standard pie charts
- o Proportional presentation of tasks in pie charts
- o Pie chart representation of work tasks for each patient
- o Role-based authorization and permissions
- o Securely store input logged by users
- o Patient/ward workload score / weight calculated
- o Analysis of past hospital workflow data
- o Predict future hospital workload

2.2 User Characteristics and Objectives

The target users for this application can be looked at in two groups; nurses and nurse management/director.

Nurse users refer to all nurses working on the wards looking after patients. The system will be designed so it can be operated by users of all levels of tech expertise as there is no specific knowledge or skill level required.
The objectives of the application for this user is to create a system where their time and effort is most efficiently distributed and can be recorded to reflect it. The requirements for these users are to log their work that they carry out and maintain compliance with the system.

Nurse manager/director users refer to any nurse management or direction staff in a hospital. These users will not be expected to have any specific knowledge or skill level regarding technology and the system will be designed for them accordingly.

The objectives for nurse management will be to display information which represents the current state and status of the current nurse workload being carried out in each ward. This information will be beneficial to immediate decision-making regarding nurse reallocation and future planning. Requirements for these users would involve initial configuration and maintaining constant access to the information displayed on their window.

2.3 Operational Scenarios

2.3.1 User initialises system

USE CASE 1	User initialises system
Goal in Context	The system is initialised and displayed with the home page.
Scope & Level	System, subfunction
Preconditions	The user has installed the application on their PC and/or mobile device
Success End Condition	The system successfully initialises
Failed End Condition	The system is not successfully initialised.
Primary, Secondary Actors	User
Trigger	User selects the system icon on their PC or mobile/tablet.

DESCRIPTION	Step	Action
	1	The user selects the system icon on their PC or mobile/tablet
	2	The application initialises
	3	The user is presented with the home screen
EXTENSIONS	Step	Branching Action
		N/A
VARIATIONS		Branching Action
		N/A

2.3.2 User completes system Set-up

USE CASE 2	User completes system Set-up
Goal in Context	User is assigned master authorization PIN and authorization PIN is generated for selected nurses
Scope & Level	System, summary
Preconditions	System is integrated with existing patient/staff systems System has been initialized

Success End Condition	User has been assigned master authorization PIN and authorization PIN is generated for any nurses selected	
Failed End Condition	User has not been assigned master authorization PIN and authorization PIN is not generated for any nurses selected	
Primary, Secondary Actors	Nurse management/director user	
Trigger	User selects "begin set-up" option	
DESCRIPTION	**Step**	**Action**
	1	User selects "begin set-up"
	2	System displays a list of all employed nursing staff
	3	User selects their name from the staff list
	4	System displays a master 4 digit PIN
	5	System displays home screen
	6	User enters master PIN
	7	User selects "enter"
	8	System displays master administrator page

	9	User selects "assign PIN to staff" option
	10	System displays a list of staff and their corresponding occupation type
	11	User selects nurse names
	12	User selects the "generate PIN" button
	13	System generates PIN for nurses selected
EXTENSIONS	**Step**	**Branching Action**
	8a	Cannot open window: user that their PIN is invalid
	9a	Cannot generate PIN: user is notified to check if they have selected names correctly
VARIATIONS		**Branching Action**
	8a	User selects "select all" option

2.3.3 User attempts authorization

USE CASE 3	User attempts authorization
Goal in Context	User is displayed their user-type appropriate window

Scope & Level	System, subfunction
Preconditions	System is integrated with existing patient/staff systems System has been initialized Master user has completed set-up Users PIN has been generated
Success End Condition	User is granted authorization
Failed End Condition	User is not granted authorization
Primary, **Secondary Actors**	User
Trigger	User enters PIN and selects "enter" button

DESCRIPTION	Step	Action
	1	User enters PIN and selects "enter" button
	2	System displays the options appropriate to that user-type (Nurse user or Nurse manager/director user)

EXTENSIONS	Step	Branching Action
	1a	User enters invalid PIN: notified appropriately

VARIATIONS		Branching Action
	2a	System displays window for nurse-user
	2b	System displays window for nurse-manager/director-user

2.3.4 User configures primary pie chart

USE CASE 4	User configures primary pie chart
Goal in Context	A default pie chart representing all hospital nursing tasks is successfully created.
Scope & Level	System, summary
Preconditions	System has been initialized User has completed set-up Users PIN has been generated User has been granted authorization
Success End Condition	A pie chart is made and displayed containing all appropriate tasks
Failed End Condition	A pie chart is not made and displayed containing all appropriate tasks
Primary, Secondary Actors	Nurse management/director user

Trigger	User selects "Configure primary pie chart"	
DESCRIPTION	**Step**	**Action**
	1	User selects "Configure primary pie chart"
	2	System displays a new window
	3	User enters task information
	4	User selects "submit" option
	5	System notifies the user of successful configuration
EXTENSIONS	**Step**	**Branching Action**
	3a	Invalid task info entered: Appropriate notification displayed
VARIATIONS		**Branching Action**
		N/A

2.3.5 User configures ward default/suggestion pie chart

USE CASE 5	User configures ward default/suggestion pie chart

Goal in Context	A pie chart representing all ward nursing tasks is successfully created from the default hospital pie chart
Scope & Level	System, summary
Preconditions	System has been initialized User has completed set-up Users PIN has been generated User has been granted nurse manager/director user authorization
Success End Condition	A pie chart containing all tasks applicable to the ward is created
Failed End Condition	A pie chart containing all tasks applicable to the ward is created
Primary, Secondary Actors	Nurse management/director user
Trigger	User selects "configure ward default/suggestion pie chart"

DESCRIPTION	Step	Action
	1	User selects "configure ward default/suggestion pie chart"
	2	System displays the primary pie chart

	3	User enters tasks relating to the ward being configured
	4	User selects the ward name
	5	User selects "submit"
	6	System notifies the user of successful configuration
EXTENSIONS	**Step**	**Branching Action**
	2a	System does not display primary pie chart: notification displayed that primary pie chart was not configured
	3a	Invalid task entered: notified appropriately
VARIATIONS		**Branching Action**
	4a	Appropriate wards refer to any of the existing ward names in the hospital.

2.3.6 User reconfigures the primary pie chart

USE CASE 6	User reconfigures the primary pie chart
Goal in Context	User updates or removes an existing task or adds a new one on the primary pie chart.
Scope & Level	Scope, summary

Preconditions	System has been initialized
	User has completed set-up
	Users PIN has been generated
	User has been granted nurse manager/director user authorization
	User has configured primary pie chart
Success End Condition	User successfully reconfigures the primary pie chart
Failed End Condition	User does not successfully reconfigure the primary pie chart
Primary, Secondary Actors	Nurse management/director user
Trigger	User selects "Configure primary pie chart" button

DESCRIPTION	Step	Action
	1	User selects "Configure primary pie chart" button
	2	System displays current task information
	3	User reconfigures task information
	4	User selects "submit"
	5	System notifies the user of successful configuration

EXTENSIONS	Step	Branching Action
	3a	Task is invalid: notified appropriately
VARIATIONS		**Branching Action**
	3a	User adds a new valid task
	3b	User removes an existing valid task
	3c	User edits an existing task

2.3.7 User reconfigures ward default/suggestion pie chart

USE CASE 7	User reconfigures hosp pie chart
Goal in Context	User updates or removes an existing task or adds a new one into the ward default/suggestion pie chart
Scope & Level	System, summary
Preconditions	System has been initialized User has completed set-up Users PIN has been generated User has been granted nurse manager/director user authorization User has configured primary pie chart

	User has configure the specific wards default/suggestion pie chart
Success End Condition	User successfully reconfigures ward default/suggestion pie chart
Failed End Condition	User does not successfully make edits to ward default/suggestion pie chart
Primary, Secondary Actors	Nurse management/director user
Trigger	User selects "Configure ward default/suggestion pie chart" button

DESCRIPTION	**Step**	**Action**
	1	User selects "Configure ward default/suggestion pie chart" button
	2	User selects appropriate ward
	3	System displays current task information relating to selected ward
	4	User reconfigures task information
	5	User selects "submit"
	6	System notifies the user of successful configuration

EXTENSIONS	Step	Branching Action
	3a	Task is invalid: notified appropriately
VARIATIONS		**Branching Action**
	4a	User adds a new valid task
	4b	User removes an existing valid task
	4c	User edits an existing task

2.3.8 User views ward info

USE CASE 8	User views ward information
Goal in Context	All ward information is displayed to the user i.e. the nurses on-duty, patients and their respective pie charts
Scope & Level	System, summary
Preconditions	System has been initialized User has completed set-up Users PIN has been generated User has been granted nurse manager/director user authorization User has configured primary pie chart User has configure wards default/suggestion pie chart

Success End Condition	The display of a ward's information on screen	
Failed End Condition	No display of a ward's information on screen	
Primary, Secondary Actors	Users	
Trigger	User selects ward name from "wards" menu	
DESCRIPTION	Step	Action
	1	User selects "wards menu"
	2	User selects the name of the ward who's info they want to view
	3	System displays the ward info to the user
EXTENSIONS	Step	Branching Action
		N/A
VARIATIONS		Branching Action
	2a	Ward name can be any of the options available

2.3.9 User reconfigures patient pie chart

USE CASE 9	User reconfigures patient pie chart	
Goal in Context	User adds a new task into a patient's pie chart	
Scope & Level	System, summary	
Preconditions	System has been initialized User has completed set-up Users PIN has been generated User has been granted nurse manager/director user authorization User has configured primary pie chart User has configure wards default/suggestion pie chart User has accessed patient's ward info	
Success End Condition	User successfully adds a task to patient pie chart	
Failed End Condition	User does not successfully add a task to a patient pie chart	
Primary, **Secondary Actors**	Nurse management/director user	
Trigger	User selects "configure patient pie chart"	
DESCRIPTION	**Step**	**Action**

	1	User selects patient
	2	User selects "configure patient pie chart"
	3	System displays list of valid tasks that could be added
	4	User selects the task(s) that they wish to add
	5	User selects "submit"
	6	System updates the patient pie chart with added task(s)
EXTENSIONS	**Step**	**Branching Action**
	5a	Configuration error: user notified and asked if they selected any tasks
VARIATIONS		**Branching Action**
		N/A

2.3.10 User logs tasks

USE CASE 10	User logs tasks
Goal in Context	A task on a patient pie chart is successfully logged and recorded

Scope & Level	System, subfunction
Preconditions	System has been initialized User has completed set-up Users PIN has been generated User has been granted nurse manager/director user authorization User has configured primary pie chart User has configure wards default/suggestion pie chart User has been granted nurse user authorization
Success End Condition	task is logged and recorded successfully on the system
Failed End Condition	task is not logged and not recorded successfully on the system
Primary, Secondary Actors	Nurse user
Trigger	User selects the task and associated level of difficulty

DESCRIPTION	Step	Action
	1	User selects ward
	2	User selects patient

	3	User selects the task and associated level of difficulty
	4	This information is recorded and stored by the system
EXTENSIONS	**Step**	**Branching Action**
		N/A
VARIATIONS		**Branching Action**
		N/A

2.3.11 User exits page

USE CASE 11	User exits page
Goal in Context	System displays home page
Scope & Level	System, subfunction
Preconditions	System has been initialized User has completed set-up Users PIN has been generated User has been granted authorization
Success End Condition	The home screen displays

Failed End Condition	The home screen does not display	
Primary, **Secondary Actors**	User	
Trigger	User selects "exit"	
DESCRIPTION	**Step**	**Action**
	1	User selects "exit"
	2	The home screen appears
EXTENSIONS	**Step**	**Branching Action**
		N/A
VARIATIONS		**Branching Action**
		N/A

2.3.12 User manager accesses workload statistics

USE CASE 12	User manager accesses ward statistics
Goal in Context	User gains access to all various statistics regarding the hospital

Scope & Level	System, goal	
Preconditions	System has been initialized	
	User has completed set-up	
	User PINs has been generated	
	User has been granted nurse manager/director user authorization	
	Primary pie chart has been configured	
	Wards default/suggestion pie chart has been configured	
	Tasks have been logged	
Success End Condition	User is presented with window containing workload statistics	
Failed End Condition	User is not presented with window containing workload statistics	
Primary, Secondary Actors	Nurse management/director user	
Trigger	User selects "Access statistics"	
DESCRIPTION	Step	Action
	1	User selects "Access statistics"
	2	System displays a window with available statistics
	3	User views and selects statistics in question

EXTENSIONS	Step	Branching Action	25
VARIATIONS		Branching Action	
	3a	User views ward workload info	
	3b	User views nurse compliance info	
	3c	User views prediction infor/trends	

2.4 Constraints

COVID-19 restrictions
Due to restrictions in place because of COVID-19, it is very unlikely that work
will be done together side by side in person. This lack of in-person
communication, although being treated as productively as possible, may
cause communication constraints to us and therefore our project.

Time
Due to a hard deadline assigned for the submission of this project and the
other modules and exams we must study for, we are aware that time will be a
constraint. We aspire to achieve full functionality of each and every
requirement, but keeping the time constraint in mind, we will prioritize the
most critical aspects of our project.

Learning curve
There are aspects of this project that we have not had thorough experience
with before. This will require more time to be spent on the learning and
understanding process.

Cost
We chose AWS as the cloud vendor for our project. We are making use of
their student program to host our database. There is a limit to how much
services we can run so we must keep our data that we stored with them below
their limits. This may affect the efficiency of our machine learning model which
uses this data to predict future hospital workloads.

3. Functional Requirements

We are designing our product with the assumption that the hospital's pre-existing IT system will be able to output a list of nursing staff, and patient admission records for our system to use.

We are in the process of creating an anonymous online questionnaire to send out to some directors of nursing and nurse managers who we will contact and ask to answer it for us. This questionnaire will help us to confirm and refine the functionality required for our system. It will ask for the strengths and weaknesses of existing methods of workload measurement so that we can fulfil user requirements.

Note: the personalisation of this configuration means that users give their own meaning to task names, weights, descriptions. We have provided examples throughout this description of possible scenarios but it is important to remember that our examples are simplified and may not be representative of a typical configuration, as all hospitals who may use our system will have differing configurations.

- o Personalized configuration of primary pie chart
- o Personalized configuration of ward standard pie charts
- o Proportional presentation of tasks in pie charts
- o Pie chart representation of work tasks for each patient
- o Role-based authorization and permissions
- o Securely store input logged by users
- o Patient/ward workload score / weight calculated
- o Analysis of past hospital workflow data
- o Predict future hospital workload

3.1 Personalized configuration of primary pie chart

- **Description –** The primary pie chart in the system is the one which patient pie charts are based off. The primary pie chart contains a slice for every task performed by nurses in every ward of the hospital. Each slice has a weight assigned to it by the hospital during configuration. These weights must add up to 1, or 100%. The configuration of this pie chart describes how much work is involved in every task in relation to each other. When a patient's pie chart is created, a small subset of these tasks is selected to be included. The primary determination of the ratios of each task among each other ensures that the subset included on the patients' chart are correctly proportioned among each other also. Users of the system can personalize the configuration of this primary pie chart as they wish.

  Users will utilize their professional judgement and expertise to configure the primary pie chart to suit themselves and their own needs.

This means users have the flexibility to decide which tasks to include into the pie chart and which not to include.

In other words, they can decide which tasks deserve their own slice, or which tasks should be split up into smaller tasks. For example, one hospital may consider task X to be deserving of one slice on the chart. However, another hospital may consider task X to be a combination of three smaller tasks, task A, B, and C, and they may wish to represent these individual tasks as exclusive slices on the pie chart.

Users also have the flexibility of deciding how much each task should weigh to indicate the workload involved in each of them. At this point, there is some subjectivity in deciding how much weight each work task is entitled to. For example, one hospital may deem task Y to be twice as much work as task Z, while another hospital may deem it to be three times the size. Again, users can configure to their own liking. Whichever tasks users believe to require more effort will be attributed a greater workload score than tasks deemed to require less effort.

For each task, its varying intensity is represented as a spectrum extending from the centre of the slice to the outer edge. Its spectrum is divided into levels. Each level represents a work intensity position for the respective task and has a work weight associated with it.

The level at the centre of the slice has a work weight of 0, indicating this task was not performed. To avoid confusion we wish to note that only tasks which will be performed on a patient will be included on the chart, but they may not be performed during every shift, so sometimes a user may select the inner level to log 0 as the input. For example, a wound care task may exist on a patient's chart but on a day where the dressing did not need changing, the workload could be logged as 0.

The level at the outer edge of the slice has a work weight of 1, indicating the maximum amount of work that could be done during this task was done. For example, considering the task of patient hygiene, the inner level would be selected if the patient can wash themselves without aid, and the outer level may be selected if the patient could not move from bed and required a bed bath.

The levels in between have work weights between 0 and 1 in ascending order from the centre to the outer edge. This means that for each work task, both its contribution to the overall work scheme, and the intensity of its work along its own spectrum, contribute to the workload weight. The weight is calculated by multiplying its ratio value by the work value of the selected spectrum position.

For any one task, labels for the different effort levels of labour may be personalized also. During configuration, users may enter free text to describe what kind of work is involved for a user to select the lowest level of this task's slice on the pie chart, what kind of work is involved in

order for a user to select the highest level of this task's slice, and what kind of work is involved for any middle sections.

Please refer to Appendix 1 for an example of what this pie chart will look like.

There are some limitations to note about this personalized configuration.

- o There is a limit to how many tasks can be configured. This limit exists only in order to ensure practicality is upheld. If too many tasks are included in the chart, the size of each of the slices could become much too small to be easily selected on the GUI. Users must utilize their professional judgement to gauge how granularly individual tasks should be split up.
- o For any one task, when splitting up its slice on the pie chart into section which indicate the different levels of effort that could be required to perform it on some patient, the number of sections it can be split into is limited. This is also to ensure practicality is upheld, as more sections means smaller sections, and smaller sections may be very hard to select without mistakenly selecting the adjacent section.
- o For labelling the levels of labour required for different sections of one task's slice, a character limit exists to keep labels short and concise so that they are easy for nurses inputting data to recognise. This again is up to the user's professional judgement to outline these descriptions accurately in their own eyes.

- **Criticality –** Hugely critical to the main goal of our system. This is where the system is told how much each work task weighs, so that it can make calculations later using these values.
- **Technical issues –** Upon reconfiguration of this pie chart, all patient pie charts should immediately update to include the new changes. For example, it may be decided that task X has too much weight attributed to it and a user with an administrator role reconfigures the primary chart so that task X now weighs half its original value. All patient pie charts that contain this work task should immediately update so that any new inputs logged will log the correct weight.
- **Dependencies with other requirements –** Correct installation of the software is necessary before this function can be utilized. Configuration of ward standard pie charts depends on the ability to configure the primary pie chart correctly.

3.2 Personalized configuration of ward standard pie charts

- **Description –** Instead of selecting a number of tasks from the primary pie chart every time a new patient is admitted to a ward, a standard pie chart can be created for each ward. The standard pie chart for a ward consists of the most common tasks performed for patients in that ward.

When a new patient is admitted to a ward, a standard pie chart is created for them and users may edit this if they wish.

Users are required to utilize their professional judgement in creating a standard pie chart for each ward. However, as a result of the analysis of data over time, our system aims to discover if some particular task is commonly performed in some ward but is not on that ward's standard pie chart. This analysis function is described in Section 3.10.

- **Criticality –** Not hugely critical to the functioning of the entire system but critical for user requirements as this function saves time. The implementation of this function means users will not have to create a whole new patient pie chart from scratch every time a new patient is admitted.
- **Technical issues -**
- **Dependencies with other requirements –** Dependant on the primary pie chart being implemented correctly.

3.3 Proportional presentation of tasks in pie charts

- **Description –** This function of our system is designed to make the GUI user friendly and intuitive. The size of the slices on each pie chart will be proportional to the weights assigned to those tasks. A slice representing a simple quick and easy task will be much smaller than a slice representing a complicated strenuous task that takes a lot of time.

The size of each slice represents its relative labour-intensity with respect to every other slice in the entire work scheme. The varying intensity of the work for each individual slice is represented by levels along a spectrum from the centre of the slice to the outer edge.

This function makes the system intuitive and easier to use. Nurses who are logging inputs on a patient's pie chart are busy so they want to be confident that they are making the correct selection. This proportional presentation helps make the pie charts easy to understand at a glance which will results in more efficient usage.

- **Criticality –** Low criticality. This function adds to the user's easy-of-use, as it makes the GUI more intuitive, but it does not affect the main goal of our project.
- **Technical issues –** Limitations will need to be applied as pie slices too small will not be practical as they will be very hard to select. The same goes for the levels of work intensity for each slice.
- **Dependencies with other requirements –** Dependant on the correct implementation of the primary pie chart configuration.

3.4 Pie chart representation of work tasks for each patient

- **Description –** When a patient is admitted to a ward, the standard pie chart for that ward is created for them. Users may add or remove tasks

as they wish. A patient may require the standard tasks but also require one or two extra tasks too, so tasks may be added. For example, a patient in an orthopaedic ward may also have diabetes. A work task for caring for diabetes would be added to the standard orthopaedic ward pie chart for this patient.

Each patient has their own unique interactive pie chart associated with them. This is the interactive display that users will open to log the workload required for a task they performed for this patient. When nurses wish to log information on work they have performed for this patient, they open the patient's pie chart and select the section of this particular task's slice that corresponds to how much effort it took for them to complete the task.

- **Criticality –** Highly critical. This is where workload is logged. The purpose of our system is to provide distinct evidence of the varying changes to wards workloads. This is where the changing of demands will be logged, for our system to analyse.
- **Technical issues –** If and when the primary pie chart is reconfigured, and the weight of some task is changed, the system should update all patients' charts which include that task. Ensuring this update happens immediately will be difficult.
- **Dependencies with other requirements –** Depends on configuration of primary pie chart and ward standard pie chart.

3.5 Role-based authorization and permissions

- **Description –** Users of the system are divided into 2 categories: administrators and regular nurses. Users have different permissions depending on what role they have. Administrators have access to all features of the system, while regular nurses only have access to patient pie charts in order to log workloads.

  Each user who operates the system must have a unique identifying pin code in order to access the system functions. Upon first implementation of our system, an administrator must be established. Before setting up anything in the system, they are administered a pin which they will then enter to access the features of our system.

  Along with all other features, the administrator can generate pins for other staff members and give them an administrator role if they are management staff or regular nurse role otherwise.

  This role-based authorization ensures security as no unauthorized person can access the system. The different roles also offer granular access to different users. With every input submitted on a patient's pie chart, the pin of the current user is sent to the database as a signature to track nurse compliance rate with the system and to enable review of which nurse logged any particular input in the case of any issues arising which may require this information to be known.

User with regular nurse roles may only access the list of wards, the patient's within them, and the pie chart's for each of these patients.

Users with administrator roles are not restricted to their permissions. They are presented with a number of options upon entry to the system. They may view patients pie charts the same as nurses can and input data. They may access and edit the configuration of the hospital's primary pie chart. They may access and edit the configuration of each ward's default/suggestion pie chart. They may access and edit the list of users, their roles, and their assigned access pins. They may access and analyse the real-time statistics of workload scores and the collection of past statistics from the database of previously logged inputs.

- **Criticality –** Critical for authorization of users. Main project goal may still be accomplished without this feature. User requirements demanding patient confidentiality put importance on this function.
- **Technical issues –** We are not yet familiar with role-based authentication and access permission so implementing this will prove difficult.
- **Dependencies with other requirements –** All functions which require administrator access will depend on the correct implementation of this function.

3.6 Securely store input logged by users

- **Description –** When nurses log the tasks into a patient's pie chart, the system records this input and stores it in a database. This data is encrypted to ensure patient confidentiality. Real-time processing is used so that the database is updated as soon as a selected task is logged for some patient. The data in the database is retained so that users with management roles can later access it via charts and graphs. This is explained further in Section 3.10.
- **Criticality –** Highly critical to the main goal of out project. If inputs are not stored, there will be no data to look back on, ie. no evidence of how busy any ward is.
- **Technical issues –** Real-time processing is new to us so may prove difficult to implement.
- **Dependencies with other requirements –** Each patient's pie chart must be created correctly as this function follows on from inputting data using those pie charts.

3.7 Patient/ward workload score / weight calculated

- **Description –** When users log input to our system by submitting tasks they have completed for a patient, our system calculates the sum of the weights up these tasks, to find the workload score / weight for this patient. When a new input is provided for one patient, our system recalculates the workload score immediately. Our system also immediately recalculates the workload score of the entire ward,

including this new input for one patient. This real-time processing allows management users to always be able to view the most recent updates to any patient or ward workload score.

This calculation allows for review of past workflows in the hospital and also prediction of future workflow (Section 3.9).

- **Criticality –** Highly critical. The results of these calculations are the evidence that display how busy a ward is. This is the essence of our system.
- **Technical issues –** Real time processing is new to us so may prove difficult to implement successfully.
- **Dependencies with other requirements –** Each patient's pie chart must be created correctly as this function follows on from inputting data using those pie charts.

3.8 Analysis of past hospital workflow data

- **Description –** The system provides analysis of all previously logged data. Only users with administrator roles have permission to access this feature. They can view the current weight of each ward to see how busy they each are. This is the evidence they need to help them decide if any nurses should be reallocated to another ward. They also can view the statistical information from a time period in the past to help them analyse the work that is going on in the wards.

  Examples of these statistics are the weight of ward X over the past week/month/year, the history of nurse Y's inputs, the comparison of workload scores across wards etc. This information is useful to discover trends and patterns which will be used to predict future workloads (Section 3.9) or to identify unexpected points of interests that may not be easily identified in everyday work life, such as if patients in some ward are increasingly requiring task X which was not expected to usually be required in this ward. This would ensure staff skill-mix is utilized where needed and will ensure training in a particular skill is arranged when needed.

- **Criticality –** Highly critical. The real-time statistics are crucial to the overall system. This is the essence of the entire system.
- **Technical issues –** Ensure only user with management roles can see this information.
- **Dependencies with other requirements –** Role-based authentication must be implemented correctly for the appropriate users to have access to this feature.

3.9 Predict future hospital workloads

- **Description –** Our system analyses the data that is stored in the database. It looks for trends and patterns which describe the workflow of the hospital. These trends and patterns will be used to predict the

future workflow of the hospital. Users with administrator roles can view these future predictions so that they will know what to expect in future and be better able to plan their staff rostering to accommodate the expected workflow.

- **Criticality –** Quite high criticality. Real-time statistics are the most important as it is usually sudden on-the-spot changes in workload that result in the need for reallocation of staff. The prediction of future workloads will be highly useful to users but not as important as real-time insight.
- **Technical issues –** Accurate predictions require a lot of data to analyse. As a result of our time and cost constraint, we may not be able to generate a large enough dataset to work with.
- **Dependencies with other requirements –** Dependant on the correct implementation of the storage of logged input, and the analysis of this stored data.

4. System Architecture
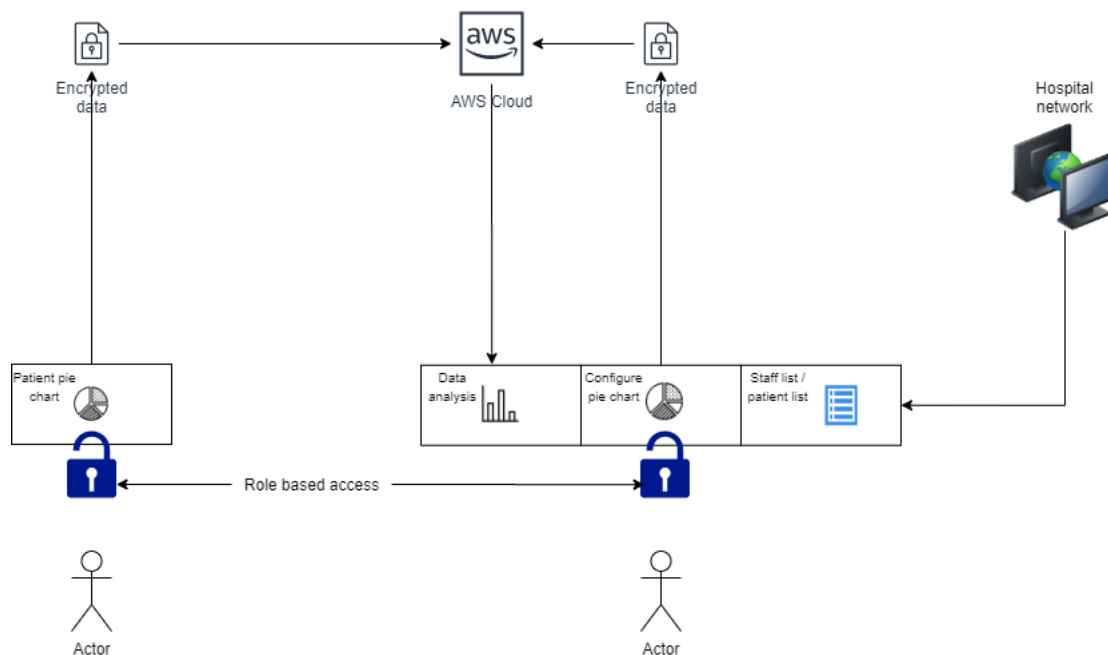
Above is the system architecture diagram for our system.
The left actor is a user with a regular nurse role. The right actor is a user with an administrator role. Both users access the system through role-based access permissions. Nurse users may only view patient's pie chart and log inputs to the database. Management users may configure the primary pie chart, configure standard ward pie charts, view the list of staff (pulled from hospital's network) in order to generate access pins, and of course view the statistical graphs from the database.
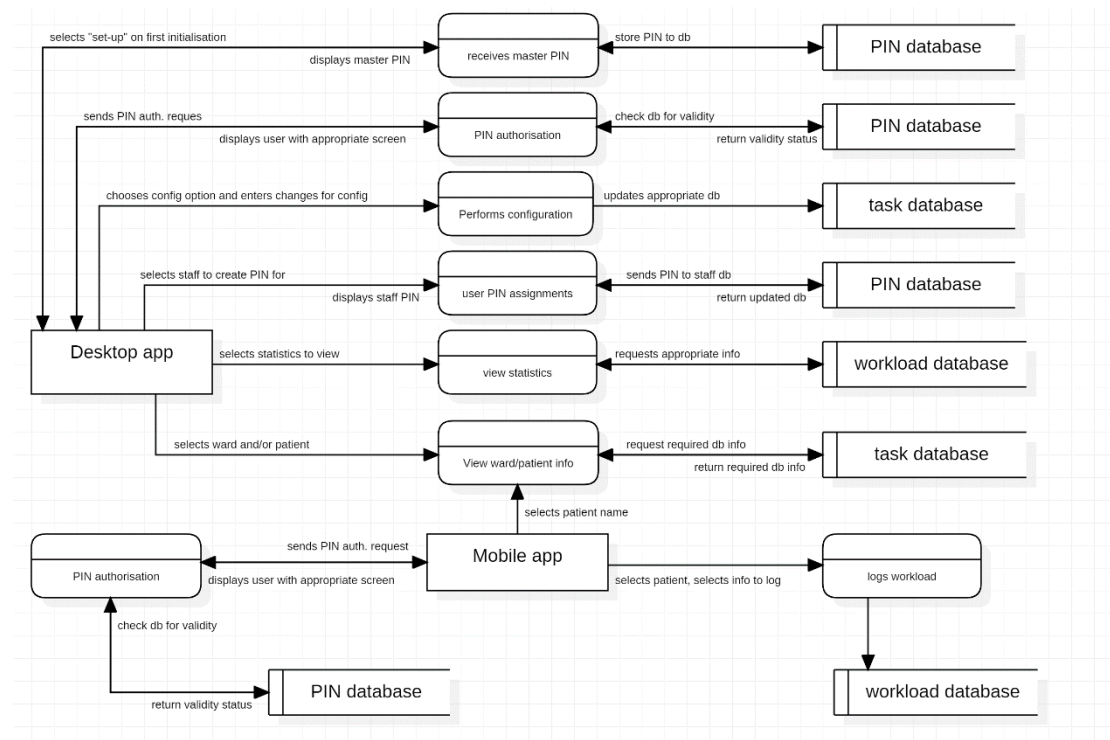
5. High-Level Design
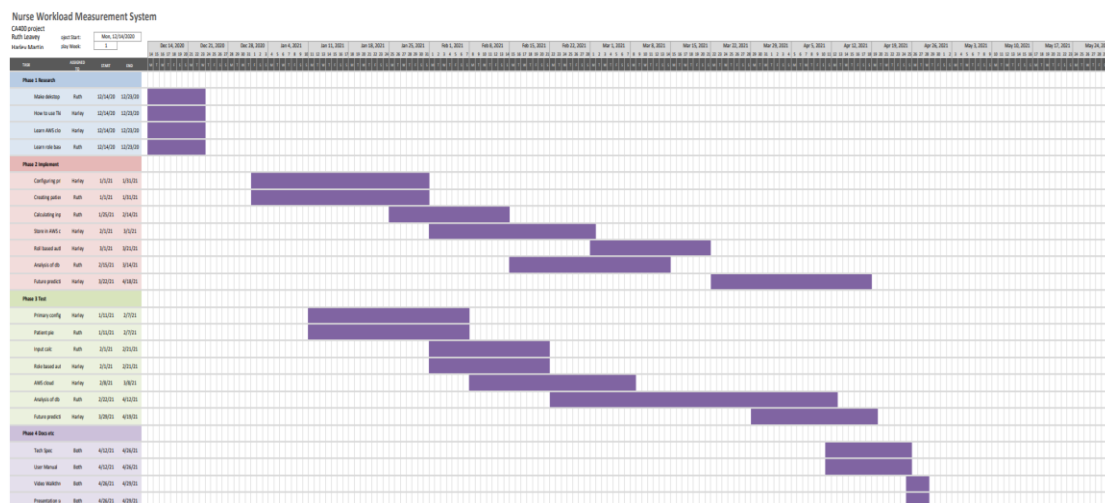
Context diagram
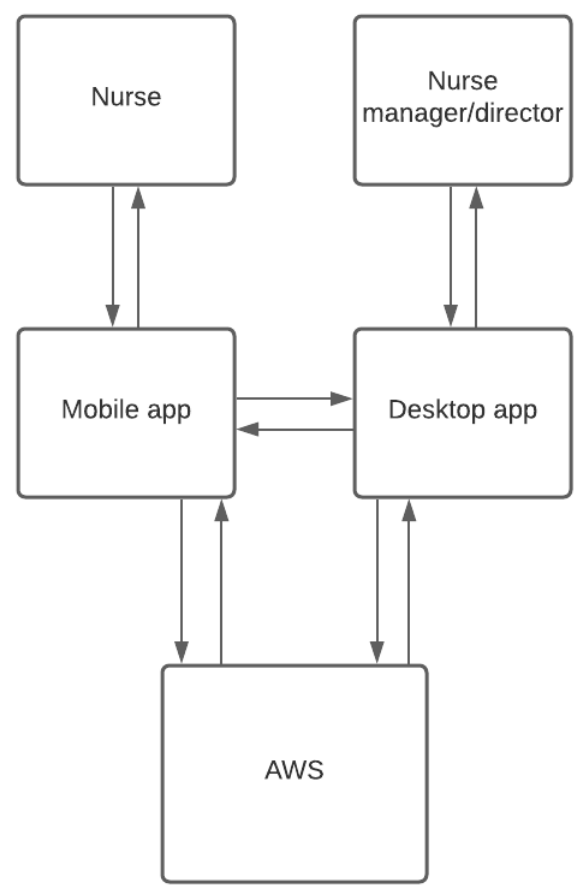
Level 0 logical DFD
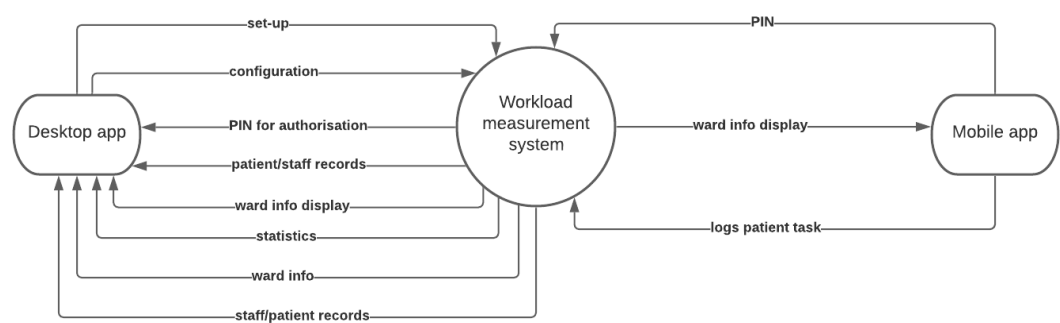
Logical DFD

6. Preliminary Schedule

In the above Gantt chart, we have divided up the work between the two team members. This is how we aim to split up the work and the schedule we aim to complete it at. We plan to work continuously on this project except for a Christmas break. This schedule is subject to change.

7. References

 [1]

https://data.oireachtas.ie/ie/oireachtas/committee/dail/32/joint_committee_on_health/submissions/2019/2019-11-13_opening-statement-phil-ni-sheaghdha-general-secretary-irish-nurses-and-midwives-organisation-inmo_en.pdf
(last accessed 04/12/2020)

[2]

https://www.inmo.ie/Home/Index/217/13597
(last accessed 04/12/2020)

8. Appendices

8.1 Appendix 1