



Using BI to Improve Patient Outcomes by Implementing a Dashboard for the Maternity & Neonatal Network

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Project Submitted as Part of the Requirements for the Award of BSc
(Hons) Computing (Data & Information Systems)

September 2022

Abstract

This report aims to implement a dashboard for the Maternity & Neonatal Network that can be used to help improve patient outcomes and use research to help aid in the design of this. The Research Onion was used for the research method, with a positivism philosophy and deductive approach to best suit the project. While a PRINCE2 Agile framework was followed as a developmental methodology to create the final product.

A series of case studies were discussed along with examples of well and poorly designed dashboards, outlining principles that can be used to create a well design dashboard.

Using the literature and methods stated above a dashboard was implemented within Power BI for use by stakeholders.

The MgS04 case study was used as the main measure to be monitored and it was shown that the rate of uptake of this has increased over the years, leading to several potential cases of Cerebral Palsy being avoided and therefore a future cost saving for the NHS.

It can be concluded that having visibility of these measures against their standards allows the Network to monitor them closely and intervene quickly when any have dropped, and in doing so inevitably leads to improved patient outcomes. It is important to note that this has been made possible by designing the dashboard carefully to ensure ease of use of the dashboard by stakeholders, with one outstanding recommendation going forwards being the inclusion of a SQL server.

Abbreviations

Abbreviation	Term
BI	Business Intelligence
NHS	National Health Service
NHSWHC	NHS Wales Health Collaborative
NNAP	National Neonatal Audit Programme
MgSO4	Magnesium Sulphate
BAU	Business as Usual
BAPM	British Association of Perinatal Medicine
PReCePT	Preventing Cerebral Palsy in Preterm Babies
HIE	Hypoxic Ischemic Encephalopathy
EPR	Electronic Patient Record
WHSSC	Welsh Health Specialised Services Committee
CCG	Clinical Commission Group
MVP	Minimum Viable Product
PII	Personally Identifiable Information
GDPR	General Data Protection Regulation
DPIA	Data Protection Impact Assessment
PHW	Public Health Wales
DHCW	Digital Health Care Wales
CPU	Central Processing Unit
RAM	Random Access Memory
DAX	Data Analysis Expression
SSIS	SQL Server Integration Services
SQL	Structured Query Language
QI	Quality Improvement
SPC	Statistical Process Control
YTD	Year to Date

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1 Introduction

Previously it was investigated whether 'BI can improve patient outcomes and be viable to implement with the NHSWHC'. The research evidenced that when BI solutions are implemented within organisations, in this case the NHS, patient outcomes do indeed improve. It also led onto a discussion on the various tools available to enable this and the pros and cons they would have for stakeholder requirements. The outcome of this was that the NHSWHC implemented Power BI as its main BI tool and purchased the licenses for each analyst in post. The premium node capacity has not been purchased yet, but a business case is currently being written. Until this is purchased, an agreement has been put in place to share capacity with PHW and this has been put in place from the recommendations of the previous report. This report looks to build and expand on that question further, implementing a dashboard for the Maternity & Neonatal Network to help improve patient outcomes.

1.1 Aims

- Research BI implementations in the wider industry and understand whether the implementation has aided in improving patient outcomes, in particular the use of dashboards.
- Research Dashboard Design and User Experience to aid in the development of the dashboard.
- Implement a MVP dashboard for stakeholders to use to improve patient outcomes.

1.2 Objectives

- Investigate literature and wider case studies to understand the benefits of implementing a BI solution, and to aid in the development of the dashboard.
 - Use the PreCePT Programme as a case study to improve Magnesium Sulphate data in Wales.
 - Case study of a dashboard being implemented within the NHS.
 - Look at examples of Dashboard designs and the user experience to aid in the design of the MVP dashboard.
- Hold stakeholder meetings to understand user requirements and gain feedback.

2 Literature Review

This literature review aims to give a high-level overview and history of the term BI and dashboards while using case studies to show how effective BI, in particular dashboards, can be in improving patient outcomes within the NHS. Example dashboards and other literature are reviewed to help aid in the dashboard design, as well as the measures that will be defined to be incorporated into this.

2.1 BI Overview

BI is a term used to encompass data mining, data visualisation, analytics/ insights and the tools and infrastructure used to enable these. This complete process allows businesses or sectors to become more data driven, helping to shape decisions and eventually optimise performance [1]. A sound BI strategy can provide a host of benefits to the Network; it can streamline and automate process's, allowing clinicians more face to face time with patients. In turn providing a more personable experience, with these time savings being reinvested within the service [2].

A MoSCoW analysis was performed previously, with the outcome being that Microsoft Power BI fulfilled the needs and requirements of the NHSWHC. Power BI was a part of the NHS Wales Office 365 strategy overall, with its ability to seamlessly integrate with Office 365 and EPR Systems. SharePoint allows the creation of online based forms, which will allow real time, reliable data and reporting [2]. This addresses both the problems of lack of reporting and the overuse of paper.

Below outlines the MoSCoW requirements for the BI Software [2].

- M.** The ability to easily share data with stakeholders, but securely within the remit of Public Health Wales Policies.
- M.** The ability to connect to multiple data sources to extract all raw data required and pull this together in one place.
- M.** Modelling capabilities to easily clean and prepare data before calculating the necessary measures.
- C.** Ability to do advanced / statistical analysis within the tool would be advantageous.

2.2 Dashboard History

Dashboards are a visual representation of data in many forms, to provide the user with instant information to make decisions or generate reports.

The term "Dashboard" can be traced back to the 1800's, during which time horse and cart were the main mode of transport. A board was introduced to stop the mud dashing up to the rider when the horse was in motion, which then evolved when cars were invented and replaced the horse and cart. The dashboard provides the driver with a visual representation of the car's status to make decisions [1].

Business Dashboards started as Decisioning Support Systems in the 1970's in the research profession to aid researchers in making decisions with computers. This then spilled into the business world helping track profit performance and becoming Executive Information Systems [3].

With businesses collecting exponentially increasing amounts of data, storing more data points on more of the business's interactions, dashboards today have evolved to incorporate all aspects of the business. Below shows this process over time.

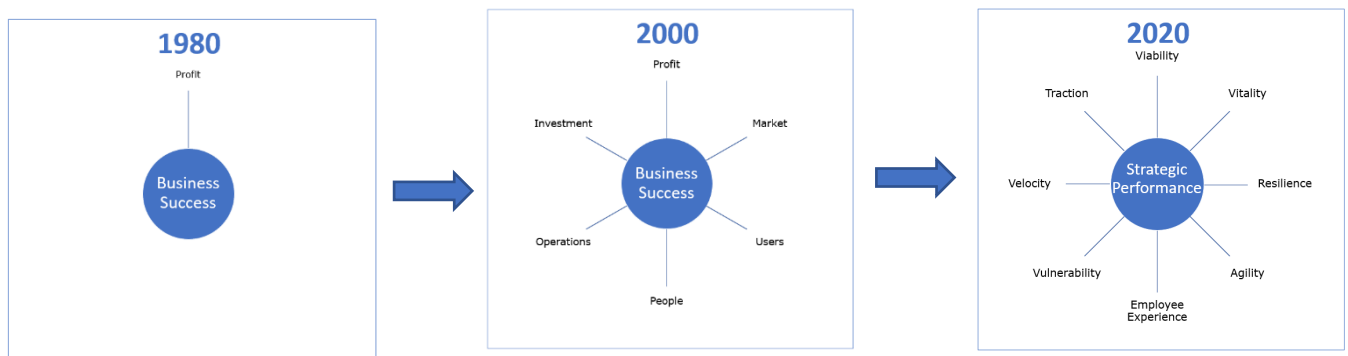


Figure 1 – Evolution of uses for a Business Dashboard [4]

2.3 Dashboard Design & User Interface Experience

Good design and user experience is paramount for the dashboard to succeed and engage stakeholders. A well-designed dashboard enables users to identify potential trends and insights quickly and efficiently, allowing organisations to grow and respond quickly to changes. A poorly designed dashboard would make it difficult or less efficient for this to happen, and in some cases could lead to wrong interpretations, leading to poorly informed decisions, costing time, money and potentially growth in the long term [5].

The initial stage of designing a dashboard is to understand who your stakeholders are, determine their needs and requirements from the dashboard. This will allow you to determine the level of detail and granularity required within the dashboard. For example, a non-technical audience might need high level aggregated numbers, whereas a more technical audience may need high level statistical trends, with the ability to drill down and investigate the data further, meaning a lower level of granularity will be needed.

Once all this information has been gathered, the purpose of the dashboard can then be established [6]. There are two main purposes that we can focus on, with the first being an Operational Dashboard. Operational Dashboards aim to provide critical information in situations like control rooms. A good example of this would be the control room of an ambulance service, where time sensitive tasks and information are needed to inform decisions in real time [7]. The other type of dashboard is Analytical. This type of dashboard is used to provide an overview of information to provide the user with analysis for decision making. This tends to be historical data looking at trends and forecasting results to be used in reports. This type of dashboard would be used in settings such as banks looking at targets and predicting results [7].

The design is another important factor to consider when building a dashboard. Data Visualisation is the term used to produce visuals of data from many forms, to allow users to easily obtain information in a way they will be able to read and understand. From this the user can make informed decisions from the available and will define the flow and layout [8]. There are a few principles that can be followed to help develop a well-designed dashboard, below are some examples:

- Types of Charts. To enable the user to make the appropriate decisions from the information presented to them, any charts that are used need to be considered carefully. Choosing the wrong chart can lead to confusion or data being misinterpreted. However, using a well thought out and designed chart, the user can analyse and distinguish trends and patterns to aid with organisational needs. The design of the dashboard also helps with the visualisation and charts. A clear, simple design [8].
- Grouping of Data. To help users access the content they need quickly, data should be grouped into categories and separated over the dashboard. This can be achieved by using boxes, lines or even by using background colours. Each of these sections should have clear, useful labels and can be used to help with highlighting the more essential data from the least.
- Formatting. The simple choice of colours and fonts can have a substantial impact on the aesthetics and ease of use of the dashboard. Using too many colours and fonts can make the dashboard look confusing, disjointed, and hard to read whereas keeping them to a minimum and using one colour scheme throughout combats this. For example, use one font for each set of text i.e., all headers should use the same font.
- Consistency. Aim to keep your report consistent throughout to make it feel like one cohesive dashboard and make the content easier to consume by the user. This can be done by using the same font size, colour and style for all visual titles, data labels etc. Also use this for placement of various elements if using multiple report pages. For example, if filters are being used ensure they are located at the same position on every page of the report.
- Keep it Simple. Users may have a limited attention span and so the dashboard needs to be clear and concise, as a cluttered and confusing dashboard may disengage them. To ensure this is simple and easy to understand, split information out into multiple visuals that show varying sections of the data, rather than putting everything into one visual, and where needed use multiple pages on the dashboard to show these. Filters are also a good way to condense the number of visuals as they can show different views of the data and provide a rich experience to the end user.

The dashboard should be designed to be accessible to as many people as possible. Within Power BI there are many built in features to help with this [9].

- Keyboard Navigation
- Screen-Reader Compatibility
- High Contrast Colour View
- Focus Mode – Enlarges tables or graphs to fill screen
- Show Data Table – Shows graph in table format



Figure 2 – Example of a well-designed dashboard [10]

The above, is a good example of a well-designed dashboard. It is simple, showing key data points and trends. There is a standardised colour scheme present, with all fonts consistent throughout. The graphs are meaningful and clearly show the different categories of data, good use of infographics to state the headline figures.

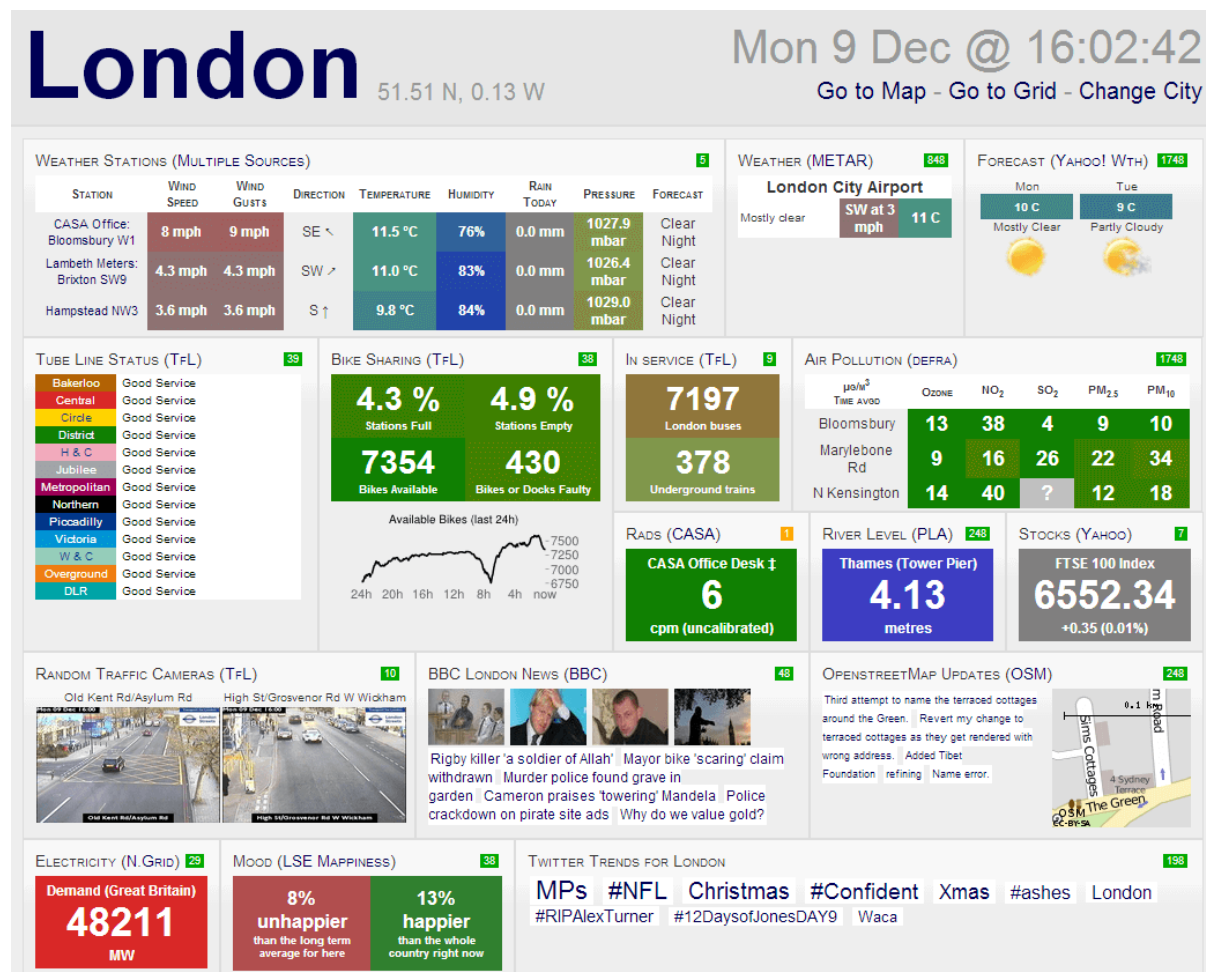


Figure 3 – Example of a poorly designed dashboard [11]

This dashboard is an example of a poorly designed dashboard. There are no consistent colour schemes or fonts. There is no clear design theme or flow as there are too many graphs and other pieces of information being displayed. This makes it extremely hard to read and interpret the data being presented.

2.3 Case Study of Dashboard Implementation in the NHS

Looking to the wider NHS for case studies of implementing dashboards, The Hertfordshire, Bedfordshire and Luton Clinical Commissioning Group wanted to improve their bed management and improve their efficiency in identifying beds for new patients.

Traditionally the NHS have used a single point of contact (normally a clinician), who would call and assess bed availability and planned discharges within units for the day. This allowed for forecasting and preparation of the unit but is a very manual task and takes valuable clinicians time to curate. Although this is mainly an accurate process, there are factors that lower the accuracy such as human error and other colleagues not being able to make phone calls. Also, as staff are normally busy on units, the bed assessments may not have been completed and so may delay preparations and forecasting.

It's clear that there was a big opportunity here for the CCG to improve current processes. The CCG utilised a SharePoint custom list to ensure accurate data collection that can be completed

online. This then feeds a Power BI dashboard showing all units with a real time data feed, giving clinicians an accurate view of available beds and planned discharges [12].

The project landed well, with the dashboard making it easy for staff to view bed availability, potential discharges, and most importantly give a real time view. The main shorter-term benefit from the project is that it saves clinicians time, allowing them to provide the best care for their patients. There are, however, some longer-term benefits which should be noted. For example, as there is now data being collected, they can use this historical data within the dashboard to show trends and long-term forecasting, providing the unit with rich data to improve bed management.

2.4 Magnesium Sulphate Case Study

It has been proven that when MgSO₄ is administered to a mother antenatally it reduces the risk of Cerebral Palsy in a preterm baby by 30%, meaning 1 in every 37 women's cases are avoided after being given MgSO₄ [13]. The aim of the PreCePT programme is to achieve an 85% uptake in MgSO₄ and reduce variation in administration. This is achieved by increasing training and awareness to staff, decreasing the variation of data collection, and monitoring the progress throughout the programme's lifecycle.

The programme started in 2016 in the Southwest of England before becoming a national programme in England after the success in the Southwest [14]. Looking at Figure 4 below, England have made some significant improvements over 2018 into 2019, which could be due to the introduction of the PreCePT Programme.

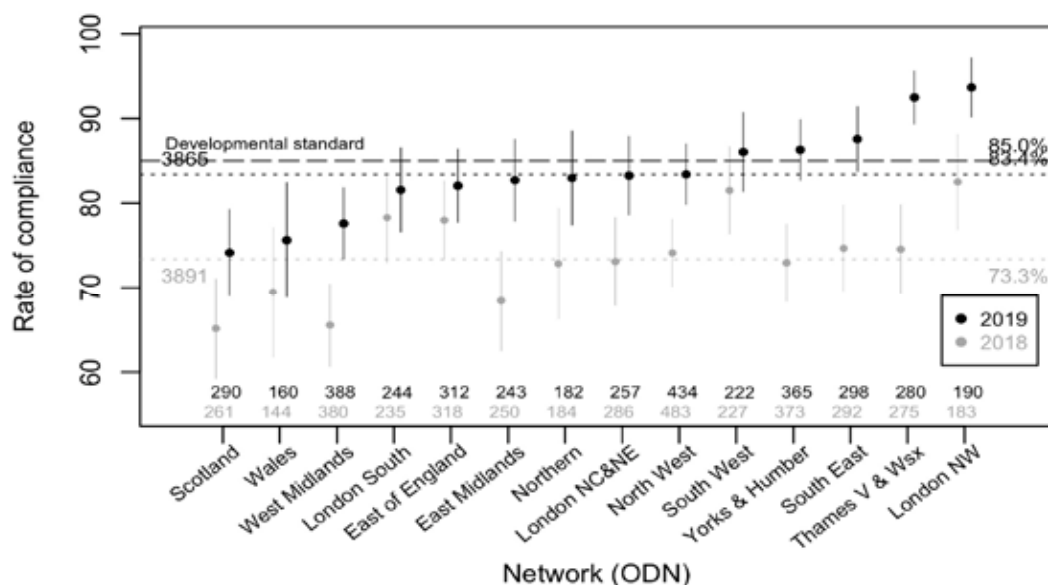


Figure 4 – Caterpillar plot of the rates of compliance for administration of magnesium sulphate: neonatal networks, 2018 and 2019 [15]

The programme assessed two methods of implementation and engagements. The first looking at a fully supported model with dedicated quality improvement coaching and the second looking at a national level implementation with less support [16].

Looking at the imperial college which is leading in the UK as London NW, they took a data led and collaborative working approach to the programme. The college started with a 60% baseline of eligible mothers, with a compliancy of 28%. After the implementation of the programme compliancy increased to 88%, rising above the NNAP Standard of 85%. The college's data suggests that the programme has prevented two cases of Cerebral Palsy, and in a patient's lifetime would cost the NHS approximately £800k. A single dose of MgSO4 costs approximately £1 [16], and so not only does this help patient outcomes it also helps save the NHS £1.6 million [17] to be reinvested elsewhere. At the end of the project an estimated 48 cases of Cerebral Palsy have been avoided due to the PreCePT Programme, with a saving of £38.4 million in lifetime health and social care costs for the NHS [14].

From the chart above we can see Wales is well below standards on administering MgSO4 to preterm mothers and has been noted as an area of concern within Wales. This would be a good measure to include within the project to improve patient's outcome using data.

The NNAP criteria for MgSO4 is a mother who delivers a baby below 30 weeks gestational age given magnesium sulphate in the 24 hours prior to delivery [15].

2.5 Summary

From reading the various literatures and case studies it is clear to see that implementing a dashboard within an organisation can bring many benefits. In particular, it was very positive to see how the implementation of a dashboard within the NHS has improved the patients care and provides strong evidence to back the project in the network of implementing a dashboard to help improve patient outcomes.

The Magnesium Sulphate case study also provides evidence of a simple and effective measure to consider bringing into the dashboard to monitor in order to help the improvement. There are clear benefits from this such as improved patient outcomes as well as a substantial NHS cost saving.

That being said, for this to be successful careful consideration will have to be made for the design and implementation of the dashboard, adhering to some of the principles stated previously.

3 Research & Development Methods

This section highlights the various research and development methodologies that can be used to undergo this project and delves deeper into the best suited method for its purposes. The importance of setting project expectations are outlined, with a view of what will be done in the project to manage those, as well as setting out a high level project plan to develop and implement the product.

3.1 Research Methodology

Research is a crucial step in any project and provides explanation and justification on decisions made within the project as well as to gain knowledge, helping to make informed decisions.

The Research Onion was developed by Saunders et al in 2007 and provides the different decisions needed to form the research methodology (see figure 5) [18].

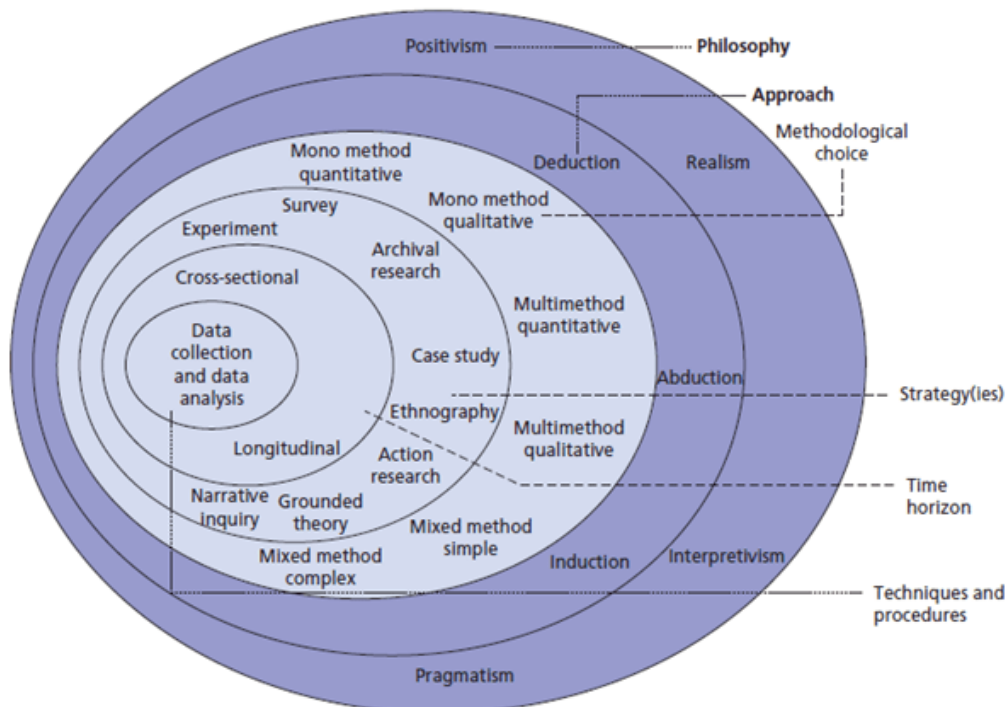


Figure 5 – Research Onion [19]

The philosophy layer determines the ways in which data can be collected, analysed, and concluded to develop knowledge. It is split into four types of philosophies, but for the purpose of this project, Positivism best suits the projects' needs [20].

Positivism philosophy looks at empirical research which are measurements, observations or knowledge that are not reliant on human reasoning, but rather gained from research. In Positivism, knowledge can only be true, false, or meaningless [20].

The Approach layer is comprised of three varying approaches that look at the broader methods being taken to undergo research. For the purposes of this project, a Deductive approach is used. A deductive approach looks at existing research and either builds on or tests

its hypothesis. Related to the deductive approach is quantitative research, which focuses on the research of numerical data [20]. The below figure shows the steps taken in the decision-making process of the deductive approach.

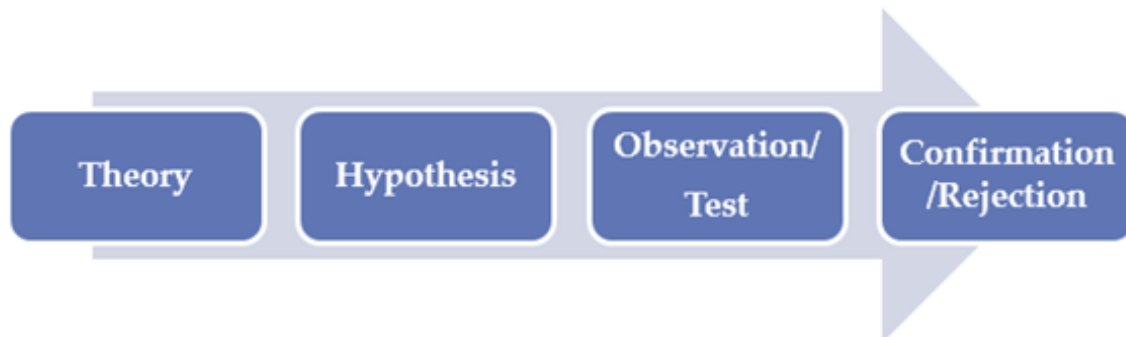


Figure 6 – Deductive Approach [21]

Choosing the above methods has considerably helped in the research and decision making for this project. One example of where a deductive approach is used is with the PReCePT programme case study, where it was seen in England that an increase in uptake of MgSO₄ has contributed to many cases of Cerebral Palsy in babies being avoided, and further led to significant NHS cost savings. Seeing that Wales was well under the NNAP standards for this, it provided a strong research theory that including this measure and monitoring it in the dashboard will help to improve patient outcomes. All of which will be evaluated later in the report.

Longitudinal data is a type of correlational research and is a method of collecting data and repetitively collecting the observations over time [22]. This is going to be a major factor for the analysis of the project and time will be needed to show the effect of any changes of practice put into place to improve patient outcomes. The dashboard will be able to present this in many forms and will provide a platform for clinicians to use for potential QI work.

3.2 Development Methodology

Below looks at the developmental methodology that the project will require to be taken forward and to aid in the project planning and governance.

On its own Agile Project Management is an iterative approach to a project's life cycle. Its goal is to realise benefits early and progressively throughout the life cycle, rather than waiting until the end, to promote flexibility and collaboration. This iterative concept also ensures no time is wasted in creating a product which doesn't match the stakeholders' requirements (see figure 8) [23].

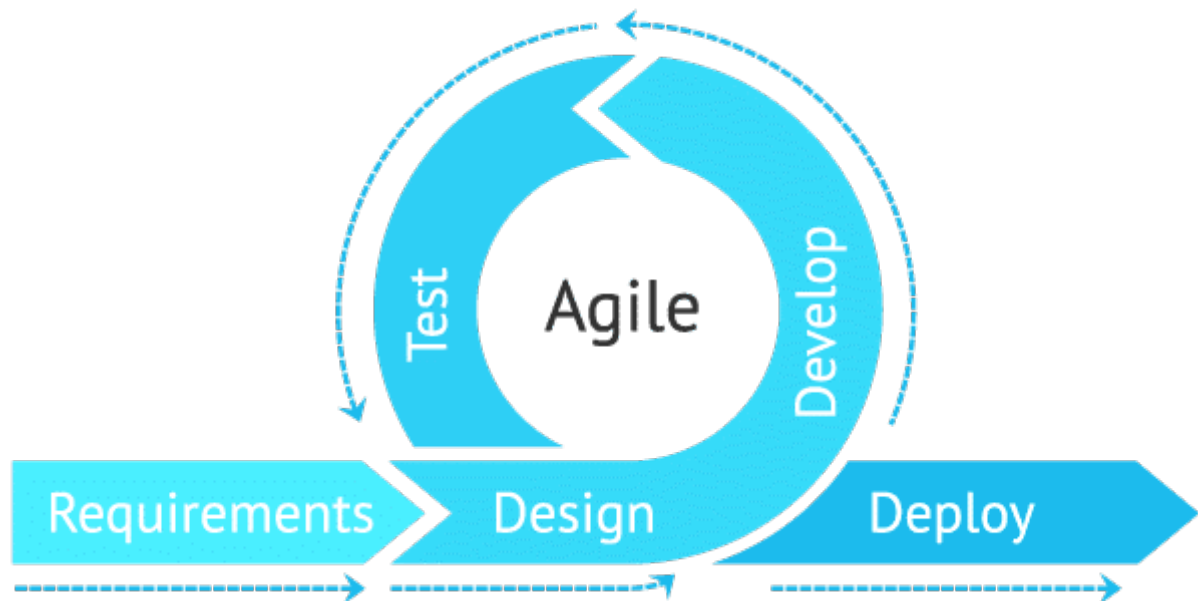


Figure 8 – Agile Stages of Project Development [23]

PRINCE2, however, is a process driven approach to Project Management, that mainly focusses on the control and organisation of a project from its start to end [2].

Bringing these two methods together into a PRINCE2 Agile framework will enable the project to have governance and accountability, but also the flexibility needed. As well as being able to focus on both the project and outcome (see figure 7) [2].

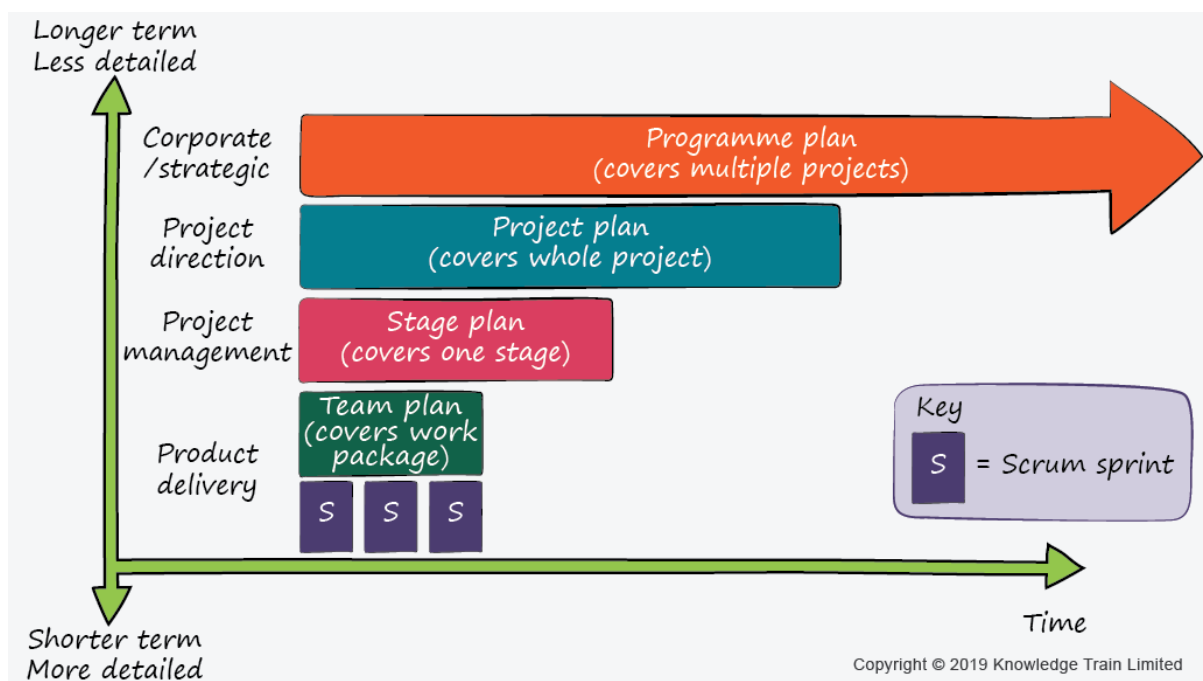


Figure 7 – Diagram of PRINCE2 Agile Phases [22]

This approach will encourage a strong relationship with the stakeholders, allowing the dashboard and measures to be evaluated regularly through the iterative feedback loop, enabling a fail fast learn quick environment to meet the needs of the stakeholders. This will be achieved by having regular contact with the Data Oversight Group. Below is an example of the Agenda and Minutes of this group.

 GIG Cymru NHS Wales Rhwydwaith Mamolaeth a Newyddenedigol Cymru Wales Maternity and Neonatal Network	
Neonatal Data Oversight Group <i>will be held on</i> Thursday 14th July 2022 2:00pm-3:00pm AGENDA	
1	Welcome & Introductions OR
2	Minutes of previous meeting + Action Log OR
3	Neonatal Dashboard Launch OR/AH
4	2022-2023 Workplan OR
5	Review of Dashboard Dataset <i>(standing agenda item)</i> OR/All
6	Examination of the Data including Performance - what data do we need to do something about? <i>(standing agenda item)</i> OR/All
7	Exception Reports <i>(standing agenda item)</i> OR/All
8	Review of Data Access Requirements <i>(standing agenda item)</i> OR
9	Date of Next Meeting TBC OR

Figure 9 – Data Oversight Group Agenda

Figure 10 – Data Oversight Group Minutes

Setting the project expectations at the start means that the product can be managed within the project team rather than with the board, within stated tolerances. There are six tolerances that the delegated person has authority to manage [24]:

- As well as this it means stakeholder expectations will be managed and set, providing a clear plan to go forwards. This can all be done by [2]:

- Providing a MoSCoW Analysis at the start of the project to outline key measures required and a prioritisation amongst them (see section 4, figure 12).
- Providing a continuous stream of communication with all parties involved, promoting collaboration and transparency throughout.
- Planning the project so that stakeholders are clear on what the outcomes and timelines are.
- Providing an MVP so that benefits can start being realised straight away and for feedback to be gained early so that improvements can be made quickly.
- Working in sprints so that stakeholders are always kept up to date with progress through artifacts such as sprint reviews and scrum meetings.

3.4 Project Plan

A project plan provides an overview of how and when objectives will be achieved. Within a PRINCE2 Agile framework planning is fluid to allow for three approaches [25]. These approaches are:

1. Product based planning - plan for features and functions, rather than design and specification.
2. Involving team in planning - this gives early access to team members and provide a more realistic plan and buy in.
3. Planning as late as possible - this allows changes to the product to be less impactful during the planning.

Even though Gantt Charts are not necessary within the framework used, one has been created to give stakeholders a rough timeline and structure. An iterative approach is in place ensuring the Agile principle is incorporated, this is shown through the Feedback Loop task on the chart in figure 11 below.

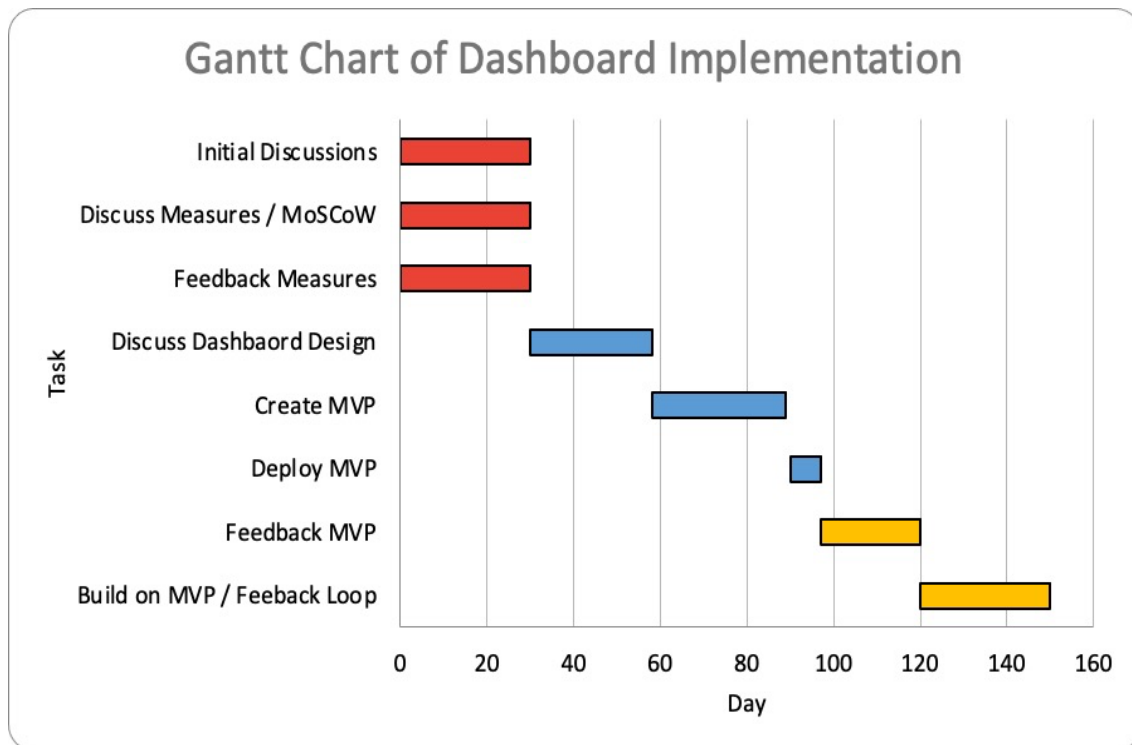


Figure 11 – Gantt Chart of Dashboard Implementation

The Gantt Chart is structured into three phases and colour coded for ease of access. The first stage (Red) is the initial discovery phase, to understand what the requirements are, what's achievable within the project and what the priorities are. This will be done by communicating with stakeholders to discuss what those requirements are and developing a MoSCoW analysis ready for implementation.

The second stage (Blue) covers the implementation of the product where these measures will be developed, and an MVP will be created for stakeholders to view and feedback on.

The final stage (Yellow) is there so that the MVP can be enhanced further through feedback provided by stakeholders.

It is worth noting that as the dashboard is a fluid project, measures may need updating to reflect changes to audits and BAPM Standards.

3.5 Summary

Choosing the right research and developmental methodology is fundamental in the project design and implementation. Using a positivism and deductive approach allows the project to be designed based on the principles researched and using case studies provide a great baseline on which to build a theory, to help shape the project implementation and outcome. A PRINCE2 Agile methodology has enabled the project to flow without resistance, with the focus being on planning the project around stakeholders, whilst managing their expectations and needs. Agile also allows benefits to be realised early from the project, with further iterations for improvements and ensures all stakeholder requirements are met.

4 Design & Implementation

This section details the development and design of the MVP dashboard and how this was implemented within the network, using the principles and initial research which was presented within the literature review.

4.1 Stakeholders & Dashboard Requirements

As stated previously the initial stage of any dashboard design is to engage with stakeholders to understand the requirements and therefore the purpose of the dashboard. The project will consist of both stakeholders and working groups to form the project. These will consist of: -

- Welsh Government
- WHSSC
- NHSWHC Staff
- Clinicians and Senior Service Managers
- Data Oversight Group
- Network Board

The working group will discuss the measures needed for the service and identify any QI projects using the dashboard, in turn improving the service and patient care.

To aid in the creation of a MVP dashboard, meetings were conducted, and it was agreed what the main measures would be to start with and any additional ones to build and develop on that. Below is a table of each measure that has been categorised and identified using MoSCoW analysis, which will rank the requirements as well as setting clear priorities. MoSCoW stands for **M**ust, **S**hould, **C**ould and **W**ould [2].

Category	Measure	MoSCoW Status
Outcome	Mortality	Should
Outcome	NEC	Should
Outcome	HIE	Must
Outcome	Temperature	Must
Outcome	Magnesium Sulphate	Must
Process	2 Year Follow Up	Should
Process	Antenatal Optimisation	Could
Process	Mothers Milk	Must
Process	Home Oxygen	Should
Process	ROP	Could
Process	Parents Ward Round	Must
Process	Parents Consultation	Must
Activity	Admissions	Must
Activity	Closures	Would
Activity	Refusals	Would
Activity	Occupancy	Must
Activity	Care Levels	Must
Activity	Term Admissions	Should
Activity	>44 Week Gestion	Must
Activity	Exception Reports Received	Should

Figure 12 – MoSCoW Analysis for Measures

From this we can now start to understand what the purpose of the Dashboard is within the Maternity & Neonatal Network. Although for this project we will be focussing on MgS04, the dashboard will also provide other BAU outcomes, for example analysing the NNAP data and the measures defined above. These measures are standards that are defined by the network and BAPM to look at how effective and efficient the service is running. This will be done by using historical data and tracking this monthly before publications, so that they can drive improvement for the NNAP results, and the service provided. With regards to MgS04 and the case study presented, the dashboard will aid in displaying the uptake rates and track the progress implemented by the clinical staff within the healthboards.

Again, the stakeholders have agreed that the frequency of reporting will be monthly. This allows enough time for the data to be captured and for the report to be quality checked with the BadgerNet clinical system.

4.2 GDPR

The NHS uses highly sensitive PII and must comply with GDPR regulations and principles. These principles are:

- Lawfulness, fairness, and transparency
- Purpose limitation
- Data minimisation
- Accuracy
- Storage limitation
- Integrity and confidentiality (security)
- Accountability

These principles inform legislation, and even though they are not rules, they are there to guide and limit exceptions. Failure to comply with the principles can lead to the highest tier of administrative fines. This means a fine of up to £17.5 million, or 4% of total worldwide annual turnover, whichever is higher [26].

Within the NHSWHC, there are policies in place to comply with GDPR. There is the Data Sharing Agreement in place with the healthboards and Caldicott Guardians of each of the healthboards. This states that the NHSWHC can receive healthboards data for analysis and audit purposes. The NHSWHC cannot share this data with any other organisation without the permissions of the Healthboard. The Maternity & Neonatal Network has a Data Request form in place for such a request, this is discussed at the Data oversight Group and can be rejected or accepted there [27].

If the network needs to collect data at any point, the network will have to complete a DPIA. A DPIA is to help identify and minimise the data protection risks of a project that requires the processing of personal data. For example, for the network this would be the collection of data within SharePoint.

4.3 Prerequisites

There are some prerequisites that should be stated, which were all necessary to be completed before work on the dashboard design could take place. These are outlined below:

1. The neonatal service uses a national procured system called BadgerNet and the downloads contain a summary of all the babies' details and a daily summary of babies' medical status and care levels for each of their days on unit. This raw data will be extracted monthly to form the foundation of the database.
2. Even though MgS04 is a neonatal measure, it is reliant on maternal intervention. In Wales it's been decided to administer this as a perinatal team. Currently there is poor data collection within the maternal care pathway, whereas neonatal is data rich with a national patient system. To aid in the data collection a Perinatal Optimisation Toolkit will be designed on SharePoint to ensure reliable data collection which can then be pulled into the dashboard.
3. Power BI was chosen as the tool to build the dashboard in due to the Office 365 agreement with NHS Wales. Currently NHSWHC are sharing their premium node capacity with PHW, until the NHSWHC procures their own which is underway. A premium node capacity is where the dashboards can be published to the Power BI service and shared to stakeholders from.
4. With guidance from PHW Data Protection Team and discussions with the Data Oversight group it has been decided to share the dashboards on the Networks SharePoint site. This allows the network to have greater control on who sees the dashboard and satisfies PHW Policy within guidance with GDPR.
5. On a monthly basis, raw data is downloaded as Microsoft Access files from the BadgerNet clinical system. This is then stored within a secured SharePoint site that the Network only has access to, which is pulled into Power BI for use.

4.4 Design & Implementation

The dashboard's first inception was before the use of Power BI or any BI solution in place. The dashboard was created in Microsoft Excel and used basic VBA and formulas. It had basic activity measures such as Admissions and Occupancy and displayed published NNAP data, as it had no advanced BI capabilities. The design used the NHS colour scheme which is:

Pantone: 534 **(Blue)**

Pantone: 465 **(Gold)**

The font used in this iteration of the dashboard was **Verdana**, as stated to use within NHS Wales brand guidelines document [28]. The design was minimalistic on a white background, making it easy for the user to read, and distinguish between graphs and tables. The figure below shows the initial dashboard created within Excel. The landing page used Macros to navigate the dashboard, using passwords to secure sections that contains PII.

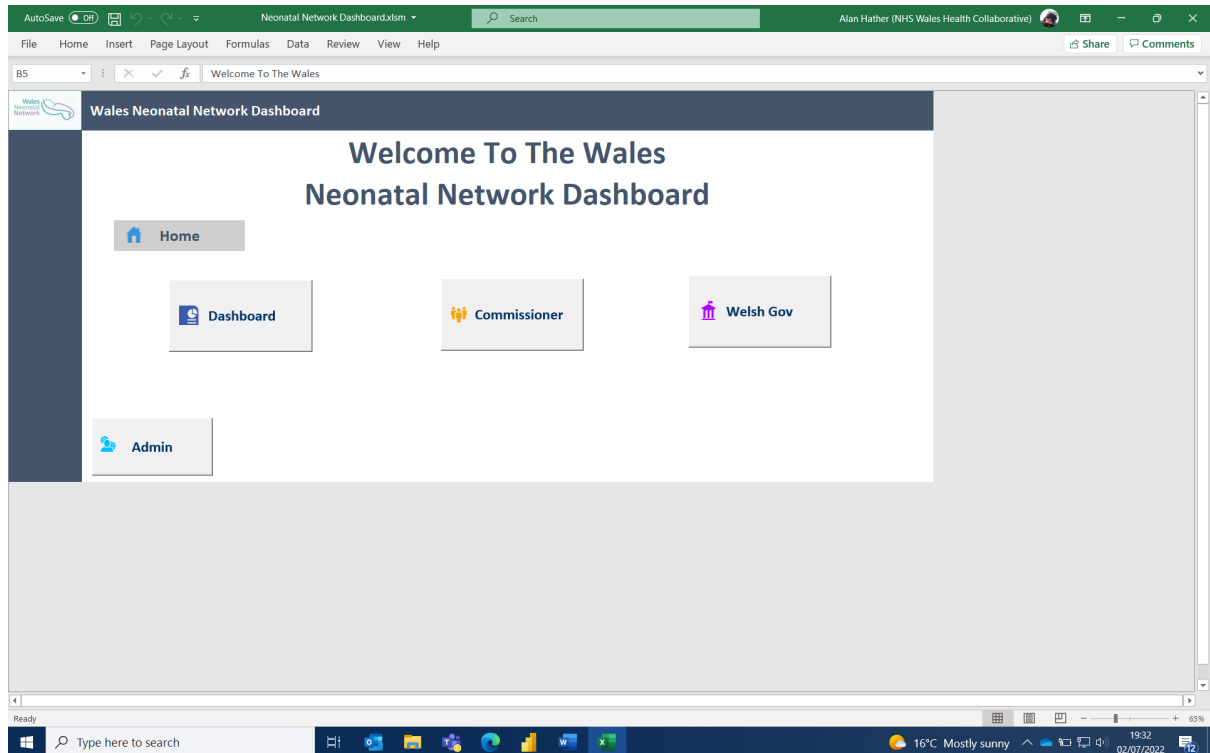


Figure 13 – Excel Dashboard Landing Page

A password was required to enable the user to access the data, which provides security to PII data.

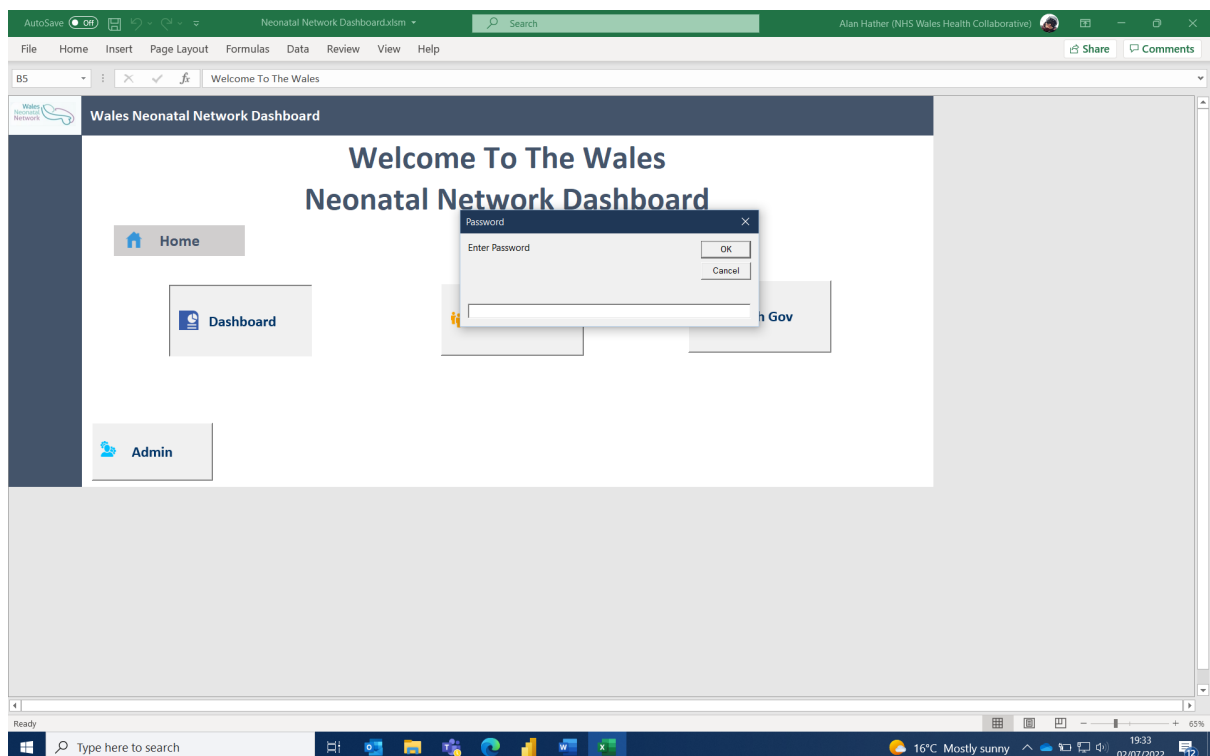


Figure 14 – Excel Dashboard Password Requirement

Once entered, the user is shown an overview of headline data that was specified as a requirement at the time (see figure 15).

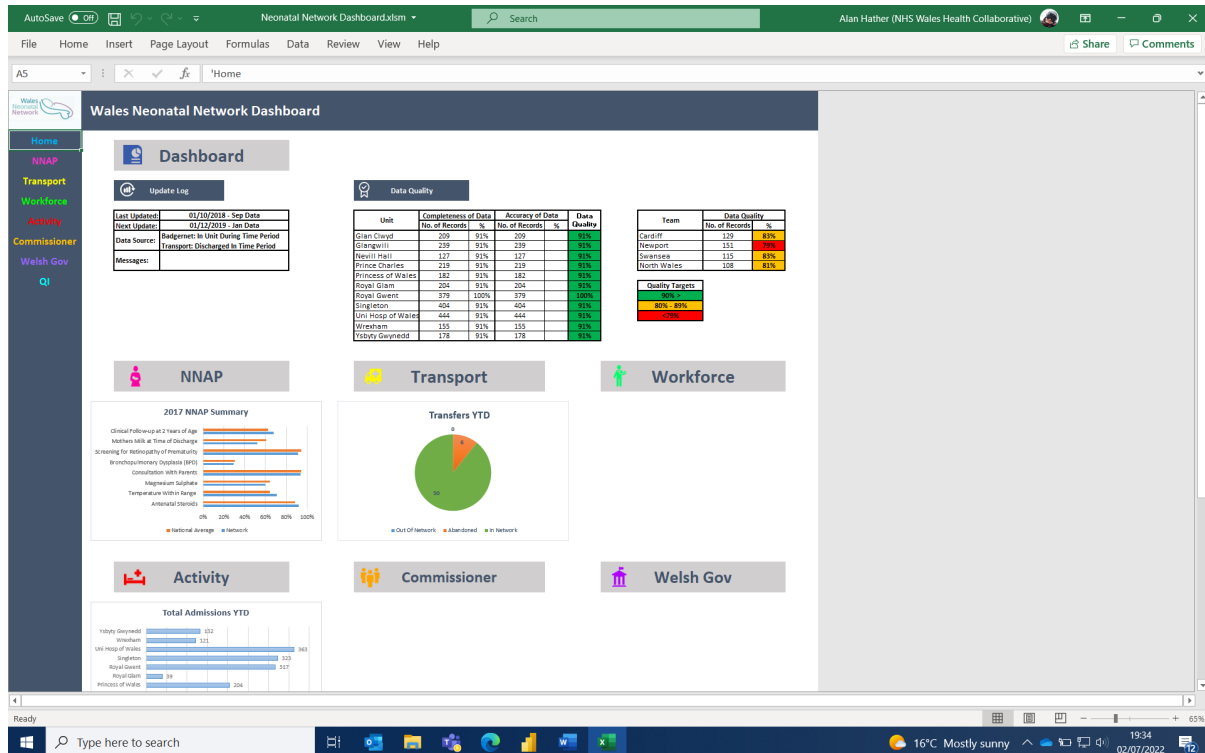


Figure 15 – Excel Dashboard Page

Figure 16 below shows a section which provides the user with an interactive dashboard to select the data they need. This was achieved by using slicers, which meant the charts would update to provide the user with the information required.

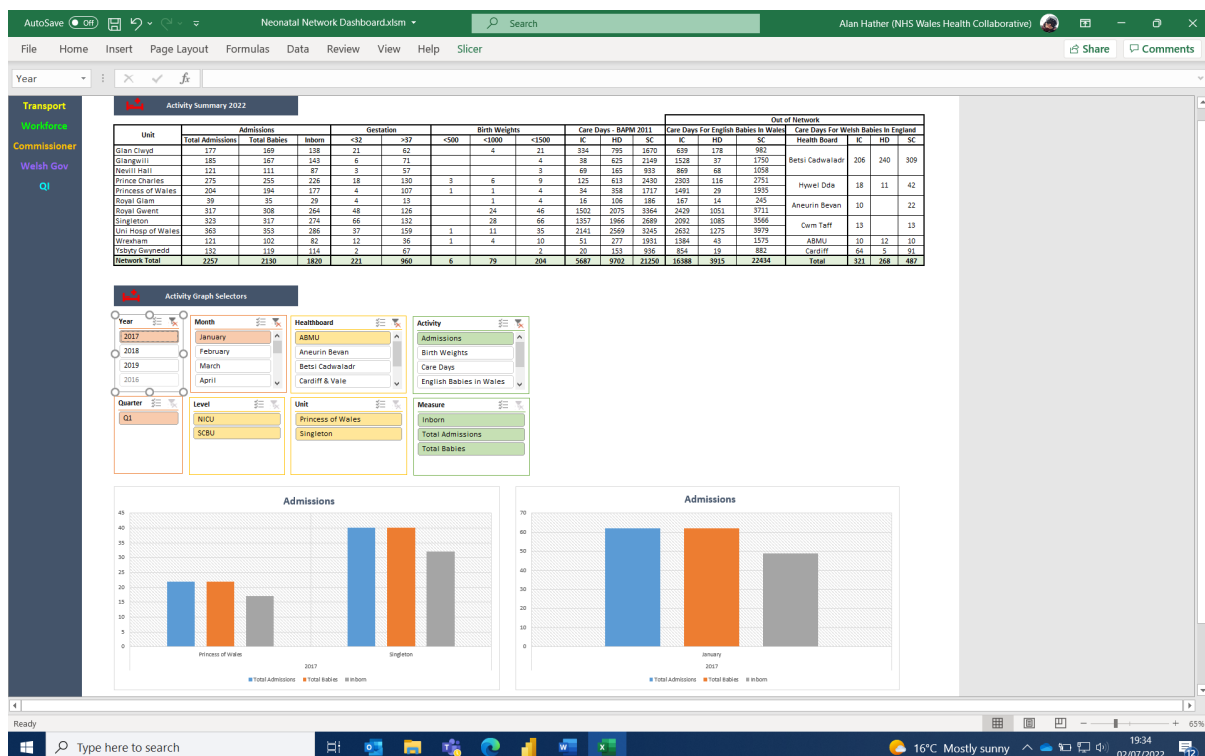


Figure 16 – Excel Activity Page with Slicers and Graphs

Once Power BI was enabled within the NHSWHC from the Office 365 tenancy, the Excel dashboard was no longer required and was replicated for use in Power BI. Power BI enables a deeper understanding of the data and gives more intelligent information as previously explained.

Beginning the initial design of the new dashboard, it was decided to keep the design scheme similar to that of the excel spreadsheet. For example, using the same fonts and colours to keep the brand identity and conform with NHS standards. The process of downloading data from BadgerNet has also remained the same as explained within the prerequisites (see figure 17). The backend function, however, to connect this data to Power BI needed to change from the Excel dashboard. This was achieved by connecting these data sources to Power BI and maintaining the ETL process within Power BI itself, which was carried out to create the MVP. Transformations can also be executed through the use of M language within Power Query, allowing the data to be prepared for analysis. This essentially provides the ETL process within Power BI.

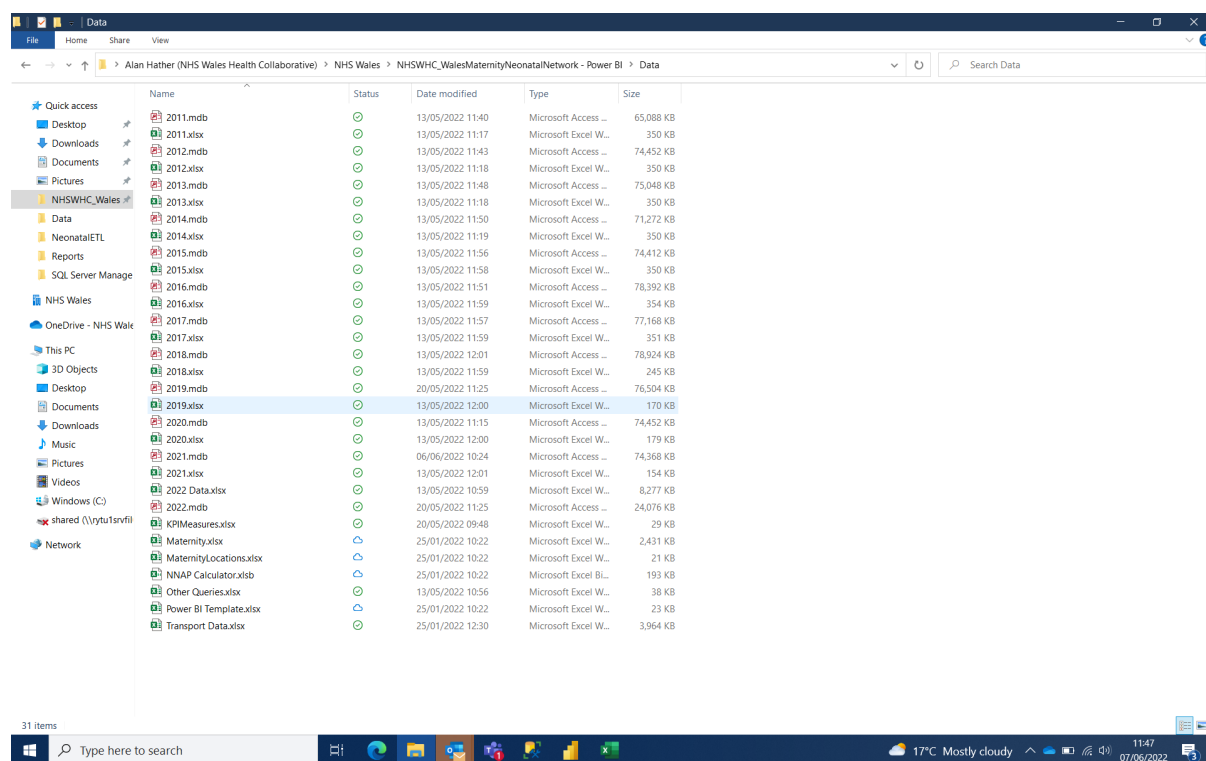


Figure 17 – Data Sources Downloaded from BadgerNet Clinical Tool

The MVP presented to the stakeholders delivered on many of the measures requested and the below figures show just some of the transformations that were made using M Language. For example, creating the baby admissions table and the MgSO4 measure, created to the NNAP criteria as stated within the Literature Review (see figures 18 and 19 resp.). The DAX expressions are functions or aggregations that are used to create the percentages or to aggregate numbers (see figure 20) [30].

FACTAdmission

Display Options ?

```

let
    Source = Sql.Database("RYTU1LAP1000333\SQLEXPRESS", "NeonatalDb"),
    dbo_FACTAdmission = Source[Schema="dbo",Item="FACTAdmission"][Data],
    #Duplicated Column = Table.DuplicateColumn(#"dbo_FACTAdmission", "AdmitTime", "AdmitTime - Copy"),
    #Renamed Columns = Table.RenameColumns(#"Duplicated Column",{{"AdmitTime - Copy", "AdmitDate"}}),
    #Removed Blank Rows = Table.SelectRows(#"Renamed Columns", each not List.IsEmpty(List.RemoveMatchingItems(Record.FieldValues(_), {"", null}))),
    #Extracted Date = Table.TransformColumns(#"Removed Blank Rows",{{"AdmitDate", DateTime.Date, type date}}),
    #Trimmed Text = Table.TransformColumns(#"Extracted Date",{{"EntityID", Text.Trim, type text}}),
    #Cleaned Text = Table.TransformColumns(#"Trimmed Text",{{"EntityID", Text.Clean, type text}}),
    #Removed Duplicates = Table.Distinct(#"Cleaned Text", {"EntityID"}),
    #<32NICUs = Table.AddColumn(#"Removed Duplicates", "<32NICUs", each if ([CareLocationID] = "CBF13486-0F66-41A3-9C8F-96C4EBA99816" or
    [CareLocationID] =
    "6C03D7C5-6BB5-457E-B50A-E990877BFA48" or
    [CareLocationID] =
    "15BC8546-7069-44C8-9ACE-2DE0E468FA74" or
    [CareLocationID] =
    "41FB5107-554E-400B-BB07-FB9B8C0A6629" or
    [CareLocationID] =
    "532F6E11-628A-4A96-B447-3FE9461D454C")
    and [GestationWeeks] <32
    then 1 else 0),
    #<27NICUs = Table.AddColumn(#"<32NICUs", "<27NICUs", each if ([CareLocationID] = "CBF13486-0F66-41A3-9C8F-96C4EBA99816" or
    [CareLocationID] =
    "6C03D7C5-6BB5-457E-B50A-E990877BFA48" or
    [CareLocationID] =
    "15BC8546-7069-44C8-9ACE-2DE0E468FA74" or
    [CareLocationID] =
    "41FB5107-554E-400B-BB07-FB9B8C0A6629" or
    [CareLocationID] =
    "532F6E11-628A-4A96-B447-3FE9461D454C")
    and [GestationWeeks] <27
    then 1 else 0),
    #<27Gestation = Table.AddColumn(#"<27NICUs", "<27Gestation", each if [GestationWeeks] < 27 then 1 else 0),
    #<32Gestation = Table.AddColumn(#"<27Gestation", "<32Gestation", each if [GestationWeeks] < 32 then 1 else 0),
    #<1500BW = Table.AddColumn(#"<32Gestation", "<1500BW", each if [BirthWeight] < 1500 then 1 else 0)
in
    #<1500BW"

```

✓ No syntax errors have been detected.

Done Cancel

Figure 18 – Example of Transformations in Power BI using M Query Language within Power Query

NNAPMagSulphate

Display Options ?

```

let
    Source = Sql.Database("RYTU1LAP1000333\SQLEXPRESS", "NeonatalDb"),
    dbo_EpisodeSum_V = Source[Schema="dbo",Item="EpisodeSum_V"][Data],
    #Changed Type = Table.TransformColumnTypes(dbo_EpisodeSum_V,{{"FinalDischargeDate", type date}, {"FirstConsultationWithParents", type date}}),
    #Grouped Rows = Table.Group(#"Changed Type", {"NationalIDBaby"}, {{"CareLocationID", each List.Min([CareLocationID], type nullable text), {"BirthOrder", each List.Min([BirthOrder], type nullable text)}}),
    #Replaced Value = Table.ReplaceValue(#"Grouped Rows", null, 0, Replacer.ReplaceValue, {"MagnesiumSulphate"}),
    #Changed Type1 = Table.TransformColumnTypes(#"Replaced Value",{{"MagnesiumSulphate", Int64.Type}}),
    Eligible = Table.AddColumn(#"Changed Type1", "MSEligible", each if [EpisodeNumber] = 1 and
    [BirthOrder] = 1 and
    [GestationWeeks] < 30
    then 1
    else 0),
    Given = Table.AddColumn(Eligible, "MSGiven", each if [MSEligible] = 1 and
    [MagnesiumSulphate] = 1
    then 1
    else 0),
    #Removed Columns = Table.RemoveColumns(Given,{"BirthOrder", "GestationWeeks", "MagnesiumSulphate", "EpisodeNumber"})
in
    #Removed Columns"

```

✓ No syntax errors have been detected.

Done Cancel

Figure 19 – Magnesium Sulphate Transformations in Power BI using M Query Language within Power Query

```

1 Magnesium Sulphate =
2 DIVIDE(
3     SUM('NNAPMagSulphate'[MSGiven]),
4     SUM('NNAPMagSulphate'[MSEligible])
5 )

```

Figure 20 – Magnesium Sulphate Calculation Using DAX

When planning the overall design of the dashboard (see figure 21), the principles that were outlined in the literature review along with the example of a well-designed dashboard were taken into consideration. Below describes the main styles and features that were incorporated to create the MVP.

Using defined colour schemes and fonts keep the dashboard simple, while also making it easier for users to navigate their way to key components. Sectioning the dashboard into similar themes or types of information has also helped with this.

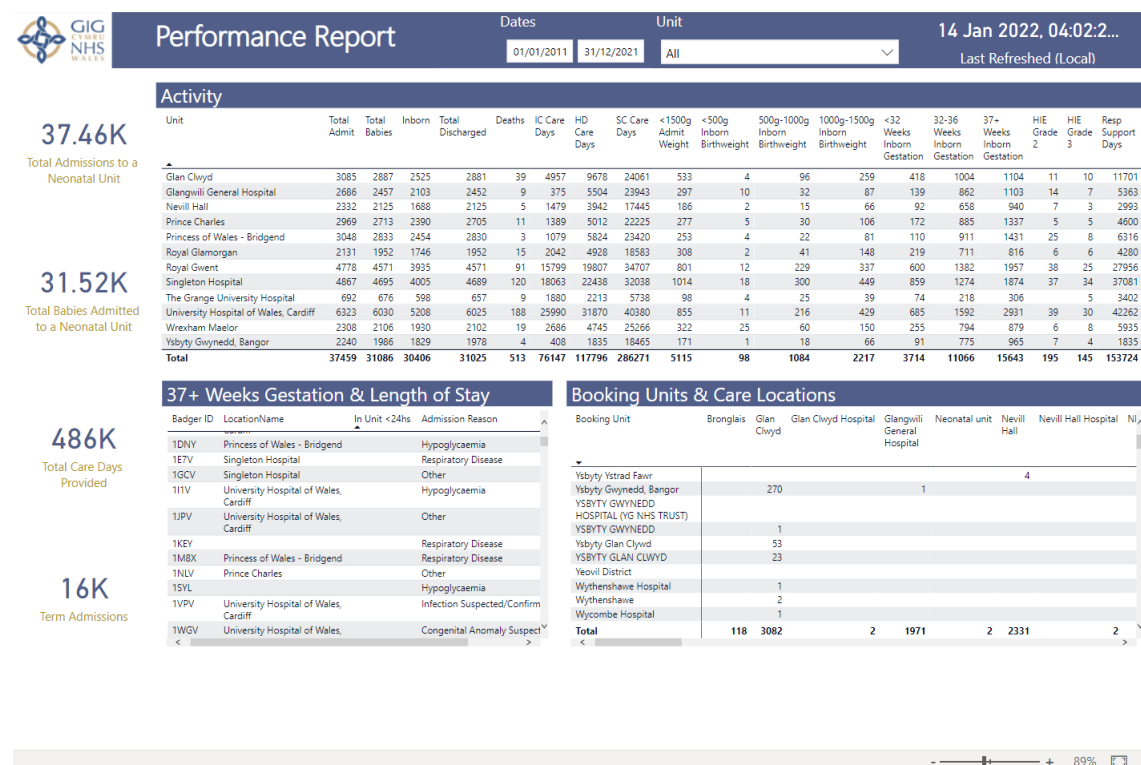


Figure 21 – MVP Dashboard in Power BI (Performance Page)

Filters were one of the key features that was included in the dashboard (see figure 24), which were located on the top banner of the dashboard. These filters included dates and units and provide the user with an interaction to allow them to drill down to the data they need. The date filter runs from 2011 – YTD and the unit filter enables the user to see data at an individual basis or Wales as a whole, meaning users can compare data between similar units.

The last refresh display, also located on this banner, shows the user the time and date the data was last refreshed locally, giving the user confidence that the data they are using is reliable and up to date.

Dates		Unit	
01/01/2011	31/12/2021	All	14 Jan 2022, 04:02:2... Last Refreshed (Local)

Figure 24 – Filters and Refresh Statement

Another key component to the dashboard is the panel down the left-hand side, which contains headline figures of the main activity (see figure 23). Headline figures or metrics have been displayed on the dashboard to provide the user information quickly and at a high level. These metrics were chosen as they provide the stakeholders a basic overview of how many admissions they have and the care they are providing.

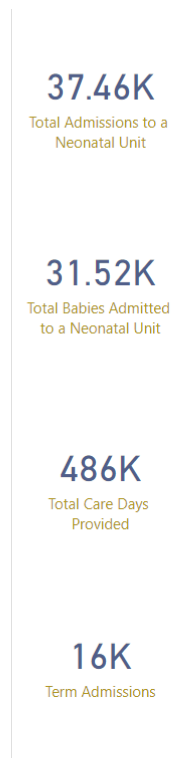


Figure 23 – Headline Figures

In addition to this, if a user hovers over any of those headline figures, a tooltip appears. This drills down further into that data, displaying the trend over the months for the selected yearly period (see figure 22), providing extra context to what is being seen in the data.

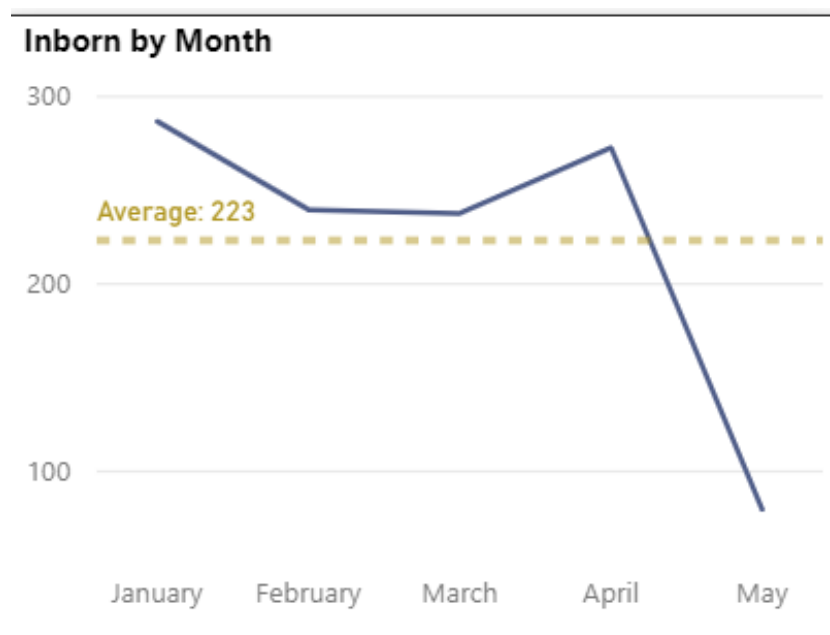


Figure 22 – Tool Tip for Measure

There were three main visuals developed for the dashboard. Although it can be said that the MVP doesn't utilise charts very effectively, one of the main requirements was to create a visual which could aid in creating the Annual Reports template. The activity chart as seen in figure 25 below, shows all the essential measures for the service. It was decided at the MVP stage to include this chart, as it allows clinicians to easily generate graphs needed for annual reports, by exporting this chart to excel using the export feature within Power BI.

Unit	Total Admit	Total Babies	Inborn	Total Discharged	Deaths	IC Care Days	HD Care Days	SC Care Days	<1500g Admit Weight	<500g Inborn Birthweight	500g-1000g Inborn Birthweight	1000g-1500g Inborn Birthweight	<32 Weeks Inborn Gestation	32-36 Weeks Inborn Gestation	37+ Weeks Inborn Gestation	HIE Grade 2	HIE Grade 3	Resp Support Days
Glan Clwyd	3085	2887	2525	2881	39	4957	9678	24061	533	4	96	259	418	1004	1104	11	10	11701
Glangwili General Hospital	2686	2457	2103	2452	9	375	5504	23943	297	10	32	87	139	862	1103	14	7	5363
Nevill Hall	2332	2125	1688	2125	5	1479	3942	17445	186	2	15	66	92	658	940	7	3	2993
Prince Charles	2969	2713	2390	2705	11	1389	5012	22225	277	5	30	106	172	885	1337	5	5	4600
Princess of Wales - Bridgend	3048	2833	2454	2830	3	1079	5824	23420	253	4	22	81	110	911	1431	25	8	6316
Royal Glamorgan	2131	1952	1746	1952	15	2042	4928	18583	308	2	41	148	219	711	816	6	6	4280
Royal Gwent	4778	4571	3935	4571	91	15799	19807	34707	801	12	229	337	600	1382	1957	38	25	27956
Singleton Hospital	4867	4695	4005	4689	120	18063	22438	32038	1014	18	300	449	859	1274	1874	37	34	37081
The Grange University Hospital	692	676	598	657	9	1880	2213	5738	98	4	25	39	74	218	306		5	3402
University Hospital of Wales, Cardiff	6323	6030	5208	6025	188	25990	31870	40380	855	11	216	429	685	1592	2931	39	30	42262
Wrexham Maelor	2308	2106	1930	2102	19	2686	4745	25266	322	25	60	150	255	794	879	6	8	5935
Ysbyty Gwynedd, Bangor	2240	1986	1829	1978	4	408	1835	18465	171	1	18	66	91	775	965	7	4	1835
Total	37459	31086	30406	31025	513	76147	117796	286271	5115	98	1084	2217	3714	11066	15643	195	145	153724

Figure 25 – Activity Figures

The second chart required (see figure 26) was to show data for at term babies being admitted to a neonatal unit, due to this being a problematic area at the time the MVP was being created. The dashboard was used to monitor what babies were being admitted and the reason as to why they were admitted. The length of stay was also recorded so clinicians could investigate why babies were admitted for less than 24 hrs to the neonatal unit. As the table is larger than the view, users can use the pop out function to enlarge the table for better accessibility.

37+ Weeks Gestation & Length of Stay			
Badger ID	LocationName	In Unit <24hs	Admission Reason
1DNY	Princess of Wales - Bridgend		Hypoglycaemia
1E7V	Singleton Hospital		Respiratory Disease
1GCV	Singleton Hospital		Other
1I1V	University Hospital of Wales, Cardiff		Hypoglycaemia
1JPV	University Hospital of Wales, Cardiff		Other
1KEY			Respiratory Disease
1M8X	Princess of Wales - Bridgend		Respiratory Disease
1NLV	Prince Charles		Other
1SYL			Hypoglycaemia
1VPV	University Hospital of Wales, Cardiff		Infection Suspected/Confirm
1WGV	University Hospital of Wales,		Congenital Anomaly Suspect

Figure 26 – Term Babies

To build on the previous chart, clinicians also wanted to check if babies were being born in the units they were booked in for. Figure 27 below shows the chart which allows clinicians to easily drill down on those babies which have been born elsewhere and investigate why they were. This is useful as there could possibly be financial implications if a baby is born in England and is a fast way to investigate to mitigate this.

Booking Units & Care Locations							
Booking Unit	Bronglais	Glan Clwyd	Glan Clwyd Hospital	Glangwili General Hospital	Neonatal unit	Nevill Hall	Nevill Hall Hospital
Ysbyty Ystrad Fawr						4	
Ysbyty Gwynedd, Bangor		270		1			
YSBYTY GWYNEDD HOSPITAL (YG NHS TRUST)							
YSBYTY GWYNEDD		1					
Ysbyty Glan Clwyd		53					
YSBYTY GLAN CLWYD		23					
Yeovil District							
Wythenshawe Hospital		1					
Wythenshawe		2					
Wycombe Hospital		1					
Total	118	3082	2	1971	2	2331	2

Figure 27 – Booking Units

Accessibility was another major factor which had to be considered while designing the dashboard. To aid with this, alternative text is just one additional feature that has been

included. This provides screen reader users with a description of the information they are consuming, to ensure they understand what the dashboard is trying to communicate. Also, as previously stated, the colours and text have remained the same due to both NHS policy and consistency but were kept to a minimum with a clear background, to make the dashboard easier for users to read and distinguish items on the dashboard [9].

4.5 Summary

The design and development phase of the project looked to establish strong relationships with stakeholders and understand their requirements using a MoSCoW analysis. This was followed by exploring GDPR guidance and ensuring the network was compliant with this. An MVP dashboard was created using the principles and literature reviewed, for example the principles which help produce a well-designed dashboard. This was deployed and presented to stakeholders for feedback, which showed that their requirements were met, with some further recommendations and improvements for future iterations which are detailed below.

5 Testing & Feedback

Throughout the entirety of this project the implementation stage has progressed in an agile way by creating the dashboard in an iterative style and using a feedback loop to continuously build to the specifications of the stakeholder requirements. This makes sure stakeholders can realise benefits quickly with an MVP product, but also that improvements can be made more efficiently. Once the MVP was created it was presented to stakeholders to use and provide feedback so that improvements could be noted and prioritised in a backlog. Below outlines some of the improvements that were made to the MVP and why:

5.1 Star Schema

A star schema is a structure, or sometimes referred to as a model, which uses fact and dimension tables that all link together to provide extra information when needed. It's called a star schema due to the fact table being the table in the centre of the diagram and the dimensional tables branching out from it. The fact table contains the measured or aggregated data of the database, where the dimension tables contain attributes of the data and are related via the Primary Key / Foreign Keys [29]. The figure below shows the star schema that was implemented for the dashboard.

The advantage to introducing a star schema is that it allows the dashboard to produce reports faster, due its simple design and reduction in having complex table joins. This in turn allows simpler insights and analytics to be generated [33].

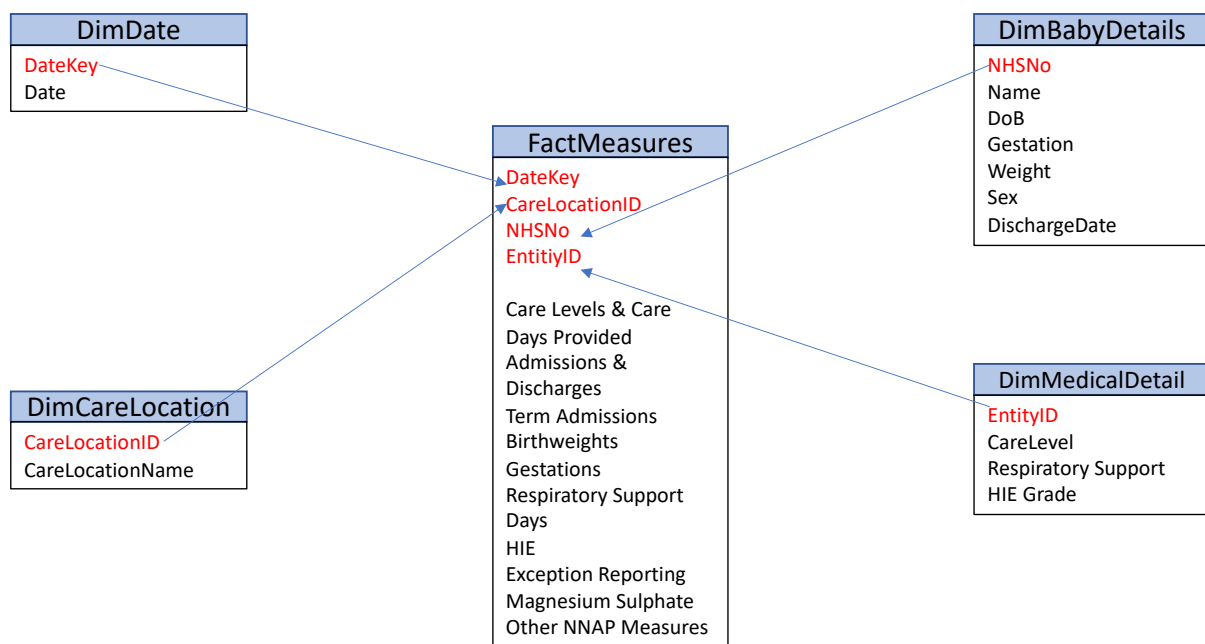


Figure 28 – Star Schema Design of Neonatal Data

5.2 Improvements

The first bit of feedback received was to seek a way of speeding up the dashboard for the end user. The dashboard was built using Access flies and creating an ETL process within Power BI. This has been resource heavy on the CPU and RAM of the laptop, causing the dashboard to respond slowly to any interaction from the user.

After discussions with DHCW, and in addition to the star schema being introduced, Visual Studio was installed on the laptop which enabled the ETL process to be streamlined and run out of Power BI itself, meaning the data behind the dashboard in Power BI was there readily available. This was achieved with the SSIS package within Visual Studio (see figures 29 - 32) and has led the dashboard to be much more efficient, allowing clinicians faster access to the data they need.

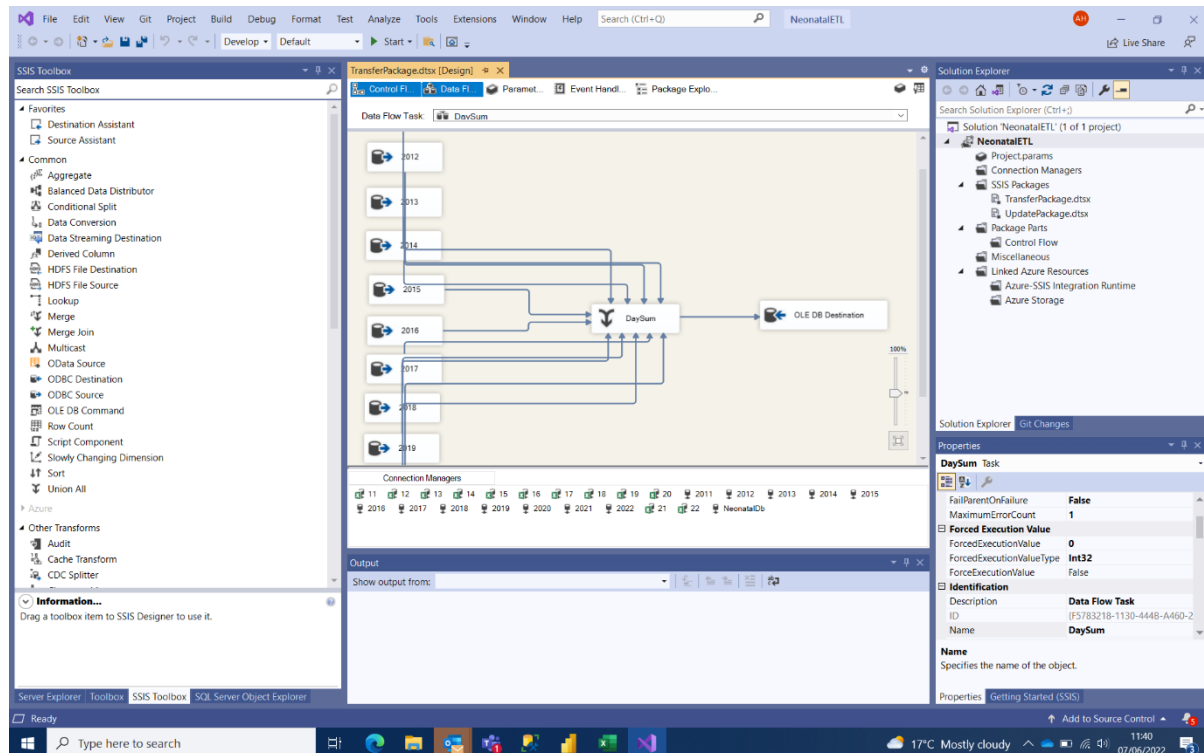


Figure 29 – ETL Package Union all data sources within Visual Studio

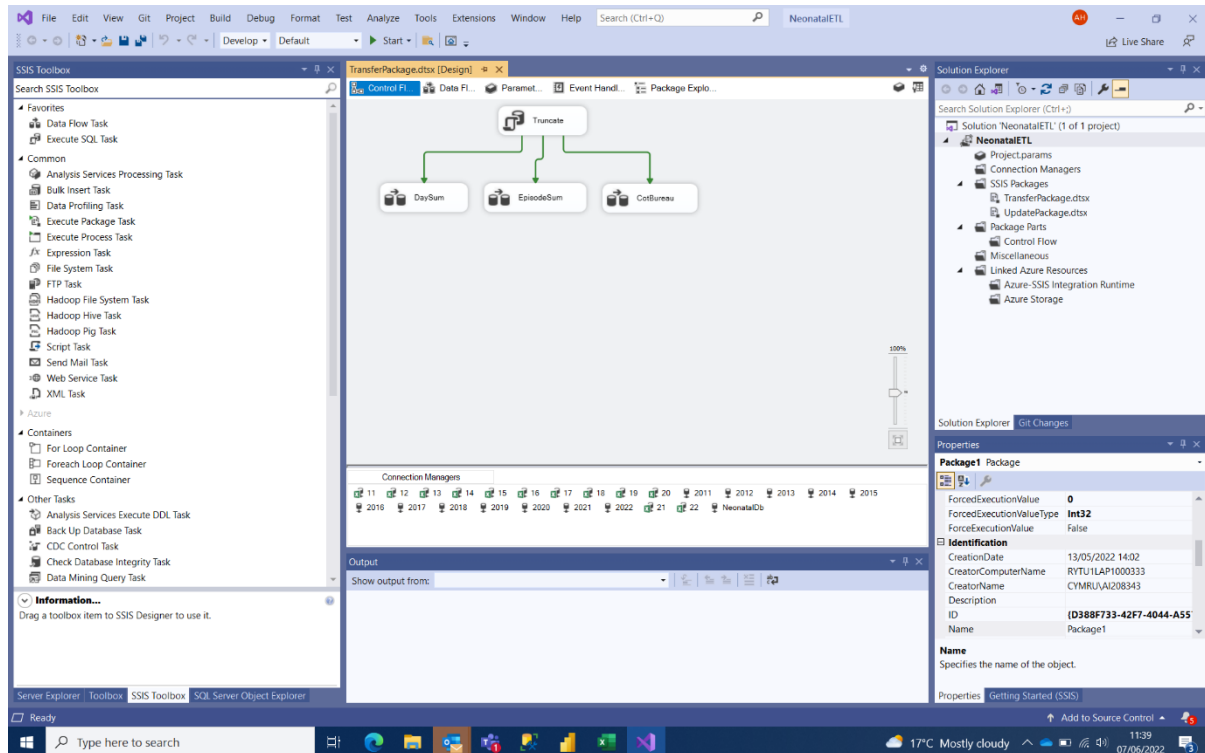


Figure 30 – ETL Package loading to local SQL DB within Visual Studio

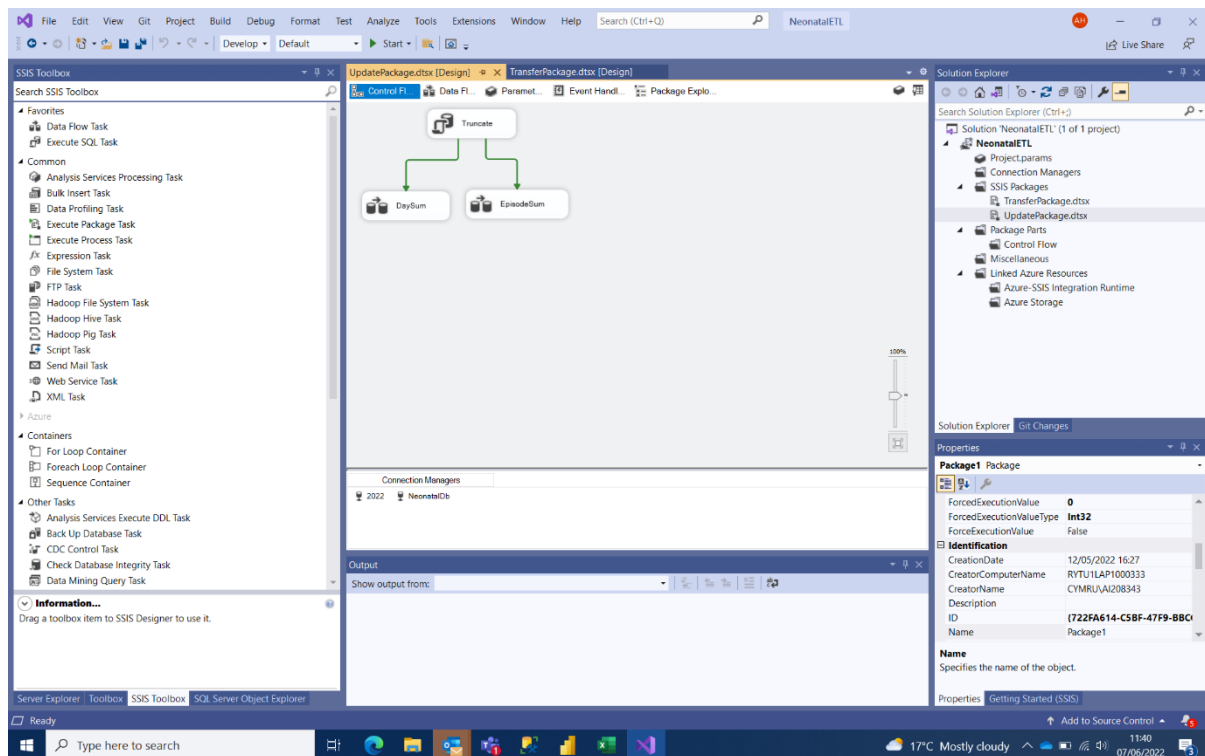


Figure 31 – Update Package loading to local SQL DB using a stage table within Visual Studio

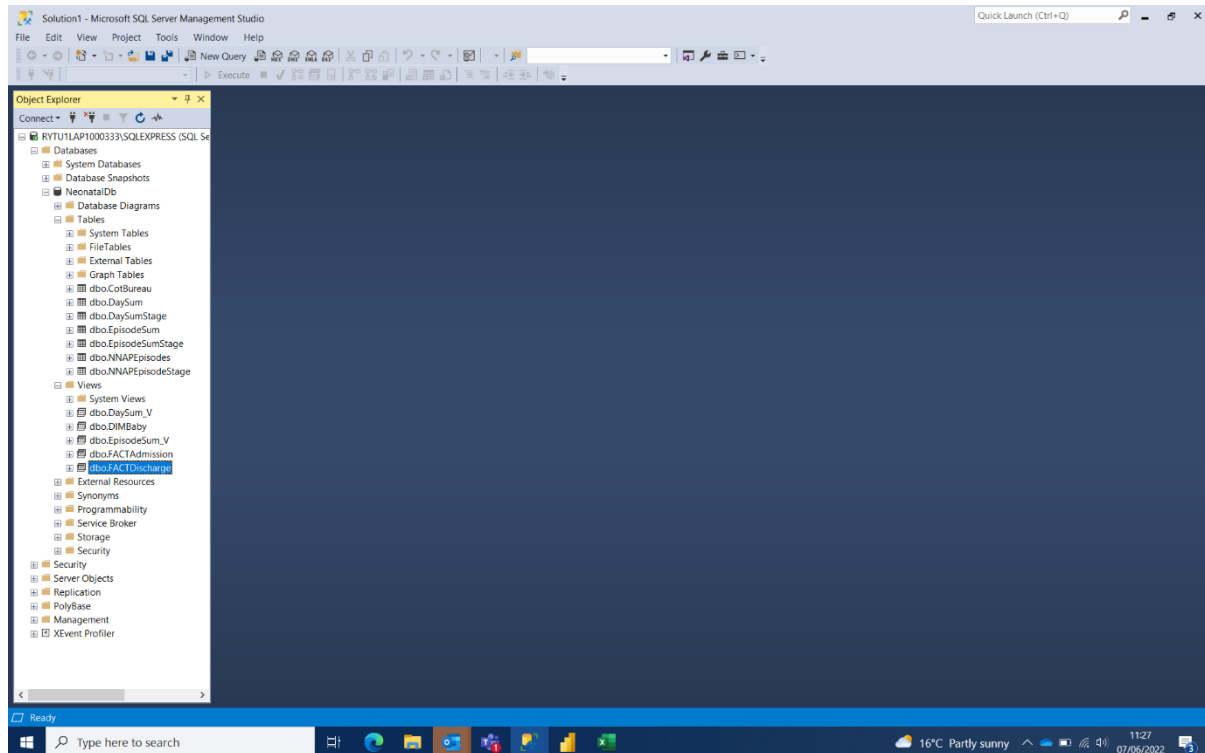


Figure 32 – Screenshot of Local SQL Server showing Tables created from ETL Process, Facts and Dimensions Ready for Import into Power BI

Another piece of feedback was in relation to how data was being fed back on the dashboard. The MVP dashboard just showed a variety of measures and highlighted some headline figures. The project group discussed that they would find more value in the dashboard that looked at the measures using a RAG rating style, as well as looking at the NNAP measure as SPC Charts. SPC Charts allows clinicians to view NNAP measures within control limits (usually set at $3 \times \Sigma$) over time, which is to help with quality improvements and shows visually any variation.

Off the back of this feedback further iterations of the dashboard were created, with figure 33 showing the new landing page for the dashboard. The top banner has remained the same, with the exception of the filters being removed as they have become redundant on this page. The chart displayed on the landing page now contains the standards for agreed measures along with their RAG status' as a benchmark for how the network is performing. The left-hand side panel now contains buttons to allow the user to switch between the various groups of measures that this chart shows.

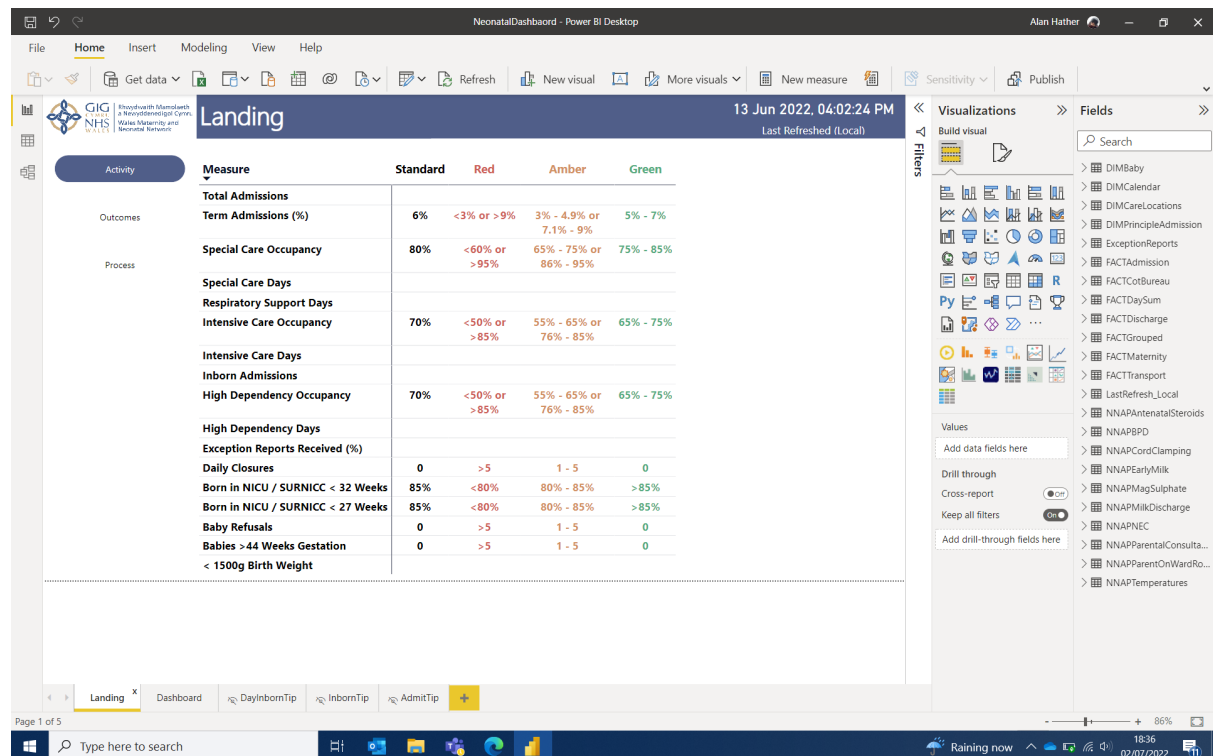


Figure 33 – Power BI Landing Page showing RAG Ratings

Switching to the dashboard view (see figure 34) through the bottom tab, we can see that the design has remained consistent with the banner at the top, now also including the filter from the initial MVP. This consistency between pages makes navigation quicker and easier for users, while also meaning the pages look part of the same dashboard. The chart shown here contains the figures for the various measures required over a set time period, with figures highlighted red, amber or green dependent on where they sit in their RAG status’.

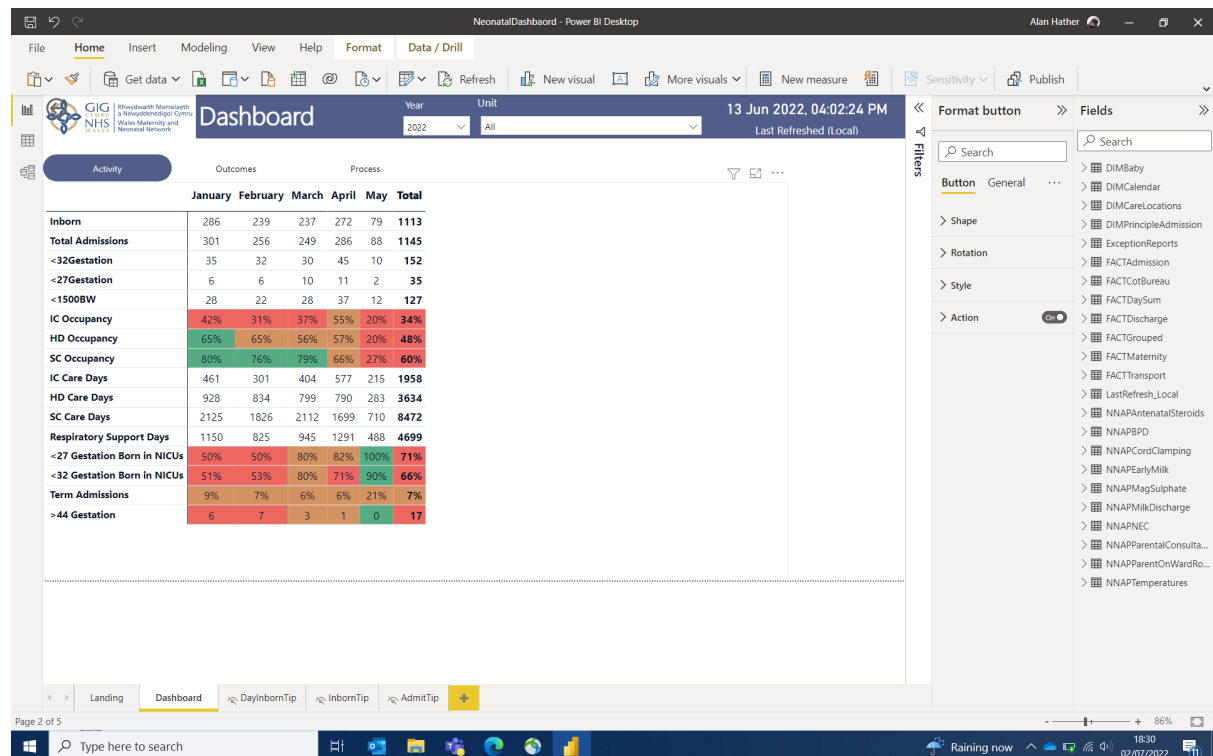


Figure 34 – Power BI Dashboard showing RAG Ratings for Activity

Again, users can switch between the groups of measures by selecting one of the buttons above the charts (see figure 35). Although MgSO₄ is captured in a separate dashboard, as described below, the measures for this have also been incorporated in this chart so that they can be monitored over a monthly basis, meaning issues can be identified much quicker.

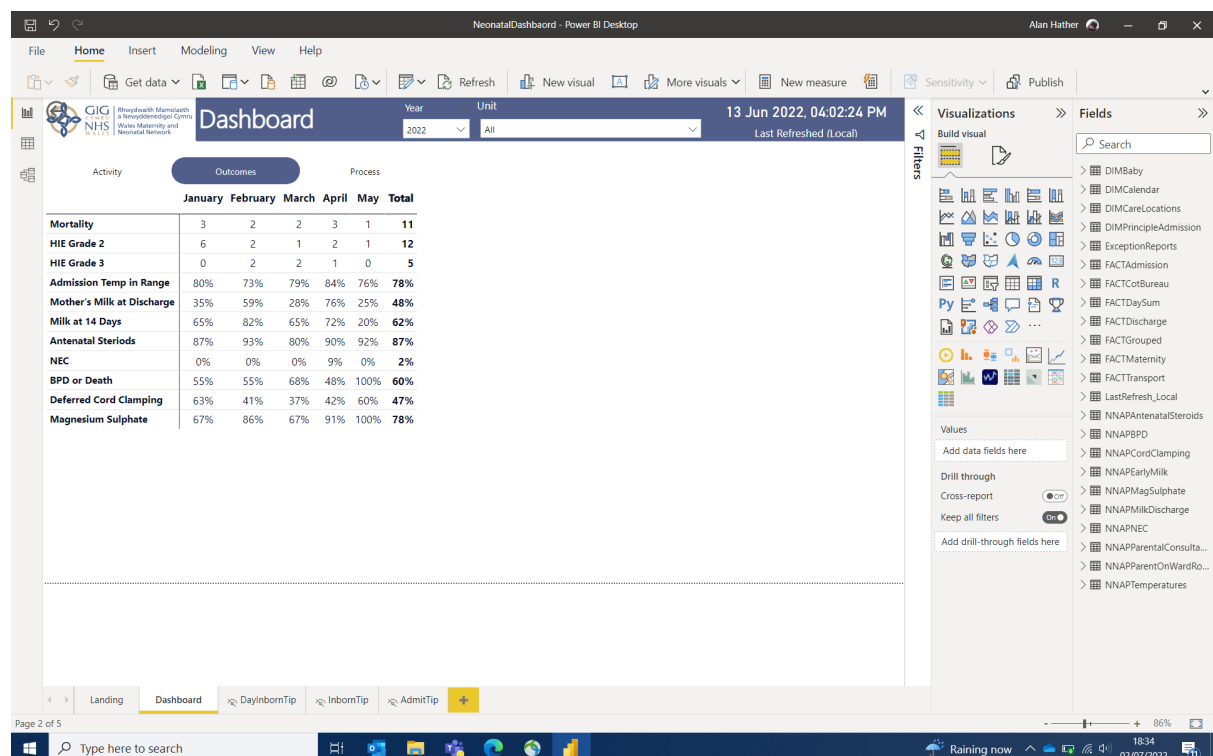


Figure 35 – Power BI Dashboard showing for Outcomes (Magnesium Sulphate)

A dashboard was created in addition to the previous dashboard to solely provide NNAP measures. Figure 36 below shows one page of the dashboard that has been created to track the MgSO₄ data. Measures here are monitored on a yearly basis through the use of SPC charts as previously explained. Care has been taken to ensure consistency across the dashboards i.e., the same colours and fonts, a top banner with filters etc.

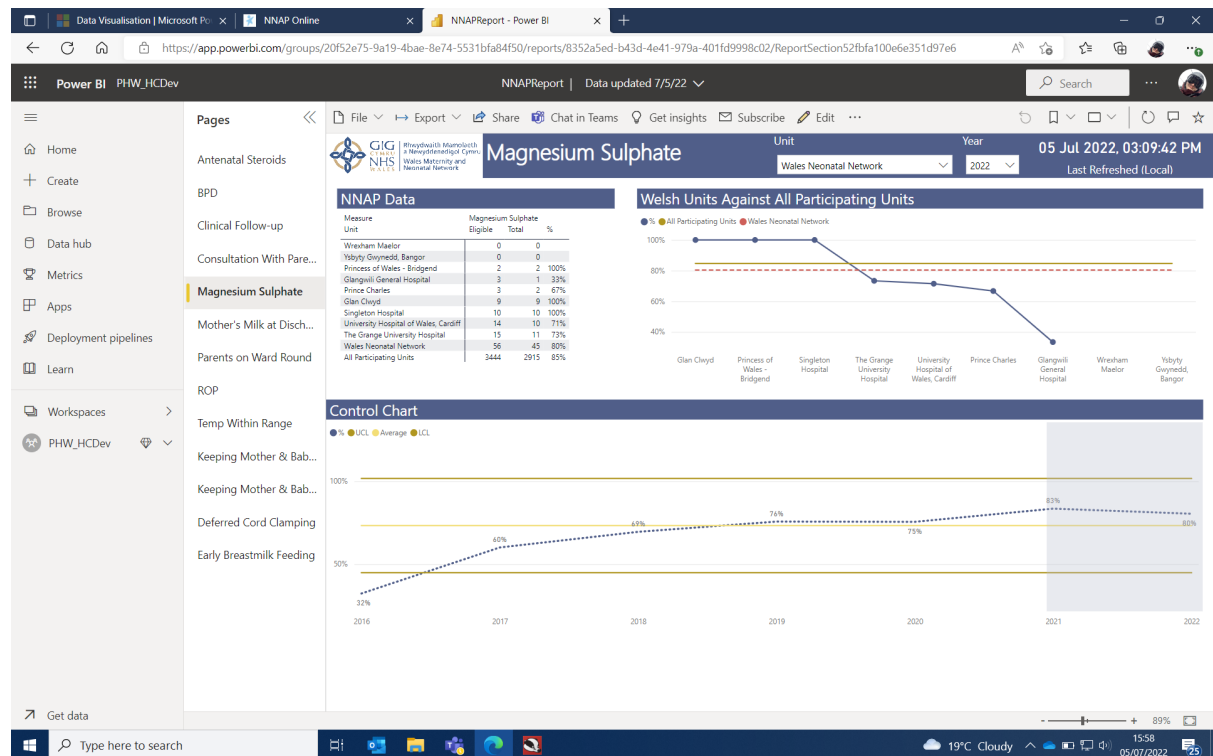


Figure 36 – Power BI Dashboard for NNAP Data (Magnesium Sulphate)

The SPC chart below (see figure 37), shows the progress of administering MgSO₄ for Wales. The highlighted sections of the chart are unpublished data so this is a predication of what the rate will be in these years. This is calculated using the NNAP methodology and is updated accordingly if this changes. Having this ability is a big improvement, as being able to monitor and predict any dips in progress can be detected early and be rectified accordingly. The SPC chart also uses a filter to change the unit, so they have a view of their own progression.

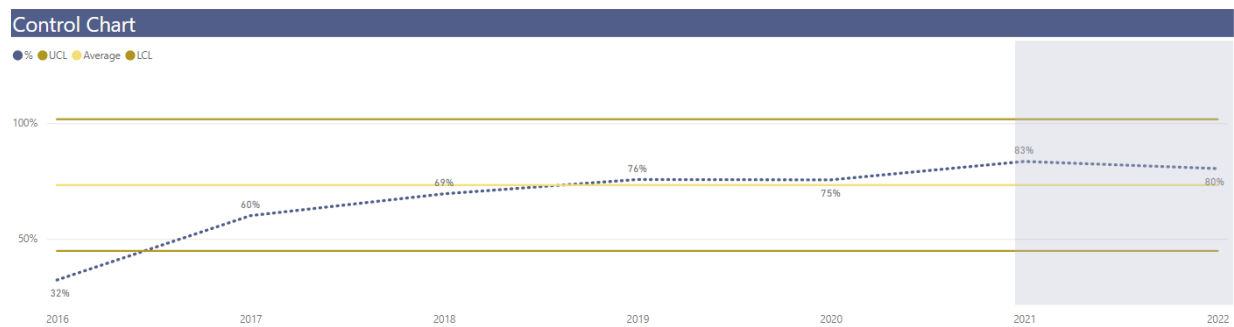


Figure 37 – SPC Chart for Magnesium Sulphate

The line chart in figure 38 shows each of the units against the network as a whole and the average for the UK, which is an easy way to show the top performing units. Clinicians can use this chart to understand any differences between their units and those top performers, to see if there is anything that can be incorporated into their own units to help improve performance.

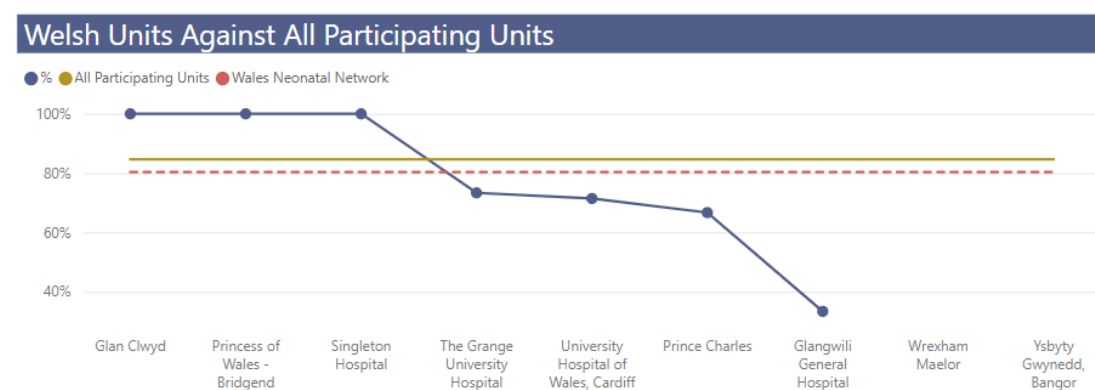


Figure 38 – Line Chart of Welsh Units Against National and Network Averages for Magnesium Sulphate

5.3 Summary

Overall the dashboard has been improved significantly through the iterative feedback loop, ensuring it has remained relevant and engaging for stakeholders. It is now much quicker to use and displays key data for them in a more useable format.

The final dashboard has been deployed and is currently shared through SharePoint for use by stakeholders in the service. Although improvements have been made to get it to its current state, standards move and priorities change so an open forum is still there for any further developments that may be needed.

6 Evaluation & Conclusion

As discussed in the research question previously proposed it was evidenced that incorporating a BI solution within an organisation can lead to improved patient outcomes, and that Power BI was the most viable solution within the NHSWHC to do this.

Building on and researching this further, one case study of a dashboard being implemented within the wider NHS, provided strong evidence of how this solution brought efficiencies to the network and in doing so ended up with better service for patients, improving their outcomes.

Also presented through a case study was the impact administration of MgSO₄ in mothers antenatally can be to the outcomes of their babies. A programme was set up to increase the rate of administration and in England alone it was seen that compliancy increased with an estimation that the project prevented 48 cases of Cerebral Palsy, which over those patients' lifetime could potentially save the NHS £38.4 million.

This research provided a solid basis for the proposed implementation of a dashboard within the Neonatal and Maternity network, with the PreCePT programme a great example of a measure which could be tracked within it to help improve patient outcomes.

Choosing the right research and developmental methodologies were also crucial in helping to shape how the project was initiated as well as the design and outcomes of the dashboard. In particular, having a strong relationship throughout with stakeholders and producing the product in an iterative fashion allowed the dashboard to be created to the exact specification they required, presenting the data in the most usable way. This along with a careful consideration of design and stakeholder's toolset i.e. Teams, SharePoint ensured that the dashboard was accessible and once the finalised dashboard was implemented and data had been collected over a period of time, this could begin to be utilised by stakeholders. This is shown through the below results which have been realised through the help of this project.

One example of where patient outcomes are being improved is with the Magnesium Sulphate case study. From figure 37 above it can be seen that the compliancy rate has been increasing over the years, partly down to increased awareness and training of staff but also due to the dashboard giving the network easy visibility to monitor and push this agenda forwards.

Figure 39 below shows the potential cost benefit that could be realised from this improvement in patient outcomes, which is quite a substantial amount to be reinvested elsewhere. The data does however show that there are still improvements to be made as Wales is still under standards, which is something that has been highlighted and interventions are being put in place.

Year	Eligible Babies	MgS04 Received	MgS04 Missed		% Received	% Missed
2016	147	50	97		34%	66%
2017	171	92	79		54%	46%
2018	152	101	51		66%	34%
2019	163	121	42		74%	26%
2020	158	117	41		74%	26%
2021	161	134	27		83%	17%
2022	54	42	12		78%	22%
Totals	1006	657	349		65%	35%
Cost of Dose	£1,006	£657	£349			
Cost of Care	£804,800,000	£525,600,000	£279,200,000			
Lifetime Cost of Care		£800,000.00				
Cost of Dose MgS04		£1.00				

Figure 39 – Magnesium Sulphate Tracker

This isn't the only area of the service which is now having improvements being made to it. As discussed previously, other measures have also been created and are tracked within the dashboard, for example the parental consultation NNAP Measure.

Stakeholders have been able to identify through the dashboard that this has started to decline (see figure 39), but as this has been picked up early enough, interventions can now be put in place to maintain a high level of care for patients. This is important as this shows it to either be a data quality issue or that clinicians are not talking to parents about their babies. In which case these units can have support assisted to them to improve either the data quality or the communication to parents. It has also been taken into consideration that the 2020 dip could be due to COVID-19 and the pressures on the NHS during that period of time.

This is significant evidence to show that the project succeeded in making a usable dashboard for the network, that can be used to improve patient outcomes.

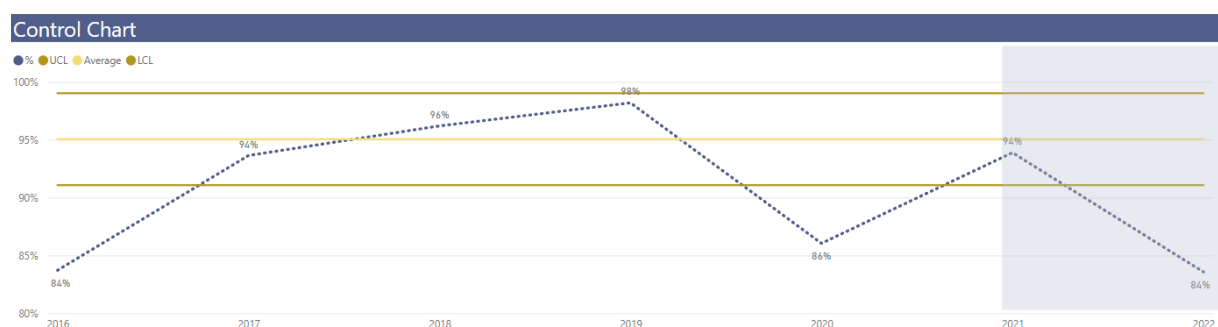


Figure 40 – SPC Chart for Parental Consultation

Overall, it is clear to see that the implementation of the dashboard is serving its purpose in helping to improve the outcomes of patients and the project itself has been well received by stakeholders. However, with all projects there have been some pain points which are worth highlighting.

- Although the project was improved through the introduction of the data oversight group, at times there was a lack of engagement from some members where they may not have an interest in data. A different approach to this could be to reach clinicians that have interest in a particular field or subject and work with them that way, increasing engagement levels.
- Inclusion from a wider network of users, would have given a better understanding of how they would want the data presented, rather than just a view from the main stakeholders. This would have saved time due to less work being needed through further developments and iterations, as these viewpoints would have been taken into consideration earlier.
- The lack of equipment or access to software has led to the dashboard crashing on occasion, but this has been rectified as demonstrated with the introduction of access to Visual Studio for ETL production using SSIS.

7 Recommendations

One recommendation that has been suggested to stakeholders is an investment into a SQL server. Currently the data is sat within SharePoint but to have a total BI solution a SQL server would be required, which would bring the following benefits:

- A SQL server would be on premisis and so would not be reliant on the internet. This means that it will use the internal NHS network and so if the internet was to go down, access would still be there to the DB and the dashboard could still be updated etc. Currently as we're reliant on SharePoint for data, going forwards there could potentially be storage constraints, due to it being cloud based.
- Security is another pitfall when it comes to SharePoint. A SQL server would make the management of stakeholder access' easier, with a hierarchy in place for role approvals. Options would also be there to generate various views for specific stakeholders etc.
- SQL server DB synchronization [30]. The network would be able to syncroinise the data with the BadgerNet system which would save the manual process of downloading data from the system itself, and create a dashboard that is more in line with 'realtime' data than before.

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