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Y Drindod Dewi Sant
University of Wales
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Recommendations for Cloud Migration & Implementation for an SME's in care homes sector

by

Gergely Somogyi

Student Number: 1814098

Supervisor:

Dr Anupam Mazumdar

Project submitted as part of the requirements for the award of BSc (Hons) Cloud Computing

November 2021

DECLARATION FORM AND FORM OF CONSENT
DECLARATION

I, Gergely Somogyi declare that I am the sole author of this Project; that all references cited have been consulted; that I have conducted all work of which this is a record, and that the finished work lies within the prescribed word limits.

This work has not previously been accepted as part of any other degree submission.

Signed:

Date:

FORM OF CONSENT

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Abstract

This project focuses on deliver a cloud-based software solution to residential care homes. Care homes with less than 40 beds can define as a small or medium sized enterprises. They have the daily routine with residents what generates data about them. These data claim to collect, store, manage, analyse. May the needs be different in every care home, but core activities and requirements all the same. All the care homes focused their resources and budget on caring, treating to make happier and easier the life of the residents. This solution expected to help the care home`s managers and nurse daily administration makes easier and deliver updated and transparent data for relatives to follow up the wellbeing of the related resident. A part of this report makes insight the cloud-based technologies as their features, advantages, and disadvantages. The paper represents research about the exist solution and their properties also. The solution will also be discussed thoroughly, with explanation of chosen software development methodology and how to get this solution what kind software were helped to gain the final version. At the end of report there will be a part for testing the solution and some parts which responsible for further improvements and personal based evaluation.

Acknowledgement

I would like to take this time to say thank you those who supported me during these three difficult and Covid-19 affected years of study.

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Copyright Acknowledgement

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1. Introduction

1.1. Introduction to the paper

This report is focuses on to deliver a cloud-based solution for care home sector members. May this sector not in primary focus od IT`s company, this not mean this sector should be out of sights forever. In the introduction parts the aim the objectives and motivation mentioned. The report shows the cloud computing attributions, benefits, and drawbacks. After search and investigate the general condition and level of IT services at care homes. The paper contains the software methodology presentation, what helps the recommended solution. Then coming the analysis of the requirements with diagrams of the outlined solutions. The design part has the description of the solution and the way to final version. The implementation section involves screenshots about the function. The testing phase looks likewise, with screenshot to show the working of the software. The evaluation part has two distinct sections, one for project evaluation, what can be the future improvements to evolve the project and one for personal evaluation, what describe the author personal and technical skill improvements during the project completion.

1.2. Aims

This project will demonstrate a cloud-based data management solution for residential care homes.

1.3. Objectives

- Review cloud services
- Investigate exist solution
- Gathering requirements
- Develop a data management web application
- Demonstrate and testing the final version
- Recommend future evaluation for evolving service

1.4. Motivation

As our course called Cloud Computing, I would like to choose some matter tight related to cloud solution. Probably this topic is one of the difficult ones, but I like the challenges and I would like to deep my knowledge the cloud linked materials. Besides my personal goals, good to think that I may help a neglected sector, being neglected in terms of information technology.

2. Review of literature and background reading

The globe is living the age where the data and the information govern and rule. Sooner or later all part of human life become a part of this data dependency. The cloud computing makes it happen, that this information is available anywhere and anytime. Beyond this features cloud computing can build up a less expensive but more reliable and secure solution for stakeholders. Perhaps care homes typically are not that place, what comes first to our mind as a cloud user. Maybe the importance or the financial situation of care homes have not predicted them to use cloud services but help of cloud technologies these premises can get better, cheaper, more reliable, and secure IT services. If the change makes easier the resident's life and care homes staff work, why would not do?

Cloud Computing is a massive bunch of services, what including many kinds of services and platforms. According to National Institute of Standards and Technology (NIST) (2011), "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models."

Cloud services is not well defined still yet. The main cloud service providers answer the question what cloud computing is as follows:

- Microsoft Azure: "Simply put, cloud computing is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence—over the Internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale You typically pay only for cloud services you use, helping you lower your operating costs, run your infrastructure more efficiently, and scale as your business needs change."
- Amazon Web Service (AWS): "Cloud computing is the on-demand delivery of IT resources over the Internet with pay-as-you-go pricing. Instead of buying, owning, and maintaining physical data centres and servers, you can access technology services, such as computing power, storage, and databases, on an as-needed basis from a cloud provider like Amazon Web Services (AWS)."
- Google: "Cloud computing is the on-demand availability of computing resources as services over the internet. It eliminates the need for enterprises to procure, configure, or manage resources themselves, and they only pay for what they use."

2.1. General overview of Cloud Services

Cloud computing extends subscription-based access to infrastructure, platforms, and applications that are popularly referred to as IaaS (Infrastructure as a Service), PaaS (Platform as a Service), and SaaS (Software as a Service) [1].

There are 3 types of service exist in cloud computing:

Software as a Service (SaaS): Software as a service is a model based on software applications hosted by the provider and available to customers via the Internet. SaaS support services-oriented architecture (SOA) and Web services model, which change the mind of people to build, buy, sell, and utilize software applications. SaaS provides a “pay as you go” licensing model. Cloud provider sustains the security, accessibility, and performance of the software to customers. SaaS most often provides software solutions to the enterprise industry at a very low cost.

Platform as a Service (PaaS): Platform as a service means developing a solution using the cloud, like having an operating system installed on the cloud. PaaS is a platform service architecture offered to customers by cloud vendors. PaaS cloud service rapidly changes the market as compared to the old times of platform, which need years of installation and pieces of training. PaaS reduces the time to a day of installation. PaaS customers are developers who are creating and executing applications for a specific platform.

Infrastructure as a Service (IaaS): Infrastructure as a service of the cloud is used to access the IT resources including applications, data, computing resources, and networks. IaaS on demand facility is very cost effective as compared to an old server of an organization. IaaS offers hardware solutions to customers in which physical resources like operating systems and middleware, is shared by virtualization to different end users. An IaaS customer uses the Application Program Interface (API) to access the virtual storage and servers and increase the control of the operating system. The customers have no control to manage the cloud infrastructure at own [2].

Types of cloud:

Private cloud: First, we consider the Private Cloud. The NIST definition is: the cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises. Private clouds are a choice for companies that already own datacentre and developed IT infrastructure and have needs around security or performance. They are a better choice for the company datacentre than Legacy servers in so many ways, bringing many benefits derived from virtualization and automation. However, they also provide Challenges and disadvantages, mostly in that the enterprise needs to migrate or re-factor applications to take advantage of the Cloud automation [3].

Public cloud: Now let us consider the Public Cloud. The NIST definition is: the cloud infrastructure is provisioned for open use by the public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider and is a form of providing public cloud services and a Cloud Service Providers business model Brings economy of scale in pooling datacentre resources, virtualization and on-demand provisioning Allows outsourcing enterprise IT infrastructure Solves/addresses disaster recovery problem Suitable for SME and agile companies. However, the Data and processing environment are not under control of enterprises, which for applications or data with a security requirement may raise concerns. Furthermore, Service Providers can't be perfect, power outages, network issues, and so on can disrupt service. Although the security and reliability of the public cloud will almost certainly exceed that of the private cloud due to the skill and staff size of the public cloud operator versus the

enterprise itself, it is not 100% fail safe. Their SLA will certainly be problematic for many enterprises [3].

Hybrid cloud: The NIST definition for Hybrid Cloud is the cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds). Hybrid cloud, while the most complicated configuration to manage, is also the most economical model for modern companies. It combines core cloud-based enterprise infrastructure and high load tasks outsourcing to public clouds. It also Combines benefits of the controlled environment in private clouds and rapid elasticity of public clouds However, it requires deeper enterprise IT/cloud modernization. Processes/workflow require re-engineering and re-architecting. And the challenges of getting seamless integration between the Private and the Public cloud can be solved but by custom work, and the issues of Compatibility, standardization and compliance are not turnkey yet [3].

Community cloud: the Community Cloud, while used by several constituencies, is something slightly different from a Public Cloud, The NIST definition is – The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises. The Community Cloud then involves cooperation and integration of IT infrastructure and resources from multiple organizations. It May serve large inter-organizational projects. For example, the scientists form many organizations at the CERN Large Hadron Collider (HC) Transcript IEEE eLearning Library Cloud Service and Deployment Models Transcript pg. 10 / 15 share a Community Cloud. It requires interoperability and compliance between member organizations and their resources, including Identity management [3].

2.2. Advantages and disadvantages of Cloud Computing

Benefits of Cloud Computing

- **Cost-effectiveness:** There are no start-up costs for using cloud-based services, businesses do not have to buy expensive hardware and software tools and data storage equipment. The service is well scalable, the maintenance of servers and other equipment is the responsibility of the service provider
- **Increased availability and data security:** The cloud providers are constantly making significant improvements and investments to be able to provide their services worldwide in the right quality. Most companies have large-scale data centres located around the world that provide high availability. Data security as an advantage can be interpreted as meaning that if our computer system crashes, our data is not on a physical device, but in the cloud, which makes subsequent system recovery easier, and the risk of information loss is lower. Different cloud providers offer reliable and flexible backup and / or recovery solutions for reasons like availability, thus providing greater security for service providers.

- “Unlimited” storage: The cloud can accommodate and store a wealth of information and data, much more than a personal computer, providing users with almost unlimited storage capacity. This eliminates the problem of running out of empty storage space and the organization providing the cloud takes care of updating and expanding the hardware and software.
- Quick installation and integration
- Device and location independency: []

Drawbacks of Cloud Computing

- Data security and data protection issues: The basic criterion of cloud services is the availability of the Internet; thus, our data is more exposed to the possibility of phishing and attack by both trained users and service providers. Furthermore, if the security protection inside the cloud is not strong enough, our data may fall into unauthorized hands due to data leakage. This is possible not only for storing our data, but also for uploading and downloading. It is also important to mention the risk of data loss, which cloud providers need to pay close attention to.
- Availability of the service: The biggest problem in this case is that the control is not in our hands. If the data on the software and hardware were in our possession, it would not be a problem if the network were to be interrupted, as we would be able to access and work with our data and work in the same way. On the other hand, if our data is in the cloud, the continuous availability of the system always remains a critical point, because if an electronic error occurs, such as a power outage, or if the Internet is interrupted, users would not be able to access their data.
- Availability of skills and workplace culture: When an issue occurs, the users must contact the cloud provider and wait them to fix the issue. This is a problem because for some support you also must pay more money [18].

2.3. Evaluating existing examples

A care home IT resources is usually limited. SEHTA surveyed 9 members of Surrey Care Association (<http://www.surreycare.org.uk>) and The Kent Integrated Care Alliance (<http://www.kica.care/>) in 2014. The results were as follows:

- 100% of the respondents communicated via email
- 67% of the respondents had a website
- 22% of the respondents supported social networking
- 22% of the respondents used electronic care records
- 67% of the respondents provided fall alarms
- 33% of the respondents used movement sensors to automatically turn lights on and off
- None of the respondents used location sensors to track clients or staff
- Only one respondent used GP video conferencing and another used telephone conferencing
- 56% of the respondents secured their property using digital locks

- One care home provider used fingerprint activated digital locks, another used facial recognition technology, and another used CCTV.

Knowing the cloud computing benefits and possibility but considering the care homes IT resources and financial limitation, the recommendation solution should be a public SaaS service. SaaS because IT cost should be kept as minimum as possible, SaaS is the cheapest of each architecture. Public because the in this case care homes do not have to invest network devices, servers. The “pay-as-you-go” model specifically conducive care homes because their needs typically not high in terms of bandwidth, CPU usage, number of users. The IT cost can be reduced to end-user devices (laptops, tablets, smartphone) and a strong and reliable internet service.

2.3.1. Existing solution

The list of software or solution what designated to care homes is quite long. They are offering plenty features and services. The range of the origin of this provider is so wide, the following table contains some of them and the services they offer.

Name	Resident state record	Payment	Relative's access	On premises software	Cloud based	Pricing (Flat rate services)
Ables Systems [5]	✓	✓	✗	✗	✓	£ 80 pcm
CareDocs [6]	✓	✗	✓	✓	✓	No data
Found CRM [7]	✓	✗	✗	✗	✗	£ 200 pcm
Log my Care [8]	✓	✓	✗	✗	✓	Free core app
PredicAire [9]	✓	✓	✓	✗	✓	No data
StoriiCare [10]	✓	✓	✓	✗	✓	£ 90 + £ 3/resident pcm

Figure #1: Table for comparison of care home software (source: author)

Residential care homes can be categorized in six class based on how they use cloud-based IT solution as shows the Figure #2.

Type	Description
Type 1	Not using any IT based technology in daily basis
Type 2	Using paper-based data recording
Type 3	Using distinct software's for different tasks
Type 4	Using a complex in-house software for all the tasks
Type 5	Using some cloud-based service for a particular task
Type 6	Using a complex cloud-based software

Figure #2: Residential care homes categories based on using cloud-based IT solutions (source: author)

2.4. Software development life cycle

The software development lifecycle consists of 4 main steps:

- Collection of requirements, specification
- Planning
- Development, implementation
- Testing

Depending on how these four elements relate to each other, we distinguish different methodologies. Without structured guidance, developers can suffer from customers' ever-changing requests, and even more so when there are miscommunications. This leads to frequent revision in the software without considering the overall implications of the project.

Examples of the most common software development methodology:

Agile Development Methodology

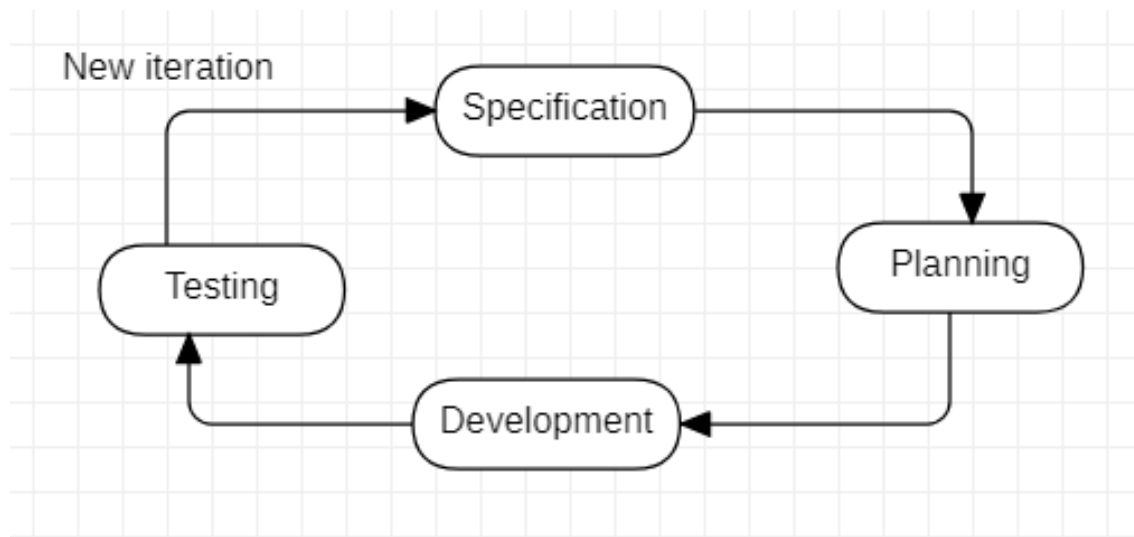


Figure #3: Agile Methodology diagram (source: author)

Agile methodology is an extreme example of iterative methods, an iteration consists of up to 2-3 weeks. It points out that in many cases the requirements are constantly changing, and it is not possible to prepare for the future. Therefore, the goal is to have a working software ready as soon as possible and customer / user feedback to help with further planning. One of its most popular uses is in creating websites and apps.

Benefits

- Software has minimal defects due to the iterative effort in testing and fine-tuning.
- Clarity between team members during development, thanks to the frequent and transparent development.
- Changes in project requirements are easily addressed and work on with little impact on the timeline.
- An overall improvement on the deliverable's quality.

Drawbacks

- The team can sometimes lose focus due to overwhelming change requests.
- Documentation takes a back seat in Agile, which can be a problem later in development.
- Agile focuses on discussions and feedback, which can be too time-consuming for the team.
- Due to its non-structured approach, Agile requires experienced developers who can work independently [13].

Waterfall Development Methodology

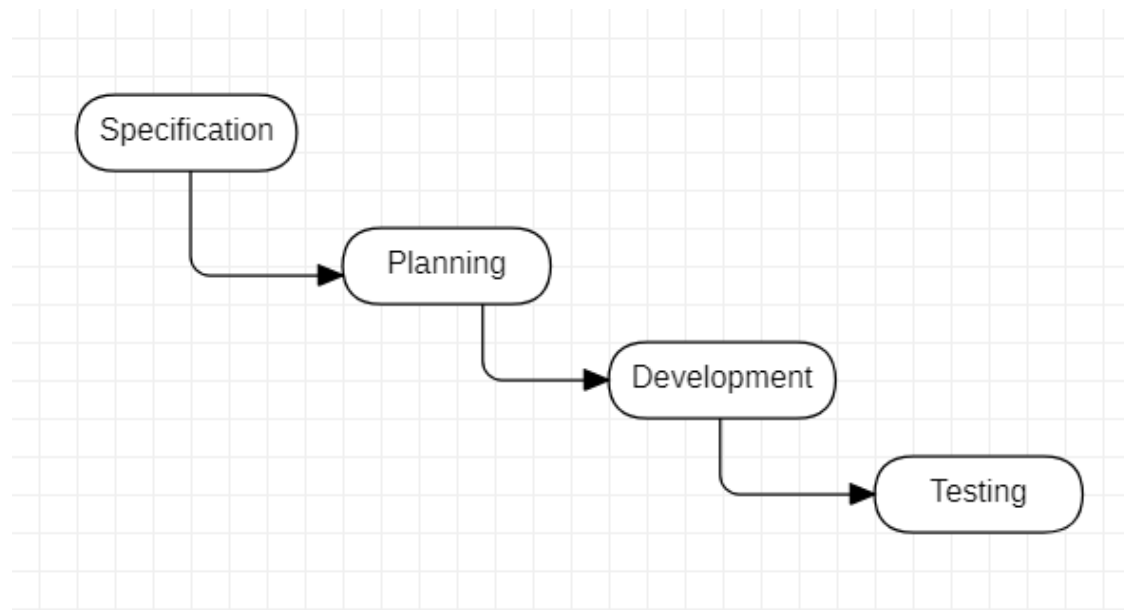


Figure #4: Waterfall methodology diagram (source: author)

It is a naive idea that this method makes sense, as how to start designing without specification, how to test without ready-made software, and so on. The biggest problem with the method is that it assumes that all previous steps were correct, flawless. In practice, however, we often find design flaws in development, and even changes in specifications. Returning to a previous phase, on the other hand, means throwing away the work done so far.

Benefits

- The linearity of the waterfall model makes it easy to understand, particularly for new developers.
- All specifications and deliverables are spelled out before the development commence.
- There's no room for miscommunicating information with the waterfall model as it's clearly defined in each stage.

Drawbacks

- It doesn't include customer feedback in the early phases, which increases the risk of the project veering off target.
- Testing is only executed at the end of the development. Some problems are harder to fix at a later stage.

- The rigidity of the waterfall model gives no room for changes, making it unsuitable for complex projects.
- The team can spend too much time on documentation instead of delivering solutions that solve the user's problems [14].

Prototype Development Methodology

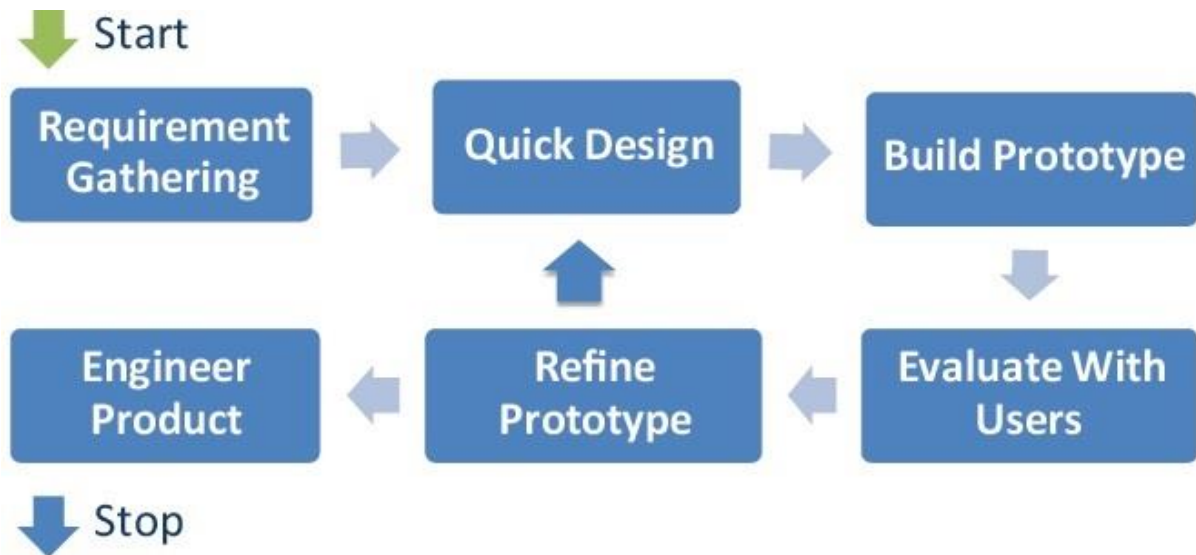


Figure #5: Prototype methodology diagram (source: <https://prototypeinfo.com>)

The prototype model is a response to the failure of the waterfall model. The development companies have realized that it is untenable for the waterfall model approach that the user will only encounter the system at the end of the project. It was only then that it became clear that the parties had misunderstood each other at the beginning of the life cycle and that a system that did not meet real requirements had been born. To avoid this, the prototype model says to deliver several prototypes before the final handover so that misunderstandings are revealed as soon as possible, and the customer can see what to expect from the system. The prototype-based approach to development is since the customer's business processes and requirements cannot be fully understood. Not just because they change over time (see agile methodologies). The requirements should be refined using prototypes. When a user adopts a prototype, they can articulate why it does not meet their expectations and how it should be changed. In this approach, the delivered system is also a prototype. This approach has been so successful that almost all modern methodologies are prototype-based. Iterative methods usually tie a prototype to each milestone. Agile methodologies even produce a new (see daily translation) prototype every day.

Benefits

- Good in ironing out potential issues in the early development stage, which greatly reduces product failure risk.
- Ensures the customer is happy with the 'product' before real development works started.

- Build rapport with the customer early on with the discussions, which helps throughout the project.
- Gather detailed information with the prototype, which is later used in building the final version.

Drawbacks

- Excessive to and for in testing out the prototype with the customer can delay the development timeline.
- The customer's expectations of the actual product may not align with the prototype.
- There's a risk of cost overrun as the works on the prototype are often paid for by the developer [15].

Scrum Development Methodology

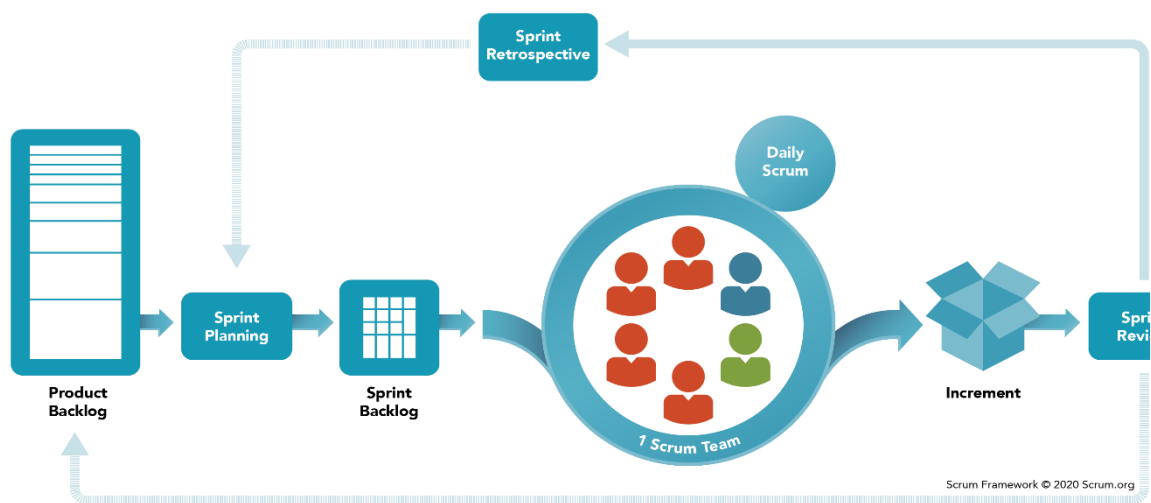


Figure #6: Scrum methodology diagram (www.source: scrum.org)

Scrum is an agile software development method. Its characteristic is that it draws its concepts from American football, also known as rugby. Such is the concept, Scrum itself, which is a brawl. The methodology attaches a significant role to cohesion within the group. There are a lot of meetings and communication within the group, there is also an opportunity to discuss problems. The recommendation is that it is good for the team to work in one place and communicate orally. The development process required by Scrum can be summarized as follows: The Product Owner creates a Product Backlog on which to add tasks as a user story. Stories need to be prioritized and told what their business value is. This is the responsibility of the Product Owner. At the Sprint Planning Meeting, team members discuss which stories they undertake to implement, preferably the highest priorities. To do this, the stories are broken down into smaller tasks so that they can estimate how long it will take to complete them. Then comes the sprint, which lasts 2-4 weeks. The duration of the sprint is fixed by the team at the beginning, it is not possible to deviate from this. If you fail to finish within the given time, you will fail the sprint, which will result in a penalty, usually a premium deduction. Within the sprint, the team and the Scrum Master discuss what happens daily at the Daily Meeting. Here, everyone tells them what they did, what their next task will be, and what obstacles (impediment) they encountered. At the end of the sprint is the Sprint Review, where the team presents the stories made during the sprint. These are either accepted or not. Then comes the

Sprint Retrospective meeting, where the team discusses issues encountered during Sprint. Concrete proposals need to be made for a solution. This is followed again by the Sprint Planning Meeting. The developed product can be put on the market before all the stories have been realized. The team includes representatives for each role, so there is also a developer and a tester. It's wrong to think that at the beginning of a sprint, the tester also writes a program, since if there is no program, there is nothing to test. In contrast, at the beginning of the sprint, the tester creates the test plan, then develops the test cases, and finally, when the classes are ready, writes unit tests and checks the changes with a regression test. Scrum, like any agile methodology, builds on the fact that customer needs may change during development. It adapts to changes so that the Product Backlog can change constantly. Documents based on this are constantly being refined, so they can be easily changed. The teams quickly implement the necessary changes. Scrum brings efficiency within a team to perfection. If multiple teams are working on a development, they may include communication disruptions, which is one of the disadvantages of the methodology.

Benefits

- Short iterations allow quick resolutions to problems.
- Scrum is very responsive to changes as the process includes regular feedback.
- Scrum is economical and effective.
- Regular meetings ensure that team members are always on the same page.
- Contributions of individual members are noticed and appreciated through the Scrum meetings.

Drawbacks

- All team members must be equally skilled and committed for Scrum to work.
- The daily Scrum meetings can be draining for team members.
- May increase time-to-market if there's no strict control on the deadline.
- Not suitable for large projects [16].

2.4.1. Chosen software development method

Considering all the listed methods above, and checking the benefits and drawbacks, my choice to develop is Prototype Development Methodology. My goal to develop a web application what provide all features what a care home needs. With Prototype Development Methodology errors can be detected at an early stage. All stakeholders can understand what remains as required during execution. This will help to change the requirement at an early stage if necessary. This helps reduce the time of development and reduce cost as well. This methodology helps to present the concepts, to test the design options, to get to know the problem better and its possible solutions. The prototype model will not work if not enough requirements are mentioned, to avoid that I am gathering and collect as many information and requirements as possible.

2.5. Analysis on Tools required

A web application is software that users can use in a web browser just as they can use mobile applications on their mobile devices. Web application development refers to the

creation of applications through a remote server that are accessible over the Internet. Web application development has evolved rapidly over the past decade. Traditional web application development consisted of creating static websites enabled by the internet. It has made the development of customized web applications more functional, easier, and more accessible. A powerful web application can add functionality, serve as an interactive tool between the provider and the user. Today, custom web application development offers a wealth of opportunities to serve any business and taking advantage of its potential is an added benefit. A web application must be distinguished from the use of the web. While in the second case we “only” use the World Wide Web, either in connection with a specific, well-defined task (e.g., we are looking for something, we correspond, we do things), or e.g. we just browse in the meantime, then we develop it creatively in the web application, that is, we create it - and then we publish a system later, which we then make available to all potential users. We can also say that with the completed system we provide an Internet service for the users and for the benefit of ourselves and the customer of the system (possibly on a non-profit basis).

Benefits of a web application

- Easy access: the web app appears in the search engine results list, it's much easier for people to find it than on mobile apps in the App Store or Google Play.
- Without installation: Instead of downloading a space-consuming mobile app from app stores, web apps can be launched from any browser, so they don't take up unnecessary storage space on your device.
- Flexibility: Unlike mobile apps, web apps aren't device-specific and can be used on a mobile, tablet, or desktop computer.

Drawbacks of a web application

- Device-specific features are limited: in case of display information that requires direct access to the features of that device, need a mobile application.
- Cannot be used without an Internet connection: web applications can only be used to a limited extent without an internet connection. Available with limited functionality by storing browser data.
- Slower loading speeds are possible: web applications load at a speed that depends on your Internet connection, so they may load slower than mobile applications. [20]

The solution requirement are follows:

- Database – Able to communicate with end users, applications, and database. It is primarily used to manage data stored in databases.
- Web page - Internet document that can be opened with a browser
- Database server - Contains a database application that provides database functionality for client applications
- Web server - Provide the necessary websites for customers
- Storage for data and backup – Hard drive what store the data and a copy of the data for backup

3. Analysis

3.1. CloudHeed web application requirements

A web application is software that users can use in a web browser just as they can use mobile applications on their mobile devices.

Main function what app provide:

- Store and collect data about resident wellbeing and daily activities
- Make payments available
- Access resident information
- Display trends and history of state of resident

This web application based on a database, what collect and store the resident`s data and payments by providing visualisation resident`s data for relatives. In the core stands the resident, with all known information about her/his state, illnesses, special requirements. Wellbeing set up is following the needs, helping nurses in daily tasks. Relatives may follow resident state, by daily updated charts and information. Relatives` other options to interact is payment system and leaving messages to the care home staff. The Figure #7 shows the Data Flow Diagram.

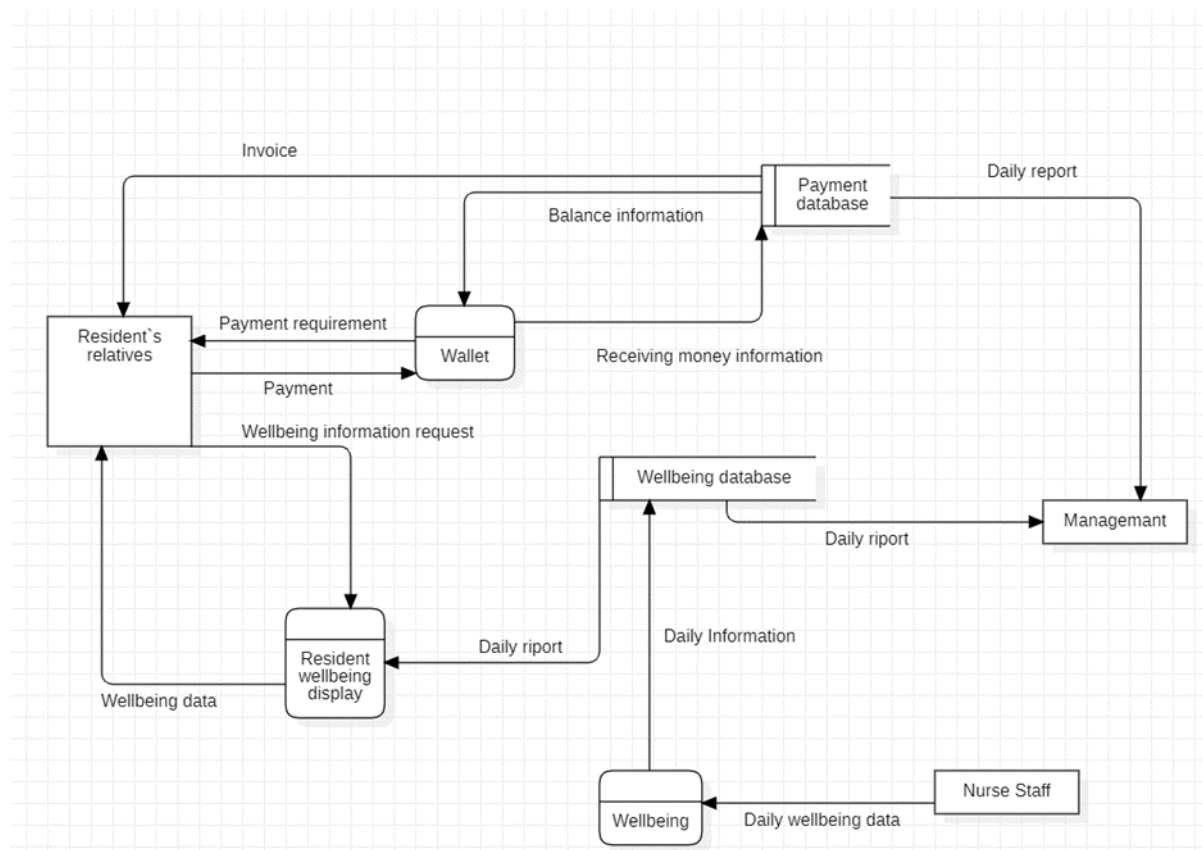


Figure #7: Data Flow Diagram (source: author)

The web application has three distinct types of users: home care management, nursing staff, resident's relative.

- Management users: Home care management has the admin access. This type of user can modify all kind of data, manage payment system, responsible new resident application, set the payment system to receive money and set the wellbeing platform for resident.
- Nursing staff users: Nurse staff has access only for wellbeing platform to record the daily activities and events.
- Resident's relatives' users: Relatives can reach the wellbeing data to watch and follow (option to send them weekly/monthly) and use the payment system to money movement.
- Admin level is existing of course to maintain and update the databases.

Figure #8 shows the User Type Diagram

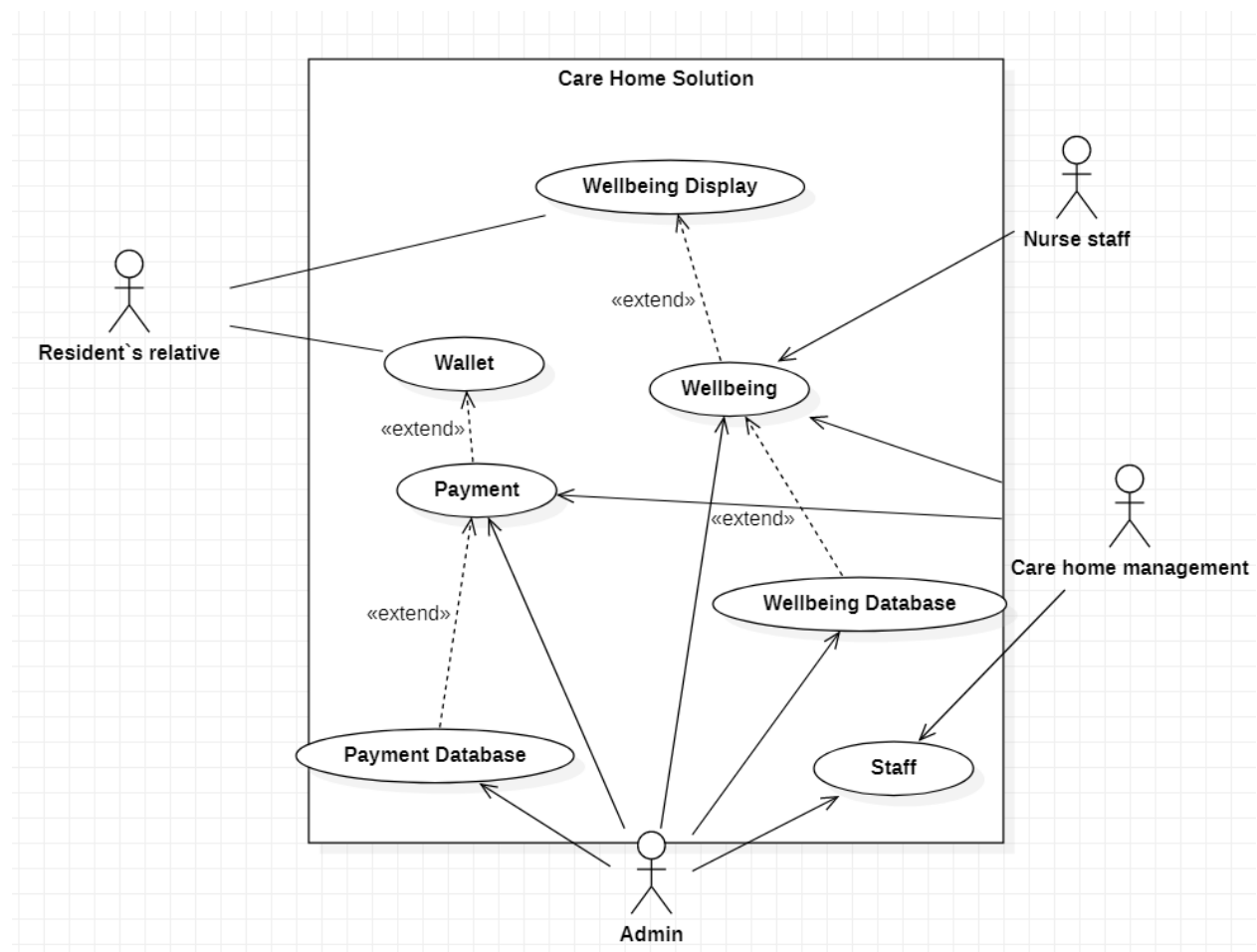


Figure #8 User Type Diagram (source: author)

3.2. System Requirements

A web application typically builds on a multi-layered (minimum of three) architecture.

There are at least three layers:

- Front End - client-side user layer (usually in a web browser)
- Middleware - server-side presentation and logic layer (usually a display and logic on a web server)
- Back End - back server-side high-capacity storage (database server) or compute layer.

Note these above, software requirement from user side is only a web browser. Depends on device the following web browser are supported:

- Microsoft Edge (latest version)
- Safari (latest version, Mac only)
- Chrome (latest version)
- Firefox (latest version)

3.3. Microsoft Azure Cloud service

Microsoft Azure is Microsoft's cloud computing platform and infrastructure for building, deploying, and running applications on Microsoft-managed data centres. The point is that each application does not run on a local workstation, but on a remote server as part of an Internet service. Developers can build their applications on the platform in virtually any .NET-based language supported by the Visual Studio environment, which Azure also provides high-level, easy-to-use tools for uploading, managing, and updating.

Some of the more than 600 services:

- Hosting
- Mobile services
- Storage
- Data management
- Media services
- CDN
- Developer tools
- Management
- Machine learning

CloudHeed web application uses the following services from Azure:

- SQL server
- SQL database
- App service

4. Design

The CloudHeed is a web application, what contain a database and a webpage. The webpage, the user interface, where users can login and can access, modify data`s depending on their rights. The data`s send to the database through dynamic webpages to reach the database. All parts of web application are provided by Microsoft Azure.

Design part is divided two parts: back-end and front-end. To back-end belongs the database, the database server, the webserver, and the application server. To front-end belongs the webpage, user interface otherwise.

4.1. Project management

Risk management matrix

Likelihood	Consequences				
	Insignificant: Risk is easily mitigated by normal day to day process	Minor: Delays up to 10% of schedule Additional cost up 10 % of budget	Moderate: Delays up to 30% of schedule Additional cost up to 30% of budget	Major: Delays up to 50% of schedule Additional cost up to 50% of budget	Catastrophic: Project abandoned
Certain >90 % chance	High	High	Extreme	Extreme	Extreme
Likely 50% - 90% chance	Moderate	High	High	Extreme	Extreme
Moderate 10% - 50% chance	Low	Moderate	High	Extreme	Extreme
Unlikely 3% - 10 % chance	Low	Low	Moderate	High	Extreme
Rare < 3% chance	Low	Low	Moderate	High	High

Figure #9: General risk management matrix (source: author)

Risk	Probability	Impact	Mitigation
Time management	High	Severe delay	Strict timetable
System failure	Low	Minor delay	Regular backups, store at different platforms
Lack of skill	Medium	Severe delay	Free, online courses and videos

Figure 10#: Project risk analysis (source: author)

Gantt chart (expected)

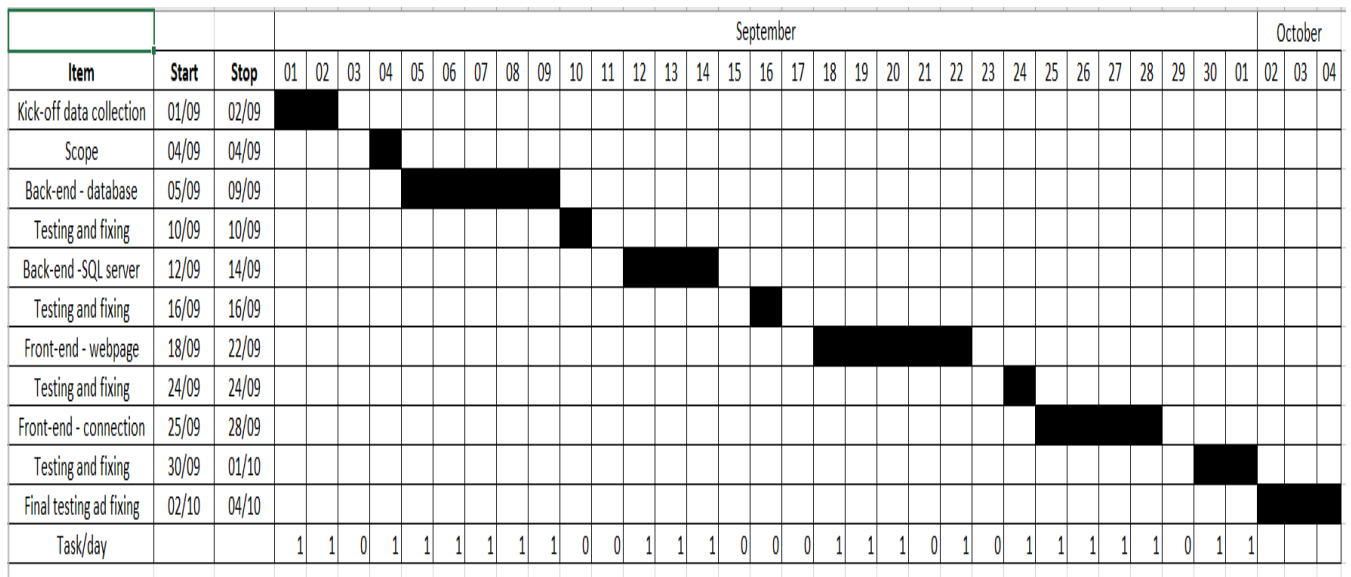


Figure 11#: Gantt chart (source: author)

4.2. Backend design

4.2.1. Database design

During designing of database for CloudHeed is an important task is to carefully plan the logical structure of the database. This process is called normalization. The different stages of normalization are described in normal forms, used normal forms are first (1NF), second (2NF) and third (3NF).

After the normalisation the following tables left, shows on Figure #12.

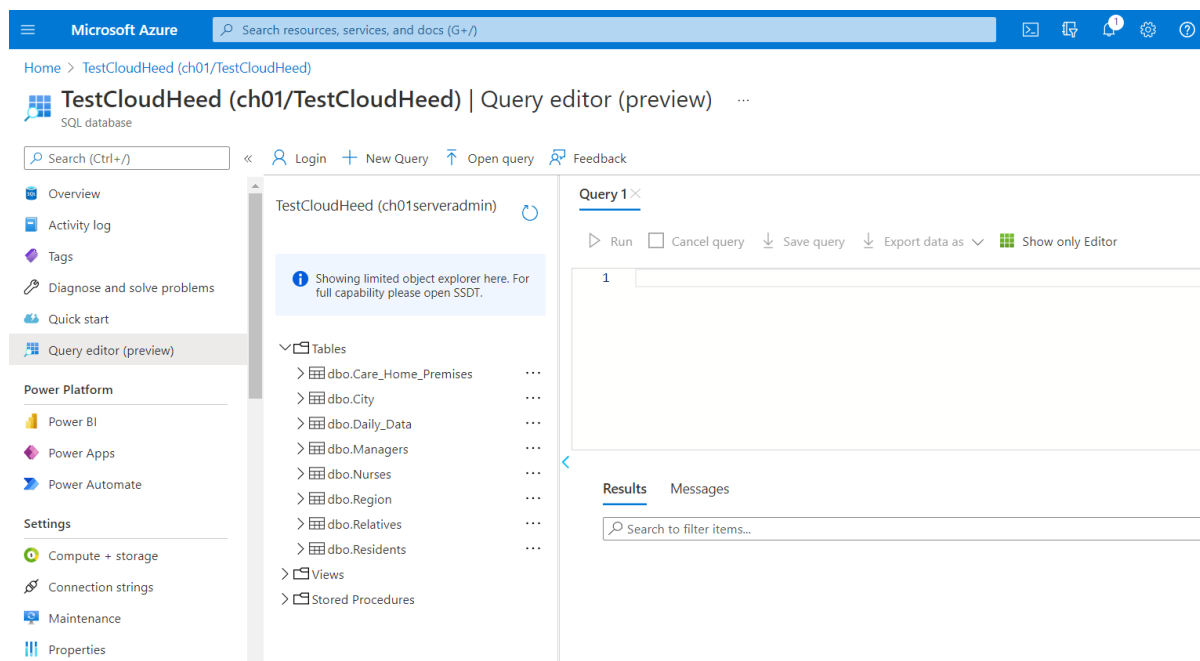


Figure #12: Screenshot about database table

The tables have the following columns:

Table name	Column's name
Region	region_ID, region_Name
Care_Home_Premises	care_home_ID, care_home_address, city_ID, care_home_postcode, care_home_phone, office_hours, visiting_hours
City	city_ID, city_name, region_ID
Managers	manager_ID, manager_name, care_home_ID
Nurses	nurse_ID, nurse_first_name, nurse_last_name, care_home_ID
Relatives	relative_ID, relative_name, relative_address, relative_postcode, relative_phone, relative_email, resident_ID
Residents	resident_ID, resident_first_name, resident_last_name, resident_DOB, relative_ID
Daily Data	resident_ID, nurse_ID, visit_time, res_temperature, res_weight, res_blood_pressure, res_pill_1, res_pill_2, res_pill_3, res_covid_test, res_notes

Figure #13: Table of the database columns (source: author)

The database has four user types: admin, manager, nurse, relative. Each of them has different rights according to their task to do in the database. The different grants shown by the Figure #14.

```

CREATE login Manager WITH password='Manpass123';
CREATE USER Manager1 FOR login Manager;

GRANT SELECT, INSERT, UPDATE, DELETE
ON Care_Home_Premises TO Manager1;

GRANT SELECT, INSERT, UPDATE, DELETE
ON Nurses TO Manager1;

GRANT SELECT, INSERT, UPDATE, DELETE
ON Residents TO Manager1;

GRANT SELECT, INSERT, UPDATE, DELETE
ON Relatives TO Manager1;

GRANT SELECT, INSERT, UPDATE, DELETE
ON Daily_Data TO Manager1;

CREATE login Nurse WITH password='nurpass123';
CREATE USER Nursel FOR login Nurse;

GRANT SELECT, INSERT
ON Daily_Data TO Nursel;

GRANT SELECT
ON Residents TO Nursel;

CREATE login Relativ WITH password='reldpass123';
CREATE USER Relativel FOR login Relativ;

GRANT SELECT
ON Daily_Data TO Relativel;

GRANT SELECT, INSERT
ON Relatives TO Relativel;

```

Figure #14: Screenshot about grants in database

4.1.2. SQL database server setup

To running a database, need a database server to setup. This server is a pay-as-you-go service, the price of the service depends on the settings. Logically, the less service and resources to select, the less price to pay. Next few figures show the setting of the SQL server.

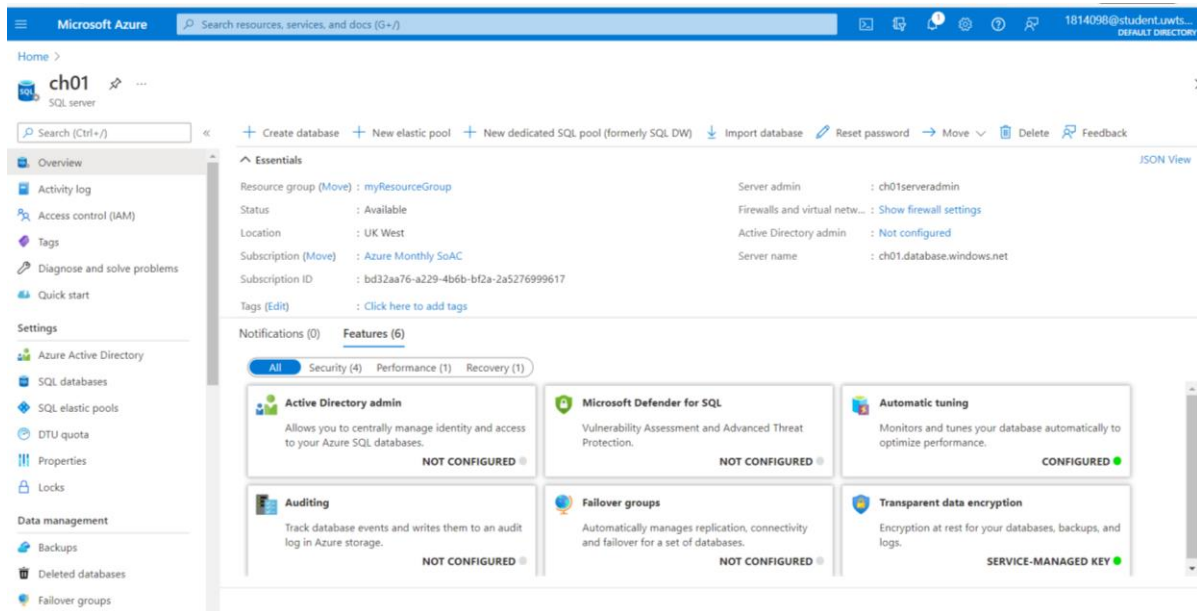


Figure #15: SQL server setup – overview

This screenshot shows the details to connection.

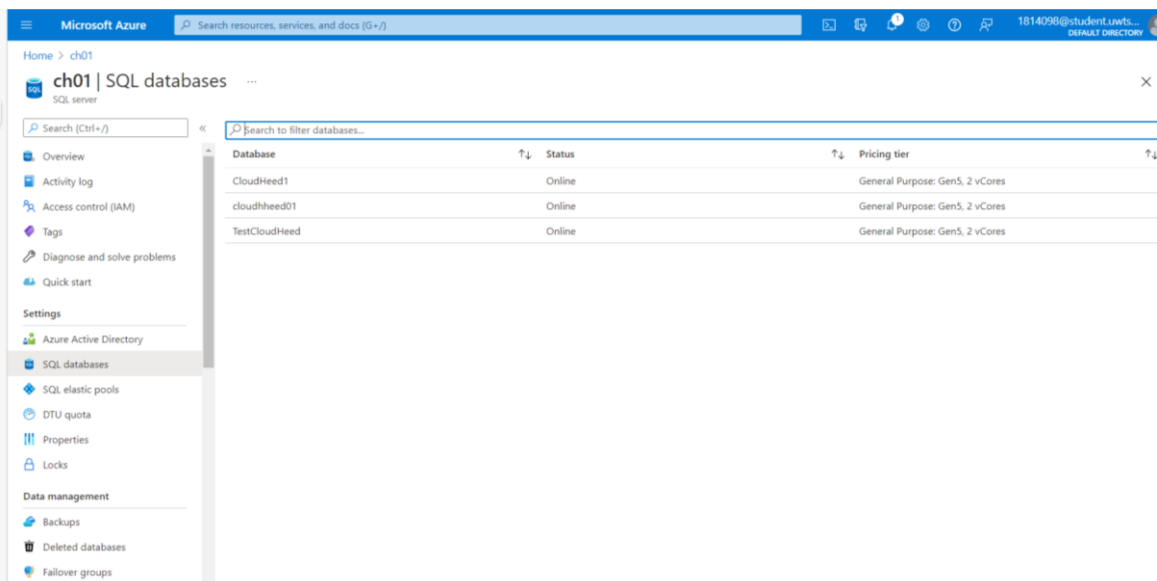


Figure #16: SQL server setup – available databases

This screenshot shows the databases what running on the server and available to work with them.

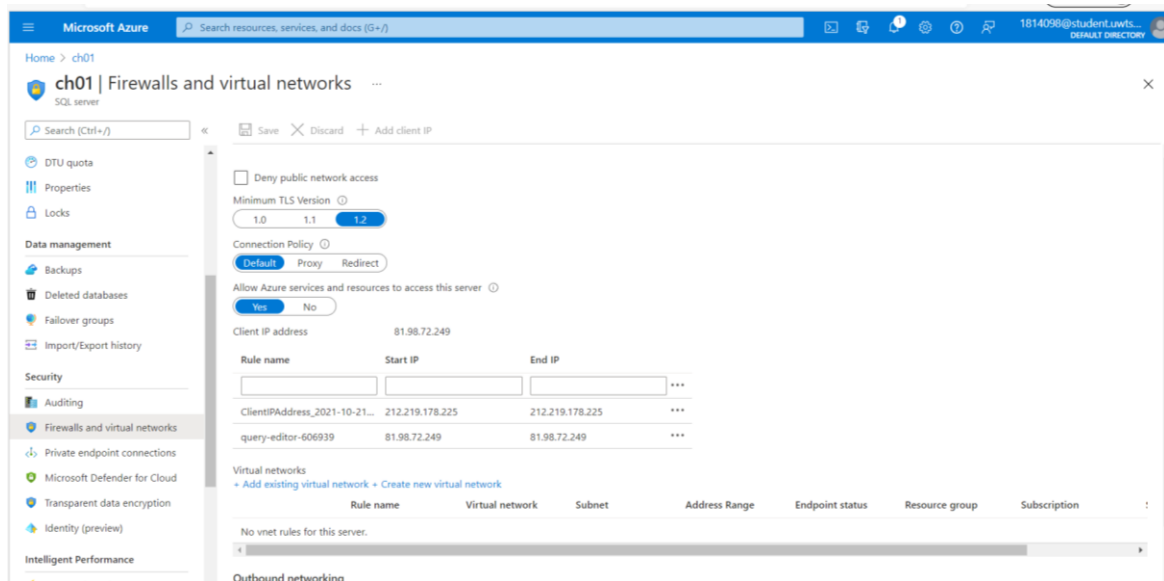


Figure #17: SQL server setup – firewall settings

An important page, to access the database. Without the proper firewall settings, the database unreachable. This is part of the security measurements.

4.2. Front-end design

The minimum requirement is responsiveness, which means that the website can adapt to the screen: to desktop, smartphone, or tablet. The responsive page is clearly visible, easy to understand and read. The next important technical requirement is speed. This is important because if the page is slow, the visitor is more likely to leave the page. Transparency is also important. In most cases, it is not worth deviating from the structure used by large websites. This is because it is easier for visitors to navigate the website if they know its structure.

About the function: user log in the webpage, fill the form for the data, press submit, and the data stored in the database. Client machines are connected to port 80 on the web server. The server is added request, that is, it looks up the directory associated with the request based on the URL, and within the index file. In case the contents of the file (in part or in throughout) PHP source code, the system calls the PHP compiler compiles it and executes the instructions in the program. Database management can be implemented at this point in the database placed in the programs using handling routines. In practice, this means that by language provided functions with the appropriate parameters in the source text we embed.

A webpage has some legal requirements what regulated by laws.

- The identity of your business
- company policies and procedures
- The right of users to grant consent for the use of their data
- Consumer protection
- Cyber security and protecting personal data

- Accessibility
- Respecting copyright

4.2.1. User interface

The front page of the web application shows by Figure #18.

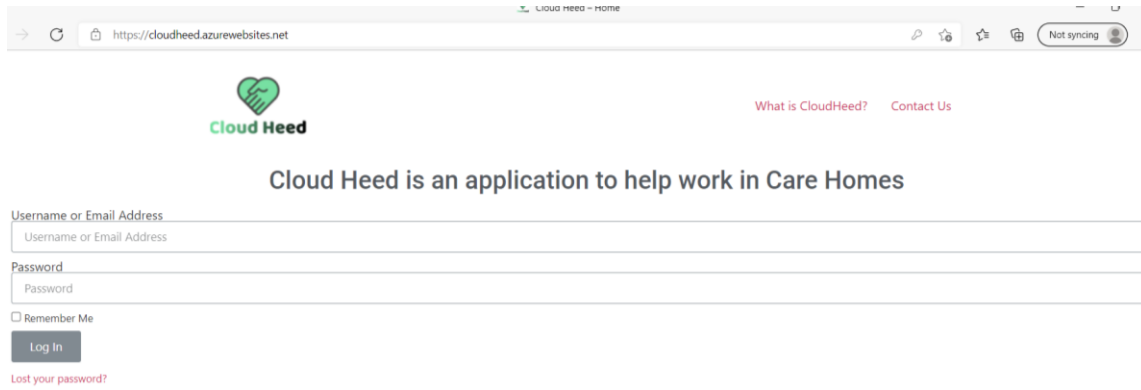


Figure #18: Front page of CloudHeed web application

Connection between the database and the webpage has not established. Expected function not working, expect login the webpage.

5. Testing

Test to non-authorized access:

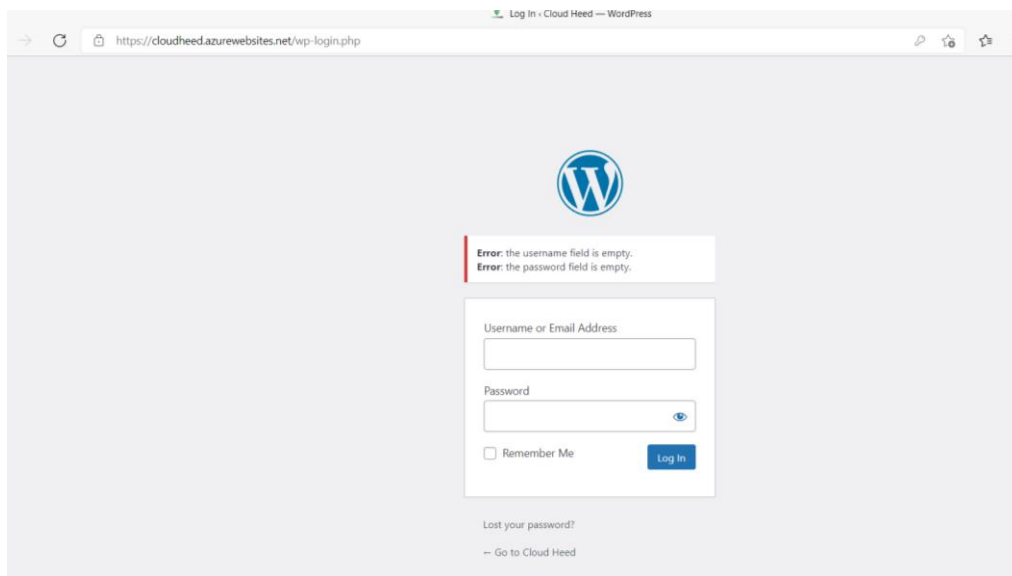


Figure #19: Screenshot about test for non-authorized access

Test to login with wrong password

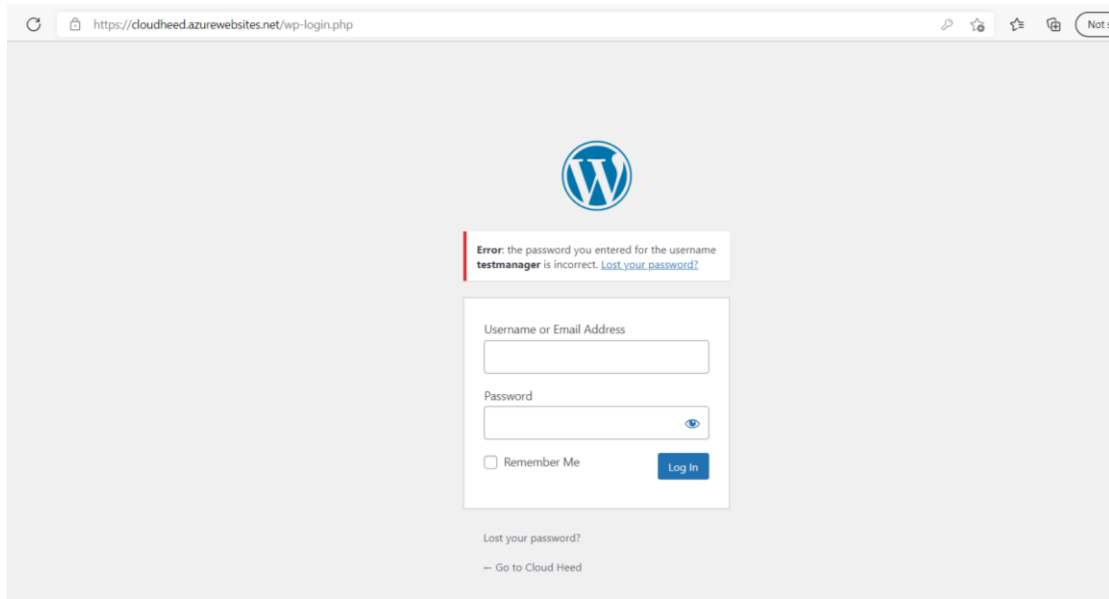


Figure #20: Screenshot about access with wrong password

Test to insert appropriate data in database

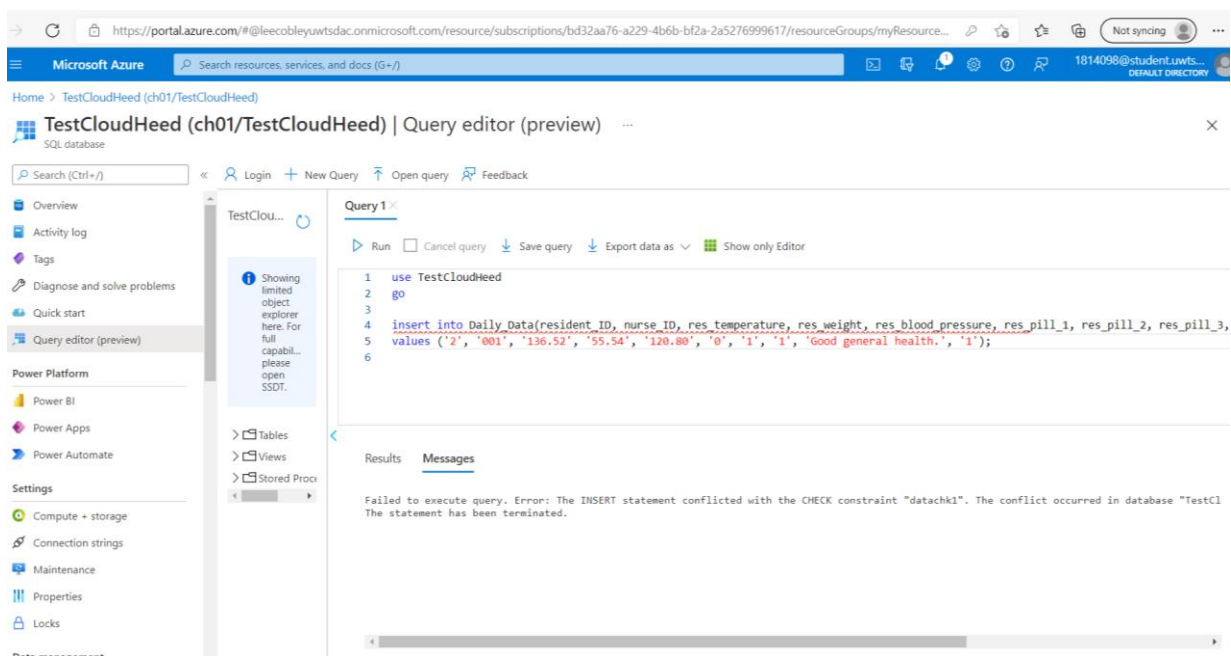


Figure 21#: Screenshot about insert an appropriate data

6. Evaluation

6.1. Personal evaluation

Meanwhile I really enjoyed the work with the project, I have strong omission, about the function are not working in the project. I have learned a lot about cloud services, especially Microsoft Azure. In the future I would like to deep my knowledge in these topics more.

6.2. System evaluation, future enhancement

The solution has many ways to improve. For example, the original plan contained a payment option for relatives. By this it would be a complex software to administer almost every process in a care home. Additional features should be a timetable extension for the care home staff about their shifts.

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