*SAG project 2023 0*



*Faculty of Computers and Artificial Intelligence,* 

*Beni-Suef University, Egypt*

**Smart Assistant Glasses**

A senior project submitted in partial fulfillment of the requirements for the degree of Bachelor of Computers and Artificial Intelligence.

**Medical Informatics Department**

**Supervisor:**

Prof.Dr. Mohammed Kayed

Dr.Abanoub Gerges

**Presented by:**

*SAG project 2023 1*

**Table Of Content**

|  |
| --- |
| Acknowledgment 5 |
| Purpose of documentation 5 |
| Abstract 6 |

**1. Chapter 1 (INTRODUCTION)**

|  |
| --- |
| 1.1 Introduction 7,8 |
| 1.2 Problem Statement 9 |
| 1.3 Objectives 11 |
| 1.4 Impact in Business 11 |
| 1.5 Ways of Marketing 12 |
| 1.6 Conclusion 13 |

**2. Chapter 2 (RELATED WORKS)**

|  |
| --- |
| 2.1 Introduction 14 |
| 2.2 Related works 15 |
| 2.3 Benefits 16 |
| 2.4 Features 16 |
| 2.5 Project Risk Management 17 |

**3. Chapter 3 (PROJECT METHODOLOGY)**

|  |
| --- |
| 3.1 Software Development Lifecycle 20 |
| 3.2 Selecting Methodology 23 |
| 3.3 V-Model 26 |
| 3.4 Application of Chosen Methodology 28 |

*SAG project 2023 2*

**4. Chapter 4 (INTERFACE DESIGN)**

|  |
| --- |
| 4.1 Introduction |
| 4.2 System Web Dashboard (Angular) |
| 4.3 Client Mobile Application (Android) |

**5. Chapter 5 (SOFTWARE ANALYSIS AND DESIGN)**

|  |
| --- |
| 5.1 Project Requirement Analysis |
| 5.2 Project Customer Requirement |
| 5.3 Project Customer Requirement Specification |
| 5.4 Project Software Requirements Specifications |
| 5.5 Project Requirements Traceability Matrix |
| 5.6 System Architecture : Android |
| 5.7 System Architecture : Frontend |
| 5.8 System Architecture : Backend |
| 5.9 System Architecture : Machine Learning model |

*SAG project 2023 3*

**6. Chapter 6 (PROJECT SOFTWARE TOOLS AND TECHNOLOGIES)**

|  |
| --- |
| 6.1 Android Studio - Kotlin |
| 6.2 Google Colab |
| 6.3 Visual Studio Code - Angular Framework |
| 6.4 Python - Flask |
| 6.5 PHP & Laravel |
| 6.6 Adobe XD (UI/UX) |
| 6.7 Mysql |

**7. CHAPTER 7 ( TESTING & Future Work )**

|  |
| --- |
| 7.1 Validation Testing |
| 7.2 Futures Work Features |
| 7.3 Reference |

*SAG project 2023 4*

**Acknowledgment**

Firstly, we would like to thank **Prof. Dr. Muhammed Kayed**, for bringing the weight of his considerable experience and knowledge to this project and his helpful, kind, patience and support us. He was always inspiring and encouraging us to move.

Secondly, we would like to thank the head of the Medical Informatics Department, **Prof. Dr. Hossam Moftah** , for his efforts with us over the years.

Finally, we would like to thank **Dr. Abanob Gerges**, because he taught us things in our project and thanks for his effort with us. Our thanks to FACI College.

**Purpose of documentation**

This document outlines the project's goal, starting with the project's idea.It also discusses the project's software development life cycle, the design of the user interface, and the technical aspects of the project, including which parts will be implemented and which should be postponed for future work. This document provides a detailed description of the project's scope.

*SAG project 2023 5*

**Abstract**

From Ancient Times, we are facing a huge problem that is negatively affecting our society. There are many people around the world who were born blind or lost their sight due to different reasons.

The WHO organization reported that about 1 million people in Egypt are blind. According to a report by the World Health Organization, there are currently 39 million people who are blind. It is possible to say that 60% of the blindness in the world can be cured, and 20% can be prevented. These people suffer from various bad and dangerous situations like scams.

So, we find the Solution in a smart assistant to help Blind People carry out their daily activities easily. The user can manage his calls, alarms, and reminders through it even more. This feature will help them be more independent and in less need of care.

In addition, these glasses can also help blind People to identify the objects and the people around them. It can also help them read the different texts on different objects like money and menus in restaurants.

*SAG project 2023 6*

**Chapter 1**

INTRODUCTION

**1.1 Introduction**

Imagine what do you do if you wake up and you are blind? What obstacles will you face?

More than 39 million people around the world suffer from blindness.

Let me tell you some of the obstacles they face throughout their lives.

They suffer from doing all the functions of life normally , They do not recognize the people or things around them , they have difficulty reading and writing , Also, relatives of a blind person have to accompany him throughout his life to ensure that he is safe.

So we decided to help the blind with smart assistant glasses.

The glasses contain four buttons.

As soon as the power button is activated, the glasses begin to identify the things around them.

By pressing the second button, the dead mode will be activated if the person does not want to listen at any time.

The blind can also know the activities that people do through the image captioning around him by pressing the third button.

By pressing the fourth button to activate the voice command, the glasses will scan the books and read them by voice through the speaker. Or he can choose one of these options (make calls , Google Search , Knowing time/date , Knowing temperature , weather tracking ,Set reminders (Routines alarm),Translation,open/ close apps on his phone) that is connected to the mobile.

In this way , the blind can rely on himself without the need for a companion all the time

*SAG project 2023 7*

. **1.2 Problem Statement**

**What is the importance of this problem?**

Early findings from a small number of studies show that people use voice assistants for entertainment purposes, seeking information, making purchases and listening to music. People also enjoy interaction and find voice assistants easy to use.

* Yet most of these assistants require internet connection even for simple tasks that can be done offline.
* Most of these assistants also depend totally on voice demands without considering the surrounding environment which is inconvenient for the blind.
* Voice assistants and smart speakers are already being used by people with vision problems, but initially they were not designed for them, so they might not cover all their needs (like recognizing the different objects and activities done around them).

**What is the current solution?**

According to Adobe’s latest State of Voice Assistants report, 32 percent of consumers now own a smart speaker, up from 14 percent in January 2018.That number is expected to rise to nearly 50 percent after the upcoming holiday season. Those who own a smart speaker use voice commands often. The study shows 71 percent of smart speaker owners use voice every day, and 44 percent use voice multiple times a day.

These smart speakers are used by visually impaired people, yet they don’t match all their needs. This doesn’t help much to let people with visual disabilities depend on themselves in many situations.

The conventional way to solve the overlooking of modern technology and smart assistants towards the blind is to seek a therapist to teach people to rely more on their other senses and to use devices for the blind, such as Braille. The goal is to help people function as well as possible, become independent, and regain their self-confidence.

Blind people also must learn how to use a cane, and family members and other caregivers must learn how to walk with them. Family members are instructed not to change the location of furniture or other objects without telling the blind person.

*SAG project 2023 8*

Learning how to use a seeing eye dog and Braille come much later. In the interim, audio books help the blind participate in reading.

**How will our solution solve the problem?**

Wearing the smart assistant glasses will help blind people relying on virtual assistants to do their everyday tasks with ease even when offline. These glasses will have cameras to detect the user’s surroundings. Users will be able to read different documents like books and menus at restaurants. They will also be able to recognize different people and money.

**1.3 Objectives**

Our project goal is to make a virtual assistant that is more usable in different situations for people with visual impairment.

**1.4 Impact in Business**

**Product range:**

The smart assistant glasses are supposed to be used by blind people who have no other disabilities that can affect the use of the glasses like hearing loss, amputation, speech disability or other.

**Product specification:**

The Design of the project is a pair of glasses closed around the head, consisting of camera, flash ,microphone, speaker, and three buttons.

**Market:**

We are targeting the Egyptian market as these glasses are new to it.

**use:**

These glasses are made to be used by the blind to help them with their daily activities whether to learn the surrounding objects, people or action. They also can be used to read different documents that are not meant to be read by the blind using braille. In addition to accessing their mobile phones with voice commands to do various actions like calling someone, setting an alarm and more.

*SAG project 2023 9*

**opportunities:**

There are about 1 million blind people in Egypt and the Smart Assistant Glasses will provide blind people to interact, communicate with the surrounding environment and realize what's around them. It is also relatively cheap compared to the other competitive products which will make our product more appealing.

**1.5 Ways of Marketing**

Good marketing must fit the market you're in and ultimately speak to the needs of your target market. That's where a strategic marketing strategy comes into play , and the ways of marketing for our product can be as following:

**Way 1: Social Media Marketing** With platforms like **Facebook**, **Instagram**, **LinkedIn**, and **Twitter,** brands can promote their business and engage with audiences on a more personal basis.

However, with social media, two things are key to success: relevant content and consistency.

No one logs on to social media looking for something to purchase, it's important to balance promotion with entertainment. Compelling images and captions that encourage your audience to like, share and comment will bring your brand that much closer to gaining a customer

**Way 2: Event Marketing** You've got an event coming up to launch a new product. Now, how do you get your target audience to show up? That's event marketing.

It requires brands to plan a promotion strategy, develop creative assets to create anticipation, and determine the right channels to spread awareness.

An event – whether it's a workshop, seminar, trade show, conference, or pop-up shop – helps brands connect directly with their target audience and build lasting relationships.

*SAG project 2023 10*

**1.6 Conclusion**

At the end of this chapter, the reader will be able to form a basic idea about what is the problem that our project aims to solve,

● what is the importance of the idea

● the problem’s other existing solutions

● what we will add to our project to make it better than the traditional or existing methods to solve the same problem.

**The reader will also understand:**

● impact of modern technologies

● how to use them to solve a worrying problem like the mentioned one.

*SAG project 2023 11*

**Chapter 2**

RELATED WORKS

**2.1 Introduction**

If we look at our world, we will find that the number of blind people around the world is not small (39 million people) who suffer from blindness, and this is what prompted us to witness this project when we also learned that their number in Egypt exceeds (3 million people), as all countries of the world tended to provide some facilities, Which makes our product competitive in the local and global market. In addition to the techniques used in this project.

Many companies seek to provide assistance to people with visual disabilities, and our project seeks to do that as well.

**2.2 Related Works**

Many manufacturers technical customer services and other new companies have developed some products based on our project idea like:

1. **ENVISION GLASSES** :
   * Developed on the Enterprise Edition of Google Glass, the smart glasses harness the power of artificial intelligence to extract different kinds of information from images then speak it back to users in over 60 different languages.
   * With its 8MP camera, the glasses can scan digital and handwritten text from any surface such as books, letters or labels and turn it into speech. The device can also give detailed descriptions of outdoor scenes and make private and secure video calls to trusted users.
   * Additional features include color detection, light detection, object recognition and facial recognition, meaning users can pick out red socks from their white laundry, know when a lamp is still on, find personal belongings, and identify colleagues in an instant
2. **MyEye2 :**

These are low vision electronic glasses designed to make reading, writing, recognizing faces and various other daily activities easier for visually impaired people. A light attachable camera distinguishes it from an ordinary pair of glasses, which is mounted on the frame of the glasses by the side.

*SAG project 2023 12*

1. **Amal Glass :** It’s a Dubai based startup, Specified in smart glasses for blind and visually impaired people depending on Artificial intelligence and images processing for enabling the users to be self independent.

**Amal Glass Applications:**

* + Reading texts such as newspapers, magazines, computer screens, Mobile screens, ATM and sign board.
  + Cash Reader: Now Visually impaired people can go shopping alone any time and be sure that they will pay and get the correct amount of cash

as Amal glass can recognize over 100 Banknotes from different countries.

* + Environment Description: Allows the user to identify the surrounding objects such as cars, street signs, furniture, etc.Help Me: Users can request for the help from family or friends and send them SMS with current location to pre-registered three contacts

1. **IrisVision :** 
   * IrisVision electronic glasses for the blind and visually impaired are a highly innovative assistive technology solution, which is registered with the FDA as a Class-1 medical device and is redefining the concept of wearable low vision aids.
   * A combination of a Samsung’s VR headset and a smartphone, IrisVision gives birth to an innovative solution aimed at helping people with eye problems like macular degeneration, cataracts, glaucoma, diabetic retinopathy (DR), retinitis pigmentosa (RP) and so forth.

**2.3 Benefits**

* Provide the blind with the essential information about their surrounding environment so that it enables them to interact with it properly.
* Affordable cost.
* Most of the smart assistant features are working offline .
* Can read normal text and handwriting in more than one language.
* Can detect objects even in dark places.
* Analyzing the surrounding activities and describing them as if the user can see what is going on around him.

*SAG project 2023 13*

**2.4 Features**

**The application helps the blind many facilities:**

1- Recognize the objects around him

2- Face recognition for closed people

3- Text and hand-written recognition

4- Translate from language to another

5- Image caption to Know the activities around him

6- adding flash (or use camera in night mode/IR sensor) and light sensor to be able to detect objects & peoples in darkness

**Voice control (offline/online)**

7-Translation (online/offline)

8- make calls (offline)

9- Google Search(online)

10- Knowing time/date(offline)

11- Knowing temperature(online)

12- weather tracking(online)

13- Set reminders (Routines alarm) (online/offline)

14- open/ close apps on his phone

15 -providing directions to whatever he asks for (Qibla for pray, place he wants to go)

16 -Emergency contact and localization

17- ability to be connected to social media and reply to it (online)

18- connect to a reader application like اقرأ لي , story Tel

*SAG project 2023 14*

19- Get recommendations based on the preferences that you set it like watching

movie or listening to music that you prefer

20- create documents/ to do lists etc. and connect to different services

21- health tracking by Iridology diagnosis

**2.5 Risk management**

**Types of Project Risk**

So now let’s look at some of our project risk:

|  |  |
| --- | --- |
| **project\_area** | Project Scope Management |
| **Project\_risk** | Lack of clarity in terms of expected deliverables |
| **Risk\_Type** | Project Scope |
| **sol.** | We made a CR document to clarity expected Customer Requirements and SRS document to clarity expected System Requirement |

|  |  |
| --- | --- |
| **project\_area** | Project Scheduling/ Project Timeline |
| **Project\_risk** | Inaccurate project schedule estimation leading to disproportionate project work allocation |
| **Risk\_Type** | Project Schedule |

*SAG project 2023 15*

**sol.** We have set a clear schedule that specifies the sufficient time to implement each part of the project with increased time to avoid any negligence in the time frame required to complete the project

|  |  |
| --- | --- |
| **project\_area** | Resource Management |
| **Project\_risk** | Lack of rightly skilled or experienced resources |
| **Risk\_Type** | Skills |
| **sol.** | In the beginning, we had to choose the skills we needed to implement our project, the person who would be responsible for each part, and each person started to develop their skills so that they could implement what was required of them. |

|  |  |
| --- | --- |
| **project\_area** | Project security |
| **Project\_risk** | the potential loss of control over personal information |
| **Risk\_Type** | security |

**sol.** Our project has gone through different stages of testing in order to be safe for users

16

*SAG project 2023*

**Chapter 3**

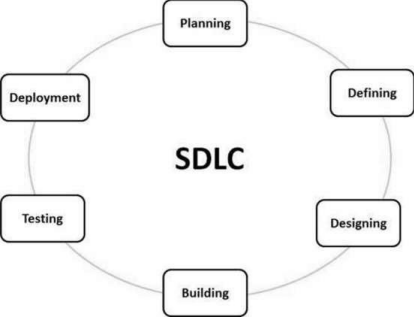
PROJECT METHODOLOGY

**Introduction:**

 This chapter will cover the software engineering process applied in this project which is the agile v-model. The V-Model is a software development method often found in areas with high requirements on safety and security, which are common in highly regulated areas. Combining the traditional V-Model with a disciplined agile approach promises to allow as much agility as possible, while addressing the issues often found in AIoT initiatives: complex dependencies, different speeds of development, and the "first time right" requirements of those parts of the system which cannot be updated after the Start of Production (SOP).

**3.1 Software Development Life Cycle**

In this section, we are going to talk about the life cycle of our project. First of all, what is SDLC? SDLC is a methodology for producing software projects, within any software project. It must have a detailed plan describing how to develop, maintain, replace and alter or enhance specific software. The life cycle helps us to improve the quality of software and the overall development process.The following figure is a graphical representation of the various stages of a typical SDLC. A typical Software Development Life Cycle consists of the following stages as shown in figure 3.1



*SAG project 2023 17*

**Stage 1: Planning and Requirement Analysis**

Requirement analysis is the most important and fundamental stage in SDLC. It is performed by the senior members of the team with inputs from the customer, the sales department, market surveys, and domain experts in the industry. This information is then used to plan the basic project approach and to conduct product feasibility studies in the economical, operational, and technical areas.

Planning for the quality assurance requirements and identification of the risks associated with the project is also done in the planning stage. The outcome of the technical feasibility study is to define the various technical approaches that can be followed to implement the project successfully with minimum risks.

**Stage 2: Defining Requirements**

Once the requirement analysis is done the next step is to clearly define and document the product requirements and get them approved by the customer or the market analysts. This is done through an SRS (Software Requirement Specification) document which consists of all the product requirements to be designed and developed during the project life cycle.

**Stage 3: Designing the Product Architecture**

SRS is the reference for product masterminds to come out with the trim framework for the product to be developed. Predicated on the necessities specified in SRS, normally, farther than one design approach for the product framework is proposed and proved in a GDD- Design Document Specification. This GDD is reviewed by all the important stakeholders and predicated on polychrome parameters as

peril assessment, product robustness, design modularity, budget, and time constraints, the trim design approach is named for the product.

*SAG project 2023 18*

A design approach defines all the architectural modules of the product along with its communication and data exodus representation with the external and third- party modules (if any). The internal design of all the modules of the proposed structure should be definitely defined with the tiniest of the details in GDD.

**Stage 4: Building or Developing the Product**

In this stage of SDLC, the actual development starts, and the product is built. The programming code is generated as per GDD during this stage. If the design is performed in a detailed and organized manner, code generation can be accomplished without much hassle. Developers must follow the coding guidelines defined by their organization and programming tools like compilers, interpreters, debuggers, etc. are used to generate the code. Different high-level programming languages such as C, C++, Pascal, Java, and PHP are used for coding. The programming language is chosen with respect to the type of software being developed.

**Stage 5: Testing the Product**

This stage is usually a subset of all the stages as in the modern SDLC models, the testing activities are mostly involved in all the stages of SDLC. However, this stage refers to the testing only stage of the product where product defects are reported, tracked, fixed and retested, until the product reaches the quality standards defined in the SRS.

**Stage 6: Deployment in the Market and Maintenance**

Once the product is tested and ready to be deployed it is released formally in the appropriate market. Sometimes product deployment happens in stages as per the business strategy of that organization. The product may first be released in a limited segment and tested in the real business environment (UAT- User acceptance testing).Then based on the feedback, the product may be released as it is or with suggested enhancements in the targeting market segment. After the product is released in the market, its maintenance is done for the existing customer base.

*SAG project 2023 19*

**3.2 Selecting Methodology**

Selecting a Software Development Life Cycle (SDLC) methodology is a challenging task for many of us. What tends to make it challenging is the fact that few of us know what are the criteria to use in selecting a methodology to add value to our project **[6].**

So to select the right SDLC methodology, you have to follow some steps to get it.

**1. Learn the about SDLC Methodologies:**

In order to select the right SDLC methodology, you must have sufficient experience and properly understand and be familiar with the SDLCs to be selected.

**2. Understanding the needs of Stakeholders:**

We have to know about the business area, stakeholder concerns and requirements, business priorities, our technical capacity and capability, and technological limitations so that we can select the appropriate SDLC according to their selection criteria.

**3. Select the Criteria:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Factors | Waterfall | V-model Evolutionary | Prototyping | Spiral | Iterative  &Incremental | Agile |
| Unclear User  Requirement | Poor | Poor | Good | Excellent | Good | Excellent |
| Unfamiliar  Technology | Poor | Poor | Excellent | Excellent | Good | Poor |
| Complex System | Good | Good | Excellent | Excellent | Good | Poor |
| Reliable system | Good | Good | Poor | Excellent | Good | Good |
| Short Time  Schedule | Poor | Poor | Good | Poor | Excellent | Excellent |
| Strong Project  Management | Excellent | Excellent | Excellent | Excellent | Excellent | Excellent |
| Cost limitation | Poor | Poor | Poor | Poor | Excellent | Excellent |
| Visibility of  Stakeholders | Good | Good | Excellent | Excellent | Good | Excellent |
| Skills limitation | Good | Good | Poor | Poor | Good | Poor |
| Documentation | Excellent | Excellent | Good | Good | Excellent | Poor |
| Component  reusability | Excellent | Excellent | Poor | Poor | Excellent | Poor |

In this step, you have to select some of the criteria or arguments that you may use to compare between different methodologies and select an SDLC.

**4. Decide:**

In this step, after completing the comparison process, you start a discussion with your team to decide your choice .

**For example of Chosen Methodology:**

When we come to select the SDLC methodology that we will use in our project. First, we started with knowing about different methodologies of SDLC**[7]**. And on the other side, we wrote documents to be clear requirements, business priorities, our technical capacity and capability, and technological limitations. Then, we started a comparison between different methodologies of SDLC.And this is the Factors we use to compare between different methodologies: Unclear User Requirement, Unfamiliar Technology, Complex System**,** Reliable system, Short Time Schedule, Strong Project Management, Cost limitation, Visibility of Stakeholders, Skills limitation, Documentation, Component reusability**.**

*SAG project 2023 20*

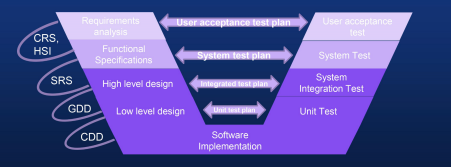
**And this is the comparison between different methodologies of SDLC:**

*SAG project 2023 21*

After this comparison, we started a discussion to decide what we will choose. In the end, we decided on both the v-model and agile.

**3.3 V-model**

It is a type of SDLC model where the process is executed in a sequential manner in the form of a V. It is known as the validation and verification model. Because it depends on the association of a testing phase for each corresponding development stage **[8]**.



Now we will explain the different stages of the v model.

**Design Phase:**

o **Requirements Analysis:**

This phase contains detailed communication with the patron to understand their requirements and expectancies. This stage is referred to as Requirement Gathering.

o **functional Specifications:**

System design is divided into modules that take on different functions. The data transfer and communication among the inner modules and with the outdoor international (other systems) is clearly understood.

*SAG project 2023 22*

o **High -Level Design(HLD):**

This stage contains the system design and the complete hardware and communication setup for developing the product.

o **Low-Level Design(LLD):**

At this point, the system is divided into small modules. The detailed Module Design, also known as Module Design .

**Testing Phases:**

o **User Acceptance Testing (UAT):**

UAT is implemented in a user environment similar to a production environment. UAT verifies that the delivered system meets the user’s requirements and the system is ready for use in the real world.

o **System Testing:**

System Testing tests the complete application with its functionality, interdependence, and communication. Tests the functional and non-functional requirements of the developed application.

o **Unit Testing**:

Unit test plans are developed during the unit design phase. These unit test plans are implemented to eliminate errors at the code or unit level.

o **System Integration testing:**

After completing the unit test, the integration test is performed. In integration testing, the modules are integrated and the system is tested. Integration testing is performed at the architectural design stage. This test checks whether the modules are connected to each other.

*SAG project 2023 23*

**Software Implementation:**

The verification and verification phases are linked through the Software Implementation phase.

**Advantages of V-model:**

o This is a highly disciplined model and the stages are completed one by one.

o V-Model is used for small projects where project requirements are clear.

o It is simple and easy to understand and use.

o This model focuses on validation and verification activities early in the life cycle thereby enhancing the probability of building an error-free and good quality product.

o It enables project management to track

progress.

**Disadvantages Of V-model:**

o High risk and uncertainty.

o It is not good for complex and object-oriented projects

o It is not suitable for projects where requirements are not clear and contains high risk of changing.

o This model does not support iteration of phases.

o It does not easily handle concurrent events.

*SAG project 2023 24*

**3.4 Application of chosen methodology v-model:**

V-model means Verification and Validation model. Just like the waterfall model, the V-Shaped life cycle is a sequential path of execution of processes. Each phase must be completed before the next phase begins**.** V-Model is one of the many software development models. It has typically been used to describe the development of the system and its subsystems. The test environments or beds and test laboratories and facilities are also systems, however, and must be tested and otherwise verified. Thus, these test-oriented V models are applicable to them as well.

It can be applied to electronic or mechanical systems in research and science.

1. Axiomatic Design: The ideas of Axiomatic Design (AD) originate from industrial production and industrial systems, but they are relevant for software and hardware systems. The design method bridges different domains when describing the design of a suitable system. AD assumes that designing systems requires input from different domains. The domains that are introduced are: the customer domain, where customer needs are elicited, the functional domain, in which functional requirements are positioned, the physical domain for describing the design parameters of the system and the process domain that complements the foregoing domains with information for the process of manufacturing the system. The first axiom states that when a design is made all Functional Requirements (FRs) must be formulated on a fundamental level, in such a way that they are independent from each other. The FRs are later mapped to its corresponding Design Parameters (DPs). A DP describes a property or characteristic of the system. It is expected to fulfill the related FR. **[9][10][11][12]**

2. Update a Digital Pathology system: it used to diagnose cancer was a Class 2 FDA-approved device. The V-model was the way to develop this diagnostic software, with documented customer and system requirements going in, traceable system and acceptance tests going out, all docs

configuration managed, and all requirements verified, validated and auditable. **[13]**

*SAG project 2023 25*

3. Systems Engineering with SysML/UML : The ‘Das V Modell’ is the official project management method used by the German Government and provides guidance for planning and executing projects. A key feature of the V Model is definition of who has to do what and when in a project, and the use of decision gates to indicate a milestone in the progress of a project In the V Model, an emphasis is placed on verification on the left hand side of the V and validation on the right hand side with the use of test cases to ensure adherence between equivalent activities on either side of the V. The key elements of the V Model have been widely translated and adapted resulting in many variations. The Das V Modell has some equivalence with PRINCE2. [14]