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**“GLAD – A Voice Assistant for People Living With Dementia”**

**Supervisor : Prins Butt**

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# Acknowledgements

Write a paragraph here acknowledging everyone who has helped you while you have been preparing the content of your dissertation.

This may be you supervisor or other academic staff that have provided guidance and support, other students or colleagues with whom you have collaborated on any research or project work, interviewees, librarians, or perhaps any external bodies that have given you assistance, such as access to data or the opportunity for hands on experience.

* Prins Butt
* Matthew Dear

# Abstract

This should clarify to the reader why they should read your report, Abstracts are a short summary, one paragraph 300 words max. giving a snapshot of your entire project; why, how, results and conclusions/ recommendations. The Abstract needs to work as a “standalone” so avoid using any citations. Write your abstract last.

[TBC]

# Acronyms

* VA – Voice Assistant
* GLAD – General Living Assistance Device
* TTS – Text-to-Speech
* STT – Speech-to-Text

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You might wish to add a section for **Project Specification/Requirements** after **the Literature Review** if you are doing a **software product/build** type of project

List of Figures

Figure 1: 2014 Logo Trends

**GARDNER, 2014**. *2014 Logo Trends* [viewed 15 November 2014]. Available

from: https://www.logolounge.com/article/2014logotrends#.VJRtAA5xIw

Figure 2: Graph of Network testing March 2018

NOTE: ‘Figures’ refers to all charts, graphs, photographs, drawings and other illustrations. Number everything in the sequence it appears in the text

These can be two separate lists for your tables & Figures (charts, Graphs, photos, diagrams etc.) or just one list called Figures depending on the amount of table you have.

These should be structured with the figure number, the figure title, description and then the Harvard reference source. If the figure was created by you, there is no need to include the Harvard source, only the figure number and the figure title/description

# 1. Introduction

An introduction is an expansion of your project title with a clearly defined problem statement along with a research question or hypothesis. It will present a clear statement of your purpose – Why did you carry out the research? Why are you writing this report?

It will also indicate the scope of your research and define any key terms which aid understanding in the introduction.

Dementia is one of the leading causes of disability among the global elderly population which causes the deterioration of cognitive functioning. As modern advances in healthcare cause the average age of the world’s population to rise, so too is the number of elderly persons living with dementia that require care and support (World Health Organization 2019). There are estimated to be over 885,000 people in the UK diagnosed with dementia (Wittenberg *et al*. 2019) and over 50 million worldwide (Prince *et al.* 2015). People living with dementia require constant care and, although the nursing care industry is growing, training care-workers is difficult, time-consuming, and expensive. As a result, the number of care-workers is not sufficient to match the growing number of dementia cases.

There is great promise for voice assistants[[1]](#footnote-1) (VAs) such as Apple’s Siri and Amazon’s Alexa to support care-workers and patients by managing routine tasks such as setting medication reminders, carrying out mental stimulation exercises, and alerting human carers when needed. These products are operated through voice commands and can run on existing internet-enabled devices or dedicated hardware. They are capable of monitoring the wellbeing of vulnerable people at a lower cost of time and money than training a care-worker. Such devices could serve as a buffer on the workload placed on care-givers and enable persons living with dementia to have more independence. Unfortunately, current consumer products are not sufficiently reliable enough to provide support in this capacity. Despite being marketed as easy-to-use, these products still require a degree of technical understanding to be used effectively. While younger users (“Digital Natives”) of these products may find it easy to adapt to their use, older generations (“Digital Immigrants”) have more difficulty learning the technology. Furthermore, as these products are intended for general use, they are not suitable for users with special needs.

This project aims to develop a prototype VA called the *General Living Assistance Device* (*GLAD*) that is tailored for users living with dementia. This prototype will include features common to current VAs such as setting reminders, performing search queries, and calling contacts, as well as ease-of-use considerations made for elderly users in general. A shortlist of additional features designed to maintain user independence, monitor wellbeing, and reduce the effects of cognitive decline will be created following a review of best practices and the viability of implementing these features on limited hardware will be assessed.

In this paper, I review current literature surrounding the challenges caused by dementia for sufferers and carers and review the current state of VA technology including its shortcomings. This research is used to list potential features and requirements of a VA to assist people living with dementia. Next, a simple VA that will serve as the foundation of the selected features is designed and presented. This paper then describes the research and implementation of each feature, the difficulties faced, and evaluates their effectiveness. Finally, an evaluation of the feasibility of the entire developed prototype is given and future areas of work are considered.

[Roadmap of project]

# 2. Literature Review

This is a referenced review of books, journals, scholarly articles, documentation and other **quality peer-reviewed sources** relevant to your project. It allows you to critically evaluate relevant sources to demonstrate to your readers how your research fits within a larger field of study. It will allow discovery of current ideas, current practice and processes to support the Project’s aim.

You need to set your work in the context of previous work with your field of study or problem to solve and identify any gaps in current practice and/or literature, explaining how you intend to address them.

## 2.1 Method

To assess the difficulties caused by cognitive decline and potential technologies that could mitigate them, a review of existing literature was conducted. The literature was gathered through multiple search queries on ScienceDirect using combinations of the following keywords: dementia, “caring for”, “home care”, palliative, helping, challenges, difficulties, needs, prevention, independence, enabling, preferences, “assistive technology”, “smart home”, capability, voice, assistant, “consumer product”, adoption, elderly, “digital immigrants”, design, “early onset”. Studies mentioning “social media”, student, or diagnosis were excluded. Each search query was refined until it produced 30 or fewer results and exclusion criteria were applied.

## 2.2 Dementia

Dementia is the impairment of higher brain functions such as memory and cognitive processing and is commonly caused by Alzheimer’s disease (AD). The World Health Organization (2019) estimated 50 million people worldwide living with dementia burdening individuals, caregivers, and healthcare services with an approximate global cost of US$ 818 billion in 2015. Dementia cases are expected to reach 82 million by 2030 and 152 million by 2050. This inflation is the result of a global aging population caused by increased life expectancy worldwide. Galende et al. (2021) assessed the social impact of dementia to advise healthcare policies in Spain, concluding that robust healthcare programs were essential. Their review found between 4% and 9% of people in Spain over 65 affected by dementia with rates increasing proportional to age. These proportions are typical of other countries.

The decline of cognitive functioning causes difficulties in safety, autonomy, and quality-of-life (QoL) affecting both patients and carers; and various focus groups, interviews, and workshops have attempted to formalise the design requirements of care services based on these concerns (Morgan et al. 2002; Thoma-Lürken et al. 2018; Lockerbie and Maiden 2020). Focus groups with formal and informal caregivers conducted by Thoma-Lürken et al. (2018) revealed 6 recurring domains of problems preventing aging-in-place for people living with dementia: Self-reliance, safety, social, behavioural, formal Services, and cognition; however they did not address the causal relationships between these domains. The most common issues raised were patients suffering a loss of independence and inability to perform activities of daily living (ADL). In a review by Alexopoulos et al. (2002), mid- and late-life depressions were found to exacerbate cognitive decline, and the increased loss of independence produced further depression. One study that focused on support for informal caregivers found that many felt they could continue to provide sufficient care for their dependant for longer if they were given better education and relief as they lacked appropriate training and were hindered by time constraints (Chi et al. 2020).

## 2.3 Assisted Living

As technologies such as robotics, the internet-of-things (IoT), and machine learning are developed worldwide, these innovations have been applied to improve the quality-of-life (QoL) for both the fully cognitive elderly and those suffering from cognitive decline (Li, Lu, and McDonald-Maier 2015). Traditionally, caring for people living with dementia would be performed at home by family members until they were unable and the dependent was moved into formal care (Kemp, Ball, and Perkins 2013); however financial pressure placed on both individuals and healthcare services has motivated research into assisted living (AL) technologies to promote “aging-in-place” and allowing dependents to maintain their autonomy. These advances aim to relieve pressure on healthcare services and informal carers.

Telecare refers to technologies that provide remote healthcare directly to patients in their own homes such as monitoring sensors (Barlow, Bayer, and Curry 2006; Roberts and Mort 2009). These approaches are also referred to as telemedicine and telehealth inconsistently across different authors. Some of the earliest telecare solutions include the EU-ACTION project that began in 1997 – a system intended to introduce ICT into home environments to educate home carers and dependants in correct care techniques (Magnusson et al. 2002).

The ubiquity of IoT devices has led to the notion of intra-connected smart homes in which multiple sensors and devices can communicate and be controlled through a unified interface such as a voice assistant. Cooper et al. (2008) describe “intelligent environments” similar to the newer idea of smart homes, noting how they could assist individuals with cognitive impairments using reminders, directional guidance, or monitoring. They recognise the importance of technology understanding the context of a situation (such as a user’s location or task), an issue that has been addressed more recently with machine learning. Other early work on smart homes also foresaw their use in telecare for elderly and disabled people including those with cognitive impairment (Chan et al. 2008; Chan et al. 2009). Belley et al. (2015) present a practical algorithm for detecting erratic behaviour in people with cognitive decline by analysing power usage of smart devices. Liu et al. (2016) also focused on the benefits of health monitoring of elderly in smart homes, however they conclude that smart homes were not capable of completely supporting the elderly. Rumeau et al. (2020) investigated co-living spaces for elders to reduce isolation with a tangential experiment related to smart home technology.

Shishehgar, Kerr, and Blake (2018) outline a variety of robotics projects for supporting elders including companion robots, mounted mechanical arms, electronic wheelchairs and walking assistants, domestic cleaning robots, and health and time management robots. Wilson et al. (2019) discuss how these robotics projects can be integrated with smart homes.

Despite the number of care projects that have been created, few have seen widespread adoption or made it past early pilot stages due to poor evidence of cost-effectiveness (Obi, Ishmatova, and Iwasaki 2013; Clarkson et al. 2017). The effectiveness of these solutions is difficult to measure because the majority of studies use qualitative means of assessment or failed to apply their findings to a formal framework (Siegel and Dorner 2017). Dodd et al. (2020) were also unable to find an existing measure for assessing the effectiveness of care solutions with respect to the key desired outcomes of stakeholders. Limited study sizes also question the validity of any positive findings in these studies. Among those projects that were deployed, adoption is likely hindered by the deep-rooted social stigma related to dementia and AL technologies; particularly in rural areas (Morgan et al. 2002).

End-of-life care should preserve an individual’s dignity and QoL. Östlund, Brown, and Johnston (2012) reviewed palliative care studies to assess how well recipient’s dignity was addressed. Palliative care includes solutions to ease the pain of conditions without addressing the cause of the problem. Dementia care is considered palliative as it improves the comfort of the patient and may reduce deterioration, but cannot reverse any existing damage. None of their reviewed studies addressed patients concerns regarding the impact of their own death on their surviving friends and family. Rich relationships, autonomy and control, knowledge, and improved mental health were identified as the desired outcomes of care solutions (Dodd et al. 2020). Lockerbie and Maiden (2020) created a model for defining the QoL goals for people with dementia through workshops with four experienced UK care workers, also concluding that improving independence and social connectivity were desirable outcomes of support. Gómez (2015) discusses the nature of autonomy for elders and the sustainability of solutions that support their independence, arguing that autonomy should not be accepted as a guaranteed improvement to QoL. Hersh (2014) developed a framework for assessing the outcomes of ICT support.

## 2.4 Digital Divide

The concept of a digital divide between elderly (digital immigrants) and younger (digital natives) users of technology is well documented. Digital immigrants are characterised by their struggle or resistance to adopt technology because of decreased learning capabilities, a rapidly changing industry, limited or poor experiences, or lack of confidence; instead using technology only when necessary.

Mobile phones have the capability of improving QoL for elders (Plaza et al. 2011). Many applications are available for encouraging personal health and wellbeing.

Despite the existence of tech-savvy elders and the inevitable generational shift as digital natives continue to age with technology, it is crucial to consider the difficulties caused by natural aging and late-life disabilities that are barriers to assistive technologies (Fischer et al. 2014). The results of a survey into motivations behind elder’s technology adoption by Sintonen and Immonen (2013) found that prior experience with technology their own physical limitations are key deciding factors for frail elderly. Their population had an approximately 1:2 split of frail and well-coping elderly. Hawley-Hague et al. (2014) found that concern for their own safety was a another crucial factor in elders adoption of AL technology. A review by Song and van der Cammen (2019) was concerned with how AL technology affects elders living alone.

The needs and preferences of elderly users should be considered before designing any AL technology. Jacelon and Hanson (2013) discuss the benefits of involving elders in the design process for smart homes to ensure they meet the practical needs of this specialist group. Gkouskos and Burgos (2017) also highlight the importance of involving elders in the design process of any AL technology.

Detweiler and Hindriks (2016) formalised a taxonomy for value sensitive design of AL technology and raise the issue of limited coverage of research into all permutations of their identified values, technologies, and contexts.

After interviewing elders who consider themselves technologically savvy, Kania-Lundholm and Torres (2015) question the importance of age as a factor in the Digital Divide; instead finding socio-economic explanations. The elders interviewed were generally highly educated and had used computers as early as the 1970s.

Castilla et al. (2013) created a software tool for the elderly that streamlines common computing features such as email and telecommunication. They realised that simply enlarging icons and text was insufficient for making software accessible. To better aid user’s synchronous learning of what capabilities were offered and how to perform them, they concluded that no more than three options should be available at any time. Similarly, Iancu and Iancu (2020) suggest principals to be considered when designing mobile phones for Elders and found that multiple paths of completing the same action were confusing to users. They recommend familiarity and consistency in the design of tasks. Alternative human computer interaction (HCI) technologies have been considered to facilitate digital immigrant’s engagement with modern devices.

Hsiao et al. (2017) present natural hand motion controls for desktop applications with limited success. Other means of natural HCI that have been used include voice control and eye tracking (Li, Lu, McDonald-Maier 2015).

## 2.5 The State of VAs

Recently, consumer VAs such as Google Assistant and Amazon’s Alexa have become familiar presences in households and on mobile devices (McLean and Osei-Frimpong 2019). These consumer VAs are frequently tasked with performing web queries and making online purchases. Current VAs are still somewhat limited, despite considerable advances in natural language processing, however, privacy concerns are a common factor restricting their usage (Ho-Sam-Sooi, Pieters, and Kroesen 2021).

VAs are able to integrate with Smart Home technology and provide a conversational means of controlling the devices within. Conversational controls are accessible even for elders with cognitive decline. Chatbots and natural language interaction computers have been used for various healthcare services (Adamopoulou and Moussiades 2020).

Trust in the VA is an essential requirement as carers and family members will be unwilling to place their dependent’s well-being in jeopardy. Poushneh (2021) explored the perception factors of artificial personalities in mobile voice assistants. Hu, Lu, and Gong (2021) investigate how user interactions with and trust of AI are affected by human-like qualities, determining that the humanness of voice output does not impact competence-related trust. However, Hu et al. (2021) found evidence that improving the perceived intelligence of VAs results in more frequent use. Chattaraman et al. (2019) conducted a usability experiment with elders and found that for users with cognitive impairment, an informal personality in a VA was less effective and caused difficulty.

Intent detection involves translating a natural language command into a digital instruction and is a crucial component of a VA. The varying nature of natural language in its terminology, intonation, speed, and context makes this a difficult task that is accomplished only through machine learning such as the multi-layered neural network used by Firdaus et al. (2019) or the deep neural network used by Lin and Xu (2019) to learn new intents.

Mulfari et al. (2021) approached the task of designing VA system for users with speech disorders by using keyword spotting algorithms for intent detection. Kumar, Deepak, and Santhanavijayan (2020) propose an efficient emotion detection algorithm, although limited. As dementia significantly impacts speech, an appropriate method of understanding a user’s request or inferring their need is crucial.

# 3. Methodology

This section will discuss and justify all aspects of the project methods used to undertake the project which could include: How was an initial survey data collected to justify the aims of the project and how they were analysed? How will the project be implemented and tested?  How was the finished artefact evaluated? If using qualitative research how are sample sizes -representative of your prospective user base?

## 3.1 Methods Section

Make sure you break down your methodologies into subsections titled to match the discussion

## 3.3 Professional, Legal and Ethical issues

How will you undertake ethical research and a discussion of all professional, legal and ethical issues associated with your project. A mention of your ethical release will appear in this section with a link to its placement within an appendix.

## 3.3 Project Management

This section covers how you managed your project and any deviation for what was presented in your review report AE1. Write up a brief introduction/reflection on how you planned/manage your project. Link to appendices that contain further information such as time charts etc.

4. Requirements

* Offline

4. The GLAD Voice Assistant

## 4.1 Components of a VA

The principal components of a voice interaction system are STT, Intent Detection, and TTS. Together, these technologies are able to register a spoken command, identify and act upon it, and vocalise a response; allowing for conversational software interfaces. These components may operate programmatically or utilise machine learning techniques. Open-source implementations of these components were evaluated and selected to create the basis for GLAD.

## 4.2 Technologies

### 4.2.1 Voice Assistants

Although there are many familiar consumer VAs such as Amazon’s Alexa, Google’s Google Home, Apple’s Siri, and Microsoft’s Cortana, digital privacy concerns have prompted the development of a number of open-source alternatives.

Mycroft (Mycroft AI Inc. n.d.) is an open-source VA comparable to most popular consumer products and designed to run on a range of devices including desktops, Raspberry Pis, or on specialised hardware – the Mycroft Mark I and Mark II. It features an existing library of installable skills and a back-end suite of services.

Open Assistant (Open Assistant n.d.) is designed for controlling computer operations using voice commands. It is written in Python and is capable of running enitirely self-contained and without requiring internet access. Unlike other VAs, it does not respond to a wake word. However, it is limited by its voice and intent detection as they must be specifically programmed to identify certain phrases.

The Jasper Project (Jasper Project n.d.) was considered for the prototype. As with Open Assistant, Jasper is always-on but has few native capabilities. However, Jasper development is inactive, having no major contributions since 2015.

### 4.2.2 Speech-to-Text

Modern STT technology takes advantage of machine learning techniques to effectively identify spoken words []. DeepSpeech is deep learning STT engine developed by Mozilla Corporation (2020) that uses Google TensorFlow. There are pre-trained models available for TensorFlow covering many languages and these can be easily integrated into DeepSpeech clients.

Most STT technologies are designed around users with an average level of diction, however this assumption cannot be made when designing for the cognitively impaired.

Iancu and Iancu (2020)

* + Mobile design considerations for elders
  + Single path for tasks
  + Consider speech speed
* Mulfari *et al.* (2021)
  + Machine learning for staggered speech
  + ML models require staggered speech examples for training
  + Keyword spotting
    - Searching for key command phrases
  + Italian

### 4.2.3 Intent Analysis

Intent analysis has uses in marketing feedback.

* Firdaus *et al.* (2019)
  + Intent detection
* Hu, Lu, and Gong (2021)
  + “We also find that voice humanization cannot facilitate competence-related trust when AI devices’ language understanding is perceived as poor.”
* Adamopoulou and Moussiades (2020)
  + Privacy and trust

### 4.2.4 Text to Speech

TTS technology has improved considerably in recent years with modern projects such as Resemble.AI[] able to construct high-quality voices in real-time.

In addition to the clarity of the chosen voice, the personality of a VA can impact its success (Poushneh 2021). The personality is affected by the sound of the voice and the tone of the language it uses. From their experiment with cognitively impaired and unimpaired individuals, Chattaraman *et al.* (2019) found that

* + Social vs Task orientation

## 4.3 Design

Initial prototyping for the GLAD VA involved implementing a self-contained back-end for Mycroft, with the intention of developing further features as skills. The back-end services could not be completed in a timely manner, and would have had significant

GLAD was instead developed based on Open Assistant (n.d.). It is written in Python 3. Open Assistant has a modular architecture comprised of the following: Ear – refers to the module responsible for receiving auditory data; Speech Recognition – refers to the STT module that processes the data; Minds – simple intent detection modules that compare the text with known commands; Abilities – modules that are triggered by commands to perform a task and generate a response; Voice – the STT module; and Sound – the audio playback module.

The modular design of Open Assistant allowed for specific components to be replaced. Open Assistant’s speech recognition module was insufficiently robust for GLAD’s needs and was modified to instead utilize Mozilla DeepSpeech (Mozilla Corporation, 2020).

The audio detection module was configured with longer pause times to support users with staggered or slow speech.

Open Assistant’s minds and abilities – comparable to skills in Amazon’s Alexa – fulfilled the extendibility requirement of GLAD.

Open Assistant is self-contained and able to function without internet access.

The default voice synthetisation for OpenAssistant is less sophisticated than other available options; however it was sufficiently clear for the needs of GLAD.

## 4.4 Implementation

* discussion on any issues/problems that arose and how each was resolved.

Mycroft (Mycroft AI Inc, n.d.) was used in the first prototype, however the required back-end services were too memory intensive for a self-contained offline version.

* Process of selecting the technology and creating the VA
* Pi Virtual Machine
  + Debian
  + 8GB HDD, 6.9GB used for storage
  + Trouble with memory/storage/speeds
* Original VM
  + Ubuntu
  + Virtual Environment
* Mozilla Deepspeech
  + Keyword spotting/improved speech recognition not extensively investigated due to time constraints
* Social vs Task orientation
  + Task oriented for functionality, social-oriented for engagement exercises/games
* Mycroft backend was difficult to implement
* Voice Synthesis

## 4.5 Evaluation

For the VA to be successful, each component – STT, Intent Detection, and TTS – of the initial architecture must be sufficiently robust. To assess this, a sample of robustness of each component will be tested through a comparison of its accuracy and speed of transcription of live audio.

Given a selection of commands, the voice assistant

* Testing
* Speed benchmarks
* Raspberry Pi VM
* Address successes of implementation
  + Speech model can be updated at later date
* Address limitations of implementation
  + Intent detection

The STT results show poor performance in both speed and accuracy of the given phrases.

Despite the drawbacks of its implementation,

# 5. Cognitive Exercises

## Introduction

Because dementia and related conditions are largely irreversible, the only course of treatment is to slow the rate of cognitive decline. To this end, efforts have been made to incorporate cognitive training exercises in the form of serious games into the GLAD VA.

## Research

Serious games have applications in education. These games can stimulate memory and perception skills.

Serious games and mental exercises have been developed for individuals with cognitive impairment

In addition to cognitive exercises, there have been numerous studies of the effects of physical exercise on cognitive functioning (Heyn, Abreu, Ottenbacher 2004). The results of these studies have found only moderate correlation between physical exercise and improved cognition, although there are other psychological benefits to physical exercise (Thune-Boyle *et al*. 2012).

Chi, Agama, and Prodanoff (2017)

Gates *et al.* (2011)

## Implementation

* Counting game (higher - lower)

## Evaluation

# 6. Feature 2

## Introduction

## Research



## Implementation

## Evaluation

# 7. Companionship

## Introduction

## Research

Companionship and social relationships have been consistently shown to be very important for maintaining both physical and mental health. For the elderly, social relationships are hampered by difficulty communicating (A. Palmer et al. 2016). The proposed VA could help overcome this obstacle and assist early-stage dementia sufferers with maintaining their social relationships and health. The VA could also provide a degree of companionship itself. Improved voice synthesis will make VA’s more relatable.

## Implementation

## Evaluation

# 8. Results

Here you will detail all of the results you collected. You may choose to use tables or graphs to show your results.

This section summarises and provides evidence of what has been achieved and will reference additional materials in the appendices.   For projects that test a theory or concept, it will analyse the results of the investigation in relation to original expectations and draw conclusions about the theory or concept.

A critical appraisal of the project, indicating the rationale for any design/implementation decisions, lessons learnt during the course of the project, and evaluation (with hindsight) of the project outcome and the process of its production (including a review of the plan and any deviations from it)

# Evaluation of Developed System

While persons suffering with late-stage dementia will likely still require constant support, this system should allow persons with early stage dementia and pre-dementia to continue living independently for a longer period before requiring more consistent care.

# 9. Conclusion

This section will evaluate both the process and products of your project based on your previously developed criteria.

Note that the ‘products’ of your project include not just the principal artefact that you have developed, but also design and other documentation associated with the development process.   It is also appropriate to discuss the results of any external validation of your artefacts in this section.  The evaluation of the process should consider all elements of your project methodology as well as project management issues

# 10. Further Research

Based upon your evaluation of the process and products of the project you should make recommendations about how the project could be carried forward in the future. For example, what improvements could be made to your system or experiment if you were able to continue further work on your project?   If your project was re-scoped at the review stage to ensure it was achievable, this section is likely to discuss elements removed at that point.  If your project consisted of creating a design document for a complex system, it might discuss how your design might be implemented.

# 11. Reference list

* A list of citations for sources you have referred to in the body
* Alphabetical order
* Single line spaced
* DOI links

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# 12. Bibliography

* Sources not referenced in the body of the report
* Match format of references section

# 13. Appendices

## Appendix A: Title

An appendix is for anything you feel is useful for your reader to see, but which isn’t essential for understanding your dissertation. It is optional.

Note: An appendix normally includes research related material that does not fit easily or suitably in the body of the report. Start each appendix on a new page

Notice that the sequence of your appendices is given using letters ‘Appendix A’, ‘Appendix B’, etc.

Also, the numbering of the pages in your appendix is done at the bottom of the page as ‘A-1, A-2’/ ‘B-1, B-2’ etc.

To get this separate numbering, you need to insert a continuous break at the heading of the appendix, this will start the numbering again. Then click into the footer and uncheck the box which says ‘same as previous’. You should then be able to change the letter next to the number (e.g. ‘A-1’ changed to ‘B-1’)to match the letter of your Appendix.

In-text citation (link) to an Appendix should look like this: (Appendix A)

Use a footnote reference system Foo Bar1

## Appendix B: Title

Paragraph.

Paragraph.

|  |  |
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## Appendix C: Title

Paragraph.

1. There is no consensus on a general term for this class of products. Alternative terms include intelligent virtual assistant (IVA), intelligent personal assistant (IPA), and smart speaker. For this document the term voice assistant (VA) will be used. [↑](#footnote-ref-1)