

Smart Kart (Project Initiation Document)

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Contents

1	Project Background and Purpose	3
1.1	Objectives	3
1.1.1	Primary Objectives	3
1.1.2	Secondary Objectives	4
1.1.3	Tertiary Objectives	4
1.2	Scope	4
1.3	Deliverables	5
1.4	Constraints	5
1.5	Assumptions	5
2	Project Rationale and Operation	7
2.1	Project Benefits	7
2.2	Project Operation	7
2.3	Options	8
2.3.1	Which Platform?	8
2.3.2	Which Language?	8
2.4	Risk Analysis	9
2.5	Resources Required	9
3	Project Methodology and Outcomes	10
3.1	Initial Project Plan	10
3.1.1	Tasks and Milestones	10
3.1.2	Schedule Gantt Chart	11
3.2	Project Control	13
3.3	Project Evaluation	13
A	Initial Kanban Board	14
B	Risk Analysis Table	15

Chapter 1

Project Background and Purpose

1.1 Objectives

This project seeks to create a software application for a smartphone, that detects when a vehicle the phone is in enters an "Average Speed Check zone", starts tracking the vehicle's speed, and gives the driver an audible alert if they are at risk of breaking the speed limit.

The usefulness of this project is the safety benefits it may provide. If the application produced can reduce the frequency that a driver needs to check their speedometer, then they will be more aware of road conditions; which can lead to safer driving.

This project is motivated by the increasing deployment of average speed check zones throughout the UK (doubling between 2013 and 2016 (BBC News, 2016)), and the potential they may have for leading to distracted driving.

1.1.1 Primary Objectives

The Primary Objectives of this project are:

1. To develop an app (for a smartphone) that determines when the user is in an "average speed check zone", and begins tracking average speed.
2. Said app then warns, with an audible warning, if the user's average speed is above the limit.
3. Integration with a platform's voice commands¹ may be used to launch the app at the user's request (for example, if there is temporary speed check area).

¹e.g. Google Assistant (Google LLC, n.d.) or Apple Siri (Apple Inc., n.d.b).

4. Within the application, voice commands may be used to control the functions of the app; for example, changing the speed limit, or resetting the average speed.

1.1.2 Secondary Objectives

If time allows, the project may achieve the following objectives:

5. The app allows for the user to manually set what the speed limit is (for example if a road has a temporarily reduced speed limit).
6. The app allows for setting the audible warning to a custom sound.

1.1.3 Tertiary Objectives

In many territories globally, the use of devices to detect speed cameras is illegal, and apps are either explicitly or potentially illegal; for example in France, any device or system used to "detect the presence" of devices for regulation of road traffic, is illegal under the Code de la route (Légifrance, 2012). It would be ideal if the app could detect it was in such a territory, and prevent its own usage.

As well, the app may allow the users to contribute to an open dataset of average speed check zones.

Different classes of vehicles have different speed limits; for example, the National Speed Limit for LGVs over 7.5 metric tonnes is 60, regardless of whether the road is single or dual carriageway (GOV.UK, n.d.). It would be useful if the application allowed for the user to set what type of vehicle they are driving, and then altered the speed limit used for warnings accordingly.

1.2 Scope

There is scope within the project to provide an app that is cross platform, using technologies such as Flutter, UNO, and .NET MAUI (née Xamarin.Forms)². This would allow users of the major mobile ecosystems to use the app.

However, doing so requires a developer to be familiar with the relevant tooling and languages (Dart for Flutter, C# for UNO and MAUI). If a developer is not familiar, learning the tooling may take up a significant amount of time that should be spent on the actual programming. Hence, we are presented with a choice to be made during the analysis stage of the project.

There is also scope to build an independent database of average speed check areas; this would bring "server-side" programming into the project.

²Flutter (Google LLC, 2021b), UNO (nventive Inc., 2021), .NET MAUI (nventive Inc., 2021)

Alternatively, there may already be public datasets available for use. Whether to use existing datasets (if possible) or build an independent one is another decision for the analysis stage.

Should the project opt to use public dataset(s), allowing for contribution to such datasets from within the app would serve the public good and benefit the app's users; so this may well be within the scope of the project.

1.3 Deliverables

The Project will deliver a smartphone application that meets the Primary Objectives (defined in section 1.1.1).

The project will have met its objectives when the app matches provides features defined by the Primary Objectives. If the project **also** implements Secondary or Tertiary Objectives, it may be considered to have "exceeded" its objectives.

1.4 Constraints

Testing the application in the most *direct* way - using the app while driving - may be constrained by:

- Law: It's illegal to use a mobile phone whilst driving, under the Road Vehicles (Construction and Use) Regulations, 1986 (amended 2003):110 (Jamieson, 1986).
- Insurance: most motor insurers aren't favourable to claimants using their mobile phones. Furthermore, most insurance doesn't cover "testing" on public nor private roads.
- Ethics: The University of Hull's Research Ethics Policy (Smith & Richards, 2017) defines "non-maleficence" as the "avoidance of harm". Testing the application in the above way flies in the face of this, as driving distracted is an easy way to cause harm.

The obstruction this causes to testing can be mitigated through the use of an emulated device and "falsified" location data.

Otherwise, there are no external constraints known at this time.

1.5 Assumptions

The assumptions being made during the development of this project are:

- That a future version of the platform(s)/framework(s) being used does not deprecate key features/APIs that the application depends on (e.g. increased restrictions on accurate location access).

- That any external dataset used does not become unavailable, or increase costs to an unsustainable level.
- That the UK does not introduce laws similar to France's that ban the use of the app.

Chapter 2

Project Rationale and Operation

2.1 Project Benefits

Successful delivery of this project will most benefit car drivers (primarily in the UK, but possibly in other territories), with phones, who often drive in areas with average speed check zones.

By reducing the time spent monitoring their speedometer, they can be more conscious of the road around them, and be more alert to potential incidents.

As well, by providing *advance* warning of exceeding the average speed, they may be able to drive in a smoother manner and avoid the "kangarooing" effect, as seen when a driver brakes harshly to avoid a ticket; this can reduce congestion and prevent accidents.

2.2 Project Operation

Agile Software Development is a paradigm, commonly defined by the Manifesto (Beck et al., 2001); within this paradigm are many varied methodologies. For projects where there is only one team member, methodologies such as Kanban and Scrum (as modified by Scrum for One (Lucid Content Team, n.d.)) are optimal.

The Kanban board is a useful tool to understand the current state of the project; what is in progress, what needs to be started, etc. Combined with the user-input and cyclical nature of the Agile paradigm, this is ideal for a project like this one, with one developer and fast development times.

The overall planning and schedule for this project is laid out in the Gantt Chart in section 3.1.2. The intention is to stick with this schedule; however, the agile paradigm requires flexibility, so this may change with time.

2.3 Options

As discussed in the section on Scope (1.2), for developing this project there is certainly one choice to be made: is the app developed using one of various cross-platform frameworks, or using platform-native frameworks.

While it was not decided in that discussion whether to use cross-platform or platform native, there are choices within platform-native that are pertinent to discuss here.

2.3.1 Which Platform?

The Project's nature requires a mobile platform. However, there is a choice within this; despite Android and iOS' apparent dominance of the market (with Statcounter Limited (2021) claiming combined a 99.19% share, as of September 2021), there are various other mobile platforms, such as Tizen¹, KaiOS, and Sailfish OS; as well as mobile implementations of desktop platforms, such as pureOS.

Despite this variety, Android stands tall as the easiest to develop for and most accessible platform. The Android Open Source Project means that obtaining an image to test on, or examining the OS' source to aid in debugging, is relatively easy. Hence, should platform-native be chosen, Android is an ideal platform to develop this project for. Furthermore, using Android Jetpack² whenever possible will provide the project with a consistent base to build upon.

In comparison, developing platform-native applications for iOS devices requires a MacOSX device (real or emulated, either of which are expensive) to use Xcode, and a payment of \$99 if you wish to distribute your application on the Apple App Store (Apple Inc., n.d.a). This is significant outlay for a small development team. The other mobile platforms have significantly small market share.

2.3.2 Which Language?

Android applications have historically been written in Java, and the foundation of the OS is a JVM (originally Dalvik but later ART). The ecosystem around Java on Android is mature and well-documented.

However, in 2011 JetBrainsTM announced Kotlin, a JVM language "having the features so desperately wanted by the developers" (Krill, 2011). Being a JVM language, it was inherently "usable" on Android; but the Android Team announced "first-class support" in 2017 (Shafirov, 2017) and "Android development will become increasingly Kotlin-first," in 2019 (Lardinois, 2019).

¹Backed by the Linux Foundation, but primarily developed by Samsung.

²Android Jetpack (Google LLC, 2021a)

Hence, this project could develop the app in Kotlin or in Java. Kotlin is now the contemporary language, and Google suggests that "If you're starting a new project, you should write it in Kotlin" (Lardinois, 2019); however, Java already has a massive ecosystem surrounding it.

2.4 Risk Analysis

The most major risks to the Project at this time are those associated with Covid-19: Potential future lockdowns, mutations of the virus, supply issues, and potential infection of the Author. These risks can be mitigated by the actions of the Author, but only to an extent; it depends upon the actions of others as well.

There are various other risks, such as personal illness, strikes, and equipment breakdowns; the analysis table is in Appendix B.

2.5 Resources Required

There are no abnormal resources required for this project. All that is needed is a computer to develop on, and an android phone (or the AVD emulator) to test with.

If any of these were unavailable (for example, if the computer being used became non-functional), it would delay the project until an alternative could be sourced, or until the University's Labs are available.

Chapter 3

Project Methodology and Outcomes

3.1 Initial Project Plan

3.1.1 Tasks and Milestones

The tasks for developing the application can be broken down into Milestones. Within milestones, tasks may be performed asynchronously and simultaneously; but generally, milestones are dependant on the previous milestone.

Milestone 1: Design and Architecture.

- Evaluate potential application designs and architectures.
- Plan the overall application architecture.

Milestone 2: UI and UX.

- Plan the User Interface (UI) design.
- Plan the User Experience (UX).
- Implement the UI.
- Implement the UX.
- Testing of the UI and UX.

Milestone 3: Average Speed Algorithm.

- Evaluation of Algorithms for determining average speed.
- Implementation of Algorithm.
- Algorithm Testing.

Milestone 4: Determining if the Device is within an Average Speed Check Zone.

- Evaluation of potential Datasets.

- Design of Data Model.
- Implementation of Data Model.

Milestone 5: Glue Code, Bug Fixes, Further Objectives, and Delivery.

- Creation of any "glue code" necessary; for example, changes to build tools, code necessary to publish on the Play Store/F-Droid, etc.
- Bug fixes: Any final bug fixes for issues not found during testing in prior milestones.
- If time permits, Secondary and Tertiary Objectives will be delivered under this milestone.
- Delivery of the final Artefact.

Alongside these tasks, there is the singular long-running task of writing the final report.

3.1.2 Schedule Gantt Chart

The Gantt chart here is not as detailed as the task list above. This is due to the project using Agile and Kanban, meaning that tasks can be running out-of-order, simultaneously, and asynchronously; which isn't easily represented on a Gantt chart. Hence, the chart is more of a "timeline", and this PID also includes a snapshot of the initial state of the Kanban board, found in appendix A. This initial state may change upon commencement of the report and the creation of User Stories, Epics, etc.

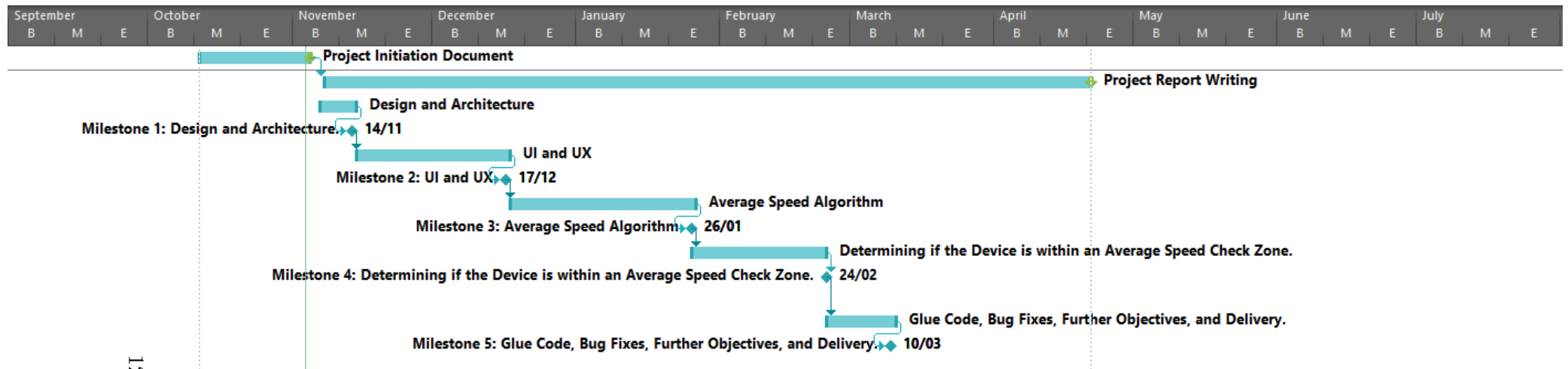


Figure 3.1: Gantt Chart at the time of the PID.

3.2 Project Control

Management of the project will be through the use of the Kanban board. The start of any development session begins by inspecting the board to understand the state of play. Then, the developer shall choose a task that is already in development (or if there are none, a task that hasn't been started), and work on it for the session.

Performance will be monitored based on the rate of progress through tasks. Should tasks take too long to complete, this is an indicator of a low performance. However, the inverse, tasks being completed quickly, is not inherently an indicator of high performance; it may well mean that tasks are not being completed to sufficient depth.

Whether the project is successful will be judged based on the resulting artefact, and whether this artefact has met the objectives in 1.1.1.

3.3 Project Evaluation

Evaluation of the Project's artefact(s) will be based on how close it adheres to the objectives in 2.2.

In terms of User Evaluation, testing the entire application is limited by the constraints layed out in 1.4. However, the UI/UX could possibly be tested by users, independent of the underlying application.

Appendix A

Initial Kanban Board

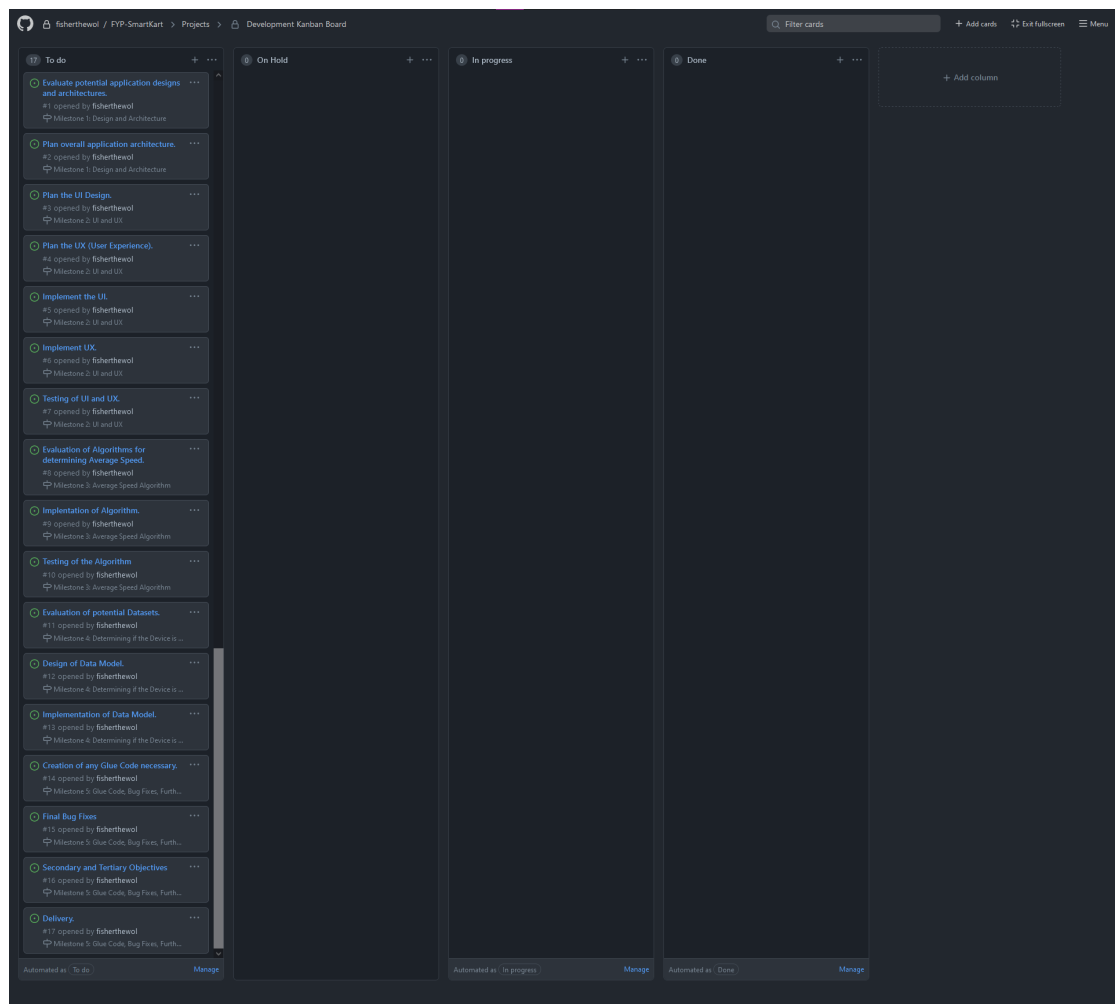


Figure A.1: Initial state of the Kanban Board.

Appendix B

Risk Analysis Table

1. Total Equipment Failure

- Description: The Author's equipment (computer, phone) experiences total failure, preventing progress on the project until repaired.
- Likelihood: 1.
- Severity: 4.
- Impact Score: 4.
- Mitigation: Regular Maintenance is performed on the equipment, and backups are made. As well, the data for this Project is stored as a repository on Github, so data loss should be minimal.
- Recovery: The Author shall use the University of Hull's library computers, until such a time as replacement equipment can be sourced.

2. Partial Equipment Failure

- Description: A part of the Author's equipment fails, degrading the ability to progress with the project.
- Likelihood: 1.
- Severity: 3.
- Impact Score: 3.
- Mitigation: Very similar to Total Equipment Failure, mitigation relies on maintenance, backup, and Github.
- Recovery: Similar to Total Failure, Hull University's library has computers available for student use.

3. Covid Lockdown

- Description: The UK goes into another lockdown due to rising covid cases, preventing access to campus.
- Likelihood: 2.
- Severity: 3.
- Impact Score: 6.
- Mitigation: Covid is a public health issue, hence mitigation requires societal collaboration on individual actions, such as mask wearing and social distancing.
- Recovery: Lockdown won't directly affect the writing of code in this project, but may affect the Author's mental health, or other health aspects. Hence, recovery involves mental wellbeing and awaiting the end of lockdown.

4. Use of Phone in a Car

- Description: While testing the application, bugs or other issues cause distracted driving, which leads to a vehicular accident, injury, or death.
- Likelihood: 1.
- Severity: 4.
- Impact Score: 4.
- Mitigation: The app will not be tested on the public roads. Instead it will be tested using the Android Emulator.
- Recovery: There is no recovery from death. However recovery from Injury involves various medical treatments.

5. Application causes Damage to a device.

- Description: The application, through serious errors, causes physical or "software" damage to a user's device.
- Likelihood: 1.
- Severity: 4.
- Impact Score: 4.
- Mitigation: The app will not use obscure and undocumented features of the platform, unless absolutely necessary. This shifts the risk from the application to the developers of the standard library of the platform.
- Recovery: A device damaged by the application would be sent to a repair shop/manufacturer for repair.

6. Application gives user false average speed.

- Description: The application either miscalculates the average speed of the vehicle, or believes the speed limit is higher than it actually is; leading to the user speeding and receiving a fine.
- Likelihood: 2.
- Severity: 2.
- Impact Score: 4.
- Mitigation: Regarding the miscalculation: comprehensive software tests and a thorough review and understanding of the relevant kinematics will reduce the chance of miscalculation. Regarding the erroneous speed limit: this is mitigated by allowing the user to set their own speed limit outside of what is automatically detected, and by attempting to keep the dataset in use up to date.
- Recovery: There is not much the application can do to recover the speeding fine the user may receive; however, reports of such issues should be used as feedback to improve the application.

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