



# final report

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## Smart Management Technology for Feral Animals

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## Abstract

Feral Animals cost more than 700 million to Australian economy every year. The current measures such as baiting, trapping & shooting are not selective or targeted. There is no way to measure effectiveness of the money spent on the controls. Solution under development by OutofBox Solutions will enable selective trapping and provide alerts on trapping.

The Project P.PSH.1025 was aimed at developing a Minimum Viable Product (MVP) of the proposed solution - Alfie. Alfie integrates with existing feral animal controls such as traps and provides capability to avoid non-targeted species. The solution provides alerts when the control is activated. The solution was built using IoT and Artificial Intelligence by following Rapid & Iterative Development.

Customised designs were built for mechanical, electronics and hardware components. These designs included hundreds of components and required huge effort to integrate all the development aspects.

The MVP has helped us conduct field trials in controlled environment and identify necessary design optimisation to get the product market ready.

We have seen growing interest from farmers and farmer groups to participate in the wider trials of the solution. The product can save time and money every season for the livestock farmers and supporting businesses.

The project P.PSH.1025 has achieved planned outcomes and is planning for product commercialisation activities.

## Executive summary

Feral Animals cost more than 700 million to Australian economy every year.

The current measures such as baiting, trapping & shooting are not selective or targeted. The non-selective nature leads to high operational costs and by-catch which impact native species. There is no way to measure effectiveness of the money spent on the controls. Solution under development by OutofBox Solutions will enable selective trapping and provide alerts on trapping.

The Project P.PSH.1025 was aimed at developing a Minimum Viable Product (MVP) of the proposed solution - Alfie. Alfie integrates with existing feral animal controls such as traps and provides capability to avoid non-targeted species. The solution provides alerts when the control is activated. The solution was built using IoT and Artificial Intelligence by following Rapid & Iterative Development.

As part of Customer Discovery process, OutofBox Solutions team interviewed over 100 of farmers, community groups & industry representatives. The insights from these discussions along with industry reports highlighted need to make existing feral animal controls smarter by making them selective and measurable.

Customised designs were built for mechanical, electronics and hardware components. These designs included hundreds of components and required huge effort to integrate all the development aspects. Key challenges included building the solution that works in on-the-farm conditions.

The Project P.PSH.1025 has achieved planned outcomes. The MVP helped the team to conduct field trials in controlled environment and identified necessary design optimisation to get the product market ready. The design changes required are mainly to optimise power consumption and integration with existing controls such as traps, baits.

With further design fine tuning, product will be field trialled on wider scale. We have seen growing interest from farmers and farmer groups to participate in the wider trials of the solution. The product can save time and money every season for the livestock farmers and supporting businesses.

Design fine tuning and product optimisation are the next steps for the next phase of this project that will prepare Alfie to be market ready. The next stage of the product development will include multiple suppliers, wider field trials and more number of sample units produced to achieve product commercialisation.

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## 1 Background

MLA has identified Feral Animal problem as one of the top 5 problems faced by Red Meat Industry in Australia. Feral animals cost over \$700 million in Australia. It is a global issue with much higher costs across the world. Traditional measures used by farmers include trapping, baiting & shooting. These are not selective & targeted in their nature. The usage and effectiveness of the control measures was based on the experience of the farmer & regulations around poison baiting within the region.

OutofBox Solutions is an AgTech start-up incorporated in Australia. In 2017, OutofBox Solutions carried out a detailed customer discovery as part of Sproutx Agtech Accelerator program. Losses due to feral animals was a repeated concern observed in the discussions.

In February 2018, MDC approved 250K AUD to co-fund Phase-1 of the project to develop a 'Smart technology solution for Feral Animals'. Phase 1 of this project (Ref: P.PSH.1025) was focused on developing the MVP of the proposed product. With this support from MLA, OutofBox Solutions developed an innovative product, named Alfie. This solution will improve effectiveness and efficiency of feral animal controls by making them selective avoiding by-catches that causes efficiency reductions and native animal endangerment.

Alfie which is now a minimum viable product (MVP), uses Machine Learning and Internet of Things (IoT) to make traditional farming and conservation practices efficient. Alfie uses machine learning software that analyses images. The software can be used to automate image analysis. The 'bush ready' hardware device integrates this software to provide solution for selective feral animal control and native animal protection. The solution uses Artificial Intelligence for making controls selective. The solution also enables various other use cases for livestock farmers and conservation bodies.

## 2 Project objectives

Project Objective as agreed in the Research Agreement are as below:

- Develop a solution for farmers to make feral animal controls selective & targeted
- Demonstrate implementation of the solution in farms with varying connectivity needs
- Assess feasibility of setting up a data source for information on conservation of native life around the farms

## 3 Methodology

As part of this project, Rapid & Iterative approach was adopted to develop and testing regularly to achieve required functionality iteratively. This is different to traditional manufacturing approach where a fully functional product is devised before taking it to the field trials.

Key benefit to this approach includes early user feedback and faster product development cycle.

### **Rapid & Iterative Development**

Rapid Development is commonly followed approach in software development. This consists of tools to simulate test scenarios and working toward achieving success criteria.

IoT and Artificial Intelligence are relatively new technologies and will require continuous testing for confirming right design and components. Every design decision is field trialled before proceeding to the next update.

## 4 Results

### 4.1 Alfie: Selective Solution for Feral Animal Control

Alfie provides a selective control for feral animal prevention and native animal conservation. Typically used controls such as traps, baits do not distinguish between targeted and non-targeted species. This results in high operational cost and significant collateral damage (i.e. impact on non-targeted species). Alfie can integrate with existing controls in farms, bushland and turn them into effective solution. Key users include farmers, councils and government agencies responsible for feral animal controls and native animal conservation.

Alfie is designed to integrate with controls such as traps, baits commonly used for feral animal control and native animal conservation.

Alfie has following features that turn traditional controls into smart and efficient solutions:

- In-built Artificial Intelligence to identify targeted species
- Robust mechanical enclosure that integrates with existing controls
- Embedded Hardware that enables control actions depending on the image analysis
- Alerts from remote areas using low bandwidth technologies

The core unit can be attached to a cage trap or can be placed on an isolated stand. It is designed to work with most commonly used controls. Alert feature is enabled on various technology platforms such as Sigfox, CAT M1, LoRa. The modular design enables using other communication technologies such as satellite without disrupting core functional unit. The solution provided is portable i.e. it can be used in other scenarios where similar solutions are implemented.

The Alfie MVP built by OutofBox Solutions has demonstrated the benefits it can achieve on ongoing basis to Australian farming industry. Key features of the solutions are integration with existing feral animal controls and alerts based on the control status.

In this initial phase of the project, integration was achieved with controls like traps used for foxes/ cats and native animals. This was achieved using custom-built mechanical enclosure and embedded software to integrate rest of the solution. Project has achieved its planned outcome of preparing MVP. Further design optimisation is required to get the product market-ready.

### 4.2 Milestone Status

The project was divided in 5 Milestones from Feb 2018 – Feb 2019.

Planned Milestones	Status
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<p><b>Milestone 1: Functional Prototype Completion</b>  Planned Activity: Prototyping in line with findings from the customer discovery process  Exit Criteria: This milestone will be achieved when a prototype with required functional features is ready.  Milestone report to be submitted to MLA for review and approval.</p>	<p><b>COMPLETE.</b>  Milestone Report Submitted</p>
<p><b>Milestone 2: Field Trial with Alpha MVP</b>  Planned Activity: Functional prototype will be assessed for engineering &amp; design changes to prepare Alpha MVP. i.e. an early testable product. This phase will focus on achieving at least one critical functionality. This testing will be mainly carried out in Victoria.  Exit Criteria: At least one end-to-end functional requirement is ready for testing with Alpha MVP.  Milestone report to be submitted to MLA for review and approval.</p>	<p><b>COMPLETE.</b>  Milestone Report Submitted</p>
<p><b>Milestone 3: Field Trial with Beta MVP</b>  Planned Activity: Based on testing of Alpha MVP, MVP will be improved further. This phase will focus on achieving all the critical functionalities expected in the MVP. This testing will be carried out in Victoria &amp; a couple of other states.  Exit Criteria: All the critical functionality expected in the MVP are ready for testing.  Milestone report to be submitted to MLA for review and approval.</p>	<p><b>COMPLETE.</b>  Milestone Report Submitted</p>
<p><b>Milestone 4: Field Trial with MVP</b>  Planned Activity: Beta MVP will be tested &amp; improved in this phase. Field Trial will commence with the improved product across Australia.  Exit Criteria: MVP is ready for field trial  Milestone report to be submitted to MLA for review and approval.</p>	<p><b>COMPLETE.</b>  Milestone Report Submitted</p>
<p><b>Milestone 5: Project Completion</b>  Planned Activity: Based on MVP field trial, list of features of the MVP will be finalised. Project report will be prepared to highlight findings &amp; recommendations of the project.  Exit Criteria: Project Completion Report  A confidential and both a public report will be produced outlining the design conditions and technical functionality arrived at through the customer discovery and validation journey in developing a solution for farmers to make feral animal controls selective &amp; targeted, demonstrate the implementation of the solution in farms with varying connectivity needs and assess feasibility of setting up a data source for information on conservation of native life around the farms</p>	<p><b>COMPLETE.</b>  This Report</p>

## 5 Discussion : Inferences and Insights

### 5.1 Customer discovery insights

As part of Customer Discovery process, OutofBox Solutions team interviewed over 100 farmers, community groups & industry representatives. The insights from these discussions along with industry reports highlighted that a key concern that existing feral animal controls are not selective & measurable. This is a high-level break-up of discovery process:

- over 75% livestock farmers (mainly sheep & goat) in the regions of Victoria, NSW, Queensland & WA
- Over 15 community groups from WA & NSW
- 5 Landcare groups within Victoria
- over 25 industry group representatives. These representatives include Senior Executives from Farmers Federation, Agriculture Department & Bio-Security Officers
- Research Scientists who have carried extensive feral animal research for Department of Agriculture & State bodies such as Parks Victoria & Queensland.

OutofBox Solutions team sought feedback on possible solution and subsequently on the prototype under development. The MVP will be modified on the feedback that we continue to get during field trial process.

Our very first prototype in July 2017 was based on Cloud Platform. This was immediately considered unreasonable due to limited coverage area in the remote area.

Our key challenge during the prototype phase has been image analysis in offline mode. Entire processing & data analysis happens in Alfie. Based on the analysis, decision is taken such as trigger the trap shut.

When the targeted animal is trapped, notification needs to be sent out. For this part, we rely on low-bandwidth network options such as Sigfox, LoRa, Telstra CAT M1/1.

Some of the incidents are recorded below:

- The solution for feral animal control was devised based on extensive customer discovery process. We spoke with various farmers, industry groups & controls groups that run feral animal control programs using trapping & baiting. Currently when baits are placed, there is no way of knowing who has taken the bait. Trapping is often time-consuming as it can trap non-targeted species including native endangered species.
- The need of checking the traps in less than 12-24 hours adds to a huge cost & labour overhead. Harsh weather & rough terrains make the job of doggers/ trappers very demanding. The community groups highlighted that these professionals were expensive to hire & good professionals were hard to find. There is a small number of such professionals due to hard nature of the job.
- Another community group wanted to put access control around water point & make effective baiting / trapping using the insights from monitoring.



- Many farmers have shared their views on various farm monitoring-based use cases that can be achieved with Alfie set-up (Monitoring, Camera & Alert set up).
- .

## 5.2 Integration with existing feral animal controls provides an effective feral animal control

This aspect of the solution was important to the farmers we have worked with. Effectiveness in the usage of traps and baiting are often reliant on farmers/ trappers skill and experience. Its effectiveness depends on minute decisions and on weather and environmental conditions. With the technology integration, alerts and other sensor data, the farmer is able to augment their existing experience and knowledge of feral animal controls.

## 5.3 Rapid prototyping and design thinking for the product market fit of Alfie

The MVP work included custom-built mechanical enclosure, electronic and hardware design that included hundreds of the components, assembly and fabrication of the necessary electronic circuit boards. Multiple iterations were necessary to achieve working solution.

The entire process was managed by following industry-recommended practices of managing software and product development practices. We used online collaborative tools to manage the processes and ongoing status.

## 5.4 Value Proposition to Red Meat Industry

The benefits of the project will include:

### *Improved Efficiency and Effectiveness:*

- Farmers can save money and effort spent on Feral Animal Controls every season.
- Improve the effectiveness of existing control measures by making them selective & measurable.

*Reduce environmental impact:* Alfie will be a useful solution for reducing impact on native animals which are common victims of feral animals and by the use of feral animal controls.

*Optionality to improve farming practices by utilising machine learning and IOT capabilities:* Various additional on-the-farm use cases can be enabled by the infrastructure implemented by this solution such as connectivity, camera monitoring, IoT platform.

## 5.5 Team Profile

OutofBox Solutions team comprises of in-house skills and collaborative partnerships. Both Co-Founders have over 18 years of technology industry experience. They are supported by in-house team-members with necessary skills in design and build activities. OutofBox Solutions team has partnerships with La Trobe University and experienced design companies. Multiple teams have worked well together to achieve necessary project outcomes.

## 6 Conclusions/recommendations

### 6.1 Conclusion

The project P.PSH.1025 has achieved its key success criteria and the prototype proved concept of technology usage. The key activities completed in this phase were:

1. Prototype completion of Alfie
2. Mechanical and Electronic Design for the Alfie MVP
3. Prepared 2 units with the completed design
4. Field trials conducted to validate & test the design and functionality

Based on the testing completed, further design changes and fine-tuning requirements have been identified. Addressing these changes in the next phase of the project (Phase -2) would prepare the product for the next stage of commercialisation

### 6.2 Recommendations

Further work is required to fine-tune the design to get the product to be market-ready. Key focus needs to be provided in resolving the defects identified in the lab testing and during field trials.

Following areas of improvement has been identified:

1. Electronic Design Improvements:
  - a. Power consumption needs to be optimised further and include options such as Solar Power support. Further optimisation is required to reduce power consumption and effective error handling.
2. Mechanical design improvements:
  - a. External parts that connect to the traps require further work to protect them from possible damage from the animals.
  - b. The Mechanical design should also be refined for the product to be placed away from traps.
3. Fixing the Defects discovered during the testing:
  - a. Defects were identified in the design, fabrication and assembly process of the trial units. These defects need to be fixed and designs need to be adjusted.
4. Regression testing of the revised components:
  - a. Due to number of components involved, regression testing is essential with all the fixes introduced.
5. Further Product Development required for coverage:
  - a. Further variants need to be designed and tested as part of the next steps: 1. emails using CAT M1 2. Sigfox integration 3. LORA using available backhaul options 4. Satellite connectivity.
6. More Field trials to be done to ensure geographic, fauna and communications coverage.
  - a. More field trials are required to be done. These are planned in the following regions:
    - i. Victoria with trappers
    - ii. Western Australia with focus on wild dogs
    - iii. Western Australia with focus on feral cats and foxes

## 7 Key messages

### 7.1 Next Steps – Phase 02

Design fine-tuning and optimisation are the next steps that will prepare the product for market. Next stage of the product development will include multiple suppliers, wider field trials and more number of sample units produced to achieve product commercialisation.

### 7.2 Phase -02 Milestone Plan

The following milestone plan and delivery details are developed for Phase -2 of this project.

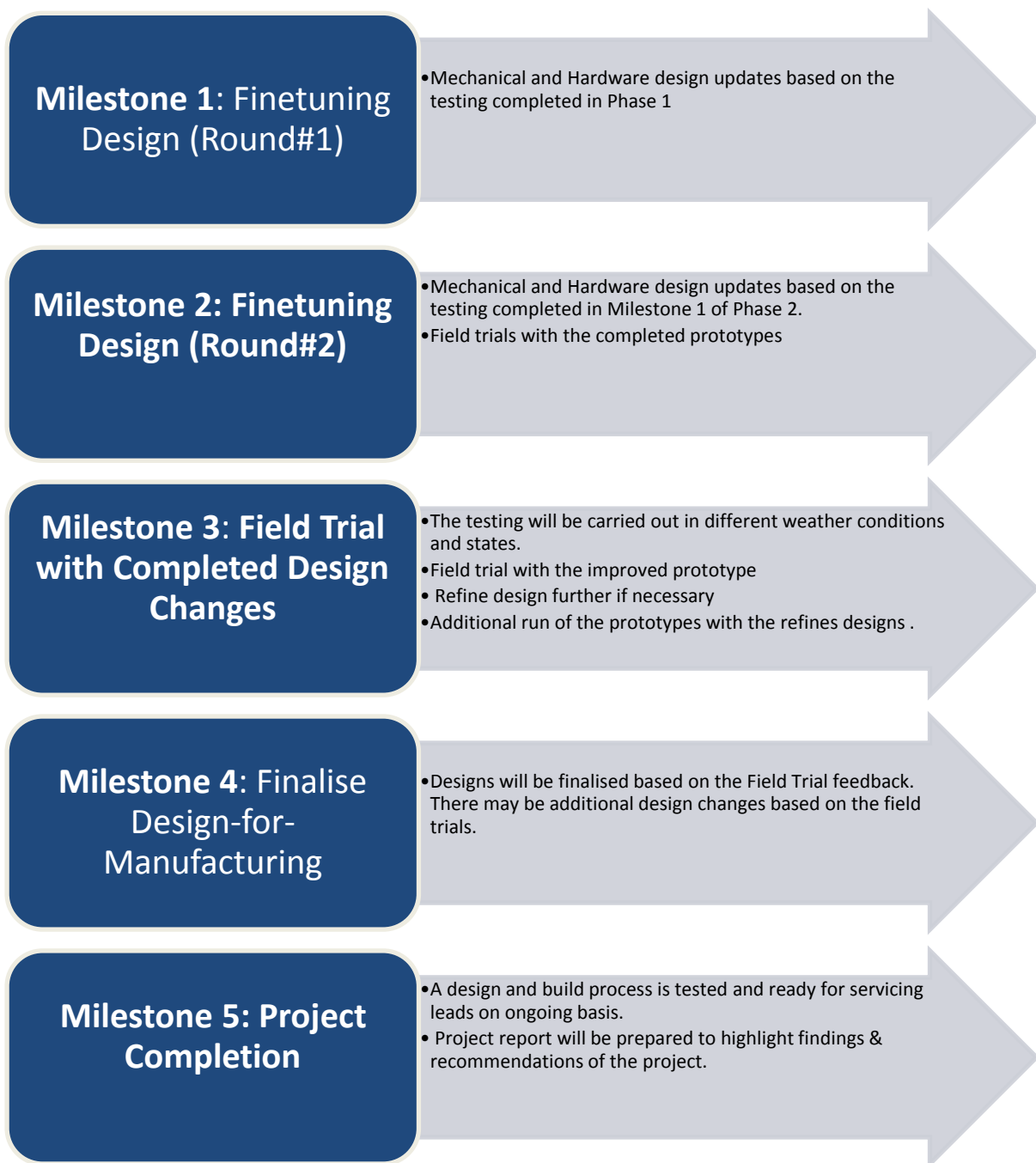
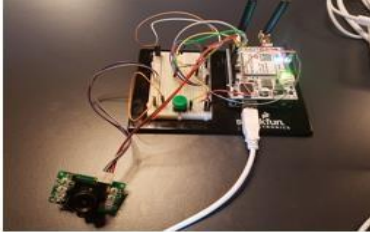


Fig. 1 Phase02 Milestone Plan

## 8 Appendix

### 8.1 Product Journey



#### Custom-designed Electronic Components:

