GADE Smoke Detector: from design to manufacturing

PDI 4th Semester project report

Group: A7A
Supervisors: Christian Hammerich, Thomas Gulløv and Winnie Bundsgaard
University of Southern Denmark
B.Sc. Product Development and Innovation

28th May 2014
**THEME: PRODUCT INNOVATION PROJECT**

**4th semester project**

B.Sc. in Product Development and Innovation

Project title: Gade Smoke Detector: from design to manufacturing

Group number: A7A

Group members:
325344 – Asger Thomsen
322332 – Morten Rison Nielsen
322479 – Bjarne Hansen Bonde
222314 – Maria Pilar Martín Romero
325711 – Kevin Jakobson
318515 – Tine Uldahl Vigsø
336968 – Max Busch

Project Supervisors: Christian Hammerich, Jens Christian Jensen, Thomas Gulløv and Winnie Bundsgaard

Project period: 5th of February to 28th of May 2014

Bjarne Bonde

Kevin Jakobson

Morten Risom

Asger Thomsen

Pilar Martin

Max Busch

Tine Vigsø
EXECUTIVE SUMMARY

The goal of this project is to take Keld Gade’s idea of a new fire detection system and finalizing it for the market and production. This involves going through 3 stages of a defined stage gate model: Design, Market Penetration and Production Engineering. This is done as part of the Semester project at the Product Development and Innovation educations 4th semester. The group worked as if it was a start-up company.

The original invention by Keld Gade consists of a detector unit, a main hub and a dismounting tool. The detector unit’s signals the main hub when fire is detected. The main hub will then warn via the Internet, mobile and sound. The dismounting tool is used to easily take down and putting up the detector units.

The market was investigated and the targeted market defined as elderly and small businesses. Denmark has the lowest number of smoke detectors in the Northern countries and especially the elderly are lacking behind. Further the dismounting tool could be very beneficial for this group. The main values for the customers were defined as:

- Time it takes to change battery
- Color/Shape
- Unit cost
- Time it takes to install

Based on the company situation, the market, manufacturing, design, technical and the customer the invention was redesigned. The result of this was a simplified version with no main hub and only a local connection between the detector units. Further the detector units were split into two different models: one only with battery and one that are both with a battery and a connection to the permanent electrical grid. Each was also optimized so that it would be more resilient to dust and insects. The dismounting tool was redesigned so that it would be easier to use with different poles to extend the reach. A list of Unique Selling points for our product was created:

- Simple to install
- Easy to maintain and service
- Are able to be inter-connected with other GADE smoke detection units
- Use either with or without permanent connection to the grid
- Beautifully designed
- Comes with an unique dismounting tool

Using Modular Function Deployment the product was modularized to reduce production cost and difficulty of product upgrades. The dismounting tool was split into two modules and the detector unit into 4 modules. Furthermore the product was optimized for production using Design for Manufacturing, resulting in a reduced manufacturing cost of 12.3%.

The parts for production will be bought from sub suppliers and assembled in Denmark for a period of 5 years. It will be complying EU standards and can be sold all over Europe.
The main distribution channels will be direct sales through physical and web based retail stores. There will be spend 50.000,- per year on promotion in magazines. The product would be sold to the retailers at the following prices:

- Wired smoke detector: 149,- DKK
- Smoke detector with battery: 129,- DKK
- Dismounting tool: 49,- DKK
- Package containing one of each: 299,- DKK

The economic aspects of the product for the next 5 years were investigated. In the optimal scenario, where the sales forecast will be fully meet, there is a payback period of 2,11 years, an Internal Rate of return on 73% and a Net Present value of 1,1 mil. DKK. On this the product seems highly profitable, however there are a number of considerations. Based on a sensitivity analysis the single most sensitive parameter was a decrease in selling price. Furthermore the calculations were made on a number of uncertain numbers. The recommendation is to invest some time and money in really assessing all the risks.

The group’s recommendation is to not launch the product. There would be too high a risk as a start-up company to develop and sell the product. This type of product is declining if you look at it from a technology point of view (using the S-curve approach). The market are changing towards more intelligent solutions such as NEST (Smart fire detecting systems) that are increasing in technological capabilities and decreasing in price.

If the product should be launched it should be done together with existing companies. The design and the idea is ours, but could be launched under that companies name.
# Table of Content

**Theme: Product Innovation Project** .................................................................................. 1  
**Executive Summary** ....................................................................................................... 2  
**Table of Content** ............................................................................................................. 4  
1 **Preface** .......................................................................................................................... 5  
   1.1 How to read the report .................................................................................................. 5  
2 **Introduction** ..................................................................................................................... 6  
   2.1 The Project .................................................................................................................. 6  
   2.2 Project Planning and Organization ............................................................................. 6  
   2.3 Limitations ................................................................................................................... 7  
3 **Investigation** ................................................................................................................... 8  
   3.1 Description of Original Concept ............................................................................... 8  
   3.2 Evaluation of Original Concept ................................................................................ 9  
4 **Business Plan** ................................................................................................................. 10  
   4.1 General Company Description ............................................................................... 10  
   4.2 Product Redesign ....................................................................................................... 12  
   4.3 Product Description ................................................................................................... 13  
   4.4 Technical Description ............................................................................................... 14  
   4.5 Production ................................................................................................................ 18  
   4.6 Technical Risks ......................................................................................................... 19  
   4.7 Marketing Plan .......................................................................................................... 21  
   4.8 Operational Plan ....................................................................................................... 28  
   4.9 Financial Plan ........................................................................................................... 33  
   4.10 Future Perspectives ................................................................................................. 38  
5 **Evaluation** ..................................................................................................................... 39  
   5.1 Product Evaluation .................................................................................................... 39  
   5.2 Evaluation on Teamwork ......................................................................................... 39  
6 **Bibliography** .................................................................................................................. 41  
   6.1 Literature .................................................................................................................... 41  
   6.2 Websites': ................................................................................................................ 41  
   6.3 Electronic Journals ................................................................................................... 41  
   6.4 Journals ..................................................................................................................... 42  
   6.5 Experts ....................................................................................................................... 42  
   6.6 Software: ................................................................................................................. 42  
7 **Table and Figure Overview** .......................................................................................... 43  
   7.1 Figures ...................................................................................................................... 43  
   7.2 Tables ....................................................................................................................... 43  

---

Page 4 of 44
1 PREFACE

Thanks to
- Christian Hammerich
- Winnie Bundsgaard
- Thomas Gulløv Longhi
- Jens Christian Jensen

Special thanks to
- Keld Gade Andersen, Inventor and Electrician

1.1 HOW TO READ THE REPORT

The report consists of two main subjects: A short Investigation and The Business plan.

All the references to Appendix are highlighted with bold and italic. The Appendix is placed separately from the main report called “Appendix Report”.

The business plan is the main part of the report, and should therefore not be seen only as a business plan. There is a more thorough description of the different parts, to keep it academic.
2 INTRODUCTION

The main focus during this semester is about taking an already existing design and finalizing it for the market and production. In relation to the Product Development Process, the focus is to go from stage 3-6. Confer to figure 1:

![Product Development Process Diagram]

Figure 1 - The Product Development Process

The development team might also be focusing on redesigning (stage 3) and market testing (stage 6). Furthermore competences and models from previous semesters will be used.

2.1 THE PROJECT

2.1.1 THE INPUT

The Danish electrician Keld Gade has invented a new smoke detector system. The idea is protected as a utility model (brugsmodelbeskyttelse) in Denmark. Currently the idea is only on a conceptual level, but the physical design is close to being ready for manufacturing. The technical design is however still lacking behind in some areas.

The inventor has the wish to start up a production, and get the smoke detector system on the market.

2.1.2 THE OUTPUT

We will take the concept and make it ready for market and production. The aim is to develop a safe and reliable smoke detector system with a high market potential.

2.2 PROJECT PLANNING AND ORGANIZATION

In the following section, a description of how the project is planned and organized is explained. By inspiration from a company structure we have organized the project into 4 main departments: Financial, operating, technical and marketing. Each group member was responsible for their own area. Organizational chart can be seen on figure 2.

---

A group contract was made, in order to ensure a common understanding of rules during the process of creating a good working environment. The group contract can be found in Appendix 1 – Group contract.

2.2.1 Gantt Chart
To plan the project and manage the time we used a Gantt chart. The chart can be found in Appendix 2 - Gantt chart. On figure 3 a miniature of the chart is shown.

Figure 3 – Gantt chart, miniature

2.3 LIMITATIONS
There are two types of limitations in this project: project limitations and report limitations.

2.3.1 PROJECT LIMITATIONS
- The budget of the project is at maximum 1000 DKK.
- The time consumption is 17 ETCS = avg. 460 hours per group member including Semester project, Product Development and Innovation 4, Product management and Business economics.

2.3.2 REPORT LIMITATIONS
- The project report must not exceed 40 pages exclusive enclosures.
- All must be written in English.
- The deadline for handing in the project report is the 28\textsuperscript{th} of May 2014.
3 INVESTIGATION

In this part we will investigate the original concept given by the inventor.

3.1 DESCRIPTION OF ORIGINAL CONCEPT

The concept can be classified as an architectural innovation, since it consists of known technologies put together in a new way. The concept consists of the following parts:

1. **Detector Unit**, to be placed around the building, with both temperature- and optical sensor for best fire detection. It runs on battery.
2. **Main Hub**, to be placed on top of a breaker panel, with a permanent connection to the electrical grid, this will communicate wirelessly with the detector units in the home, and the Internet or phone out of the home. This has a temperature sensor as well.
3. **Dismounting Tool**, consist of a telescope shaft and a gripper that fits on the detector units, this makes it possible to test/stop the unit, while standing on the floor.

The system works by either a detector unit or the main hub detecting a fire. After the fire is detected a signal from the main hub is sent out to all nearby units, which will produce a high and clear sound. Additionally the main hub will send out a signal via Internet or phone link, to the owner of the building or an emergency center, to inform about the fire.

If there is a false alarm, or if the batteries need to be changed, the dismounting tool makes it easy for the user to take the detector units down.

![Figure 4](image1.jpg)  
*Figure 4– Main Hub on top of the breaker panel*  

![Figure 5](image2.jpg)  
*Figure 5 – Detector Unit and Dismounting Tool*
3.2 EVALUATION OF ORIGINAL CONCEPT

An evaluation of the original concept is made, in order to secure the right starting point for the project. The evaluation is based on a meeting with the inventor, Keld Gade Andersen, and the initial business plan made by him. This business plan (written in Danish) can be found in Appendix 3 – Initial Business plan.

3.2.1 UPSIDES

- The system is connected to the grid: Thereby it fulfills the new Danish law, which requires at minimum a single smoke detector to be permanently connected to the grid. The law is valid for private homes built later than 1. December 2004.
- The Dismounting Tool is new to the market and could have potential to become a big motivation when buying the product. Furthermore the Dismounting Tool could ensure a more frequent testing and cleaning of the fire detector.
- It is easy to add new functions to the system (e.g. weather station and burglar alarm)
- The concept is developed by an electrician, with expert knowledge in the area.

3.2.2 DOWNSIDES

- The system requires effort to install, and parts of it have to be installed by a licensed electrician.
- It is a product that requires the user to have a certain technical knowledge.
- Since it is an architectural innovation, with no new technology introduced, it might not be a suitable product for a startup company.
- High initial investment on product development, due to complexity
- Due to the placement beside the breaker panel, there is a chance of system malfunction if there is a fire in the breaker panel.
- Many well established companies already on the market.

From this we judge that the downsides weigh higher than the upsides, so we will need to make a redesign of the product, in order to reduce the risks.

For full description of the original concept and initial market investigation, please see Appendix 12 – Investigation.

---

4 BUSINESS PLAN

4.1 GENERAL COMPANY DESCRIPTION

4.1.1 VISION

- Ensure better life quality by creating safe and simple products.

4.1.2 MISSION STATEMENT

GADE is a start-up company. The company mission statements are:

- To improve fire detection and safety in private homes and small businesses.
- Create a simple reliable and easy to use product for our market

4.1.3 GOAL AND OBJECTIVES

- Have the product launched within a year
- That 80% of our target group has heard about our product within 2 years
- To have the product ready for market testing within 8 month
- Have a competing price within our target market

4.1.4 NAME AND LOGO

The development team has chosen to call the system for GADE Smoke Detector, due to the surname of the inventor Keld Gade. The company name is GADE.

The development team has designed a logo, which can be seen on figure 6.

![Figure 6 – GADE logo](image)

4.1.5 BUSINESS PHILOSOPHY

No company survives without customers who buy their products or services. That is why we at Gade put our customers first and work hard to reach their expectations. We strive to secure the customer’s loyalty through high-quality and reliable products. We also do our best to help the society, especially to our potential customer groups, to live or work in better places.

At Gade we embrace the professionalism and the hard work. To improve, we dedicate effort and resources to investigate and develop our products.

4.1.6 INDUSTRY AND MARKET

GADE is part of the fire detection market including smoke detection, fire prevention and fire extinguishers. The companies that form parts of this industry normally have great resources and economical power to investigate and develop their products and launch the best one possible.
4.1.7 Core company strengths and challenges

In this section, we will be describing some of the strength and challenges surrounding the company.

4.1.7.1 Strengths

One of our core strengths as a start-up is that we have a high degree of adaptability. It is mainly due to the size of the company and the low level of bureaucracy, which often is an affect thereof. A high degree of adaptability, will allow us to more quickly pivot the entire organization into a new direction, if we detect or figure out that we for instance has misjudged the market, and needs to radically change the product or the way we fare within the markets.

4.1.7.2 Challenges

Running a start-up company involves a series of challenges that is partly different from running a fully established business. Some of the challenges can be present in any company, but they are more likely to occur and pose a risk in a start-up company.

4.1.7.2.1 Inexperience with the market

Having a lack of experience with the market, can be a challenge. A consequence might be not making a proper product-market fit due to not knowing enough about the customer, user and regulations. There can also be a challenge with not realizing the competiveness of the market, risking being overtaken by competitors, for instance by lacking behind on price, features or quality.

4.1.7.2.2 Lack of seniority

Another important aspect is seniority. It is related to how for instance partners, competitors and customers perceive you. Among other things, it is related to accumulated experience and time spent in a given market. If the customer is able to see that the company has several years of experience, has many references and has served many satisfied customers. The company gains some seniority in the eyes of the customer, making it easier for the customer to put trust in the company and the product, increasing the likelihood of the customer taking the deal. In a similar fashion, being perceived as having seniority might help with getting better partner and supplier deals due to increased trust.

4.1.7.2.3 Resources

A lack of resources can pose another problem. Speaking about resources, liquidity is often the first one that springs to mind, but it not the only one threatening the start-up. There are also the human resources like employees. It is true the employees can be bought with enough liquidity, but they do not become truly valuable until after some time of earning experience in and with the company. Another resource is the network. With a broad and competent network, it is a lot easier to gain access to mission-critical resources and knowledge.
4.2 PRODUCT REDESIGN

The development team has decided to make a number of changes to the original concept. One reason is that some features are already seen in competing products, and will therefore not be efficient to focus on. This is described further in Section 4.7.4 – Competition.

Another reason for changing the original concept is that we, based on the evaluation in section 3.2 – Evaluation of original concept, found that there were more downsides than upsides.

As a result, we have chosen not to incorporate the Main Hub into the system, and to only focus on the detector unit and the dismounting tool. The development team has instead chosen to look into the problems, which are found on existing smoke detectors.

In a report from Siemens the most common errors in smoke detectors are described as:

- Dust
- Insects
- Use of wrong batteries

Additionally the House of Quality has revealed the most important aspects for a smoke detector, seen from the user point of view. This is something we will take into consideration:

- Time it takes to change battery
- Color/Shape
- Unit cost
- Time it takes to install

The full House of Quality can be found in Appendix 4 – House of Quality.

4.2.1 DESIGN CHANGES

The above-mentioned aspects will be taken into account in the further development. We have pointed out in figure 7, which specific elements that we have chosen to change in the original design. The parts on the figure are directly from the inventor, and cannot be copied, since the design is protected as a Utility Model.

---

Figure 7 – Overview of design changes

4.3 PRODUCT DESCRIPTION

The GADE Smoke Detector is a simple and reliable smoke detection system. The system is easy to mount and regularly service because of the unique mounting system.

The system will connect to nearby units, so that if one unit detects smoke, a radio signal is sent out and all connected detector units also sound the alarm. It is possible to choose between a unit with a 9V Battery or one that in addition is connected to the grid.

The system consists of 2 products:

![Smoke detector unit](image1)

![Dismounting tool](image2)

Figure 8 - Smoke detector unit

Figure 9 - Dismounting tool
• Smoke detector unit
  o The smoke detector works by optically sensing smoke particles (photoelectric sensor). A temperature sensor is not used in the detector, since the development team has learned that it is subject for many false alarms. A mount that are permanently attached to the ceiling. Comes in two versions, one you just put up, and one you connect to the electrical grid.
  o A tool to easily stop/test and take down the smoke detector. The tool can be mounted on a normal broomstick, or a similar type of shaft. Thereby the user will be remembered to test/clean the smoke detector each time the broomstick is used. The reason is that it is recommended to check/clean a smoke detector weekly. The product is sold without a shaft.

4.3.1 PRODUCT SPECIFICATIONS
• Two models:
  o 9V battery
  o 230V* connection and 9V rechargeable battery
• Fulfill EU directives EN 54 and EN 14604
• Dimensions: Diameter 110 mm, Height 35 mm
• Sound level: 85 dB
• Place no longer than 15 meters from each other
• Dismounting tool fits shaft with diameter ranging from 25 mm to 40 mm.

*Have to be installed by a licensed electrician.

4.4 TECHNICAL DESCRIPTION

4.4.1 SMOKE DETECTOR
The smoke detector uses a photoelectric cell to register smoke particles in the air. When danger is detected the unit sends out an alarm signal. The primary alarm signal is a speaker with a sound level of minimum 85 dB at 3 m after 1 min from alarm and 82 dB at 3 m after 4 min from alarm operation. A visual alarm indication, big blinking LED light, is triggered together with the audio alarm.

In addition to the above, when smoke is detected, a secondary alarm signal is sent out to other nearby detector units by a radio module. This signal, which has a range of 15 meters, will then course the other units to sound their alarm too. When the alarm is turned off, a similar signal is sent, which turns the other units off.

---

4. SIEMENS: Check liste ved fejl i brugen af røgalarm, oktober 2011, page 3
6. EN 14604, 5.17.3 Sound output Requirements, European Commitee for Standardization, Page 28
The power unit with the simple mount supports a 9V DC-battery. This power source shall at least last for a year with repeatable testing for 10 seconds every week\(^7\). The power unit with connection to the grid supports 230V AC. 230V AC is transformed into 9V DC in the transformer located inside the mount. In case of a power loss, a 9V DC rechargeable battery will be used as backup. By making it rechargeable, we can make sure that it will be recharged by the permanent power supply.

The adapter is made with a little male plug centered in the middle, and on the top cover is a matching female plug, to transfer the 9V. This makes it possible to take down the detector without any wiring is interfered.

The electrical components are mounted on a circuit board. For a detailed description of the circuit, see Appendix 5 – Circuit Board.

The body of the smoke detector is made from ABS plastic, so it has low material costs and can be manufactured by injection molding. It is also designed so it conforms to the EU standard\(^8\), that a sphere with a diameter of 1.3 mm cannot pass into the chambers of the sensor.

### 4.4.2 DISMOUNTING TOOL AND WORKING PRINCIPLE

The dismounting tool works as a mechanical hook powered only by human force. On the hand are 3 teeth, and on the lower cover are 3 grooves. By placing the hand on the lower cover and turning it to the side it is possible to take the smoke detector down, while the ceiling mount (and adapter) will stay fastened to the ceiling.

The dismounting tool can be fastened on a broomstick or a similar-sized shaft with a threaded clamping mechanism. The clamping mechanism closes smoothly and can be operated without any additional tools.

For visualization of the principles, see Section 4.4.4 Product Architecture.

The dismounting tool parts are also made from ABS plastic, and will be manufactured by injection molding.

### 4.4.3 MODULARIZATION

The original concept architecture is integrated, because it consists of few parts with many functions. The development team seeks to make the architecture more modularized. There are more reasons for making a product in modules, but the three main module drivers for the GADE smoke detector are:

- Reduce manufacturing time and cost
- Service and upgrade on final product
- Easy administration

#### 4.4.3.1 MODULES IN THE GADE SMOKE DETECTOR

---

\(^7\) EN 14604, 4.7 Normal power source, European Commitee for Standardization, Page 7
\(^8\) EN 14604, 4.16 Protection against the ingress of foreign bodies, European Committee of Standardization, Page 9
A rule of thumb is that the number of modules is equal to: $\sqrt{\text{no. of parts}}$

The GADE Smoke detector consists of two different products: The smoke detector unit and the dismounting tool. According to the BOM (Appendix 6) the dismounting tool consist of 3 parts and the smoke detector of 17 parts. Therefore:

- Dismounting Tool = $\sqrt{3} \approx 2$ modules
- Smoke detector = $\sqrt{17} \approx 4$ modules

**Modules in the dismounting tool:**
1. Hand
2. Wrist (connector + fastener)

*This is a Slot-modular architecture*

**Modules in the Smoke detector unit:**
1. Lower cover
2. Top cover with electrical board
3. Ceiling mount
4. Adapter unit with wiring

*This is a Slot-modular architecture*

### 4.4.3.2 ADVANTAGES
- The tool will have the possibility of fitting different shafts, and by making the wrist changeable, it will be much easier for the user.
- The lower cover becomes easily changeable - this makes it possible to get it in different colors.
- The top cover with the electrical board is modulated in order to make service and maintenance easier.
- The ceiling mount and adapter is made in two different modules to make production cheaper. The reason is that the smoke detector will come in two versions: one with permanent connection to the grid and one only with a battery. Because of the modularization it is now unnecessary to produce two different products – instead the adapter module just has to be added, if you want the smoke detector to be connected to the grid.

### 4.4.4 PRODUCT ARCHITECTURE
The CAD drawings of the original concept were already made by the inventor. The redesigned parts are added on to these drawings. The drawings are made using Autodesk Inventor Professional 2014.

*Figure 10 – Smoke detector FRONT  Figure 11 – Smoke detector SIDE  Figure 12 – Smoke detector BACK*
Dismounting tool:

Figure 13 – Dismounting tool
4.4.4.1 Prototype
A 3D-printed prototype is made using the CAD-drawings. The prototype is full scale and shows the overall architecture, and the function of how the dismounting tool can dismount the smoke detector from the ceiling mount.

4.5 Production
In this section the technical aspects of production is described. For further information about the production go to section 4.8.2 – Production.

4.5.1 Design for Assembly/Manufacturing

4.5.1.1 DfA
Design for Assembly (DfA) is a method for redesigning a product in order to reduce assembly time and thus production cost.
Regarding DfA in the GADE smoke detector it would be possible to change the design of the cover closing mechanisms from screws to snap-fits.

Average assembly time for components:\(^9\)

- Screw: 10,3 sec
- Snap-fit: 5,9 sec

**Difference**: 4,4 sec = 0,0012 hour

- Total amount of screws: 5
- Labor cost: 200 DKK/hour

**Cost reduction:**

\[
5 \cdot 0.0012 \text{ hour} \cdot 200 \frac{\text{DKK}}{\text{hour}} = 1,22 \text{ DKK/Unit}
\]

By changing from screw to snap-fit it would lower production cost with 1,22 DKK/unit in regards to assembly. However it would increase the price of the injection mold, because of the design changes, so this will have to be factored into the calculations.

4.5.1.2 DfM
Design for Manufacturing (DfM) is a method for redesigning a product in order to reduce manufacturing cost\(^10\).
As stated in **Section 4.4.3 – Modularization**, the ceiling mount is redesigned in order to reduce the cost of manufacturing. Using the DfM method it is now calculated if the redesign actually is efficient.

In the beginning of the project there were two versions of the ceiling mount:

---

1. **Advanced ceiling mount** with a built-in adapter and wiring for connecting the smoke detector with a permanent connection to the grid.

2. **Simple ceiling mount**, only function is to keep the smoke detector in place on the ceiling.

Currently the development team has changed it to be only one ceiling mount, and a modular adapter.

Using the DfM method the difference in manufacturing costs for the 2 alternatives is calculated.

The calculations can be found in *Appendix 7 – DfM calculations*.

4.5.1.3 **RESULT**

Below is listed the manufacturing cost for the 2 alternatives.

*NOTE*: The number of products produced in this example is set to: 10.000 pcs, and that not all manufacturing costs are taken into the calculation - only the ones there have a direct impact on the 2 alternatives.

- Advanced and simple ceiling mount: **35,8 DKK**.
- New ceiling mount and adapter: **31,4 DKK**.

Overview of the total cost reduction is given in table 1.

<table>
<thead>
<tr>
<th>Cost reduction</th>
<th>DKK/product</th>
<th>10.000 pcs</th>
<th>Percent [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,4</td>
<td>44.000</td>
<td>12,3</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1 – Cost reduction using DfM*

4.5.1.4 **CONCLUSION**

By only making one type of ceiling mount and adding a modulated adapter unit, a 12,3 % cost reduction can be obtained – this gives a total cost reduction for 10.000 units on: **44.000 DKK**.

4.6 **TECHNICAL RISKS**

Doing the development, there has both been removed and added risks to the product. In the following these risks are evaluated.

4.6.1 **REDUCED RISKS**

- At first the concept was a complex communication system, with a central hub connected to the Internet. In case of a fire there is a chance that the system will shut down, making the alarm useless. Furthermore the user has to be good at using modern technology (e.g. smartphone), which not everybody is. By making the product simple and minimizing user interaction, the product is now more reliable and safe.
- By using modularization and incorporating DFMA in the product design, it can be produced with a lower production cost and risk of having to compete with products with a lower selling price.
- The big button minimizes the risk of not being able to test/stop the alarm.
- Smaller holes in the lower cover minimize the risk of allowing dust and insects getting in and start a false alarm or destroy components.
4.6.2 Increased Risks

- Selling the dismounting tool without a shaft, there is a chance that the customer will not end up using the tool, which would make its function less noticeable.
- Making the whole product simpler, without much new technology, it has the chance of getting outdated more quickly.
4.7 **MARKETING PLAN**

*The data used for this marketing plan is purely secondary data from the Analysis report and internal experiences in the company. Theory used for this chapter is from the book: Lehmann & Winer (2005) “Product Management” 4th ed. McGraw-Hill.*

4.7.1 **MARKET**

4.7.1.1 **MARKET SHARE**

At the current moment we do not expect to have any percentage of the market share since we are a new start-up company with no market experience or no established brand. We do expect that in the future we will have a small percentage of the market share since our focus is to establish a product line, which will target a broader market and different groups. The target market will geographically be European countries, since our product fulfills the legal requirements and standards for the European market. We will however start in the Danish market for a trial period of 1 to 2 years in order to receive some feedback before targeting a bigger market.

4.7.1.2 **CURRENT DEMAND ON TARGET MARKET**

It is required that in all newly-build houses in Denmark, that there should be at least one smoke detector. This is also a requirement, if you are adding 50% or more to your existing house\(^{11}\). This means that the market consistently will be requiring smoke detectors. In 2012 there was built around 12,000 new houses in Denmark. Denmark has the lowest number of smoke detectors compared to the Northern countries. 600,000 homes in Denmark do not have a smoke detector and especially the elderly does not have a smoke detector in their home. Approximately 77 Danes dies each year because of fire and most of the homes did not have a smoke detector\(^{12}\).

Safety in general on the Danish market have a turnover of around 2,9 billion (in 2007) and monitoring of safety equipment in the household have the biggest percentage of the turnover, 38%\(^{13}\).

In general when focusing on electronic devices there has been a demand for simple and easily installed products. The target market is seeking products which are easy to install and mount so that when they buy a new product it should not take more than an hour to get it to work.

4.7.1.3 **TRENDS IN TARGET MARKET**

Design has for a long time been a very important factor when buying a product. It is also increasingly having an impact on the buying decision for smoke detectors. There has been collaboration between a smoke detector manufacturer and interior designer, Jacob Jensen, in order to redesign the smoke detec-

---


tor in order to increase reach new market and target groups.
It has become desirable to think outside the traditional smoke detector and redesign the appearance and the functions of the smoke detector, especially Google’s newest investment, Nest Protect, have gone in new directions.
The intelligent alarm system had a boom in development and sales over the last couple of years. Especially in Denmark the interest for an intelligent system, that both protect from robbery and fire, has increased. The smart devices have also affected the alarm systems, since it is more and more desirable to be able to control the smoke detectors through an app on the smartphone or tablet.

4.7.1.4 GROWTH POTENTIAL AND OPPORTUNITY FOR OUR BUSINESS
Since the Danish law says that there has to be a smoke detector in newly built houses; there will continuously be a demand for smoke detectors.
Also the fact that a high safety in house holds are very important in Denmark we will expect that smoke detectors will be a relevant safety product.
As long as we, as a new business, remember to follow the technological development and the customers demand then there should be an opportunity for potential growth.

4.7.1.5 BARRIERS TO ENTRY AND HOW TO OVERCOME THE BARRIERS

- **High marketing costs** – The marketing cost will be very high in the beginning, since we are a new company entering the market with an unknown brand. We therefore need to create awareness and get our brand out to the customers.
- **Consumer acceptance and brand recognition** – There will always be some kind of brand recognition and consumer acceptance, but there are no monopoly brands or companies in the Danish smoke detector market and therefore this will be a small barrier. A way to overcome this barrier could be to collaborate with well-known and respected firms, like Falck.

4.7.1.6 CHANGES THAT WILL AFFECT OUR COMPANY

- **Change in technology** – Changes in technology will provide more development opportunities for our products, but it could also mean that our product might be outdated more quickly.
- **Change in government regulations** – We have already experienced a lot of regulations from the government in connection to smoke detectors and therefore when new relevant regulations occur it could both provide opportunities and limitations for our business.
- **Change in the economy** – Smoke detectors provides safety for the consumers, therefore we should not expect that our smoke detector, which is effective and cheap, would be affected by changes in economy. But there is a lot of competitors with low-priced smoke detectors therefore there will be a high competition and a chance that our product sales will be affected.
- **Change in our industry** – Right now there is a change happening in the industry. The intelligent alarm systems are becoming a bigger part of the alarm industry and therefore it is important for our business to remember to keep developing our product and make new product lines, so that we consider the intelligent alarm systems but remember the cheap and simple qualities of our product.
4.7.2  PRODUCT

4.7.2.1  USP’s
- Simple to install.
- Easy to maintain and service.
- Are able to be inter-connected with other GADE smoke detection units.
- Use either with or without permanent connection to the grid.
- Aesthetical and pleasing design.
- Comes with an unique dismounting tool.

It is important that our smoke detector provides safety and security for the consumer, so that they are able to trust fully on our product and its functions.

4.7.3  CUSTOMER
Our smoke detector has a certain characteristics that are perfect to address the product to elderly and disabled people. Both groups have the same problem and it can be solve with one of the strong point of the product, the dismounting tool.

4.7.3.1  ELDERLY PEOPLE
Our main target group is elderly people; here we are mainly targeting the ones who are more than 65 years old, living alone or with a life partner in same age group. The reason why this is our main target group is because of the benefits our dismounting tool will provide for an elderly person, who has difficulties, either physical or psychological, with standing on chairs or ladders in order to reach the smoke detector.

It has to be taken into account that they might be people with sensory problems. They maybe require easy signals to see or high levels of sound to hear the alarm.

It also shows that the elderly in Denmark have the lowest number of smoke detectors in their homes and therefore there is a lot of potential in targeting this group with a simple accessible smoke detector.

4.7.3.2  DISABLED PEOPLE
In this group we have people who are unable to stand tall due to their disability. It is clear that they cannot reach their smoke detector in high positions. However, with the dismounting tool they will able to use the smoke detector without the help of the others.

4.7.3.3  NEXT OF KIN
The next of kin will not be the consumer of our product but it is important not to forget them since they are potential customers. They are very interested in securing and helping their loved ones.

4.7.4  COMPETITION
When considering the competitors GADE smoke detector is competing with other manufactures of smoke detectors, but it is important also to remember that in the market there are other types of potential competitors.

See Appendix 8 – Competitor Analysis.
4.7.4.1 OUR PRODUCT
Smoke detectors are useful for private market, while the other categories, like fire alarm systems, are more practical for bigger buildings.

For a better overview of the competitors we have divided them into three categories – Standard, Design and Professional. See Appendix 9 - Competitor description. The GADE smoke detector is situated in design category, but implement aspects from standard and professional categories. In regard to the design category it is not only related to aesthetics but also to fundamental product design and modularity. Technologically it is a standard version and in the standard price range, but could also be used in more professional settings due to increased product quality and ease of use (maintenance).

4.7.4.2 MAIN COMPETITORS
SIEMENS, Germany
IKEA, Sweden
NEST, USA
Jacob Jensen Design, Denmark

![Competitive Analysis from the QFD, showing main competitors](image)

**Figure 14 – Competitive Analysis from the QFD, showing main competitors**

From the competitive analysis from the QFD we see where our product differentiates from the competitors.

4.7.5 NICHE
We are capable of competing in niche market because of the unique functions of dismounting tool.
4.7.6  PROMOTION STRATEGY

4.7.6.1  HOW TO PROMOTE
The main promotion will be through advertisements in Danish magazines which has market similar to ours. This could be Familie Journalen, Billede Bladet and Hjemmet. We could also consider advertisements in newspapers such as Politikken and BT.

In addition, it could be very desirable to have an article or review along with our ad. This will provide some important information about our product to the consumer.

Web advertisement could also be a part of our promotion strategy. This would especially be to reach the next of kin and therefore the advertisement should be on sites that are often visited, like social media or informative sites like BT.dk and TV2.dk.

In the beginning of the launch we would attend trade shows. This would be interesting because of the possibilities of finding new collaboration partners.

4.7.6.2  PROMOTION BUDGET
We will be willing to invest in a large promotion. Since there is not that much focus on promoting smoke detectors in general this could be an advantage to start promoting in consumer magazines to create new awareness. Also promoting our product would help us to reach our consumers who are not seeking new smoke detectors and therefore this could be a push strategy.

Prices\textsuperscript{14}:
Ad in a magazine: 18,000 DKK
Ad in a newspaper: 16,000 DKK
Ad in sticky banner on jp.dk: 30,000 DKK

4.7.7  DISTRIBUTION CHANNELS
In this section, we will be determining which distribution channels to utilize, in order to reach our expected customers. We will also be taking a look at the distribution channels of our competitors, in order to get an idea about how our distribution strategy aligns with theirs.

4.7.7.1  OUR DISTRIBUTION CHANNELS
In relation to distribution channels, we will have to consider, whether we will be using direct, indirect or a combination of both types of distribution channels.

We are highly considering not focusing as much on direct sales, since we would not be able to provide the same availability and cost effectiveness as retailers for instance would. It would also create unnecessary tension with our indirect channels, to sell directly to our customers, since we would be competing and be able to offer a better price than them.

As a way of reaching the Danish consumer market through indirect distribution channels, we will be selling our product through an array of different retailers and Internet shops. A reason for focusing on several different retailers and chains, it that we will be using several different distribution channels instead of a single one, which helps to decrease the risk and the dependence on a single channel.

It is relatively easy to cover a large part of the Danish market, since there are only so many different chains. For instance will we be able to reach 57% of the retail market by focusing on COOP and Dansk Supermarked. COOP has 39% and Dansk Supermarked has 18% of the market.

4.7.7.2 DISTRIBUTION CHANNELS OF COMPETITORS

There are numerous competing fire alarms on the market, so we will be splitting them up into some meaningful categories. One category is your cheap basic fire alarm and the other one is networked fire alarms that are able to communicate with each other or another system.

When looking at the range of basic fire alarms, our initial research indicates that they typically are bought through retailers, both in online web shops and in physical stores.

A networked fire alarm is capable of notifying nearby fire alarms of the same type, of an eventual fire, making all nearby alarms sound.

We noticed that these kinds of fire alarms were present in more than a single distribution channel. Some products of this type were sold through retailers while others were sold as part of a more advanced alarm system, covering more than just fire detection.

4.7.7.3 PERSPECTIVES

Looking at our distribution channels versus those of our competitors, there seems to be some correlation, since both of us are focusing on physical retailers and Internet shops.

4.7.8 SMALL BUSINESSES

The GADE smoke detector is also targeting another small market that is desirable to remember. This is small businesses. To be more precise it includes small workshops that are doing practical work like carpentering, blacksmithing and auto repairing.

This market is desirable for the GADE smoke detector since there is a need of a smoke detector that is easy to stop if false alarming and easy to clean.


It is a market where the well-known brands are very dominating and it is crucial to achieve professionalism in connecting with our brand in order to be on this market.

The distribution channels would mainly be hardware store where our customers usually go to buy other things for their workshops.

To see the whole marketing plan for the small businesses: Appendix 10 - marketing plan, small businesses.
4.8 OPERATIONAL PLAN

In this section, we will be discussing the operational plan. This includes going through aspects of the operation of the company. We will for instance be looking at how we are going to set up production, how this relates to inventory build-up, and finally, we will connect the dots of this and the part about distribution channels, in order to sketch our supply chain.

4.8.1 PRODUCTION

In this section, we will be looking into how we are going to produce our product. First we will be looking into the flow of the production, or the different steps of how we will be producing the product. Next we will look into current plans for where to produce it, and the considerations we have made. Last, we will focus on how we see the production progressing in the future.

4.8.1.1 PRODUCTION FLOW

In relation to the flow of the production, we will need to identify the separate processes in the production and how they interrelate.

To form a starting point, we will be using the BOM (See Appendix 6) as a reference, since it contains the different parts to be manufactured. From the bill of materials, we have created a breakdown map of the product structure (See Appendix 6), which helps to illustrate the interdependence of the different parts of the product. The two final product assemblies, is the smoke detector itself and the dismounting tool.

The dismounting tool is assembled from three different parts, the hand, the connector and the fastener. Before the dismounting tool can be assembled, all of these three parts needs to be injection molded.

The smoke detector is assembled from four parts. There is the top and lover cover, the circuit board and the mount. The two covers and ceiling mount are injection molded while the circuit board and adapter is sub-assembled. The circuit board is assembled from a list of components, which is specified in the BOM. The mount is assembled from an injection-molded part called the ceiling mount and an AC to DC power adapter, if it is in regards to the production of the wired edition.

From the specified information, we can create the following overview, which details the flow of the production. It should be noted, that the injection molding of all the different parts, a specified as a single process in the flow.

The flow is quite basic, and involves the injection molding of parts, some of which are used in the assembly of the mount and others directly in the final assembly. In addition to these, an electronics assembly is also present, where the circuit board is assembled.
**Figure 15 – Production flow**

### 4.8.1.2 CHOICE OF PRODUCTION

We are going to start out with a low volume production, with the final assembly of parts and packaging taking place at our office location in Denmark. All other parts will be bought or out-sourced. Something we are going to outsource is the injection-molded parts while electronic components will be bought form suppliers.

Due to Danish laboring costs, it will have the drawback of being more expensive to manufacture each unit. We do however expect to counter this by several tradeoffs.

We have no proper experience with the market, so to reduce risk; we see a low-volume production as a positive tradeoff, since it will allow us to get a feeling of the inner workings of the market, before focusing on large-scale production. This gives us a form of adaptability, which will allow us to be able to pivot our plans, in case we figure out that we have ended up with the wrong product in the wrong market. In could either be by placing our product in a new market, change the product to better fit the current market or even that we decide to discontinue with the entire product line.

Besides the market, another tradeoff is in relation to product development. It is almost impossible to do things right the first time around, especially for start-ups. In that regard, we can expect there to be aesthetically as well as functional design changes to the product when we start pushing out the first versions and get to field-test it. By having a low and in-house production, we will be able to make certain last-minute changes to the design, without risking ending up with a huge batch of unusable or at least outdated product versions.

### 4.8.1.3 PRODUCTION IN THE FUTURE

As we have talked about, we will be having a low-volume in-house production, which is justified by several tradeoffs. There will however be a point, when we better know the market and have created a well-performing product, where there will not be sufficient tradeoffs to make this type of production viable.

When that point in time occurs, we will need to look towards other options. One that we are considering is to outsource the entire production to Asia, where we expect to get lower costs per unit due to their lower laboring costs.

The price for shipping product from Asia to Europe is generally a bit steep. In order to ensure that it is still is a viable option, we will need to look into a combination of freight forwarders and making sure that our shipping volume is so large, that the shipping cost distributed on each unit, is reasonable small.

A common way of lessening this burden is to work with a freight forwarder\(^{18}\). It is a company that can act as an agent for both import and export. They are of course not free, but if the intention is to conducting business in another country, they can be of great help. Some areas they might help with, is to

---

advise about the best shipping options, or even help by providing warehousing options. They are also able to help with the bureaucracy of filling out legal shipping documentation.

4.8.2 INVENTORY
In this section, we will be taking a look at the different aspects of how we are going to do inventory keeping, involving which kinds of inventory we are going to keep, how much and for how long.

1.1.1.1 KIND OF INVENTORY
According to the production plans, the final assembly of circuits and parts will occur at our location in Denmark. In order to support this, we will need to have the appropriate supplies in stock, which includes electronic components and plastic parts.

We will not be keeping raw materials for the plastic parts, since we will be buying them injection molded from appropriate manufacturers. Instead we will be keeping finished parts in supply.

The electronic circuit board is to be assembled in-house, so we will need to have all electronic components in stock.

This means, that we will be keeping relevant raw materials and semi-manufactured parts as inventory. This is in addition to work-in-progress and finished products, which comes as an output of production.

1.1.1.2 INVENTORY BUILDUP AND VALUE
Looking at our sales forecast, it is seen that we will be selling 1,500 smoke detectors during the first year. Of this amount, 1,000 units are sold in a packaging deal with the dismounting tool. In addition, half of the amount of smoke detectors is expected to be sold as the wired version, and the other half only with a battery. In regards to the dismounting tool, we expect, including the ones sold in packages and separately, that we will be selling 500 dismounting tools during the first year. These sales numbers are expected to double every year, over the first five years. At year five, we expect to be selling 24,000 smoke detectors and 12,000 dismounting tools per year.

We expect to be selling the products relatively evenly throughout the year, so the amount of units will be evenly distributed throughout the year. From this, during the first year, we expect to sell roughly 125 smoke detectors and 42 dismounting tools every month, which is also the least amount that we can expect to be per month.

To make sure that we always have enough products in stock, we are planning to be ahead in production with a month. This means that inventory for the current month has to be on stock right now, and that we will be producing for the next month in this month.

In addition to being produced ahead of time, we will also be producing for a buffer, meaning that we will be making sure that we have a surplus of finished goods in stock. We plan to add 5% of the production volume to the buffer each month.

This means, that for the first year, we will be producing 131 smoke detectors and 44 dismounting tools every month. This will increase to 2100 smoke detectors and 1050 dismount tools per month at year five.
4.8.2.1 Inventory Location

In regards to the location of the product storage, we will start out by only keep stock in-house. This is our preferred option, since it will allow us to keep costs low in the period where production volume also is relatively small. When the production volume increases, we should look towards different warehousing options that allows for better security and storing facility. It could be by outsourcing parts or the entire inventory or by building better in-house storage.

When we are able to expand to other countries, it makes increasingly more sense, to have distribution centers in the respective countries, which allows us to bring goods closer to our customers.

The part of the inventory that carries raw or semi-manufactured items and which is being used in production needs to be located close to the assembly line, which supports that we will need to start-out with in-house inventory storage.

4.8.3 Supply Chain

In this section we will be following up on the previous sections, including distribution channels, production and inventory, and describe how they are related in the supply chain.

The supply chain is the chain of processes and instances that adds value to the product and which in the end allows us to supply our customers with exactly the product variation they need. Included in our supply chain, are our suppliers, our own production flow, inventory, distributors and finally our customers.

At this point in the process, we have not yet specified which specific suppliers that we will be using, to supply the parts needed in the production. In addition, we have not been able to specify the entire range of distributors that we will be using. Because of this, these parts will be generalized and shown as a kind of a black box within the supply chain.

The first part of the supply chain, contains the production flow, which was mentioned a bit earlier. A small change has been made, in that an electronics supplier has been added.

![Supply Chain Diagram](image-url)
After the production, we have the in-house storage of the assembled goods, after which follow the distribution. Distribution is done through retailers, some of which we will be selling to through wholesalers.

4.8.4 **LEGAL ENVIRONMENT**

Since we primarily will be selling our smoke detector in Denmark and potentially in the rest of the EU, our product needs to conform to some of the European standards.

Laws and standards for the European market have been set up jointly by members of the European Union. For smoke detectors the standards have been set up by the European committee of standardization and they apply to all of the member countries. Since we plan to market our product in Denmark and Europe, we have to meet the requirements to put CE marking on our product, and thus make it legal to sell in European Union.

European standards for smoke detectors are noted down in following standards:

- EN 54 – Fire detection and fire alarm systems
- EN14604 – Smoke alarm devices

Most of the requirements our smoke detector has to meet are brought out in standard EN 14604, but since we have special functions in our product we have to make sure we comply with sub-standards of EN 54 also. Regarding our wired mount we must meet the requirements of EN 54-4 - Power supply equipment and regarding radio connection we must meet the requirements of EN 54-25 - Components using radio links. These requirements might be pesky to deal with but the good side is that if we meet these standards we open ourselves up to a big market in a legal perspective.
4.9 Financial Plan

Here we will take a look at some of the financial aspects of the project. There are made a number of assumptions to decrease the complexity and the number of parameters. There are still so many things that are not yet sure, that it will not be beneficial to add any more uncertainty. Therefore the financial plan should be seen as an initial grasp on the financial situation.

The main assumptions are:

- We will produce the same product for 5 years
- We will have the assembly in Denmark all the time
- Our startup expenses will cover a 5 year production with the capacity to produce all in the sales forecast
- We will be able to hire workers, as we need them, so only as a variable cost.
- We do not need to buy a large inventory from sub suppliers (no investment in stock)
- We will not give our self any payment

See Appendix 11 – Financial plan for full tables.

4.9.1 Startup Expenses

First we need to find the price of starting up the company and production. To have as low a start-up cost as possible, all production other than assembly will be outsourced. We will only buy cheap injection molds with a low production capacity. The risks are simple to high to do high investments.

- Development and production of 6 injections molds
  - 100,000 DKK
- Development of the electrical component
  - 50,000 DKK
- Setting up an assembly production
  - 100,000 DKK

4.9.2 Yearly Expenses

There will be a yearly expense to housing of the company and the final assembly of the product. We have also stated that there should be a fixed budget used for promotion of the product.

- Housing, electricity, water etc.
  - 50,000 DKK
- Promotion cost
  - 50,000 DKK

4.9.3 Job Order Costing (BOM)

Job order costing is one of two basic types of costing systems. The other one being process costing. We will however use job-order costing, because we are interested in the price of each product.

We use the BOM (Appendix 6) created from the technical part to find the expenses to material and labor costs. We also need the price (section 4.9.4 - Pricing) of our product, so that we can find our contribution margins.
4.9.4 PRICING
We need to find the right price for our product. Defining the right price for a product is extremely difficult and can be done with many different models. There are more things influencing such as reference prices, perceived value, stage of the product life cycle, overall objectives, threat of new entrants, competition, substitutes etc.

4.9.4.1 GADE SMOKE DETECTOR
For our project we will however limit it to looking at the variable cost, the competition and the overall objective. We need to cover our variable cost and have a contribution margin high enough to cover all our expenses.

Lets look at the competing products prices as sold by retail (so here also the retailer is earning something).

<table>
<thead>
<tr>
<th>Brand</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mumbi</td>
<td>50 DKK</td>
</tr>
<tr>
<td>Ikea</td>
<td>80 DKK</td>
</tr>
<tr>
<td>Kidde</td>
<td>90 DKK</td>
</tr>
<tr>
<td>Gira</td>
<td>155 DKK</td>
</tr>
<tr>
<td>Siemens</td>
<td>279 DKK</td>
</tr>
<tr>
<td>Jacob Jensen</td>
<td>550 DKK</td>
</tr>
</tbody>
</table>

*Table 3 – Competing products prices*

To get better idea of the actual production price of the product, you could buy each one and do a breakdown of them. Based on this you could create a BOM, to get an idea of their actual costs.

The main objective of our product is to be able to cover our costs. However it should still be competitive. Our product are higher priced then the standard one, but are not to compete with the ones with both high brand and design value.

Based on this we will try to set some prices with at least a 40% contribution margin (See job order costing). However this should only be seen as a ground on which we can do our calculations Based on that and further research, we might need to adjust the price.
On top of this, the retailer should also be able to earn on the product. We estimate that an extra 30% of the price should be added to the end consumer. Even on top of that, we need to add 25% in Danish taxes.

4.9.5 **SALES FORECAST**

When creating the sales forecast we could do this on many different grounds. However the best would be data from previous selling of the product. If we have tested how well it sold in on a small scale, we could scale it to the full market that we are going into. Other factors are the sales of similar products, our market research, industry data and our distribution channels.

4.9.5.1 **GADE SMOKE DETECTOR**

We tried creating a sales forecast for the next 5 years based on the knowledge we have about the market. However this is just a guess that will need to be investigated further.

<table>
<thead>
<tr>
<th>Optimal scenario</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wired</td>
<td>250</td>
<td>500</td>
<td>1.000</td>
<td>2.000</td>
<td>4.000</td>
</tr>
<tr>
<td>W. Battery</td>
<td>250</td>
<td>500</td>
<td>1.000</td>
<td>2.000</td>
<td>4.000</td>
</tr>
<tr>
<td>Dis. Tool</td>
<td>250</td>
<td>500</td>
<td>1.000</td>
<td>2.000</td>
<td>4.000</td>
</tr>
<tr>
<td>Package</td>
<td>500</td>
<td>1.000</td>
<td>2.000</td>
<td>4.000</td>
<td>8.000</td>
</tr>
</tbody>
</table>

*Table 4 – Sales forecast*

In here we assume that our sales the first year is relatively low, but that it will double each year.

4.9.6 **INCOME STATEMENT (P&L)**

The income statement also known as Profit and Loss is a way of getting an overview of revenues and expenses at a given period. For our project we will look at the first two years:

<table>
<thead>
<tr>
<th>Income statement</th>
<th>Year 1</th>
<th>Year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>231.250</td>
<td>462.500</td>
</tr>
<tr>
<td>Materials and Labour</td>
<td>128.988</td>
<td>257.975</td>
</tr>
<tr>
<td>Other costs (faulty products)</td>
<td>6.449</td>
<td>12.899</td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
<td>95.813</td>
<td>191.626</td>
</tr>
<tr>
<td>Promotion</td>
<td>50.000</td>
<td>50.000</td>
</tr>
<tr>
<td>Housing</td>
<td>50.000</td>
<td>50.000</td>
</tr>
<tr>
<td>EBITDA</td>
<td>-4.187</td>
<td>91.626</td>
</tr>
<tr>
<td>Depreciation (Start-up/5 years)</td>
<td>50.000</td>
<td>50.000</td>
</tr>
<tr>
<td>EBIT</td>
<td>-54.187</td>
<td>41.626</td>
</tr>
</tbody>
</table>

*Table 5 – Income statement*

Here you can see that there will be a negative balance the first year, which we are not even able to pay out the second year. This could by a serious problem, that we are not able to earn anything the first couple of years.
4.9.7 CASH FLOW STATEMENT
The cash flow statement looks directly at what is going in and out of the company for a given period. We have chosen to look at each of the years.

<table>
<thead>
<tr>
<th>Cash Flow</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>231250</td>
<td>46200</td>
<td>925000</td>
<td>1850000</td>
<td>370000</td>
</tr>
<tr>
<td>Cash outflow</td>
<td>128987.5</td>
<td>257975</td>
<td>515950</td>
<td>1031900</td>
<td>2063800</td>
</tr>
<tr>
<td>Variable costs</td>
<td>6449</td>
<td>12.899</td>
<td>25.798</td>
<td>51.595</td>
<td>103.190</td>
</tr>
<tr>
<td>Promotion</td>
<td>50000</td>
<td>50000</td>
<td>50000</td>
<td>50000</td>
<td>50000</td>
</tr>
<tr>
<td>Housing</td>
<td>50000</td>
<td>50000</td>
<td>50000</td>
<td>50000</td>
<td>50000</td>
</tr>
<tr>
<td>Investment</td>
<td>250000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total cash outflow</td>
<td>385437</td>
<td>970874</td>
<td>641748</td>
<td>1183495</td>
<td>2266990</td>
</tr>
<tr>
<td>Net cash flow</td>
<td>kr -254.166.88</td>
<td>kr 150.626.25</td>
<td>kr 283.252.50</td>
<td>kr 666.505.00</td>
<td>kr 1.433.030.00</td>
</tr>
</tbody>
</table>

Here we can see, differently from the income statement, that we have a huge debit to cover the first year. We will have to loan money that we then need to pay interest on. This is not taken in to account here.

4.9.8 BREAKEVEN ANALYSIS
When will have sold enough products to cover all our expenses?

We will look at the amount of products we need to sell every year to cover both the yearly expenses and the initial investment (divided over 5 years). The analysis will only be done on the number of packages we need to sell.

<table>
<thead>
<tr>
<th>Breakeven / year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM Margin on package</td>
</tr>
<tr>
<td>Costs year 1 (income statement)</td>
</tr>
<tr>
<td>Breakeven in units</td>
</tr>
<tr>
<td>Breakeven in DKK</td>
</tr>
</tbody>
</table>

Check

| Revenue | 344073,6479 |
| Variable cost | 194073,6479 |
| CM | 150000 |
| Costs year 1 (income statement) | 150,000 |
| Profit | 0 |

Table 7 – Breakeven analysis per year

We can see that we need to sell 1151 packages every year to cover all of our expenses.

4.9.9 CAPITAL INVESTMENT DECISIONS (NPV, PAYBACK, ROI AND SENSITIVITY ANALYSIS)
Lets investigate our product with some different financial tools: Net Present Value, (NPV) Payback, Internal Rate of Return (IRR) and a Sensitivity analysis.

Lets look at the optimal scenario (Correct price and with everything sold in our sales forecast) and compare that with some different scenarios:
### Capital investment

<table>
<thead>
<tr>
<th>Scenario</th>
<th>What</th>
<th>NPV</th>
<th>IRR</th>
<th>Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal Scenario</td>
<td>Optimal</td>
<td>kr 1,095,421</td>
<td>72.96%</td>
<td>2.11</td>
</tr>
<tr>
<td>Decrease in sales</td>
<td>Decrease with 25%</td>
<td>kr 675,262</td>
<td>55.09%</td>
<td>2.22</td>
</tr>
<tr>
<td>Larger investment</td>
<td>2x the investment</td>
<td>kr 425,262</td>
<td>32.22%</td>
<td>2.46</td>
</tr>
<tr>
<td>Decrease in selling price</td>
<td>Decrease with 25%</td>
<td>(kr 85,295)</td>
<td>7.60%</td>
<td>5.02</td>
</tr>
<tr>
<td>Increase in selling price</td>
<td>Increase with 25%</td>
<td>kr 1,435,818</td>
<td>85.79%</td>
<td>2.06</td>
</tr>
</tbody>
</table>

*Table 8 – Capital investment for the optimal scenario*

Here we can see that in the optimal scenario we have high NPV and have a payback period of 2.11 years. A rule of thumb is that the IRR should be higher than 15%. In the optimal scenario it is at 73% and should therefore be a very good investment.

The single biggest risk is a decrease in selling price. Decreasing the selling price with just 25%, decrease the IRR with a factor 10. Opposite, increasing the selling price with 25% only gives us a 13% higher IRR.

It also comes clear here that the payback period is not very sensitive. It always takes around 2-2.5 years to pay back the investment. This has to do with relatively low sales number the first two years. If the sales were to be high from year 1, the payback period could be even shorter.

#### 4.9.10 Key Performance (DuPont)

KPI’s (Key Performance Indicators) are some different indicators that can give an idea of the performance of the company.

#### Key Performance Indicators

<table>
<thead>
<tr>
<th>Average Sales DKK/year</th>
<th>1433750</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Operating profit before interest (EBIT)</td>
<td>444041.375</td>
</tr>
<tr>
<td>Average operating assets DKK/year</td>
<td>150000</td>
</tr>
<tr>
<td>Margin</td>
<td>31%</td>
</tr>
<tr>
<td>Turnover</td>
<td>9.358313333</td>
</tr>
<tr>
<td>ROI</td>
<td>2.960758329</td>
</tr>
</tbody>
</table>

*Table 9 – Key performance indicators*

#### 4.9.11 Conclusion

Based on the calculations we have done here, it will be a profitable project. We have a very high IRR and a good payback period around two years. However there are still a number of risks that should be taken into considerations.

- The initial investment is set too low
- We will not be able to sell that many products
- We will have a lower selling price
- There will come higher expenses to production

Beside this, it should be noted that we do not pay our self anything. We haven’t hired any administration and sales personal.

In the analysis done here, we do not take in to consideration that the manufacturing could be outsourced later. This could lower the variable cost, and thereby increase our contribution margin and profits. However again, a larger investment should be made.
The recommendation is to invest some time and money in really assessing all the risks. The project has potential to be profitable.

4.10 Future Perspectives

The future perspective is an important factor for the GADE smoke detector. The most important step in connection with the final launch is finding a focus group to receive feedback on the product and to get the promotion started. There are several other future aspects that are important to consider for the future of our product: Technological possibilities, municipal, geographical expansion and brand.

4.10.1 Technological possibilities

In order to ensure that the GADE Smoke detector is competitive, it is important to consider technological changes both in connection to new technological opportunities but also in connection to new demand from the target market. We expect that when a new generation becomes ‘the elderly’ there will be some new demands on what and how much technological possibilities there should be in a smoke detector. This could be to consider an APP for controlling the smoke detector.

4.10.2 Municipal

A good way of getting the smoke detector to the consumer is to consider collaboration with the municipal. This could be beneficial both in connection with raising the sales, because each time a new elderly home is build, our smoke detector should be in that home. Also in connection with testing the product, and future products, this would provide efficient information from our consumer and generate mouth-to-mouth promotion.

4.10.3 Geographical expansion

As mentioned in the marketing plan it is in our consideration to expand to bigger geographical markets when we have tested our product on the Danish market. This will be in a time range of 2-5 years from the launch on the Danish market.

4.10.4 Brand

It is a high priority for us to create a brand. Our brand should not just be associated with elderly houses and helping equipment but it should represent products that consider easy and simple safety. A good way of showing that our smoke detector is not just some practical equipment for old people we consider a collaborating with an industrial designer or a known brand. This could be Arne Jacobsen, Herstal or Holmegaard. This would also make it possible for us to sell our smoke detector in other types of stores. This could be Inspiration and Magasin. We will not consider this before 3-4 years after the launch and then we could use the redesign of the smoke detector as a re-launch of the smoke detector.
5 Evaluation

5.1 Product Evaluation

In overall this evaluation will be based on the information and risks we have brought out in the business plan, the team would say that this project is not feasible. This decision is based on many factors. First of all, a change in the market is happening towards more intelligent systems like the Google NEST and it would be very dangerous to release a product now when it is already behind regarding the technology S-curve (Figure 17). The second factor is about money: Financial-wise, we have high risk of failure since our selling price is very sensitive and could drastically lower our NPV and IRR, and thus render the investment pointless.

![Figure 17 – Technology S-curve](image)

On the other hand the project could also have positive outcomes. If more resources were to be spent and the direction of the market is changed, from competing and comparing the product with other fire alarm systems, to competing and comparing the product with other self-helping products - which all usually have higher prices - we could do some modifications in our product capabilities. This will allow us to market it as a high-level product, giving it a greater chance of being feasible.

5.2 Evaluation on Teamwork

Throughout the project period the team has been working towards a common goal. However, changes have been made during the process in order to keep up with the ambitions.

Before starting the group work we sketched a group contract (Appendix 1) with rules and consequences, this was to ensure that all of the members in the group had the some expectations to the project work and new that if these expectations were not followed then there would be some consequences. This provided us with a starting point for the project.

In the beginning of the process we arranged the project structure into four main parts, where the members of the team each were responsible for one part. One member of the team was acting as the CEO of the project. This was an efficient way of starting the project because each member felt a responsibility for his or her section and it was a good way of keeping a clear structure throughout the project. In the middle of the project process we started to feel a bit cut off from the main project and we were missing the bigger picture. The reason was that each member had only focused on his or her section and did not actually know precisely what was going on in the other sections.
The CEO’s responsibility was to ensure that the project and each section was going in the same direction and was acting as the chairman at each meeting.

The meetings were arranged from meeting to meeting and we ensured that each meeting was arranged so that most of the members were able to attend. We used Dropbox, Facebook and Skype as communication tools, which ensured that all of the group members were updated on the process of the project.

Our team was mixed with exchange students and Danish students which provided us with a good combination of knowledge, experiences and personalities, that have been beneficial for our project work and the team dynamic.

The group has in general been working goal-oriented towards creating a new and innovative product. Throughout the process there have been a friendly, but ambitious, atmosphere and that has made it comfortable to work in the group.
6 Bibliography

6.1 Literature


6.2 Websites:


6.3 Electronic Journals

6.4 JOURNALS

- EN 14604, 5.17.3 Sound output Requirements, European Commitee for Standardization
- EN 14604, 4.7 Normal power source, European Committee for Standardization
- EN 14604, 4.16 Protection against the ingress of foreign bodies, European Committee of Standardization

6.5 EXPERTS

- Smoke detector producer: Thorkild Larsen A/S, Slangerup DK, 2011
- Inventor and electrician: Keld Gade Andersen

6.6 SOFTWARE:

- Autodesk, Inventor Professional (2014)
- Autodesk, Inventor Professional (2014), Pluin program – Thread modeler
7 TABLE AND FIGURE OVERVIEW

7.1 FIGURES

- Figure 1 - The Product Development Process
- Figure 2 - Organizational chart
- Figure 3 – Gantt Chart miniature
- Figure 4 – Main Hub on top of the breaker panel
- Figure 5 – Detector Unit and Dismounting Tool
- Figure 6 – GADE logo
- Figure 7 – overview of design changes
- Figure 8 - Smoke detector unit
- Figure 9 - Dismounting tool
- Figure 10 – Smoke detector FRONT
- Figure 11 – Smoke detector SIDE
- Figure 12 – Smoke detector BACK
- Figure 13 – Dismounting tool
- Figure 14 – Competitive Analysis with the main competitors
- Figure 15 – Production flow
- Figure 16 – Supply chain flow
- Figure 17 – Technology S-curve

7.2 TABLES

- Table 1 – Cost reduction using MFD
- Table 2 - Job Order Costing
- Table 3 – Competing products prices
- Table 4 – Sales forecast
- Table 5 – Income statement
- Table 6 – Cash flow
- Table 7 – Breakeven analysis per year
- Table 8 – Capital investment for the optimal scenario
- Table 9 – Key performance indicators