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MSc Thesis Business Economics

Partial budgeting analysis of the provision of allergen information and allergen free food in a catering business

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Abstract

The revised version of the Regulation (EU) No 1169/2011 on the provision of food information to consumers (FIC) will come into force on 13 December 2014. The objective of the current study was to quantify costs and benefits of allergen free production at a catering business under two scenarios. Scenario one encompasses the provision of information about food allergens to the patrons. Scenario two encompasses the provision of information about food allergens to the patrons and the prevention of cross contamination. The necessary adaptations are necessary to assure allergen free catered products. By performing a partial budgeting analysis, it was assessed whether the necessary adaptations due to the upcoming regulation are economically feasible for catering businesses. Fixed and variable cost items were identified using a literature review, critical inspection of a catering business, necessary adaptations according to the FIC regulation, and the expert judgment of a general quality manager together with the chief of a catering business. Benefit items were quantified by a questionnaire about willingness to pay for provision of allergen information and willingness to patronize. A stochastic element was added to the parameters of the costs and benefits to include uncertainty and a Monte Carlo simulation with 2000 random draws were performed. Results showed that the break-even point of scenario one is estimated to be nine months, whereas for scenario two it is eight months. From this case study, it can be concluded that the changes needed to the catering businesses to adapt to the new FIC Regulation are economically feasible under both scenarios.

Key words: food allergens; catering business; cost-benefit analysis; Regulation (EU) No 1169/2011 on the provision of food information to consumers; willingness to pay for provision of allergen information

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Acronyms

AIC= Akaike Information Criterion

ARMP= Allergen risk management plan

BEP= Break-even point

PBA = Partial budgeting analysis

FIC= EU Food Information for Consumers regulation

DALY= Disability adjusted life years

HACCP= Hazard analysis critical control point

Max= Maximum

Min= Minimum

MMS = Menu management system

SFBB= Safer food better business

PRP = Prerequisite Programs

PPM= Parts per million

RIKILT= Institute of Food Safety of Wageningen UR

RotF = Restaurant of the Future

VITAL = Voluntary Incidental Trace Allergen Labelling

WTP= Willingness to pay

WTP_1= Willingness to pay for the provision of allergen information

WTP_2= Willingness to pay for the provision of allergen information and allergen free food

1. Introduction

1.1 Background

Food allergy presents a food safety issue whose consequences can be very severe after the intake of minor quantities of the allergens (Watson 2013). Information about allergens is perceived as being more and more important for consumers as their awareness about food allergens is rising (Batt and Noonan 2009).

Food allergens cause problems for people with food hypersensitivity, leading to food allergies and food intolerance. A food allergy is described as an abnormal response to a food due to an immunoglobulin-E (IGE) immune mediated reaction (Skripak and Sampson 2012). Peanuts, tree nuts, and shellfish are examples of allergens which can cause severe symptoms like anaphylaxis (Abbot, Byrd-Bredbenner, and Grasso 2007). Food intolerance, also known as non-allergic food hypersensitivity, is caused by a non-immune mediated reaction. Persons with a food intolerance can ingest small amounts of foods without serious problems, whereas food allergies can cause severe reactions as anaphylaxis (Sicherer and Sampson 2006). Celiac disease is an non-IGE immune-mediated reaction to gluten (wheat), which occurs in genetically predisposed individuals (Pietzak 2012). Figure 1 presents the types of food hypersensitivity as described above.

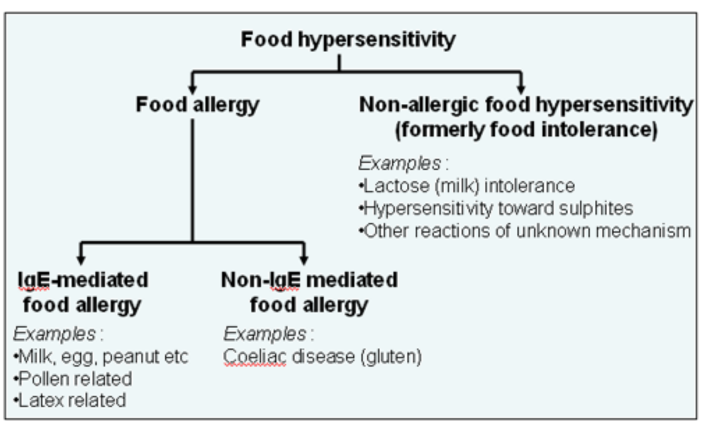

Figure 1: Types of food hypersensitivity

Source: (Institute of Food Research 2013)

More than 160 foods can cause allergic reactions, but only eight foods are thought to account for 90% of all food allergic reactions in the United States (Jackson et al. 2008). The prevalence of food allergies in the Netherlands as diagnosed by medical tests is 2-3% (Rona et al. 2007, Niestijl Jansen et al. 1994). The scope of food hypersensitivity is bigger, since 20-22% of the Dutch sample reported to experience food hypersensitivity (McBride et al. 2012).

Food allergic people experience on average two reactions per year and 30% of the total reactions are severe (Versluis 2012). The prevalence and severity of food adverse reactions has increased over the years (O'Neil, Zanovec, and Nicklas 2011, Hadley 2006). For example, hospital admissions for food allergies have increased by 500% in United Kingdom since 1990 (Gupta et al. 2007). Moreover, peanut allergy is becoming more common in younger generations. Since peanut allergy is rarely outgrown, it can be expected that peanut allergic children will still suffer from their peanut allergy as they get older (van Putten et al. 2006). However, the increase of diagnosed food adverse reactions could also be the result of improved serological screening methods (Metcalfe et al. 2013). The mortality rate amongst people with severe food allergic reactions is 1% (Flabbee et al. 2008). This number will increase, since reactions become more severe due to cross-sensitisation (Macdougall, Cant, and Colver 2002). Cross sensitivity is the induced sensitivity to foods that contain similar proteins (Fæste and Namork 2010).

Food allergic people highly rely on provision of allergen information, since the only way to manage food allergies is to avoid foods containing allergens (Jackson et al. 2008). Food industry managers agree that providing food allergen information to consumers is becoming more and more important (Batt and Noonan 2009). Nowadays, there is considerable information about allergens in pre-packaged foods as it is mandated by law, but catering businesses who sell unpackaged foods possess still very limited knowledge about allergens and may not be able to respond adequately (Pratten and Towers 2003).

In order to control for the presence of food allergens and to prevent high exposures to them, the European Union has created regulations. The main goal of the regulations is to ensure that foods sold are safe for everybody, including food allergic consumers (European General Food law (178/2002), article 14(4c). According to Regulation (EU) No 1169/2011 on the provision of Food Information to Consumers (hereinafter FIC), fourteen allergens have to be declared on food product packages (table 1). Moreover, according to Regulation (EC) No 852/2004 on the hygiene of foodstuffs, food businesses are required to implement procedures to prevent to bring unsafe foods on the market.

Table 1: Annex II of Regulation (EU) No 1169/2011 on the provision of food information to consumers

Food allergens and products thereof
Cereals containing gluten, (Wheat, rye, barley, oats, spelt or their hybridised strains)
Crustaceans
Eggs
Fish
Peanuts
Soybeans
Milk (including Lactose)
Nuts (Almond, Hazelnut, Walnut, Cashew, Pecan nut, Brazil nut, Pistachio nut, Macadamia nut and Queensland nut)
Celery
Mustard
Sesame seeds
Sulphur dioxide and sulphites at concentrations of more than 10mg/kg or 10 mg/litre expressed as SO2
Molluscs
Lupins

Source: Annex II of Regulation (EU) No 1169/2011 (Regulation (EU) 2011).

Food industries make sure allergen information is provided, as when food allergen information is not provided on the package, it can be injurous to food allergic consumers and the food cannot be sold. Moreover, food industries want to prevent recalls. Most recalls (34%) in the food industry are due to undeclared allergens, which result in major costs for the food companies (Taylor et al. 2004). Nevertheless, recalls of unsafe foods are important since there is a reasonable probability that the use of, or the exposure to, products containing allergens can cause serious adverse health consequences or death (Gendel and Zhu 2013, Davenport 2013).

Currently, it is not mandatory for catering businesses and other out of home eateries to provide information about allergens in unpackaged foods. However, the adjusted FIC regulation will come into force 13 December 2014 and requires provision information on allergens also cover unpackaged foods including those sold in food services like catering businesses, restaurants, and cafés. The focus of this study will be on catering businesses. For catering businesses, article 9 and 44 of the FIC are of specific interest. These articles mandate catering businesses to provide information about fourteen allergens in the production of unpackaged foods (table 1). The FIC specifically states that catering businesses selling unpackaged foods need to have information about allergens readily available and easily accessible (European Parliament 2013). It will not be allowed to provide allergen information only at the moment of a consumer request, but information needs to be readily available on paper and menu cards (Eurocommerce 2013).

Each member state of the European Union will decide how food allergen information in unpackaged foods has to be made available to consumers (Food safety authority Ireland 2012, KTBA People in Food 2013). The Netherlands proposed to enforce all food services to have food allergen information readily available, including catering businesses. However, the presence of hidden allergens by cross contamination does not have to be taken into account[1] (Voedingscentrum 2013, Anibarro, Seoane, and Mugica 2007). Mostly, cross contamination is caused by the manufacturing, handling or cooking process, when the same equipment and areas are used (Duan, Zhao, and Daeschel 2011).[2]

There are two types of catering businesses, and the FIC regulation applies to both. The first is an on-premise catering business, which is situated at the location of the customer (e.g. a specific institute or company), and uses their equipment. The places can vary from an actual restaurant, hotel, or main catering facility (Hertzman and Barrash 2007). The second is an off-premise catering business preparing food in a licensed commissary, and transports the food to a location selected by the client (Kahraman, Cebeci, and Ruan 2004). The focus of this study will be on the on-premise catering businesses.

Catering businesses will have to make adaptations in order to provide correct information about food allergens, which will lead to higher costs. Besides costs, the upcoming FIC regulation may also

1 Hidden allergens are unrecognised and not declared ingredients

2 Other reasons include the absence of ingredient specifications at restaurants and public places, incorrect use of terms, poor labels, and unnoticed changes in the food composition (Anibarro, Seoane, and Mugica 2007).

bring benefits to on-premise catering business. Benefits include a contribution to the healthiness of consumer, assurance of safe production, increased service to the customer and increase of the market due to increase of willingness to patronize for provision of allergen information (hereinafter mentioned as: willingness to patronize) (Kronenberg 2012, Ajala et al. 2010, Leitch, Walker, and Davey 2005). Moreover, catering businesses may increase sales or attract consumers with a higher willingness to pay (WTP) for provision of allergen information and allergen free food. To the best of my knowledge, no studies have been performed on this aspect; therefore this will be investigated in this study.

1.2 Research objective and research questions

The objective of this study is to estimate the costs and benefits of providing allergen information and allergen free food by on-premise catering businesses. In line with the objective, this study includes the following research questions:

1. What are critical control points for presence of food allergens in an on-premise catering business?
2. Which adaptations are necessary to assure allergen free catered products under the following two scenarios:
   - Scenario one: the provision of information about food allergens to the patrons
   - Scenario two: the provision of information about food allergens to the patrons and the prevention of cross contamination
3. What are the estimated costs and benefits for an on-premise catering business under the two scenarios?

For research question one, the focus was on the presence of gluten and peanuts, since these allergens have a high impact to the food industry and to the consumers. The high impact of gluten is caused by its abundant presence due to its useful characteristics (e.g. that is it is very elastic which is useful for baking) and its low price (Day et al. 2006). Peanut is one of the most severe food allergens with a worldwide prevalence of 0.6-2.9% (Remington et al. 2013a). The established critical control points are used to determine the necessary adaptations for on-premise catering business. These necessary adaptations are in turn determinants of contributing costs of producing allergen free food under the two scenarios.

1.3 Report outline

- Chapter 2 presents a literature review of existing models to manage food allergens, costs of food allergy in different sectors and critical control points of allergen free production.
- Chapter 3 presents the materials and methods used to perform the cost-benefit analyses. It includes a description of the questionnaire and describes how the predictive model was built.
- Chapter 4 presents the results of the critical control points, the questionnaire, the partial budgeting analysis (PBA), and the predictive model.
- Chapter 5 contains the discussion.
- Chapter 6 presents the conclusion and suggestions for further research

2. Literature review

This chapter consists of a literature review about the costs of food allergy in different sectors, existing models to manage food allergens, and critical control points of allergen free production. The costs of allergen management options by catering businesses are not quantified yet. Therefore, the critical control points are used to present the relevant cost and benefit items from a specific catering business.

2.1 Costs of food allergy in different sectors

Decision making will be easier when costs of food allergies of all stakeholders are known (Kerbach et al. 2009, Miles et al. 2005). However, costs and benefits for the control of food allergens are not quantified yet. Cost and benefit calculations are difficult due to the lack of information about economic and social costs (Regent 2011). It is necessary to quantify costs of food allergies in all sectors to be able to analyse the economic impact of allergen management decisions (Regent 2011). Table 2 gives an overview of possible costs of food allergy within different sectors. Costs are divided into different economic sectors, such as individual household, health sector, food industry, and public sector. However, it is important to address that this overview is simplified and it is possible that a cost in one sector may be a benefit to another sector (Mugford 2006). For example, an increase of direct costs of allergen free food production for the food industry will probably reduce the hospital primary care for the health sector and reduce the intangible costs of effects on quality of life for the public sector. Only a few studies have quantified costs due to food allergies, which are about individual costs due to food allergies and costs for the health sector due to food allergies. These costs are described in section 2.1.1 and 2.1.2.

Table 2: Costs of food allergy

	Individual or household	Health sector	Food industries	All employers	Regulations and enforcers	Society
Direct costs	Out of pocket expenses*†		Loss/gain of market†	Lost output from affected workers†	Inspection and monitoring*	
Indirect costs	Informal care and loss of education and income*†	Public health campaigns†	Costs of regulation and adaptation to market forces†		Drafting, debating, consulting, researching*	Overall performance of the economy*
Intangible costs	Quality of life†		Consumer perception of products†	Employee morale†	Public opinion, public safety*	Public health and Social welfare*

Source: *: Mugford 2006, †: (Mugford 2006, Miles et al. 2005)

2.1.1 Costs for food allergic individuals

Direct costs and indirect costs for food allergic people are significantly higher than for non-food allergic people (Voordouw et al. 2010, Patel et al. 2011, Madsen et al. 2012). Direct costs for individuals consist of out of pocket expenses, which include total costs of health care, total costs of medicines, and total costs of health insurance (Voordouw et al. 2010). Indirect costs for individuals consist of lost working time because of being unable to work, seeking additional information on allergens in food, and coping with a food allergy (Mills et al. 2007).

In the Netherlands, direct and indirect costs due to food allergies has been estimated to be €3,500 per allergic person per year, which is around €1.1 billion euros per year for the whole country (Voordouw et al. 2010). Costs due to other types of allergies were more extensively studied. In Europe, the costs for asthma, chronic obstructive pulmonary disease, and respiratory allergies are 29 billion euros per year, which includes €2 billion per year for the Netherlands (Aas et al. 1997).

Intangible costs, like consumer perception of the product and the public opinion, remain hard to quantify (Miles et al. 2005). Intangible costs can be estimated in terms of disability adjusted life years (DALYs) and quality adjusted life years (QALYs). DALYs and QALYs represent the reduction in quality of life of allergic persons (Murray et al. 2013). These concepts are used to express health aspects into monetary terms for individuals and society; however, DALYs and QALYs cannot be used for quantifying costs for catering businesses.

2.1.2 Costs for the society

In the United States, societal costs due to severe food allergies are estimated to be € 247 million per year[3]. These costs include direct costs (€163 million), and indirect costs (€84 million) (Patel et al. 2011). A large part of the societal costs are represented by children with food allergies. The highest costs arise for children younger than four years old (Patel et al. 2011).

2.2 Models to manage food allergens

Allergen management systems can be helpful to quantify the costs for a catering business (Cucu, Jacxsens, and De Meulenaer 2013). Moreover, the implementation of a structured management plan or system can help a catering business to reduce liability and capitalize on the emerging market of allergy-conscious consumers (Kronenberg 2012). It is more useful to adjust and add elements rather than to implement a whole new allergen management system (Gilissen et al. 2006, Lichtenberg, Heidecke, and Becker 2008). Therefore, several models have been reviewed for their relevance for allergen free production, in order to detect all critical control points and to determine which adaptations need to be made.

The cost items are based on four existing models and plans: HACCP, allergen risk management plan (Ward et al. 2010), risk analysis, and the allergen control plan (Jackson et al. 2008). The HACCP and the allergen risk management plan will be discussed in further detail below. Elements of these models are used to determine all necessary adaptations for allergen free production in an on-premise catering business.

2.1.1 HACCP

HACCP (Hazard Analysis and Critical Control Point) is an important quality assurance system for a food company to ensure food safety and hygiene (Peter, Mateja, and Mojca 2013). European food business operators are obligated to have hygiene procedures in place that are based on HACCP (Carreno 2005). HACCP is used to analyse and correct critical control points and consists of the seven principles as illustrated in figure 2 (Mortimore and Wallace 2013, Garayoa et al. 2011).

3 Assumed that 1 US dollar equals 0,73 euro

1	Preliminary Procedures	Assemble HACCP team
2		Describe product
3		Identify intended use
4		Construct flow diagram
5		On-site confirmation of fl ow diagram
6	Principle One	List all potential hazards Conduct a hazard analysis Consider control measures
7	Principle Two	Determine Critical Control Points (CCPs)
8	Principle Three	Establish Critical Limits for each CCP
9	Principle Four	Establish a Monitoring System for each CCP
10	Principle Five	Establish Corrective Actions
11	Principle Six	Establish Verification Procedures
12	Principle Seven	Establish Documentation and Record Keeping

Figure 2: The principles of HACCP
Source: (Taylor 2008)

The principles of HACCP are quite general costly and extensive, which makes it difficult for small on-premise catering business to implement (Dzwolak 2014, Green and Kane 2014, Taylor 2008). Therefore, systems based on HACCP like the Safer Food Better Business (SFBB) model are used (Taylor 2008). The SFBB model was developed by the food safety authority as a ready-to-use package for on-premise catering business with less than five staff members (Taylor 2008, Mortimore and Wallace 1998).

2.2.2 Allergen risk management plan

The allergen risk management plan (ARMP) is a model with a focus on the management of food allergens in the whole production process (figure 3). The ARMP covers aspects that are important for catering businesses. The most important aspects of this model are the use of a database of (hidden) allergens per meal and the preventive measures to control the presence of hidden allergens. In this case study, the database is called menu management system (MMS). The menu management system (MMS) is a database which stores all information of the ingredients in the meals (Gendel 2012).

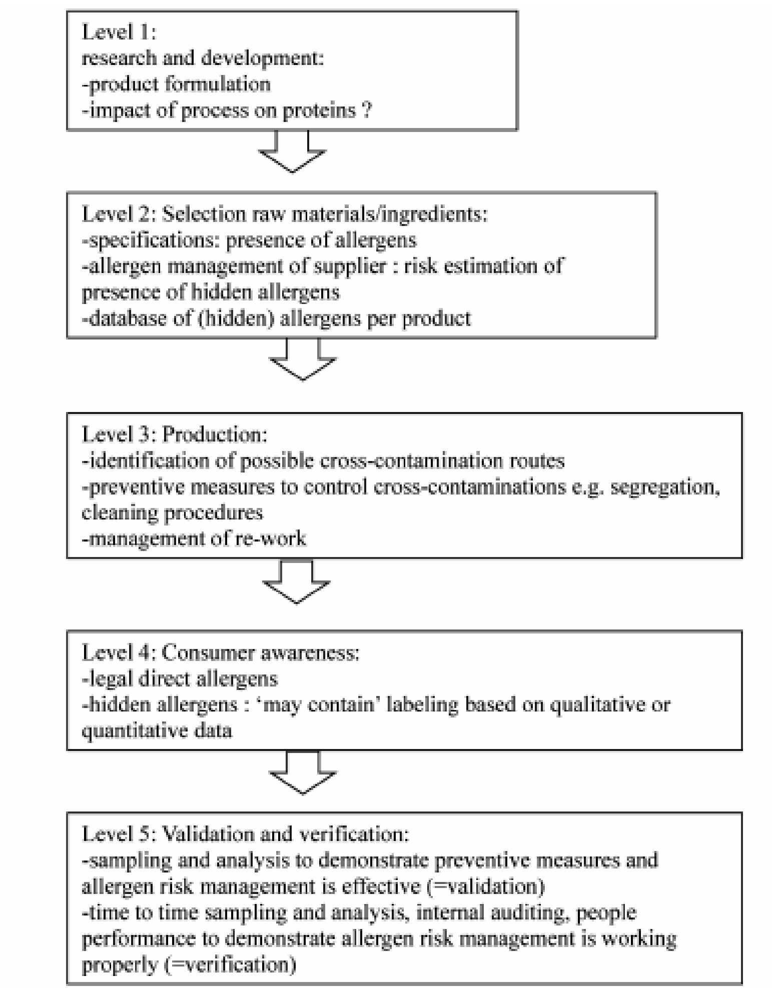

Figure 3: Allergen risk management plan

Source: (Cucu, Jacxsens, and De Meulenaer 2013)

2.3 Critical control points for allergen free production based on literature

In this section, five critical control points (CCPs) will be discussed. These CCPs are a basis for the necessary adaptations and define cost elements. Therefore, ways to reduce risks of these CCPs were analysed. Options to prevent cross contamination and enhance traceability throughout the supply chain were reviewed. The use of detection levels has been explained and ways of providing food allergen information are given, including staff training. Finally, the importance of validation and verification of the adaptations has been shown.

2.3.1 Prevention of cross contamination

Cross contamination is the main cause of the presence of hidden allergens (Kumar and Budin 2006, Anibarro, Seoane, and Mugica 2007). Cross contamination is an on-going concern for food manufacturers (Anibarro, Seoane, and Mugica 2007). Cross contamination mainly occurs in three ways: food to food, people to food and equipment to food (Duan, Zhao, and Daeschel 2011). Cross contamination generally occurs when allergenic substances are transferred during processing or handling. This is especially likely to happen when multiple foods or ingredients are produced in the same area (Kirsch et al. 2009).

The most practical and easy approach to reduce the risk of allergen contamination are appropriate preparation and scheduling the food preparation in the right order (Huggett and Hischenhuber 1998, Deibel et al. 1997). This means that all meals containing food allergens should be prepared after non-allergic meals and preferably at a separate place directly before cleaning (Blanchfield 2001). In addition, equipment and working areas for allergen free food should be used separately to prevent cross contamination (Kumar and Budin 2006). Utensils and equipment should be dedicated to specific products or thoroughly cleaned before they are used for allergen free meal preparation (Huggett and Hischenhuber 1998, Jackson et al. 2008). Moreover, correct cleaning is a very effective way to minimize the spreading of allergens due to cross contamination (Jackson et al. 2008). For allergen prevention, wet cleaning with disinfectants is recommended (Lampidonis and Siragakis 2013). Wet cleaning is also useful to prevent the spread of dust, since dust from an allergen-containing meal can easily get in contact with other meals (Huggett and Hischenhuber 1998). However, as micro-organisms grow easily in humid environments, wet places should be dried afterwards (Adams and Moss 1995, Duan, Zhao, and Daeschel 2011).

When cross contamination is prevented and allergens are not present in the final product, the usage of the 'may contain allergens' labelling can be reduced. This is beneficial for allergy-conscious consumers and food-service professionals who rely on the information whether a meal is free from particular allergens (Hazel Gowland 2002). Moreover, the prevention of cross contamination can improve the quality of life for allergy-conscious consumers since they are less likely to get an unwanted reaction.

2.3.2 Traceability throughout the supply chain

Traceability systems become increasingly mandatory for the global food industry (Chrysochou, Chryssochoidis, and Kehagia 2009). Traceability helps to determine which allergens and other ingredients are present in the product. Moreover, it can detect critical control points along the supply chain (Kerbach et al. 2009). Management system inconsistencies can be prevented by involving all stages of the supply chain (Rediers et al. 2012, Deibel et al. 1997, Ward et al. 2010).

Traceability can help to transfer the liability to earlier stages (Pouliot and Sumner 2008). Liability costs and potential loss of reputation associated with publicized lawsuits create significant incentives for suppliers to implement traceability systems (Pouliot and Sumner 2008, Henson and Caswell 1999).

Regulations about the declaration of food allergens in prepackaged foods differ between countries, because of a variance in prevalence of food allergies and food intake habits (Gendel 2012, Dalal et al. 2002). For example, mustard and celery are allergens which only need to be declared in the European Union, since the prevalence of these allergens and allergies in this area is relatively high (Technology 2014). In Japan, 25 allergens need to be declared, whereas only eight in the United States (Boye and Godefroy 2011). When international traceability systems are used, food industries can more easily be exported (Caswell 1998, Garcia Martinez, Verbruggen, and Fearne 2013).

2.3.2.1 Action levels of allergens

Allergen levels should be quantified in order to provide correct information and control cross contamination. However, until now only qualitative standards such as "visibly clean" are used (Madsen et al. 2012, Gendel 2012). Action levels based on a quantitative risk assessment provide the threshold at which there is a reasonable risk that allergic people get a food adverse reaction (Mugford 2006, Remington et al. 2013a). When the quantity is unknown or underestimated, this can be a risk for food allergic people (Cornelisse-Vermaat et al. 2008). Quantitative action levels can ease decision making for catering businesses and provide correct food allergen information (Madsen et al. 2012, Remington et al. 2013a). Moreover, the use of action levels can enhance the trust in correct allergen information (Mugford 2006).

Japan, Switzerland, Australia and New Zealand are the only countries that have adopted regulatory action levels (Crevel et al. 2008, Diaz-Amigo and Popping 2010, Allen et al. 2013, Kerbach et al. 2009). However, no global standards exist that determine maximum amounts of food allergens present in a product and still be deemed safe (Ward et al. 2010). The implementation of action levels is hard due to differences in prevalence and severity of allergens per country (Griffiths 2009). If global standards were present, food companies would be able to assess their current state of allergen cross contamination easier, and able to export their products more easily (Mills et al. 2004). Therefore, the Voluntary Incidental Trace Allergen Labelling (VITAL) 2.0 has been developed by several international food producers and the Australian Food and Grocery Council in 2007 (Buchanan et al. 2008, Remington et al. 2013b). VITAL 2.0 assists the food industry in the use of advisory labelling and (Allen et al. 2013, Ward et al. 2010). As shown in equation one, the VITAL 2.0 action levels are derived from a reference dose (RfD) $\left(\text{in } \frac{\mu g}{ml} \text{ or } \frac{\mu g}{mg}\right)$ and the portion size (Taylor et al. 2014). The formula of the VITAL action level (Nance and Wexler, 2005) is reported in equation 1.

$$\boldsymbol{Vital\ action\ level} = \mathbf{RfD} * \mathbf{Portion\ size\ (g)} \qquad \mathbf{(1)}$$

Source: VITAL action level, (Nance and Wexler 2005).

The reference dose is a quantitative estimate of a daily oral exposure to the human sample that is not likely to cause a risk for 95 - 99% of all allergic persons (Nance and Wexler 2005). As shown in equation 2, the RfD is based on either the no-observed-adverse effect level (NOAEL) or the lowest-observed-adverse level (LOAEL). Moreover, modifying factors (MF) such as the seriousness of the reaction, objective versus subjective reactions and the inclusion of uncertainty factors (UF) have been taken into account to include an acceptable degree of risk (Taylor et al. 2004).

$$\boldsymbol{RfD} = \frac{\mathbf{NOAEL\ (or\ LOAEL)}}{\mathbf{(UF * MF)}} \qquad \mathbf{(2)}$$

Source: (Nance and Wexler 2005).

Action levels are set to 8 PPM[4] for peanut and 20 PPM for gluten (Regulation EC 41/2009)(EU-VITAL 2013). By knowing the RfD, a catering business can fill in the specific portion size to determine whether the action levels are in accordance to the acceptable level set by VITAL. The values of all food allergens can be found in appendix 1.

2.3.3 Providing food allergen information with the use of a menu management system

The provision of food allergen information can help to avoid unnecessary choice restrictions of allergy-conscious consumers, while protecting them (Cucu, Jacxsens, and De Meulenaer 2013, Mugford 2006). However, the provision of allergen information by on-premise catering businesses and other out of home eateries is currently inadequate. A lot of products sold in catering businesses have incomplete or misleading allergen information. Products contain statements like "may contain", "same/shared equipment" and "shared facility" when referring to a specific allergen. Since a lot of these food products are in fact free of allergens, these statements lose their value and trust (Mills and Breiteneder 2005, Mills et al. 2007, Robertson et al. 2013). For example, in the United States only 7.3% of the products with peanut advisory statements actually contained detectable

4 parts per million: milligram allergenic substance/kilogram food

levels of peanut (Remington 2013). Unfortunately, the opposite also occurs: for example, in a study amongst ten European member states, over 50% of the 254 chocolate products for which there was no precautionary label, actually tested positive for hazelnut, and 23% tested positive for peanut (Kerbach et al. 2009). Because of this, consumers are overwhelmed by the diverse and contradictory information about food allergens (Cornelisse-Vermaat et al. 2008). This causes allergy-conscious consumers to increasingly ignore precautionary allergen statements on labels, which can have short- and long term health effects for them (Golan et al. 2001). The current use of advisory labelling and lack of transparency of its use limits food choices, which can lead to an unbalanced diet and thus decrease the quality of life of allergic individuals (Remington 2013).

The MMS can be a helpful way to document allergen information and control the main critical control points for allergens in on-premise catering. It is helpful to get more insight in the presence of allergens, the use of right terminology, and prevent mistakes in labelling and/or menu preparation (Mortimore and Wallace 1998, Gendel and Zhu 2013). Besides that, information about numerous other food allergens (like specific fruits and vegetables) can easily be found and communicated (Poms, Klein, and Anklam 2004).

Based on the information in the MMS, unambiguous allergen symbols (including the quantity) placed on menu cards can be used to improve information by on-premise catering businesses (Gilissen, Gao, and Chen 2012, Cornelisse-Vermaat et al. 2008). This will give clear and quick information and prevent linguistic misunderstandings (Cornelisse-Vermaat et al. 2008). Moreover, ICT methods like hand scanners, smartphone apps, and the Quick Response Code can be useful to quickly provide MMS information to the consumer (McMahon et al. 2013, Gilissen, Gao, and Chen 2012, Cornelisse-Vermaat et al. 2008, Voordouw et al. 2011).

Providing correct allergen information can have several advantages for consumers and businesses. To start with, on-premise catering business and restaurants will improve their image and reduce liability (Kronenberg 2012, Ajala et al. 2010). Moreover, allergy-conscious consumers will have an increased feeling of safeness, and probably more people allergic consumers will consider having meals at restaurants (Leitch, Walker et al. 2005). Currently, 80% of the people with celiac disease avoid restaurants because of the high risk of getting a reaction (Zarkadas et al. 2006). In addition, not only allergy-conscious consumers prefer allergen-free food (Worosz and Wilson 2012). Many people do not eat gluten because of other reasons: 46% believe gluten-free products are generally healthier; 36% see them as helpful for weight loss; 24% view gluten-free as an indicator of higher quality; 13% link gluten to benefits associated with hyperactivity/autism (Sloan 2011). When specific allergen free foods and/or information are provided, consumers can feel safer and/or more comfortable with allergen free food. News articles reported that restaurants which started to provide allergen-free meals seemed to have an increase in revenue varying from 8% to 25% (Sloan 2011). To conclude, allergen information should be comprehensive and deliver targeted information which directly meets the needs of allergy-conscious consumers (Mugford 2006).

2.3.4 Staff training

Currently, staff members of catering businesses have insufficient knowledge about food allergens (Pratten and Towers 2003). This is due to a combination of: training the wrong people; not training enough people; and not providing enough training (Kumar and Budin 2006). According to a questionnaire in New York, 42% (n=100) of restaurant managers, chefs and servers did not receive any food allergy training (Ahuja and Sicherer 2007). In addition, study in the United Kingdom showed that 84% (n=90) of the food staff of restaurants expressed interest in additional training on food allergies (Bailey et al. 2011).

Training should be given in such a way that all Employees work according to the implemented system, since proper procedures are often not followed (Hertzman and Barrash 2007). It would be most useful to educate Employees and show them (for example with the use of a movie) about the causes of food allergies, the severity of food allergies and the way they can assist consumers in making informed choices (Gilissen et al. 2006).

Ineffective employee training causes 32% of errors resulting in recalls (Kumar and Budin 2006). The reduction of these recalls will result in reduction of costs, which is an economic benefit. Correct training of the staff of a catering business has several other benefits: coordination and correct training will help to ensure that all aspects including preventative controls for allergens are covered by the management system (Gendel 2012). Staff training programs have proven to be one of the most effective tools for preventing cross contamination with allergens (Deibel et al. 1997, Gendel and Zhu 2013). Moreover, training is often accompanied by an externally accredited certificate and/or qualification, which contributes to the image of the business (Bishop 2011).

2.3.5 Validation and verification

Catering businesses should audit their suppliers annually to assess the risk of cross contamination and monitor whether ingredient specifications have changed (Kumar and Budin 2006). Records should be kept for cleaning, validation and verification. In addition, the preparation and cleaning procedures should be evaluated by a periodical audit (Jackson et al. 2008). Moreover, specific allergen detection tests can be used to assess whether all allergen residues have been cleaned properly (Lampidonis and Siragakis 2013). Finally, validation and verification can be useful to avoid claims. Especially liability claims can be extremely costly and harmful for the image of the business.

2.4 Cost items of allergen free production

Cost items have been identified using literature review, and are based on the critical control points as described in section 2.3. In table 3, all cost items are summarized along with the reference to the article or source where they were pointed out. For example, elements of the allergen control plan have been used for the food allergen catering business model. The allergen control plan was the only allergen model which highlighted the importance of training (Jackson et al. 2008). The risk analysis model addresses the importance of providing information about product identification, traceability, and declarations of present allergens (Ward et al. 2010, Madsen et al. 2009). Both plans are shown in appendix 2.

Table 3: Cost items of allergen free production

Cost items	Reference
Update of the MMS	Level 3 of ARMP (Cucu, Jacxsens, and De Meulenaer 2013)
Preventing cross contamination	Level 2 of ARMP HACCP Principle 4
Training	Allergen control plan (Jackson et al. 2008) Questionnaire of Gilissen et al. 2006
Information provision to consumers	Risk communication of RA
Validation and verification	Level 5 of ARMP HACCP – Principle 6

2.5 Benefit items of allergen free production

Different economic sectors can benefit from the implementation of the FIC regulation. The quality of life of allergic individuals will rise, together with lower costs for individuals, households, the healthcare sector and society as a whole (Mugford 2006). However, to the best of our knowledge, the benefits for these sectors, including the catering businesses, have not been quantified yet. There has only been only one study about WTP for allergen treatment, were caregivers of food allergic children in the United States reported an aggregate WTP of € 15.1 billion annually for food allergy treatment, which is € 2,544 per year per child (Gupta et al. 2013). Estimates of consumers' WTP can be used to present a quantitative estimate of the potential increase in revenue under the two scenarios (Sullivan, Follin, and Nichol 2004, Cope et al. 2010). Therefore, the willingness to pay for provision of allergen information (WTP_1) and the willingness to patronize for provision of allergen information and/or the provision of allergen free food (willingness to patronize) are used to quantify the benefits.

3. Materials and methods

3.1. Methods per research question

3.1.1 Critical control points

Research question one was answered by performing a literature study, an inspection at a catering business, and collecting expert judgments. Plans to reduce risk and manage the control of food allergens including HACCP, allergen management plan, risk analysis, and the allergen control plan were reviewed. An inspection at the workplace of an on-premise catering business was performed to identify critical control points. The catering business was the Restaurant of the Future (RotF), which is a unit of Sodexo and located in Wageningen, the Netherlands.

3.1.1.1. Swab tests to determine critical control points due to cross contamination

After the inspection, the presence of gluten and peanuts was analysed by swab tests. The presence of gluten presence was tested using the test kit RIDA®Quick Gliadin (R7003). The presence of peanut residues was determined by the test kit Lateral Flow Peanut (BL606-25) together with swabbing kit (BS800-25). All test kits were provided by R-Biopharm®.

First, the performances of swab tests were pre-tested to determine the ability of allergen detection in the food matrices (peanut sauce and soup). A sample with a known amount of added peanut and gluten was analysed. The presence of allergens was tested at the detection limit (at 4.5 PPM peanut and 3 PPM gluten). Also, a higher concentration was tested (450 PPM peanut and 100 PPM gluten). The swab test was tested for the absence of nonspecific binding with components of gluten free soup and whether it was truly gluten free. For the detection, 1 mL of soup was added to the diluted sample buffer and instructions of the test kit were followed.

The measurements were performed before and after providing specific instructions to the staff of the catering business. The first measurement was performed on a regular production day when peanut sauce and a soup containing gluten were prepared. The procedure for performing the swab tests were followed according to the instruction manual of the test kit. One week later, instructions were given to the Employees to prevent cross contamination. Then, the same soups and peanut sauce were prepared taking the instructions into account. Measurements were performed at the critical control points in the same way as at the regular production day.

Finally, the presence of interaction by disinfectants with the test kits was checked for both gluten and peanut. First, the counter was cleaned with ethanol and water. Then, disinfectant was sprayed on the counter. For detection of gluten, a droplet of tomato soup was poured on the same counter and swabbed by a dipstick. Standard procedures of the gluten test kit were followed. The same procedure was followed for peanut sauce.

3.1.2 Necessary adaptations

Research question two has been answered by determining in which way the critical control points should be adapted to comply with the FIC regulation under the two scenarios considered. Critical control points have been discussed for their relevance with experts to identify all necessary adaptations for the RotF. The expert judgments were retrieved from the quality manager of Sodexo and the manager of the Restaurant of the Future.

3.1.3 Partial budgeting analysis

In order to answer research question three, a partial budgeting analysis (PBA) was performed. The partial budgeting approach includes benefits (reduced costs and extra returns) and costs (extra costs and reduced returns) (table 4). It was assessed whether necessary adaptations are costs effective (Kotchen 2010). Costs and benefits were quantified for the two scenarios individually, both relative to the baseline scenario (current situation). Cost items were identified based on literature, a critical inspection at the catering business, and the necessary adaptations according to the FIC regulation.

Table 4: The partial budgeting approach

Advantages	Disadvantages
Reduced costs	Extra costs
Extra returns	Reduced returns

Source: (Bett et al. 2007).

Costs were divided into variable and fixed items. Fixed costs remain constant when output remains constant (so when the same amount of meals are provided). Variable costs are those which need to be incurred regardless of the quantity produced, and variable costs are costs that vary with the output (production volume, which is the number of meals) (Besanko et al. 2009). The total fixed costs for both scenarios were estimated per month. Cost items were made stochastic when experts indicated variation. Cost items were considered to be deterministic when the items were not variable. The minimum, maximum and most likely amounts for the stochastic costs items were given by the experts. For those variables, triangular distributions were added. Moreover, a discrete and exponential distribution was added to the cost item 'risk of getting a fine', since this cost item is dependent on the chance that someone has an allergic reaction. The simulation was performed using @Risk 6.1 form the Palisade decision tool suite (Palisade- Corporation, 2011). Overviews of input of the fixed- and variable cost items are shown in tables 5 and 6, respectively. The fixed cost items are deterministic, except the cost item 'update product specifications in the MMS' which is stochastic with a triangular distribution (most likely number (=50), minimum (=40), maximum (=60)). The variable cost items are all stochastic. The results are shown in section 4.5. Moreover, all variable cost items are stochastic. These items are all with a triangular distribution, except the cost item 'claim', which has exponential distribution.

It was assumed that the following items did not change in the two scenarios relative to the baseline: labour wages, type of insurance, fee for the insurance, and quality of the meals. The costs of the insurance are assumed to remain the same, since catering businesses in the Netherlands have an insurance which covers all food safety items at once, including allergens. Therefore, shifting towards allergen free production does not change the insurance fee. Depreciation for equipment and machineries was not been taken into account, because it was assumed that depreciation does not differ extensively as compared to the baseline scenario.

Benefit items (the WTP_1, WTP_2 and willingness to patronize) were derived from a questionnaire. An overview of the input benefit items is shown in table 7. The input data used to quantify the cost and benefit items per month were identified using literature and expert judgment, as illustrated in table 8. With the input data, a Monte Carlo simulation was performed taking two thousands random draws from the distributions of the stochastic variables under the two scenarios.

Finally, to evaluate at which point (in our case what month of operation) the two simulated scenarios result in positive profits, the break-even point (BEP) was calculated (Bart, Foulds, and Patriarca 1996). The BEP will give the time point in months when the costs are equal to the benefits. The BEP has been calculated according with equation three.

$$\boldsymbol{BEP} = \frac{\textbf{Fixed costs}}{(\textbf{Benefits} - \textbf{variable costs})} \qquad \textbf{(3)}$$

Table 5: Input for the partial budgeting analysis: fixed cost items

Cost item	Type of scenario	Cost item	Adjustment	Formula	Reference
Preventing cross contamination	2	Labour costs	Check whether allergens are really necessary ingredients, preparation of allergenic food at final stage and at another countertop	Labour wage per hour * # hours	(Huggett and Hischenhuber 1998, Jackson et al. 2008)
Preventing cross contamination	2	Labour costs + extra material	Place all bread together on a table to prevent gluten cross-contamination	Labour wage per hour * # hours +Table	(Deibel et al. 1997)
Preventing cross contamination	2	Separate allergenic-raw materials and extra material	Using clean and marked lidded containers for allergenic ingredients	Labour wage per hour * # hours + 7 containers + 7 lids	(Huggett and Hischenhuber 1998)
Traceability throughout chain	1	Update product specifications in the MMS	Updated product specifications and allergen information if suppliers change recipe	Labour wage per hour * # hours	(Mortimore and Wallace 1998)
Information provision	1	Design of the menu cards at each food item in English and Dutch	Specifically making menu cards informing which allergens are present at specific meals including symbols	Labour wage per hour * # hours + Cost of menu cards* # extra menu cards * # days a month	(Gilissen, Gao, and Chen 2012)
Training	1	Training given by external agency on the site	Training for regular staff how to clean utensils and equipment to avoid cross-contamination	Training + gasoline * # kilometres	(Consultancy 2013c, Gilissen et al. 2006)
Training	1	Labour costs	Viewing the movie to improve consciousness about food allergens (free or paid version)	# of Employees * Labour wage per hour * # hours	(Burgman 2014)
Training	2	Costs of ordering the movie	Movie Part 2: cross contamination	Movie	(Consultancy 2013b)
Validation and verification	2	Extra labour to perform allergen focused audit	Extend the attention paid to allergens during audit	Labour wage per hour * # hours	(Jackson et al. 2008)
Validation and verification	2	Test equipment (e.g. swab tests)	Perform swab tests to check quantitative amount of allergens	Costs of swab tests * # tests per month	(Lampidonis and Siragakis 2013)
Validation and verification	2	Cost of analysing per surface/sample	Perform swab tests to check quantitative amount of allergens	Labour wage per hour * # hours	(Burgman 2014)

Table 6: Input for the partial budgeting analysis: variable cost items

Cost item	Type of scenario	Cost item	Adjustment	Formula	Reference
Preventing cross contamination	2	Cleaning disinfectant	Cleaning disinfectant	Fixed # cleaning disinfectant + # meals *Costs of cleaning disinfectant per meal	(Burgman 2014)(Callsfacilitair 2014
Preventing cross contamination	2	Labour costs	Extra cleaning of equipment and surfaces	Costs per extra meal *#meals * labour wage per hour * # hours	(Burgman 2014)
Preventing cross contamination	2	Labour costs	Extra time due to change of place of food preparation, allergenic food at final stage and prepared at another countertop	Costs per extra meal *#meals * Labour wage per hour * # hours	(Burgman 2014)
Information provision	1	Labour costs	Central dietician who provides allergen information to staff at all departments on request	Amount of questions *#meals * labour wage per hour * # hours * # days per month	(Buuren 2014)
Validation and verification	1	Claim*	Increased chance of a claim	Risk of having a food allergy * risk that a consumer gets a reaction * # meals * average costs of claim * risk of getting a claim	(Rona et al. 2007, Niestijl Jansen et al. 1994, Versluis 2012)

*all cost items are stochastic, except for ‘claim’, which has an exponential distribution.

Table 7: Input for the partial budgeting analysis: benefit items

Category	Type of scenario	Benefit item*	Adjustment	Formula
Extra returns	1	WTP_1‡	Provide information about allergens	Average WTP meal * average price of meal * # meals * WTP_1 per month* # days per month
Extra returns	1	Willingness to patronize‡	Provide information about allergens	% revenue per meal * average costs of meal * Expected extra meals * willingness to patronize per month
Extra returns	2	WTP_2‡	Including prevention of cross-contamination	Increase in WTP in % scenario two * Average WTP meal * WTP_1 per month * average price of meal * # meals
Extra returns	2	Willingness to patronize‡	Including prevention of cross-contamination	% revenue per meal * average costs of meal * Expected extra meals * willingness to patronize per month
Reduced costs	2	Chance that something wrong†	Reduced chance of a claim	Risk of getting a reaction * risk of having a food allergy * risk that a consumer gets a reaction due to the food * # meals * average costs of claim * risk of getting a claim * reduced risk due to preventing cross contamination

*The WTP has a RiskExtvalue distribution and the willingness to patronize has a RiskPareto distribution.

Source: ‡ (Questionnaire 2013), †: (Buuren 2014, Burgman 2014).

Table 8: General input values of the model

Input	Value (mean)	Description of input value	Reference
Cleaning spray	€ 6.15	=RiskTriang(4.61,6.15,7.69,RiskStatic(6.15)). 2 L of the Alcoclean Exotica allesreiniger 12x1 L. 2/12*36.9=6.15. variation between 1.5 till 2.5 L	(Callsfacilitair 2014)
Amount of questions	1/150	Estimated that there will be 1 question per 150 persons	(Burgman 2014)
	0.8	=RiskTriang(0.5,0.8,1,RiskStatic(0.8)). Chance that people claim when they got a reaction	(Burgman 2014, Buuren 2014)
Risk of getting a reaction	0.012	=RiskDiscrete(0,1),(0.988,0.012): Average risk of getting a reaction (Assumed that the person gets 2 reactions per year, 60% outdoors and eats 285 times a year outdoors (2/(0.6*285=0.012).	(Rona et al. 2007, Niestijl Jansen et al. 1994, Versluis 2012)
Risk of having a food allergy	0.1886	=RiskTriang(0.16,0.186,0.2,RiskStatic(0.1886),RiskCorrmat(Costsofclaim,4)). # people having a food adverse reaction, according to survey RIKILT and Students and literature studies	(Questionnaire 2013, McBride et al. 2012)
Average costs of claim	€ 5000	=RiskExpon(500,RiskShift(5000),RiskStatic(5000)). Exponential distribution with average 5000	(Buuren 2014)
Extra meals sold per month	0.70	Total extra meals sold per person per month = 122 (total extra meals sold per month) / 176 (total people filled in questionnaire).	(Questionnaire 2013)
Costs of cleaning disinfectant per meal	€ 0.002	=6.15/3225 (costs of 2 L cleaning spray per months, divided by number of meals per months	(Burgman 2014)
Labour wage per hour	€ 36.67	Labour wage per hour high	(Statistiek 2013)
Labour wage per hour	€ 25.05	Labour wage per hour average; gross wage Horeca and gross wage Horeca managers: (€21.13+ €28.97)/2=€25.05	(Statistiek 2013)
Labour wage per hour Auditor	€ 44.60	(Gross wage (€26,76*1.6)= €44.60 and 2 hours per audit (=2/ 12 months)	(Statistiek 2013)
Relative increase from WTP_1 to WTP_2	1.63	Increase in WTP scenario two (3.1%/1.9%) according to results of Sodexo sample.	(Questionnaire 2013)
Extra meals sold per month	3.09	=RiskPareto(1.0136,1,RiskTruncateP(0,95%) Extra meals per months for people with a willingness to patronize	(Questionnaire 2013)
# meals	150	=RiskTriang(120,150,200,RiskStatic(150))	(Burgman 2014)
# menu cards	10		(Burgman 2014)
# days per month	21.5	Opened days per month	(Questionnaire 2013)

New Employees per month	0.08	Assumed that there is 1 new employee per year (1/12)	(Questionnaire 2013)
Revenue per meal	25%		(Burgman 2014)
Price per meal	€ 4.16		(Questionnaire 2013)
WTP_1 per meal	0.51	=RiskExtvalue(0.4315,0.19107,RiskTruncateP(0,95%) Based on the respondents indicating a WTP_1	(Questionnaire 2013)
WTP_1	0.30	=RiskDiscrete({0,1},{0.7,0.3}), meaning 30% of respondents showed a WTP	(Questionnaire 2013)
Willingness to patronize for provision of food allergen information	0.11	=RiskDiscrete({0,1},{0.89,0.11}) meaning 11% of respondents showed a willingness to patronize for provision of food allergen information	(Questionnaire 2013)
Reduced risk	0.50	Reduced risk due to prevention of cross contamination	(Burgman 2014)
Lidded containers	€32.73	Necessary for peanuts, soybeans, milk, nuts, celery, sesame and mustard. + €27.5 + 19% Tax: €32.725	(BV 2013)
Lids for existing containers	€25.00	Lids for covering food in different types according to size (RVS)	(Horeca 2013b)
Table	€116.10	'Economy' table	(Horeca 2013a)
Training	€508.35	Allergenscan Horeca (395 € + 21% Tax) €477.95 + 30.40 (40km *2 *0.38= 30.40) =477.95 + 30.40	(Consultancy 2013c)
Costs of movie	€250.00	Movie about cross contamination	(Consultancy 2013c, b)
Swab tests	€11.95	Swab test (17: gluten, peanut, milk, egg, soy, crustaceans, lupine, mustard, sesame, and nuts including hazelnut, cashew, soy, walnut, paranut, pistachio, macadamia and almond.	(Consultancy 2013c, a)
# Hours to update MMS	50	=RiskTriang(40,50,60,RiskStatic(50)). Based on 50 hours, but can vary between 40 and 60 hours	(Buuren 2014) (Burgman 2014)

3.2 Questionnaire to quantify the benefit items

Benefits of providing food allergen information for on-premise catering businesses are difficult to quantify since benefit items are mainly intangible and no previous study does exist. Therefore, a questionnaire was developed to identify the benefits under the two scenarios. A questionnaire was used, because this is a relatively cost effective and time efficient method, and gives a good estimation of individual levels (Breidert, Hahsler, and Reutterer 2006). The questionnaire was sent to three samples. These samples consisted of students at WUR, Employees of the Institute of Food Safety of Wageningen UR (RIKILT) and Employees of Sodexo department in Nieuwegein and Rotterdam. The student sample consisted of Wageningen University students enrolled in the bachelor Food Technology, together with the masters Food Safety, Food Quality Management, and Food Technology. RIKILT Employees and students of the WUR were chosen for this study, because they represent a large part of the market of the RotF. Moreover, the Sodexo group was included to determine the benefits at another catering business and these results were used for the predictive model as described under section 3.3. The sample numbers and response rates are shown in table 9.

Table 9: Overview of response rate

Samples	Total individuals[5]	# Respondents	Response rate
Students	898	132	15%
RIKILT	200	42	21%
Sodexo	280	129	46%
Total	1378	303	22%

The questionnaire was developed in English and Dutch to prevent linguistic misunderstandings. The first two groups received an English version of the questionnaire, whereas a Dutch version was sent to the Employees of Sodexo. The questionnaire was sent through esurv.org, a platform for online questionnaires.

The questionnaire consisted of 24 questions, divided into four main categories:

- The demographics of the respondent (income, sex, education, age, profession, and size of household)
- Perceived importance of food attributes (price, taste, nutrition value, etc.)

5 Total number of individuals who received the survey

- Experience of one or more food adverse reactions by the respondent and whether relatives/siblings/colleagues of the respondent experience food adverse reactions
- How much the respondent spends for a lunch meal at an eatery
- Whether the respondent is willing to pay extra for food[6] (in %) and willing to patronize [7] when the catering business provides more information about allergens (and when allergen free food is provided).

Predefined options of the WTP (in % of the average amount spend to lunch) were given, as it leads to more valid WTP values than the open-ended approach (Donaldson, Thomas, and Torgerson 1997). The total questionnaire as given to the samples is shown in appendix 3.

The benefits for the partial budgeting analysis were quantified by the result of the Wageningen samples, since these results give a good representation of an average catering business (the restaurant of the Future). One sample was an outlier as it showed a very high WTP_1 and was therefore deleted. Discrete distributions were created to indicate the percentage of the samples with a WTP_1 and willingness to patronize. Then, for the samples indicating a WTP_1 and willingness to patronize, distributions were determined by @Risk and were included in the PBA. The benefit items were converted to the number of meals sold per day (n=150) and multiplied with the days per month. The willingness to patronize was multiplied with the revenue per meal (=25%) to estimate the total revenue due to extra meals sold.

The questionnaire for the Wageningen sample (the English version) included one question about the willingness to patronize and WTP_1. The respondents of the Sodexo samples also answered the questions about the willingness to $patronize_2$ and WTP_2. Therefore, these answers were used to extrapolate it to determine the WTP_2 of the Wageningen samples. This was done by multiplying the WTP_1 of the Wageningen sample by the relative increase of WTP_1 to WTP_2 of the Sodexo sample, as illustrated in equation four.

6 The exact formulation of the question was: ‘Assume you order a regular lunch at a restaurant/ bakery/canteen. How much more (in percentage, above the price indicated in the previous question) would you be willing to pay for a meal at an eatery where menu cards indicating all allergens are provided? (If you never buy a meal at an eatery, assume a price of € 5,00’.

7 The exact formulation of the Dutch question was: ‘Indien het bedrijfsrestaurant van Sodexo meer allergeneninformatie verstrekt en je nu niet dagelijks gebruik maakt van het restaurant, zou je dan bereid zijn om er vaker te lunchen?’

$$\boldsymbol{WTP2\ Wageningen = \frac{WTP2\ Sodexo}{WTP1\ Sodexo} * WTP1\ Wageningen} \qquad \textbf{(4)}$$

The extrapolation of the answers indicating the willingness to patronize under scenario two was not possible, since almost all respondents already lunch every day in the on-premise catering business.

Distributions of the results of the benefit items were determined by using @Risk 6.1. The distributions were selected based on the Akaike Information Criterion (AIC), which is a means for model selection (Posada and Buckley 2004). The lower the AIC value, the better the distribution fits.

3.3 Method to build a predictive model for willingness to pay and willingness to patronize

Demographics, and especially socioeconomic status affect the WTP (Keith, Haddon, and Birch 2000). Therefore, a predictive model has been built to predict which demographic characteristics significantly influence the WTP_1 and willingness to patronize. Therefore, an econometric analysis has been performed to assess which affect demographic factors have on the WTP_1 and willingness to patronize. Demographics of the three different samples were presented and described with the use of IBM SPSS Statistics 19 for windows version.

All samples with missing data points were deleted. For the demographics income, education, and profession; answer options were merged to reduce confounding effects. Linear regression was performed by SPSS v. 19 with WTP_1 and willingness to patronize as predictive output[8]. The predictive model was build up as shown in equation five.

$$\boldsymbol{Yi = B0 + B1X1i + B2X2i} \qquad \textbf{(5)}$$

Yi =Predicted variable (dependent variable)

B0 = intercept

B1 and B2 =slope

X1 and X2= independent variables

8 For each demographic question, one (the least significant factor) was excluded, which were the following items: Income between € 2000,- and € 2500,-; Education: Primary school; Profession: PhD student; Age 40-46 years; Ethnicity: Black; Living with partner

4. Results

4.1 Critical control points and necessary adaptations at the Restaurant of the Future

This section covers the adaptations based on a literature review of existing food allergen models, the necessary adaptations according to the FIC regulation, critical inspection of a catering business, and the judgments of experts (the general quality manager together with the manager of the catering business). These necessary adaptations are divided into fixed (independent on the number of meals) and variable (dependent on the number of meals) items.

4.1.1 Level 1: Prevention of cross contamination

Fixed items

Food allergens like nuts, peanuts and gluten containing raw ingredient should be stored separately in marked lidded containers to prevent cross contamination. Moreover, meals containing allergens should be prepared at the end. Besides this, recipes of meals should be reviewed to see if allergenic ingredients are truly functional in the meal. If this is not the case, an equivalent non-allergenic ingredient can be used (Crevel 2005). Finally, the serving place should be designed in such a way that the possibility of cross contamination is minimized, for example by putting all similar meals (like bread) together.

Variable items

Extra working hours due to cleaning equipment and surfaces are necessary to prevent cross contamination. In addition, extra cleaning products will result in extra costs.

4.1.1.1 Swab tests at critical control points to detect the state of cross contamination

Several critical control points for gluten were detected, which mostly tested positive (see appendix 4, 5, 6 and 7 for details). Results of the dipsticks at baseline measurement showed that the gluten free soup contained gluten, even after diluting the sample 195 times. At the second measurement (after giving instructions and increasing awareness) it seemed that the head-cook used a different cooking cream as compared to the gluten free soup produced at 25/2/2014.

After the instructions (consisting of information about separating the preparation of gluten free meals with the gluten containing meals and the importance of extra cleaning), less gluten residues were detected (see appendix 4 and 6). However, since regulations allow gluten levels up to 20 PPM and the detection limit is 3 PPM, some points might still be in the safe zone. Both the control and the sample with disinfectants tests were positive at a known amount of gluten and peanut. Therefore, the results of the experiment to check for interaction with disinfectants showed that disinfectants did not have an effect on the detection limit of the gluten test.

4.1.2 Level 2: Traceability

Fixed items

Product specifications from the suppliers have to be updated regularly, especially when recipe of the supplier and/or the recipe of the catering business changes. This is an important aspect of traceability which has to be improved, since product specifications help to determine which ingredients including food allergens are in the final meal (Kerbach et al. 2009).

4.1.3 Level 3: Information provision

Fixed items

The menu management system has to be updated with all product specification, in such a way that allergen information is readily accessible. Moreover, the RotF could make use of symbols in menu cards in order to communicate in a clear way and to prevent linguistic misunderstandings, which is especially useful for international consumers.

Variable items

A dietician can answer specific questions of consumers about allergens by phone on a national level. In this way, consistent allergen information can be given. This is a variable cost item as it is dependent on the number of consumers (and thus amount of questions asked) at the catering business.

4.1.4 Level 4: Training

Fixed items

Staff should be trained, to create awareness of risk of allergens and to understand how to avoid cross contamination.

4.1.5 Level 5: Validation and verification

Fixed items

A validation of the absence of allergens can be performed by swab tests. Action levels can be used to determine the quantity of allergens in the meals. Moreover, internal and external audits are necessary to verify whether allergen risk management is working properly.

Variable items

The risk of a claim should be reduced as much as possible to prevent high costs due to claims.

4.2 Partial budgeting approach

The costs (disadvantages) and benefits (advantages) items were classified using the partial budgeting approach under three scenarios, represented by table 10, 11 and 12. These tables are made according to expert judgments. The baseline scenario indicates the current state, which means that no adaptations will be performed.

Table 10: Partial budgeting scheme of baseline scenario

Advantages	Disadvantages
No adaptation costs	Risk of high lawsuit
-	Loss of revenue: loss of people going to RotF, Loss of image

Table 11: Partial budgeting scheme of scenario one

Advantages	Disadvantages
Reduced risk of claim*	Costs of updating the product specifications and MMS, Menu cards, training and dietician providing allergen information
Increased WTP_1 Increased willingness to patronize	-

Table 12: Partial budgeting scheme of scenario two

Advantages	Disadvantages
Reduced risk of claim*	Costs for cleaning, change of food preparation, separation of raw materials + meal serving, swab tests, and extension of audits *.
Increased WTP_2 Increased willingness to patronize	-

*costs shown under disadvantages in scenario one (table 11) are also included in scenario two.

4.3 Fixed and variable cost items

The cost items consist of the relevant necessary adaptations under the two scenarios, based on fixed and variable costs. The total fixed costs in scenario one are € 2766 per year and the total fixed costs in scenario two is € 3976 per year. Details of the fixed and variable cost items are shown in table 13 and 14.

Table 13: Results of the fixed cost items

Level of cost item	Scenario	Fixed cost item	Costs per year (mean)	Costs per month (mean)	# hours	Labour wage per hour
1	2	Labour costs due to food preparation	€ 73	€ 6	1	€ 36.67
1	2	Labour costs for food preparation and extra material (table)	€ 166	€ 14	0.5	€ 36.67
1	2	Separate allergenic- raw materials and extra material (Coloured lidded containers)	€ 422	€ 35	0.5	€ 36.67
2	1	Update product specifications and allergen information in case suppliers change recipe	€ 73	€ 6	2	€ 36.67
3	1	Update information about allergen in meals based on action levels*	€ 1,834	€ 153	50	€ 36.67
3	1	Design of the menu cards at each food item in English and Dutch	€ 199	€ 17	5	€ 36.67
4	1	Training given by external agency on the site	€ 508	€ 42		
4	1	Viewing the movie by Employees	€ 150	€ 13	2	€ 25.05
4	2	Costs of ordering the movie	€ 250	€ 21		
5	2	Extra labour to perform audit with a focus on allergens	€ 22	€ 2	0.17	€ 44.60
5	2	Test equipment (e.g. swab tests)	€ 203	€ 17		
5	2	Cost of analysing per surface/sample	€ 73	€ 6	2	€ 36.67
		Total fixed costs of scenario one	€ 2,765	€ 230		
		Total fixed costs of scenario two	€ 3,976	€ 331		

* The item 'Update information about allergen in meals based on action levels has a triangular distribution with minimum of 40 hours (€ 123, - per month), most likely 50 hours (€153, - per month), and maximum 60 hours (€183, - per month).

Assuming that 150 meals are sold per day, the total variable costs in scenario one are estimated to be € 206. The total variable costs in scenario two are estimated to be € 342 (see table 14). Moreover, the total costs per month are based on the assumption that fixed costs are covered within one year.

Table 14: Results of the variable cost items

Level of Cost item	Type of scenario	Variable cost item	Costs per month (mean)	Minimum	Maximum	# hours per month	Labour wage per hour
1	2	Cleaning disinfectant	€ 6	€ 5	€ 8		
1	2	Extra cleaning	€ 125	€ 101	€ 166	€ 10.00	€25.05
1	2	Extra labour due to food preparation	€ 4	€ 3	€ 6		
3	1	Dietician for allergen information	€ 197	€ 159	€ 262	€ 0.25	€36.67
5	1	Claim*	€ 9	€ 0	€ 1,023		
		Total variable costs of scenario one	€ 206	€ 159	€ 1,647		
		Total variable costs of scenario two	€ 342	€ 268	€ 1,818		

*The item 'claim' has an exponential distribution, whereas all other variable cost items have a triangular distribution.

4.4 Benefit items: results of the questionnaire

4.4.1 Demographics of the samples

The Wageningen respondents indicated that the most important food attributes were price (27%), taste (23%), and expiration date (19%). The attribute "list of ingredients in the food product (e.g. nuts)", was important for 7% of the respondents. 19% of the respondents experience adverse reactions to food, most of them being allergic to lactose (31%), (shell) fish or crustaceans (17%), gluten (14%), tree nuts (14%), and peanuts (6%). Moreover, 75% of the respondents have a colleague/sibling/family member who experiences adverse reactions to food.

21% of the respondents have bought lunch at the RotF in Wageningen in the last three months. Reasons to not eat at the RotF were: the food is too expensive (34%); restaurant is too far away

(26%); not having enough time at the lunch break (30%); not enough product information (3%). Interestingly, 44% of the respondents wrote that they were not aware of the existence and/or the possibility to order meals at the RotF.

The demographics of the three study samples are shown in table 15. The student sample has a lower income compared to the RIKILT and Sodexo sample. Education was similar for the three samples. The study/profession highly differed between the three samples whereas all students were either Bachelor or Master, at RIKILT there were solely PhD students, researchers, staff members, and professional Employees, and the whole Sodexo sample was not affiliated with WUR. Most respondents were Caucasian (80% of respondents in the Wageningen sample, 97% of respondents from Sodexo). The student respondents mainly consisted of women (73%), whereas the gender of the Sodexo and RIKILT respondents were more evenly distributed (45% and 55% women, respectively). 83% of the student sample was between 18 and 25 years. Age was more evenly distributed in the Sodexo and RIKILT samples. Finally, the living situation of students was mainly with roommates, whereas for RIKILT it was mainly with only a partner, and for Sodexo it was with partner with one or more children.

Table 15: Demographics of the samples

	Students		RIKILT		Sodexo		Total	
	%	number	%	number	%	number	%	number
Having a FAV*	19.85	26	12.82	5	13.60	17	16.03	48
Having a relative with FAV*	80.00	104	61.54	26	53.33	63	67.50	193
Income								
Less than € 500	48.85	64	2.7	1	0	0	17.18	75
Between € 500 and € 1000	46.56	61	8.11	3	8.20	10	20.96	81
Between € 1000 and € 1500	4.58	6	2.7	1	13.93	17	7.07	58
Between € 1500 and € 2000	0	0	35.14	13	41.80	51	25.65	47
Between € 2000 and € 2500	0	0	24.32	9	27.86	34	17.40	19
More than € 2500	0	0	27.03	10	8.19	10	11.74	20
Total	99.99	131.00	100.00	37.00	100.00	122.00	100.00	300.00
Education								
Primary school	0	0	0	0	1.6	2	0.53	2
Secondary school	32.58	43	2.56	1	6.4	8	13.85	52
Professional degree (MBO/HBO)	5.3	7	17.95	7	83.2	104	35.48	118
Bachelor degree	52.27	69	15.38	6	0	0	22.55	75
Master's degree	9.85	13	30.77	12	8.8	11	16.47	36
PHD	0	0	33.33	13	0	0	11.11	13
Total	100.00	132.00	99.99	39.00	100.00	125.00	100.00	296.00
Profession								
Bachelor student	34.85	46	0	0	0	0	11.62	46
Master student	65.15	86	0	0	0	0	21.72	46
PhD student	0	0	12.82	5	0	0	4.27	5
Postdoc / Researcher	0	0	46.15	18	0	0	15.38	18
Faculty / Staff Member	0	0	33.33	13	0	0	11.11	138
Professional (not affiliated with WUR)	0	0	7.69	3	100	125	35.90	128
Total	100.00	132.00	99.99	39.00	100.00	125.00	100.00	171

Ethnicity								
Asian	16.79	22	10.53	4	1.62	2	9.65	28
Middle eastern	0	0	2.63	1	0	0	0.88	1
Caucasian**	77.86	102	84.21	32	96.81	119	86.29	253
Hispanic and Latino	3.82	5	2.63	1	1.06	1	2.50	7
Black	1.53	2	2.63	1	1.06	1	1.74	4
Total	100.00	131.00	102.63	39.00	100.56	123.00	101.06	293.00
Gender								
Male	27.27	36	44.74	17	55.28	68	42.43	121
Female	72.73	96	55.26	21	44.71	55	57.57	172
Total	100.00	132.00	100.00	38.00	100.00	123.00	100.00	293.00
Age								
18-25 years	83.33	110	10.26	4	1.59	2	31.73	116
26-32 years	16.67	22	25.64	10	9.52	12	17.28	44
33-39 years	0	0	15.38	6	22.22	28	12.53	34
40-46 years	0	0	12.82	5	25.40	32	12.74	37
47-53 years	0	0	15.38	6	26.98	34	14.12	40
54-61 years	0	0	15.38	6	11.90	15	9.09	21
62+ years	0	0	5.13	2	2.38	3	2.50	5
Total	100.00	132.00	99.99	39.00	100.00	126.00	100.00	297.00
Living situation								
Live alone	34.85	46	7.89	3	10.66	13	17.80	62
With parents / siblings / relatives	2.27	3	2.63	1	0.82	1	1.91	5
With roommates	49.24	65	13.16	5	0.82	1	21.07	71
With partner	13.64	18	42.11	16	26.23	32	27.33	66
With partner + 1 or more children	0	0	34.21	13	58.20	71	30.80	84
Without partner + 1 or more children	0	0	0	0	3.28	4	1.09	4
Total	100.00	132.00	100.00	38.00	100.00	122.00	100.00	292.00

* FAV= Food adverse reaction, **= (includes Europe, western Asia, parts of India and North Africa).

4.4.2 Results of willingness to pay under scenario one amongst Wageningen respondents

52 out of 173 (30%) respondents of Wageningen indicated to be willing to pay extra for a meal at an eatery where allergens information is provided in menu cards (see figure 5). On average, these respondents were willing to pay 4.2% extra, or € 0.17 extra per meal (4.2%* € 4.16= 0.17). As it is assumed that on average 150 meals are sold per day, providing food allergen information will result in an extra revenue of € 25.24 daily (€ 0.17*150= 25.24) which will result in a monthly revenue of circa € 543 (€ 25 * 21.5 days= 543).

	Response (%)	Responses
Nothing	69.36	120
10%	21.97	38
20%	5.78	10
30%	2.89	5
40%	0.00	0
More than 40%	0.00	0
	Answered Question	173
	Skipped Question	3

Figure 4: Willingness to pay under scenario one amongst Wageningen respondents

Source: (Questionnaire 2013).

The WTP$_1$ was plotted by @RISK, with a RiskExtvalue distribution. Since the upper percentiles gave unrealistic high numbers, the tail was truncated at the 95% (see figure 5).

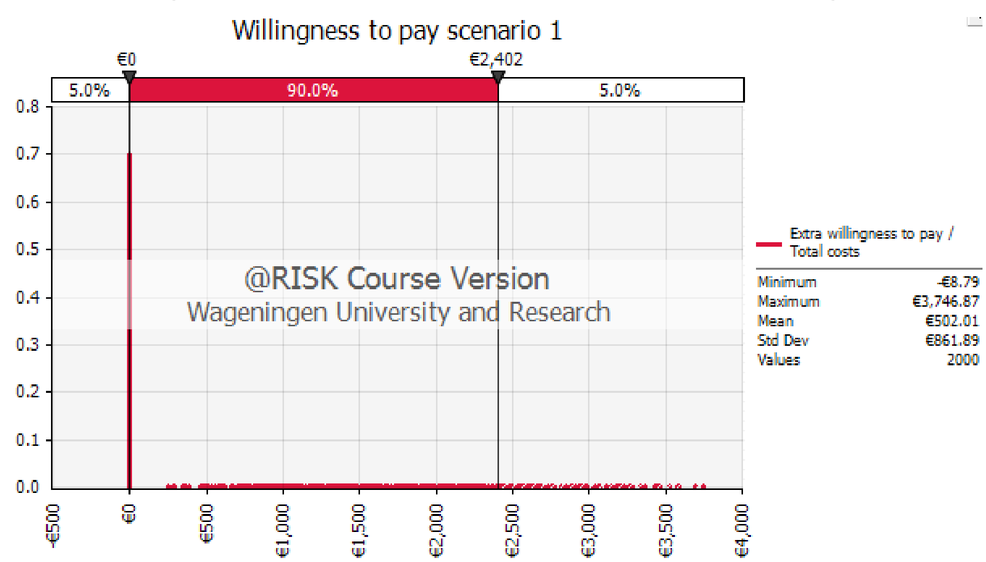

Figure 5: The distribution of willingness to pay under scenario one amongst Wageningen respondents

4.4.3 Results of willingness to patronize under scenario one amongst Wageningen respondents

29 out of the 176 Wageningen respondents were willing to patronize the RotF if more information on allergens was provided to them (see figure 6), which is 16% of the respondents.

	Response (%)	Responses
Every day	6.90	2
Twice-a week	17.24	5
Once a week	20.69	6
Twice a month	24.14	7
Once a month	31.03	9
	Answered Question	29
	Skipped Question	147

Figure 6: Willingness to patronize under scenario one amongst Wageningen respondents

Source: (Questionnaire 2013).

In total, these respondents are willing to buy 122 extra meals per month. Assuming that 150 persons purchase meals at the RotF each day, it can be expected that in total (150/176*122= 105) 105 additional meals will be sold per month. An average meal costs €4.16 and the profit of the catering business is estimated to be 25%. Therefore, the extra meals sold lead to an extra profit (105 meals * 4.16* 0.25%= 109) €109 per month. The distribution for the respondents willing to patronize the RotF if additional information is provided to them was identified by fit ranking performed by @RISK. The RiskPareto distribution showed the highest AIC value. Truncation limit was added and set at 95%.

4.4.4 Results of benefit items in scenario two

The questionnaire for the Sodexo sample included two questions about the willingness to pay, namely the WTP_1 and WTP_2. The percentages of WTP_1 were summarized and divided by the number of respondents to determine the average WTP_1. The percentage of respondents indicating a WTP_1 was: (15*10%+ 3*20%+ 1*30%=) 240. (240/126 respondents=) 1.9%.

The WTP_2 was: (16*10%+ 3*20%+ 2*30%+ 1*40%=) 320. (320/103 respondents=) 3.1%. This means that the average willingness to pay for allergen free food is 3.1%. Therefore, the relative increase of WTP_2 compared to WTP_1 is (3.1%/1.9% =) 1.63. The Sodexo sample was not used for the cost-benefit analysis and WTP_2 was not asked amongst Wageningen sample. Therefore, the WTP_1 of Wageningen sample was multiplied by 1.63 to estimate the WTP_2 of the Wageningen sample.

The data of the willingness to patronize of the Sodexo sample was not be extrapolated to the Wageningen sample It has been assumed that the willingness to patronize under scenario one is equal to willingness to patronize under scenario two, since 82% of the Sodexo sample already had lunch every day in the catering business of their workplace and thus could not be increased.

Moreover, due to the reduced cross contamination, the risk of getting a claim can also be reduced. Based on expert judgments and the results of the swab tests, it was assumed that 50% of the detected critical control points can be reduced to levels below detection limit. Therefore, the reduced costs for a claim are 50% of the original costs. An overview of all benefits can be found in table 16.

Table 16: Results of the benefit items

Benefit item	Type of scenario	Benefit item	Benefits (Mean)	Minimum	Maximum
Extra returns	1	WTP_1*	€ 491	€-	€ 3,966
Extra returns	1	Willingness to patronize*	€ 53	€-	€ 3,001
Extra returns	2	WTP_2*	€ 800	€-	€ 6,192
Extra returns	2	Willingness to patronize*	€ 53	€-	€ 3,001
Reduced costs	2	Chance that something goes wrong by also taking cross contamination into account: New probability of an error including cross contamination†	€ 5	€-	€ 625
		Benefits of scenario one	€ 544	€-	€ 5,972
		Benefits of scenario two	€ 858	€-	€ 7,844

Source: *: (Questionnaire 2013), †: (Buuren 2014, Burgman 2014).

4.5 Partial budgeting analysis and break-even point

Table 17 shows the simulated average monthly profit under the two scenarios. Appendix 8 shows the distribution of the costs minus the benefits under the simulated scenarios. Results show that both scenarios are profitable.

Table 17: Profit under the two scenarios

Description	Mean	Minimum	Maximum
Total costs in the first month for scenario one	€ 437	€ 370	€ 1,543
Total costs in the first month for scenario two	€ 673	€ 580	€ 1,964
Benefits of scenario one	€ 544	€ 0	€ 5,972
Benefits of scenario two	€ 858	€ 0	€ 7,844
Profit scenario one	€ 108	€ -1,462	€ 5,521
Profit scenario two	€ 185	€ -1,204	€ 7,132

The total fixed costs in scenario one are estimated to be € 2765, and benefits minus variable costs are € 342. This means that the break-even point is (2765/342=) 8.1 months. The total fixed costs in scenario two are estimated to be € 3976, and benefits minus variable costs are € 516. This means the break-even point is at (3976/516=) 7.7 months. After nine months, scenario one is profitable while scenario two becomes profitable after 8 months (see figure 7).

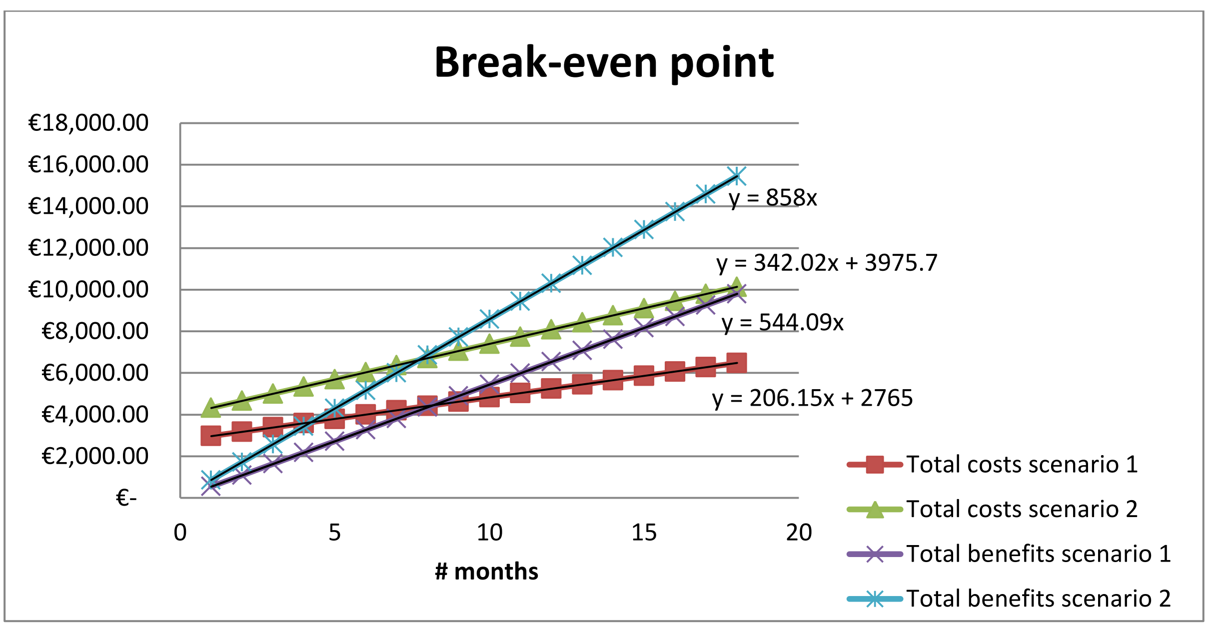

Figure 7: Total costs and benefits under two scenarios

4.6 Predictive model for willingness to pay and willingness to patronize

The results of the three samples were used to predict which individuals with corresponding demographics have a significant influence on the WTP_1 and willingness to patronize. The predictive models are shown in equation 6 and 7. Details of the modelling can be found in figure 8 and 9.

$$\boldsymbol{WTP}1 = \mathbf{0.114} + \mathbf{0.542}\, \boldsymbol{Glut} + \mathbf{0.080}\, \boldsymbol{LAlone} - \mathbf{0.075}\, \boldsymbol{Prof} - \mathbf{0.085}\, \boldsymbol{Income}\mathbf{2500} + \mathbf{0.192}\, \boldsymbol{LRelatives} \quad \mathbf{(6)}$$

Glut = Respondent is allergic to gluten (1=Yes, 2= No)

LAlone = Respondent lives alone (1=Yes, 2= No)

Prof = Respondent's profession not affiliated with WUR (1=Yes, 2= No)

LRelatives = Living together with parents/siblings/relatives (1=Yes, 2= No)

Income2500= Income more than 2500 (1=Yes, 2= No)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.473[a]	.224	.208	.210

a. Predictors: (Constant), Withparentssiblingsrelatives, Sulphurdioxide, IncomeMorethan2500, ProfessionProfessionalnotaffiliatedwithWUR, Livealone, Gluten

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.783	6	.630	14.235	.000[a]
	Residual	13.110	296	.044		
	Total	16.893	302			

a. Predictors: (Constant), Withparentssiblingsrelatives, Sulphurdioxide, IncomeMorethan2500, ProfessionProfessionalnotaffiliatedwithWUR, Livealone, Gluten
b. Dependent Variable: Extra WTP monetary value

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.114	.019		6.034	.000
	Gluten	.542	.091	.320	5.980	.000
	Livealone	.080	.031	.138	2.604	.010
	Profession Professionalnotaffiliatedw ithWUR	-.075	.025	-.156	-2.961	.003
	IncomeMorethan2500	-.085	.049	-.089	-1.740	.083
	Sulphurdioxide	.185	.126	.078	1.463	.144
	Withparentssiblingsrelativ es	.192	.097	.104	1.984	.048

a. Dependent Variable: Extra WTP monetary value

Figure 8: Details of predictive model for willingness to pay under scenario one

As shown in equation six, the R squared is 0.224, which is the coefficient of determination is a statistical measure of how well the regression line approximates the real data points. The WTP_1 is mostly dependent on whether individuals are allergic to gluten. Moreover, when respondents live alone or living with parents/siblings/relative, they indicate a higher WTP_1 and willingness to patronize. Finally, it is shown that individuals who are not affiliated with WUR and individuals who have an income higher than €2500, - indicate a lower WTP_1.

$$\boldsymbol{Willingness\ to\ patronize = 0.958 + 20.54\ SecSchool + 6.542\ Live\ with\ Oth + 4.417\ Live\ with\ childr + 7.052\ Shellf + 7.475\ Lactose} \quad \textbf{(7)}$$

SecSchool = Highest Education completed is secondary school (1=Yes, 2= No)

Lrelatives= Living with parents siblings and/or relatives (1=Yes, 2= No)

Live with Childr = without partner with one or more children (1=Yes, 2= No)

Shellf= Allergic to Shellfish or Crustaceans (1=Yes, 2= No)

Lactose= Intolerant/allergic to Lactose/milk (1=Yes, 2= No)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.579[a]	.336	.314	4.263

a. Predictors: (Constant), Lactosemilk, EducationSecondaryschool, WithparentsSiblingsRelatives, Withoutpartneroneormorechildren, ShellfishOrCrustaceans

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1432.155	5	286.431	15.758	.000[a]
	Residual	2835.649	156	18.177		
	Total	4267.804	161			

a. Predictors: (Constant), Lactosemilk, EducationSecondaryschool, WithparentsSiblingsRelatives, Withoutpartneroneormorechildren, ShellfishOrCrustaceans
b. Dependent Variable: WTpatronizePersonsperMonth

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.958	.356		2.686	.008
	Education Secondaryschool	20.542	4.278	.313	4.801	.000
	WithparentsSiblings Relatives	6.542	2.487	.172	2.630	.009
	Withoutpartneroneormore children	4.417	2.161	.134	2.044	.043
	ShellfishOrCrustaceans	7.052	2.011	.238	3.506	.001
	Lactosemilk	7.475	1.520	.334	4.919	.000

a. Dependent Variable: WTpatronizePersonsperMonth

Figure 9: Details of the predictive model of the willingness to patronize under scenario one

The R squared of this model is 0.336, which indicates that the predictive model of the willingness to patronize gives a more representative prediction compared to the predictive model of the WTP_1. The willingness to patronize is mainly dependent on the highest education completed. As indicated by equation 7, the willingness to patronize is highest for respondents who have secondary school as their highest education completed. Moreover, individuals are willing to patronize when allergic to shellfish or crustaceans and lactose.

5. Conclusion and discussion

5.1 Conclusion

This study provides insight in the costs and benefits of the provision of food allergen information and allergen free food in an on-premises catering businesses. This study is of importance since it gives insights in the possible effects of the revised version of the Regulation (EU) No 1169/2011 on the provision of food information to consumers (FIC). The results of the PBA can be used for food allergen management decisions. The results show that the mean total costs contributing to the provision of allergen information (scenario one) are lower than the total costs for the provision of allergen information and prevention of cross contamination (scenario two). Furthermore, the results showed that benefits under scenario two were higher compared to scenario two. Results show that the break-even point for scenario one is estimated to be 8.1 months, while for scenario two it is 7.7 months. Therefore, it can be concluded that the change of regulation is economically feasible for the RotF on the long term under both scenarios, with a minor preference for scenario two.

5.2 Discussion

5.2.1 Cost items

Extrapolation of the findings of the current study should be done with care, since conditions in other catering businesses will differ and the cost and benefit items of this study are based on the estimation for one specific catering business. Although the description of cost items will be comparable to other catering businesses, the magnitude of costs will vary according to size of the catering business. In fact, some of these costs show a non-linear relationship with the number of meals served, due to the presence of semi-variable costs only dependent only in part with the number of meals. Cost items are also dependent on the size of the catering business, number of meals sold, and capabilities in the kitchen. Generally, when more meals are sold, the average cost per meal will decrease (economies of scale) (Trogdon et al. 2013). Therefore, before extrapolations of these cost items are made to other catering businesses, it should first be investigated which relationship exists between the increase of meal numbers and the total costs.

5.2.2 Benefit items

The questionnaire was used to determine the benefits (WTP_1 , WTP_2 , and willingness to patronize) since it is relatively cost effective method and gives a good estimation of individual levels, and results can easily be used for prediction (Breidert, Hahsler, and Reutterer 2006). Even though, the

WTP does not always give a good presentation of the real life purchase behaviour (Breidert, Hahsler, and Reutterer 2006, Neill et al. 1994, Johannesson 1997). For example, people who are interested in allergens could be more likely to fill in the questionnaire and could have given a higher WTP_1, WTP_2, and/or willingness to patronize than the average Dutch consumer. Market data was not used due to time limitation, since meals should in that case first be thoroughly tested as mistakes could not be made when consumers are informed that meals are truly allergen free.

The results of the WTP_1 and WTP_2 of the Sodexo samples were extrapolated to obtain an estimation of the WTP_2 for the Wageningen sample, since the first questionnaire only included a question about the WTP_1. However, since the demographics of the samples were different, it should be taken into account that this number might not be truly representative. Moreover, it could not be investigated whether the provision of additional allergen information would result in an increase of willingness to patronize among the Sodexo group because the large majority of respondents already ate at their in-company catering business. Therefore, it was assumed that the willingness to patronize under scenario two is equal to the willingness to patronize under scenario one since results of the Sodexo sample showed no increase in willingness to patronize. However, it should be taken into account that real market data can show a different effect.

The most common reason for not consuming meals outside the household (including RotF) was 'the food is too expensive'. This indicates that although a certain group is willing to pay, some consumers might decide to not patronize at the RotF due to the price increase. Therefore, it should be investigated whether the demand for various foods could be affected after the implementation of the regulation (Andreyeva, Long, and Brownell 2010).

44% of the respondents who do not usually eat at the RotF were not aware that they could purchase meals at this catering business. This indicates that with more marketing, more consumers could be willing to patronize. Moreover, it is expected that catering businesses with a more diverse consumer group (consumers coming from different departments and buildings), like the RotF will gain more profit when providing allergen information and allergen free food compared to an in-company catering businesses. In other words, the RotF is a type of catering business that can possibly gain market since there are potential consumers who are currently not going to the RotF.

Beside the WTP_1 and willingness to patronize, the regulation causes more additional benefits, like the health of the consumer and an increased quality of life. These were not included in the benefit side of the analysis, since the focus was solely on the patronage of catering businesses and not on society as a whole. For (especially food allergic) consumers, the benefits are higher under scenario two. However, it is important to realise that the conclusions are drawn based on the mean values. When looking at the median, it can be concluded that from the 70^{th} percentile onwards, the scenarios become feasible. Policymakers should take this into account. Moreover, they should look at all stakeholders to assess the total impact of decision making due to the upcoming the FIC regulation.

5.2.3. Predictive model

The three samples used for the predictive model might not be a good representation of average Dutch consumer, since these respondents are all (professionally) related to food safety and production of food. Moreover, the respondents within the three groups show quite some homogeneity for the demographics; profession, age, ethnicity, and income.

Most demographics in the predictive model for the WTP_1 were expected, which indicates that the target group for the provision of allergen free food and allergen information is amongst others made by individuals allergic to gluten, shellfish, and lactose. Results showed that an 'income higher than €2500,-'would results in a lower WTP_1, whereas the opposite would have been expected. This can be explained by the fact that there are only twenty samples which indicated to belong to this income category and the significance of the effect of this demographic is 0.083. The R squared value of 0.224 shows that this predictive model only gives a moderate explanation of influencing factors. Therefore, it is possible that the model misinterpreted the effect of this demographic.

It is expected that the benefit items at other types of on-premise catering businesses (like hotels and restaurants) will be higher, since the willingness to patronize will be higher compared to our results based on an in-company catering business.

5.2.4 Swab tests

Most swabbed spots at the RotF were peanut-free. It is known from previous studies that peanut residues are more easily removable by cleaning procedures as compared to gluten (Jackson et al. 2008). Thus, it is unlikely that meals will be cross contaminated by peanut when peanut sauce is made in the RotF as during the days of measurement. Other food allergens like egg residues and fish are also relatively easy to remove by cleaning (Jackson et al. 2008). In contrast, a lot of critical control points showed high gluten levels before and after giving instructions. The unexpected presence of allergens can easily occur, for example, by a minor change in the recipe, as occurred with the gluten free soup containing single cream with gluten. Therefore, small catering businesses who prepare a lot of gluten rich products (like the RotF), should be extra careful with prevention of cross contamination by gluten.

5.3 Suggestions for future research

Once the regulation has come into force, market data can be obtained to assess whether consumers and food businesses have benefitted from the provision of allergen information. The hypothesis to be tested is that the cost and benefit items will increase when catering businesses will provide allergen free food and information, which will result in more revenue for food caterers, as the current study has indicated.

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Appendices

Appendix 1: Action levels (EU-VITAL 2013)

the action levels

	labelling	declaration
action level 1	not required	-
action level 2	required	"contains traces of ..."
action level 3	required as ingredient	"contains ... (as ingredient)"

the action levels
the table shows the declaration of the three action levels

the unit / dimension
mg allergenic substance / kg food [ppm]

EU-VITAL uses three action levels in order to define whether labelling of an allergenic substance is required or not. EU-VITAL uses specific colours for the different action levels: **white, blue** and **red** in order to avoid conflict with traffic light food labelling. The colour is used for better orientation and will not be on the food label.

the values for certain food allergens

allergen	action level 1	action level 2	action level 3
milk	< 50	50 - 500	> 500
egg	< 20	20 - 200	> 200
soy	< 25	25 - 250	> 250
fish	< 100	100 - 1.000	> 1.000
peanut	< 8	8 - 80	> 80
tree nuts	< 10	10 - 100	> 100
sesame	<10	10 - 100	> 100
crustacean	< 10	10 - 100	> 100
gluten [1]	< 20	20 - 200	> 200
celery	< 20	20 - 200	> 200
lupin	< 20	20 - 200	> 200
molluscs	< 20	20 - 200	> 200
mustard	< 20	20 - 200	> 200
SO_2	< 10	10 - 100	> 100

the values
the table shows values for action levels of certain food allergens

the unit / dimension
mg allergenic substance / kg food [ppm]

[1] according Comission regulation (EC) No 41/2009 concerning the composition and labelling of foodstuffs suitable for people intolerant to gluten, according Codex Alimentarius

All values defined in EU-VITAL action levels are based on currently available clinical thresholds for food allergens and practicability in view of food production and analytical technologies. The action levels are open for adjustment to new scientific findings.

Appendix 2: Risk analysis of food allergens (Ward et al. 2010) and allergen control plan (Jackson et al. 2008)

Risk assessment – are allergens in food and/or in handling environment?
· Intentional presence is identified and declared
· Likelihood and extent of unintentional (cross-contact) presence are assessed
Risk management – how to control and assure finished product status?
· Segregation – for storage, handling, packing – through cleaning, scheduling and planning
Risk communication – how to identify product status?
· Product identification and traceability
· Clear declarations of allergen presence

Basic components of ACP	Recommendations and comments
General	1) Form an allergen control team consisting of representatives from manufacturing, quality and regulatory affairs, research and development, engineering, sanitation, and food safety sectors. 2) Conduct a risk assessment to determine the choice of the specific allergen management procedures. 3) Develop an allergen map (allergen process flow diagram) to understand where allergenic ingredients and foods are in a plant and where they are introduced into the process. 4) Develop an ACP specific for each processing facility. 5) Review the ACP regularly and update when necessary.
Segregation of allergenic foods or ingredients during storage, handling, and processing	1) Store allergenic ingredients or products separately to prevent cross-contact. a) Use clean and closed containers. b) Separate storage areas for allergenic and nonallergenic ingredients and/or products. c) Use dedicated pallets and bins. d) Use clearly designated staging areas for allergenic foods and ingredients. 2) Identify allergenic ingredients by a mark or tag (or color code) and isolate them from nonallergenic products in storage. 3) When dedicated processing lines are in close proximity, build physical barriers to separate allergenic and nonallergenic production lines. 4) For production lines with crossover points, prevent allergenic foods from falling onto nonallergenic production lines. 5) Prevent spread of aerosols during processing.
Supplier control programs for ingredients and labels	1) Require ingredient suppliers to have a documented ACP. 2) Require letters from suppliers that guarantee that purchased ingredients are free of undeclared allergens. 3) Audit suppliers on a regular basis to assess the effectiveness of the ACP. 4) Require certificates of analysis from suppliers. 5) Conduct a supplier survey that includes: a) The ACP of the supplier. b) The range of allergenic products produced by the supplier. c) The allergen cleaning program. d) Allergen training records for the supplier. 6) Ensure that allergenic ingredients are shipped in clearly marked, sealed containers and that the containers are not damaged or broken.
Prevention of cross-contact during processing	1) Scheduling of processing runs. a) Schedule long runs of products containing allergenic ingredients to minimize changeovers. b) Segregate allergenic and nonallergenic product production areas, or if this is not possible process nonallergenic foods before allergenic products. c) Schedule sanitation immediately after production of foods containing allergenic ingredients. d) When product design permits, add allergenic ingredients as late in the process as possible. 2) Use of dedicated systems. a) Dedicate processing equipment and lines, if possible, to prevent allergen cross-contact. b) Dedicate tools, containers, and utensils and color code or clearly mark them. c) Minimize reuse of processing and/or cooking media (water or oil). d) Restrict personnel working on processing lines containing allergenic ingredients from working on nonallergenic production lines. 3) Control of rework and work in progress. a) Use color-coded tags to identify and record when reworked products with allergenic ingredients are produced, where they are stored, the products to which they are reworked into, and when these products are added back into the line. b) Use rework containing unique allergenic foods and/or ingredients only in the same formulation (e.g., "like into like" practice) 4) Maintain equipment to ensure that the systems are operating as designed. 5) Design traffic patterns and airflow in the production facility to prevent allergen cross-contact.
Product label review; label and packaging usage and control	1) Ensure that packaged foods regulated under the Federal Food, Drug, and Cosmetic Act that are labeled on or after 1 January 2006 comply with the FALCPA food allergen labeling requirements. 2) Ensure that product specification and formulation changes are reflected immediately on labels. 3) Discard out-of-date labels or packaging in a timely manner. 4) Implement proper inventory control procedures for packaging materials. 5) Implement proper packaging staging control procedures. 6) Educate line personnel on techniques for ensuring that product labels are switched appropriately at product changeover.
Validated allergen cleaning program	1) Construct processing equipment and plant structure with good sanitary features including: a) Ease of cleaning and sanitizing. b) No dead spots that allow accumulation of food. c) Accessibility of equipment for inspection. 2) Parts of the allergen cleaning program to be developed: a) Sanitation standard operating procedures. i) Protocols are clearly written and easy to follow. ii) Define the scope (range of applications, equipment, and products) of the cleaning procedures. iii) Define who is responsible for the cleaning operations. iv) Include detailed cleaning instructions. b) Cleaning validation procedures. i) Protocols are clearly written and easy to follow. ii) Define the intention and scope of validation. iii) Describe the sampling procedures. iv) Define and describe the analytical procedures to be used. v) Define the final acceptance criteria. c) Cleaning verification procedures. i) Protocols are clearly written and easy to follow. ii) Define the intention and scope of verification procedures. iii) Describe the sampling procedures. iv) Define and describe the analytical procedures to be used. v) Define the acceptance criteria. 3) Validate the analytical procedures used to validate and verify cleaning efficacy by the end user. 4) Keep records for cleaning, validation, and verification. 5) Evaluate the allergen cleaning program periodically for effectiveness.
Training	1) Provide general training on allergen awareness and control for all employees at all levels of the company. 2) Provide specific training to employees depending on their job responsibilities.

[a] Summary of published information *(2, 4, 7, 8, 11, 15, 22, 24, 30, 41, 48, 52, 55)* on food ACP. Recommendations and comments were obtained from these sources and from the NCFST Allergen Task Force members.

Appendix 3: Questionnaire

Dear participant my name is Anniek Hoogeveen and I am a MSc Food Safety student at Wageningen University. My Master thesis investigates costs and benefits of allergen free production in a catering company. This survey will help me to understand more of consumers' willingness to pay and demand for information regarding ingredients and allergens presence for lunch purchases away from home. Your answers will be anonymous and the data collected will only be used for the purpose of this research. This survey will take about 10 minutes. In case you do not want to answer a specific question, you are free to not respond. If you have any questions, you can send an email to anniek.hoogeveen@wur.nl. Thank you in advance for your contribution to my thesis.

1. Which one of following attributes do you pay more attention to, when you shop for food? - Please select a maximum of 3 items
   - ☐ Expiration date
   - ☐ Safety
   - ☐ Price
   - ☐ Caloric content
   - ☐ Nutritional value (e.g. amount of saturated fat, ant the fibre content)
   - ☐ List of ingredients in the food product (e.g. contains nuts)
   - ☐ Taste
   - ☐ Organic
   - ☐ Others, namely.................

2. a. Do you experience adverse reactions to food?

   ☐ Yes ☐ No

   2b. If yes, please specify the food product(s):
   - ☐ Tree nuts
   - ☐ Peanuts
   - ☐ (Shell)fish or crustaceans
   - ☐ Lactose/ milk
   - ☐ Celery
   - ☐ Mustard
   - ☐ Sesame seeds
   - ☐ Sulphur dioxide
   - ☐ Soybeans
   - ☐ Gluten
   - ☐ Other, namely.................

3. Do you have a colleague, friend or family member who experiences adverse reactions to food?

   ☐ Yes ☐ No

   3b. If yes, please specify the food product
   - ☐ Tree nuts
   - ☐ Peanuts
   - ☐ (Shell)fish or crustaceans
   - ☐ Lactose/ milk
   - ☐ Celery
   - ☐ Mustard
   - ☐ Sesame seeds
   - ☐ Sulphur dioxide
   - ☐ Soybeans

- ☐ Gluten
- ☐ Other, namely.................

4. In the last three months, have you bought lunch in eateries (restaurants/ caterers/ bakeries/ canteen) in Wageningen?

   ☐ Yes ☐ No

   4a. If yes, how often?
   - ☐ Every day
   - ☐ Twice a week
   - ☐ Once a week
   - ☐ Twice a month
   - ☐ Once a month
   - ☐ Only once

   4b. If no, indicate your reasons – please select all that apply
   - ☐ The food is too expensive
   - ☐ Eateries are too far away
   - ☐ I do not have (enough time at) a lunch break
   - ☐ Personnel impolite and/or not well trained
   - ☐ The outlets available do not look clean enough
   - ☐ Not enough product information is provided
   - ☐ The food looks unsafe because of the potential allergens presence
   - ☐ Others, namely ....

5. Have you ever consumed lunch at the Restaurant of the Future in the last three months?

   ☐ Yes ☐ No

   5a. If yes, how often?
   - ☐ Every day
   - ☐ Twice-a week
   - ☐ Once a week
   - ☐ Twice a month
   - ☐ Once a month
   - ☐ Only once

   5b. If no, indicate your reasons – please select all that apply
   - ☐ The food is too expensive
   - ☐ The Restaurant of the Future is too far away
   - ☐ I do not have (enough time at) a lunch break
   - ☐ Personnel impolite and/or not well trained
   - ☐ It does not look clean enough
   - ☐ Not enough product information is provided
   - ☐ The food looks unsafe because of the potential allergens presence
   - ☐ Hours of operation are too limited
   - ☐ Others, namely ....

6. How much do you spend (on average) for a lunch meal at an eatery (restaurant/ canteen/bakery)?

   € ....

7. Assume you order a regular lunch at a restaurant/ bakery/canteen. How much ***more*** (in percentage, above the price indicated in the previous question) would you be willing to pay for a meal at an eatery where menu cards indicating all allergens are provided? (If you never buy a meal at an eatery, assume a price of € 5,00).
    - ☐ Nothing
    - ☐ 10%
    - ☐ 20%
    - ☐ 30%
    - ☐ 40%
    - ☐ More than 40%

8. If the Restaurant of the Future provided you with more information regarding allergens in the meals served, would you be more likely to buy lunch there ?
   ☐ Yes ☐ No

   8 a. If yes, how often would you go?
    - ☐ Every day
    - ☐ Twice-a week
    - ☐ Once a week
    - ☐ Twice a month
    - ☐ Once a month

9. What is your personal income on a monthly basis?
    - ☐ Less than € 500,-
    - ☐ Between € 500,- and € 1500,-
    - ☐ Between € 1000,- and € 1500,-
    - ☐ Between € 1500,- and € 2000
    - ☐ Between € 2000,- and € 2500,-
    - ☐ More than € 2500,-

10. What is your highest educational degree completed?
    - ☐ Primary school
    - ☐ Secondary school
    - ☐ Professional degree (Dutch: MBO/HBO)
    - ☐ Bachelor degree
    - ☐ Master's degree
    - ☐ PHD

11. What is your profession/line of work?
    - ☐ Bachelor Student
    - ☐ Master Student
    - ☐ PhD Student
    - ☐ Postdoc / Researcher
    - ☐ Faculty / Staff Member
    - ☐ Professional (not affiliated with WUR)
    - ☐ Other.........................

12. Which of the following ethnic groups do you belong to?
    - ☐ Caucasian (includes Europe, western Asia, parts of India and North Africa)
    - ☐ Black
    - ☐ Asian
    - ☐ Middle eastern
    - ☐ Pacific Islander
    - ☐ Hispanic and Latino Americans
    - ☐ Other.........................

13. What is your gender?
    - ☐ Male
    - ☐ Female

14. Which age group do you belong to?
    - ☐ 18-25 years
    - ☐ 26-32 years
    - ☐ 33-39 years
    - ☐ 40-46 years
    - ☐ 47-53 years
    - ☐ 54-61 years
    - ☐ 62+ years

15. What is your current household situation?
    - ☐ Live alone
    - ☐ With parents / siblings / relative
    - ☐ With roommates
    - ☐ With partner
    - ☐ With partner + one or more children
    - ☐ Without partner + one or more children

16. How many persons live in your household (only the people living in a family setting, so excluding student houses)? ....

17. Do you have any comments and/or suggestions?

    ....

Thank you very much for participating in this study

Appendix 4: Results of the gluten swab tests at baseline

Time	Sample number	Place	Results *
11.15	1	Left side of cooking device, next to tomato soup	++
11.25	2	Cutting board used for salad preparation	+++
12.00	3	Left hand of Roy during flour preparation	++
12.01	4	Left hand of Roy after hand washing	-
12.30	5	Cutting board of gluten free soup	+
12.30	6	Knife used for gluten free soup	+
13.00	7	Serving spoon of tomato soup after cleaning with dishing machine	-
13.00	8	Front side of cooking device, tomato soup	++
13.15	9	Serving spoon of patty	++
13.20	10	HUPFER lowest drawer of wheeled cabinet	+++
13.30	11	Soup bowl after cleaning with dishing machine	+
13.40	12	Touchscreen left side of left cash register	+
14.00	13	Weighting scale in kitchen	+++
14.10	14	Lid of box of tomato bouillon	+++
14.10	15	Soup pan after cleaning with dishing machine	+/-
15.00	16	Sample of gluten free soup	-+
15.00	17	Sample of gluten free soup 1:1 diluted	+
15.10	18	195 times diluted tomato soup in gluten free soup	+++
14.10	19	Gluten free soup produced at 25-2	-

*= - is negative, -/+ is slightly positive, + is positive within 5 minutes, ++ is positive within 3 minutes, +++ is positive within 1 minute.

Appendix 5: Results of the peanut swab tests at baseline

Sample number	Place	Results**
1	Button of the cooking device	-
2	Sample of 100% peanut sauce	+
3	Serving spoon of peanut sauce after cleaning	-
4	Hot area serving place	-
5	Touchscreen right side of left cash register	-
6	Plate with peanut sauce after dishing machine	-
7	Pan of peanut sauce after dishing machine	-
8	Second serving spoon of peanut after cleaning	-
9	Right side of cooking device next to pan of peanut sauce	-
10*	100% peanut sauce sample, 1000 times diluted	-

*= sample 10 was performed because of negative results whereas positive would have been expected.

**= - is negative, -/+ is slightly positive, + is positive within 5 minutes, ++ is positive within 3 minutes, +++ is positive within 1 minute.

Appendix 6: Results of the gluten swab tests after giving instructions to staff members

Sample number	Place	Results *
1	Spoon of gluten free salad	-
2	Counter of gluten free salad preparation	-
3	Drawer of wheeled cabinet on top of rice	+++
4	Outer side of oven glove	+++
5	Lower part of blender gluten free soup	+++
6	Inside of oven glove	++
7	Gluten free counter after cleaning	-
8	Button of the oven in gluten free zone	-
9	Buttons of cooking device	+
10	Soup pan after dishing machine and by pre cleaning	-
11	Soup bowl after dishing machine by pre cleaning	-
12	Touchscreen right side of right cash register	-
13	Bowl for protein tomato soup with ethanol	N.A.**
14	Bowl for protein tomato soup without ethanol	-
15	Lowest part of oven in kitchen gluten free zone	-
16	Sample of gluten free soup	-
17	Tomato soup on counter with disinfectant	+++

* - is negative, -/+ is slightly positive, + is positive within 5 minutes, ++ is positive within 3 minutes, +++ is positive within 1 minute.

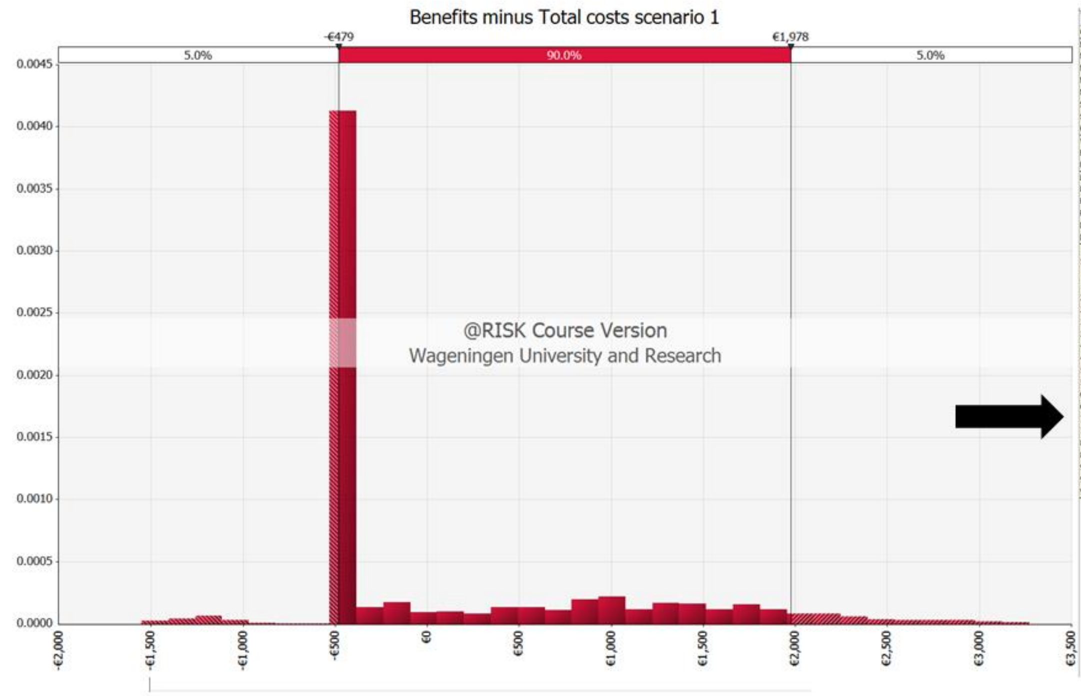
** By adding ethanol in the bowl the dipstick did not show any result. Ethanol directly on the dipstick and then swabbing did also not give a control value and are thus invalid.

Appendix 7: Results of the peanut swab tests after giving instructions to staff members

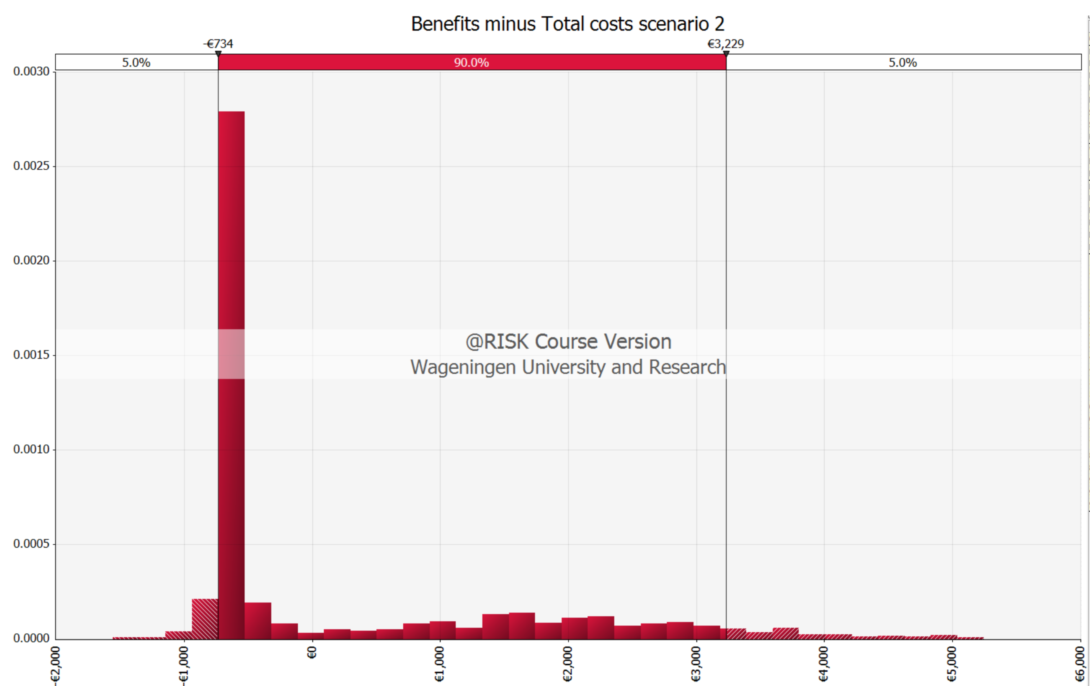
Sample number	Place	Results *
1	Front side of cooking device in front of peanut sauce	-
2	Yogurt bar: surface next to muesli	-
3	Buttons of cooking device, peanut sauce	-
4	Serving place of Nasi Goreng with peanut sauce	-
5	Touchscreen button Nasi Goreng at cash register	-
6	Tomato soup: peanuts	-
7	Droplet of peanut sauce in Lab	++
8	Droplet of peanut sauce in Lab with disinfectant	+

*= - is negative, -/+ is slightly positive, + is positive within 5 minutes, ++ is positive within 3 minutes, +++ is positive within 1 minute.

Appendix 8: Distribution of the costs minus the benefits under scenario one and two



	Benefits minus Variabl..
Cell	Variable costs!H24
Minimum	-€1,551.42
Maximum	€3,269.97
Mean	€104.37
Mode	-€430.72
Median	-€413.22
Std Dev	€900.77
Skewness	1.3023
Kurtosis	3.6964
Values	2000
Errors	0
Filtered	0
Left X	-€479
Left P	5.0%
Right X	€1,978
Right P	95.0%
Dif. X	€2,456.57
Dif. P	90.0%
1%	-€1,239.29
5%	-€478.93
10%	-€463.54
15%	-€453.81
20%	-€447.75
25%	-€442.40
30%	-€436.83
35%	-€431.13
40%	-€425.68
45%	-€419.18
50%	-€413.22
55%	-€406.08
60%	-€395.44
65%	-€213.11
70%	€231.77
75%	€642.40
80%	€971.42
85%	€1,273.36
90%	€1,611.74
95%	€1,977.64
99%	€2,805.06



	Benefits minus Variabl
Cell	Variable costs!H
Minimum	-€1,554.
Maximum	€5,244.
Mean	€207.
Mode	-€673.
Median	-€636.
Std Dev	€1,424.
Skewness	1.40
Kurtosis	3.78
Values	20
Errors	
Filtered	
Left X	-€7
Left P	5.0
Right X	€3,2
Right P	95.0
Dif. X	€3,963.
Dif. P	90.0
1%	-€970.
5%	-€733.
10%	-€712.
15%	-€699.
20%	-€688.
25%	-€679.
30%	-€672.
35%	-€663.
40%	-€655.
45%	-€644.
50%	-€636.
55%	-€627.
60%	-€611.
65%	-€451.
70%	€289.
75%	€1,081.
80%	€1,584.
85%	€2,072.
90%	€2,590.
95%	€3,229.
99%	€4,469.