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Integrated Risk Management for Mega Events

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Integrated Risk Management for Mega Events*

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Résumé / *Abstract*

Les événements spéciaux de grande envergure (les méga-événements), tels que les expositions universelles, la finale de la Coupe du monde de la FIFA ou les Jeux Olympiques, exercent des pressions énormes sur la chaîne de production et de distribution alimentaire associée à ces événements. Les caractéristiques propres à ces méga-événements augmentent, par le fait même, les risques d'atteinte à la sûreté et à la sécurité des aliments. Toute défaillance dans la chaîne alimentaire pourrait entraîner des conséquences néfastes à la fois sur les participants et sur les entreprises reliées à l'événement. Le fait d'évoluer dans un tel contexte, où les activités normales se déroulent sur une échelle beaucoup plus grande, en termes de volume et de visibilité, nécessite une réévaluation des procédures normales de gestion des risques. Le présent rapport offre aux gestionnaires une grille indispensable d'analyse de risques. Celle-ci est spécifique à l'industrie alimentaire et définit les principaux facteurs de risque et les effets indésirables liés aux méga-événements. Une fois cette étape franchie, des stratégies adéquates de gestion des risques peuvent être adoptées.

Mots clés : Sécurité alimentaire, sûreté alimentaire, chaîne d'approvisionnement (supply chain), risque, méga-événement, gestion du risque, facteur de risque, grille d'analyse des risques

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The largest special events (mega events) such as World's Fairs and Expositions, the FIFA World Cup Final, or the Olympic Games put a tremendous amount of pressure on the food production chain associated with these events, increasing the potential for food safety and security breaches. Any breach could have harmful consequences for both the people attending the event and the companies supplying the event. Evolving in such a context where normal operations take place on a much larger scale, both in terms of volume and visibility, requires a re-evaluation of standard risk management procedures. This report provides managers with an invaluable risk-analysis grid specific to the food industry, which identifies the main risk factors and undesirable outcomes associated with mega events. Once this is done, appropriate risk management strategies can be implemented.

***Keywords**: Food Safety, Food Security, Food Supply Chain, Risk, Mega-Event, Risk Management, Risk Factor, Risk Analysis Grid*

1. Introduction

1.1. Context

In recent years, special events have come to play a more prominent role in contemporary society at the social, cultural, and economic level. Whether considered as products, services, or service experiences, special events exist in a highly competitive market (Hede and al., 2002). Over the last decade, there has been considerable growth in both the number and types of special events being staged around the world (Jago and Shaw, 1998). As a result, levels of participation, sponsorship and spectatorship at special events have increased substantially.

The trend is, therefore, for special events to become larger in size and to occur more frequently, which raises a number of questions. How can we account for this change? How are these events being managed? What are the risks associated with these events? And what are the social, economic and environmental impacts of this burgeoning industry?

The largest special events (mega events) such as World's Fairs and Expositions, the FIFA World Cup Final, or the Olympic Games put a tremendous amount of pressure on the food production chain associated with these events, increasing the potential for food safety and security breaches. Any breach could have harmful consequences for both the people attending the event and the companies supplying the event. Evolving in such a context where normal operations take place on a much larger scale, both in terms of volume and visibility, requires a re-evaluation of standard risk management procedures.

The food industry already has access to a broad array of information sources on risk management related to food safety and security. There is also a rich literature available on risk management of large projects including large events. Although such information does exist, no in-depth research had been done on risk management of the food production chain (including food safety and food security) in the context of mega events.

1.2. Document structure

In preparation for the 2007 International Food Safety Conference, this report offers a methodology and a tool to assist organizations in the food industry to better manage their risk in the context of mega events.

Mega events attract a very large contingent of participants with specific needs, and are subject to inflexible constraints (schedule, security, visibility, etc.). The size of these events, combined with their high visibility, entails a different risk profile than that associated with regular operations.

There are four different types of risk management depending of the situation:

- Normal risk management
- Crisis management
- Recovery management
- Special events

This report addresses the fourth type of risk management; special events, and focuses specifically on the larger ones, the mega events. When analyzing risk management for a mega event, one has to understand the event itself, and later assess its main risk factors and undesirable outcomes in order to evaluate the potential consequences associated with the risk. Once this is done, adequate risk management strategies can be established. This process is illustrated in Figure 1.

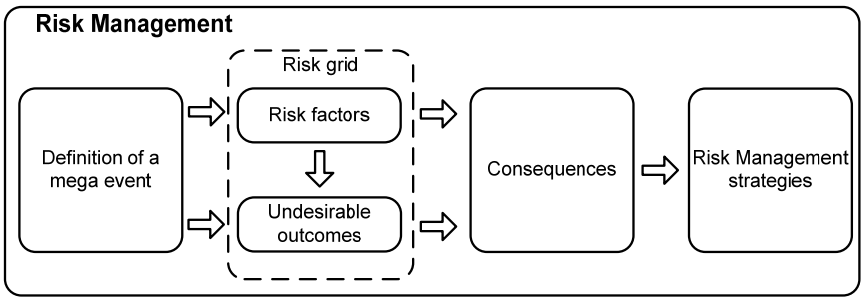

Figure 1 : Risk Management Proposed Methodology

The report is organized as follows. Section 1.3 presents an overview of the context surrounding food safety and food security. Based on the literature, section 2 presents the characteristics that differentiate mega events from other special events and from normal operations. Section 3 defines the risk exposure in the context of a mega event. Section 3.3 briefly presents a tool, the risk analysis grid, which facilitates risk management in the context of mega events. The tool is a matrix composed of undesirable outcomes (presented in section 3.4), that could afflict mega events, and risk factors (presented in section 3.5), that influence the probability of occurrence of undesirable outcomes. Undesirable outcomes and risk factors were categorized to facilitate the use of the grid. A complete version of the grid is presented in appendix, section 8. The suggested methodology, and the analysis grid which results from it, take into account the two distinct types of risks, namely safety risks and security risks. Risk management strategies, the last step of the proposed methodology, is presented in section 3.2. This section deliberately precedes the risk grid to ensure that risk management, the focal point of the methodology, was always kept in mind when covering undesirable outcomes and risk factors.

Section 4 presents the possible consequences resulting from the occurrence of undesirable outcomes. Different types of consequences are defined. Specific consequences for all identified undesirable outcomes are also outlined in this section. Section 5 presents the process flow in which the methodology can be applied. Managing risk in the food industry, especially in critical situations such as mega events, requires a methodology that integrates the whole food supply chain, from farm to fork. Finally, section 6 presents five complementary risk management methodologies and standards (applying to food safety and food security) including HACCP, ISO 22000, SQF, CARVER and ORM. The integration of the proposed methodology to the complementary tool is also discussed in this section.

1.3. Consideration of Food Safety and Food Security

1.3.1. Food Supply Chain

The food supply chain covers a spectrum of activities from agricultural production of bulk food commodities and ingredients through fresh produce to manufacturing, distribution, sales, and consumption. It includes fresh and processed food products, ingredients, and beverage (Wells and Edwards, 2004). Risks throughout the food supply are considered in this report.

Mega events generate two kinds of risks related to food supply chain: unintentional and intentional risks. Food safety and food security risks are commonly used in the food industry to define to respectively unintentional and intentional risks.

1.3.2. Food Safety

Food safety addresses the accidental contamination of food products. Food safety aimed at: "protecting the food supply from microbial, chemical (i.e. rancidity, browning) and physical (i.e. drying out, infestation) hazards or contamination that may occur during all stages of food production and handling-growing, harvesting, processing, transporting, preparing, distributing, and storing. The goal of food safety monitoring is to keep food wholesome"[1].

Food safety covers all the actions required to protect against unintentional risks. This unintentional contamination of food products can be reasonably anticipated based on the type of processing, storage and handling. This principle is the foundation of the Hazard Analysis Critical Control Point (HACCP) system used in processing plants to ensure food safety. Limits of the HACCP method in the context of mega events are presented in appendix (section 8.2.3).

[1] Definition comes from the web site of the University of Rhode Island Cooperative Extension - Food Safety Education and FSIS, 2005. (http://www.uri.edu/ce/ceec/food/factsheets/glossary.html)

1.3.3. Food Security

The definition of food security is similar to food safety at the difference that food security focuses on deliberate contaminations of food supplies. Even if, as of today, no major attack on the food supply chain have been perpetrated, events such at September 11th, the Bali, Madrid, and London bombings suggest that well organized attacks targeted on the food supply chain could occur.

Food security risk management is critical in the context of mega events. The nature of those events makes them ideal targets to any individual or group looking for visibility.

Food security involves preventing, minimizing, or responding to deliberate contaminations of food products by a variety of potential threat agents. These are criminal actions that involve wilful intent to do harm; they cannot be anticipated without intelligence information. The motivations behind these illegal actions include the desire to cause economic and psychological damage, to inspire fear among the public and create a loss of confidence in the safety of the food supply (USDA, 2005a).

Effective supply chain security involves a comprehensive and holistic approach to ensure the right people, processes, and technology are in the right place at the right time to prevent a security incident. A comprehensive understanding of the operations, interrelationships and interdependencies within the supply chain is critical to establishing a supply chain security program.

1.3.4. Importance of Food Safety and Food Security

Reid and al. (2006) identified a number of means by which food safety hazards arose. They noticed that, in the United Kingdom for the period 1998-2003, of the total 3740 incidents 3231 (86.4%) were said to be accidental.

The following figure presents the distribution of contamination by their types (intentional, unintentional or unknown) for the period studied.

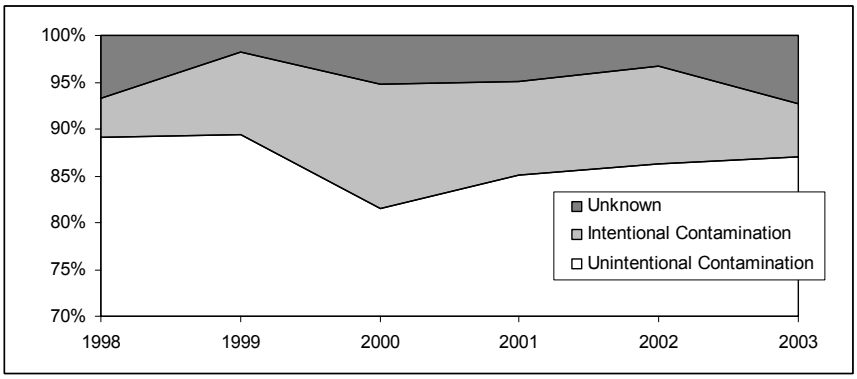

Figure 2 : Distribution of Contamination by Types (Source: adapted from Reid, 2006)

When taken together, intentional and unknown yearly contaminations average 13.6% over the period considered. These statistics underline the importance of taking into account intentional and the unintentional contamination, especially in the context of mega events, highly susceptible of being the target of an intentional contamination.

Consequently, the challenge of risk managers is to present a method capable of dealing with natural and accidental risk (unintentional) to the food supply and also with deliberate attempts (intentional) to contaminate the food supply. No such methodology exists at the moment. The method has to identify preventive steps that minimize the risk that a product will be subjected to tampering or other malicious criminal activity. In the case of mega events, this intentional risk is magnified by the importance and the reputation of the mega event itself.

2. Definition of a Mega Event

2.1. Description of an Event

When summarizing the literature, an event is often described as:

- A special activity out of the ordinary daily life
- An occurrence, especially one of great importance
- Something which generally celebrates or commemorates a special occasion

Getz (1997) defines an event as "…a unique blending of its duration, setting, management and people."

Beyond the simple definition of an event, there are many different types of event, taking place in different settings, and on very different scales.

When categorizing events, a distinction is often made between:

- Mega-events: events so large that they affect whole economies (like Olympic Games).

- Special events: broadly used in the literature to express any event that is out of the ordinary. The clear beginning and ending of the event are also associated with special events (Edwards, 1989; Wilkinson, 1988; Torkildsen, 1994). David L. Mair, risk manager for United States Olympic Committee Risk & Insurance Management defines a special event as anything outside the scope of normal activities that has a beginning and an end. This includes company picnics as well has major concerts and sports functions (Kehl, 1994).

- Hallmark events: rare major events that are connected to a specific place whereby the destination and the event become synonymous (Jago and Shaw, 1998)[2]. The carnival in Rio is a good example of a hallmark event.

It is very important to notice that these categories may overlap. The literature on large events uses a variety of terms including large,

[2] Jago, L. & Shaw, R. (1998). Special Events: A Conceptual and Differential Framework, *Festival Management & Event Tourism*, 5(1/2), 21-32.

very large, hallmark, major, and mega. Theses terms are often used quasi interchangeably to qualify those kinds of events. The terminology "mega event" will be used in this report as it reflects the considerable size of those kinds of events.

2.2. Specificities of Mega Events

Even if this paper can be used by practitioners to help them manage the risks of any special event, it is specifically intended for the largest events (mega events) such as World's Fairs and Expositions, the FIFA World Cup Final or the Olympic Games.

Getz (1997) used the term mega-events to qualify the biggest type of event: "Mega events, by way of their size or significance, are those that yield extraordinarily high levels of tourism, media coverage, prestige, or economic impact for the host community or destination . . . their volume should exceed 1 million visits, their capital costs should be at least $500 million, and their reputation should be of a 'must see' event".

According to Jago and Shaw (1998), mega events are one-time major events that are generally on an international scale.

Bovy (2004) associated the magnitude of the event with the host-city size. A 25 000 spectators event in a town with a population of 10 000 to 30 000 would be qualified as large event as much of a 100 000 to 250 000 spectators in a one million people city. To be considered as "very large", an event should attract more than 250 000 spectators a day or sells 5 to 10 million tickets on a period of 2 to 3 weeks.

Emery (2002) used two definitions as a basis for his study on the bidding process to host major sports events. Either a sporting championship recognised by the appropriate governing body of sport and attracting a minimum of 1 000 spectators or a sporting championship that receives national or international media coverage as a result of calibre of competition, and attracting a minimum of 1 000 spectators would qualify as a major sports event. This definition includes a broad array of events ranging from an annual single sport competition to the cyclical multi-sports events such as the Olympics games.

Simply said, mega events can be defined as special events that are highly prestigious, having important politic and economic impacts and involving and attracting a very large number of people. The following Table defines more precisely the specificities of mega events (based on a detailed literature review)

Specificity	**Details**
Highly prestigious	
Historical event	The event will be remember long time after it ends
High media exposure	International media coverage and broadcast, continuous exposure
Important amount of sponsorship	
Important economic and politic impacts	
Important public financial involvement	Investments for a specific event can be measured in hundred of millions or billions
Important construction of facilities	Built of permanent and temporary infrastructures
High economic impact for the host destination (long term)	High investments before event, tourism revenue during event and benefit from the infrastructures built
Important politic effect	International exposure to any politic decisions
Involve and attract a large number of people	
Attract and target a large crowd	Targeted to national and international audience
High number of employees / volunteers	

Table 1: Specificity of Mega Events

3. Risk Factors and Undesirable Outcomes

To better evaluate and manage the risk in the context of mega events, a risk analysis grid is proposed. This grid presents risk factors and their associated undesirable outcomes. To begin this section an explanation of the sources used to build the grid is given.

Some of the risk factors come from the project risk management literature. Many similarities exist in the management of events and projects. Getz (1997) underlines these similarities. Lundin and Söderholm[3] described projects as temporary organisations using four central concepts: time, task, team, and transition. Hence, what characterises a temporary organisation or a project is that it has a time constraint, one or limited number of defined tasks and that it is dependent on people and teamwork. Similarly, events are characterised by a specific task that is carried out by a group of people within a limited time frame, where some kind of transformation takes place (Larson, 2003[4]). Hence, an event can be considered as a project.

The risky nature of project was broadly documented (Aubert and Bernard, 2004; Chapman and Ward, 1997; Williams, 1995; Cooper and Chapman, 1987) and the importance of risk management in a project is widely recognized (Boehm, 1989; Barki et al. 1993; Chapman et Ward, 1997; Kerzner, 2001; William, 1993). Research done on risk in various project types provides insights when analyzing mega events.

3.1. Risk Exposure

Risk exposure can be defined as

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[3] Lundin, R. A. & Söderholm, A. (1995). A Theory of the Temporary Organisation. *Scandinavian Journal of Management*, 11(4), 437-455.

[4] Larson, M. (2003). *Evenemangsmarknadsföringens organisering: Interaktion mellan aktörer på ett politiskt torg*. Örnsköldsvik: Ågrens Tryckeri AB, find in Anttonen, Roosa and Klemm, Päivi and Sarrivaara, Emmi. (2005), *EXPLORING EVENT TOURISM STRATEGIES - A CASE STUDY OF FOUR NORDIC TOURISM ORGANISATIONS* , Göteborg, Graduate Business School, masters thesis

$$Risk\ exposure = \sum_{i=1}^{n} P(UO_i) * C(UO_i)$$

where $P(UO_i)$ is the probability of an undesirable outcome i and $C(UO_i)$ is the consequence of the undesirable outcome i (Boehm, 1989; Barki and al., 1993).

A literature review of risk definition in different domains reveals that risk is generally associated with negative outcomes. Domains were risk has a negative connotation include insurance, law, ecology, management, computer sciences, medicine, environment protection, fire prevention, and statistics (Bourdeau and al., 2003). On the other hand, some areas like finance associate risk with variance and consider both positive and negative outcomes. This research only considers negatives outcomes as it is specifically targeted to help businesses avoid negative consequences when managing tasks in large events.

To illustrate the risk exposure in the context of a mega event, a two dimensional map is used. The abscissa (x-axis) represents the probability of occurrence of an undesirable outcome and the ordinate (y-axis) represents the impact associated with the undesirable outcome. If an undesirable outcome is situated in the lower left corner, it will be considered at low risk. If an undesirable outcome is in the upper right corner, it will be considered at high risk.

The following figure illustrates undesirable outcomes (like food contamination). The difference in terms of probability and impact between the two dots represents the difference of risk level between normal operations and mega events.

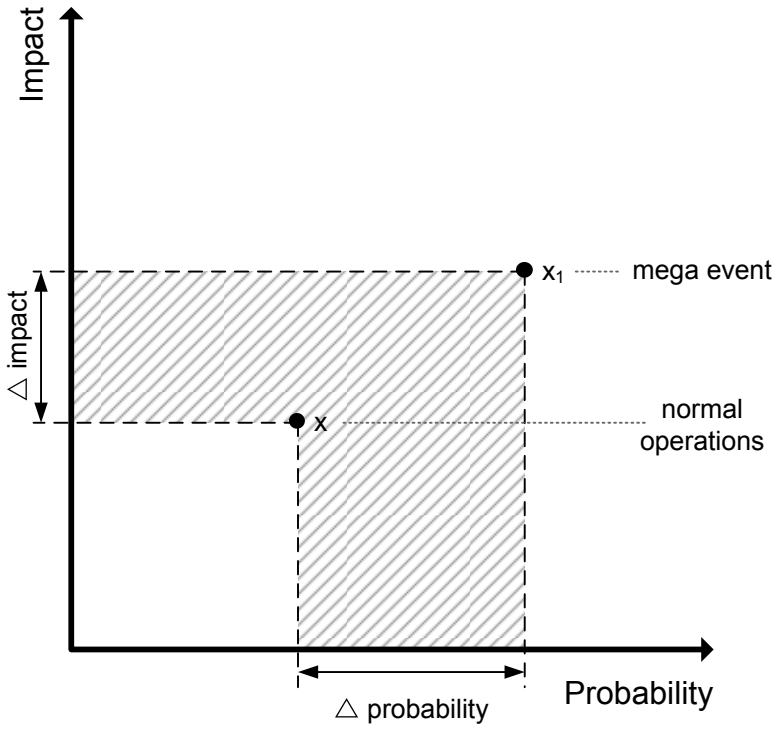

Figure 3 : Risk exposure map

In the Figure, x represents any given undesirable outcome with its probability and its associated impact under normal operations. X_1 will be the same undesirable outcome in the context of a mega event. It shows a higher probability than x and a more significant impact than x.

The materialization of undesirable outcome depends on risk factors. A risk factor is something that is likely to increase the chances that a particular event will occur. Risk factors in a situation of mega events are usually more numerous and more intense than in normal operations. For example, the fact that a company hires many new employees to fulfil the need of a mega event represents an additional risk factor because the new employees could be less aware of the food contamination risk than regular ones. Additionally, the impact associated with a physical contamination is higher in the context of mega event due to the fact that more people will eat the product.

The variation of probability and impact for an undesirable outcome in normal operation and in a situation of mega events will vary from

one undesirable outcome to another. In some case, the happening of the mega event will have no significant effect on the risk factor or on the impact and x_1 will be equal to x ($\triangle$ probability = 0 and $\triangle$ impact= 0). This report is intended to cover risk management related to mega events. Therefore, only undesirable outcomes where the unique situation of the mega event is influencing its probability or its impact will be included in the analysis. All outcomes unaffected by the context of a mega event will not be included in the analysis as they can be considered normal operational risks.

3.2. Risk Management Strategies

Since the context of a mega event influences risk exposure, risk management has to be adapted. In any situation, four main strategies can be used. Those strategies aimed at reducing risk by reducing the probability of an undesirable outcome, reducing the impact of the undesirable outcome, or both of them. All strategies are not well suited to manage every kind of risks. More than one strategy at the time can be used to manage a single risk. The strategies used to manage a specific risk might vary from one business to the other as the risk aversion varies from one organization to another.

3.2.1. Eliminate

This first strategy aims at reducing the probability of occurrence of an undesirable outcome to zero. This can only be done if all the risk factors affecting the likelihood of an undesirable outcome are fully controlled. It is usually quasi-impossible (or extremely costly) to do so.

Risk elimination is often associated with “not doing” the risky venture. For example, the only way to eliminate completely the risk associated with dealing with business partners would be to avoid having any business partners by being entirely vertically integrated.

3.2.2. Reduce

This second strategy is similar to the previous one with the difference that the probability of occurrence of an undesirable outcome is not brought down to zero. It is reduced to an acceptable

(tolerable) level. Efforts can also be deployed to reduce the impact of undesirable outcomes. This strategy will be used when no complete control of every risk factors affecting the probability is possible or when the cost of eliminating the risk is higher than transferring or supporting it. Either probability or consequence can be reduced by this strategy.

For example, contamination risks can be reduced by implementing certifications such as ISO 12 000 or ISO 9001 and by implementing auditing processes. In the same manner, the likelihood of a shortage can be reduced by having just-in-time capable suppliers and by having more than one supplying alternative for any given product.

3.2.3. Transfer

Transferring risk implies transferring the responsibility of the consequences of a given risk to a third party. The best example of risk transfer would be the concept of insurance. Insurance can be defined as the promise of reimbursement in the case of loss; paid to people or companies so concerned about hazards that they have made prepayments to an insurance company (WordNet® online lexical).

Risk transfer does not change the probability of occurrence nor the consequences of an undesirable outcome, it only transfers the responsibility of the consequences. All risks cannot be transferred. Generally the entire responsibility of the consequence cannot be transferred. Deductible or coverage limit in insurance are good examples of a partial risk transfer.

3.2.4. Retain

This fourth and last strategy makes the business responsible for the residual risk. Not all risks can be eliminated and even in the case where risks are reduced or transferred, a portion still remains. Several explanations justify the fact that a business would like to retain some risks.

There is a rising marginal cost when reducing the probability of occurrence of an undesirable outcome. At a certain level, the cost of reducing the probability of an undesirable outcome will be

considered higher than the cost of the possible loss resulting of the same undesirable outcome. The same logic can be applied to the risk transfer. There is a rising marginal cost of transferring a proportion of the responsibility of an undesirable outcome. Therefore, companies will reduce or transfer some level of risk; until they reach a level of residual risk that they fell they can bear.

3.3. Risk Analysis Grid

The risk analysis grid is a tool used by organizations who want to assess their situation before tendering or accepting to become a supplier in a mega event. The entire risk analysis grid is included in Appendix, section 8. The grid is presented as a matrix linking undesirable outcomes (presented in section 3.4) and risk factors (presented in section 3.5). A risk factor is an element that is likely to increase the chances that a particular undesirable outcome will occur. Each undesirable outcome is split into food security and food safety to take into account the differences between these two kinds of risks. For each aspect (security or safety), risk management strategies might differ.

The first step to evaluate risk exposure is to assess the gravity associated with the materialization of an undesirable outcome. Once this is done, the likelihood of such materialization has to be determined. Because probability distributions are not available to measure precisely the likelihood of a given undesirable outcome, risk factors are used as proxies. Those factors have been organized along categories: event, business, and business partners.

The following simplified example illustrates the concept of risk exposure. Assuming a company wants to avoid any form of contamination (impact is high), it has to determine the likelihood of such contamination. The organization is considering the risk factor "reliable sourcing channels" (as illustrated below). In this case it was determined that the risk factor would likely affect microbiological, chemical and physical contamination for both food safety and food security. In a second step, it was determined that the situation regarding the risk factor "reliable sourcing channels", was highly favourable at the moment of the evaluation. The sourcing channels are very reliable. This means that while the consequence

would be severe, the probability is low, which results in a moderate level of risk exposure.

Over time, for any reason, the level of favorability of the risk factors will evolve. It is important to go through the risk grid regularly and ensure that the risk factors are well tracked. For instance, in the previous example, if the sourcing channels changed and their reliability could be threatened, the likelihood of a contamination would increase. Risk management actions would have to be taken in such situation.

The following table is an excerpt of the risk analysis grid representing the previous example.

Business	**Microbiological food contamination**		**Chemical food contamination**		**Physical food contamination**		**...**	**Favourability of the factor (2007-01-01)**
	Safety	**Security**	**Safety**	**Security**	**Safety**	**Security**		
Business products								
Number of sourcing channels								
Reliable sourcing channels	✓	✓	✓	✓	✓	✓		**good**
Number of storage sites								
…								

Table 2: Risk grid example

In summary, for each specific risk factor, a dual evaluation has to be done:

1. Does the risk factor affect the probability of occurrence of any of the undesirable outcomes in the context of the event evaluated ("check" if it is the case)?

2. To what extent the risk factor is favourable or unfavourable (high/medium/low) to the company at the moment of the evaluation? This evaluation is done regularly to track the evolution of risk exposure.

In parallel, the potential impact of each undesirable outcome has to be assessed. These evaluations have to be updated regularly to ensure that the risk exposure map is continuously up to date. The next sections detail undesirable outcomes and risk factors.

3.4. Undesirable Outcomes

An undesirable outcome is a negative event which could happen during a mega event. Undesirable outcomes generate losses and represent a cost for the organization. Undesirable outcomes have been classified into three categories: food, project, and other outcomes. The list of Undesirable outcomes was created using the literature related to the food industry and other fields, and from discussions with specialists in the food industry.

3.4.1. Food Related Undesirable Outcomes

This category includes seven undesirable outcomes directly related to food. The first five outcomes are related to food contamination. Contamination can be defined as the act of contaminating or polluting; including (either intentionally or accidentally) unwanted substances or factors (WordNet® online lexical). The last two outcomes are related to food supply.

3.4.1.1. Microbiological Food Contamination

Microbiological contamination occurs due to the presence of unwanted micro-organisms in food, such as bacteria, viruses, fungi, and parasites. Microbiological contamination can cause food related illnesses.

3.4.1.2. Chemical Food Contamination

Chemical contamination occurs due to the presence of chemical agents in food like cleaning chemicals, fertilizers, pesticides, insecticides, degreasers, and drugs. The level of chemical contamination must be sufficiently high to generate consequences that can be directly related to the consumption of a specific food during an event. For example, the presence of trace quantities of pesticides in food, which may cause cancer after years of consumption, is not considered a chemical contamination; since the

short time-frame of an event would never lead to a traceable quantity being found.

3.4.1.3. Physical Food Contamination

Physical contamination is related to the presence of a foreign item such as metal, wood, glass, plastic, or even fingernails within prepared food. These contaminants generally do not cause food related illness. Instead, they can be classified as causing food related injury or harm.

3.4.1.4. Presence of Allergens

Presence of allergens can be considered the fourth food contamination category. In that particular case, the food itself is creating the reaction (instead of a contaminant in the food). As everyone is not sensitive to allergens, this fourth category is not classified as causing food related illness.

3.4.1.5. Non Respect of Stated Compliance with Religious or Other Beliefs

Mega events attract an international crowd having different religious and other beliefs related to food. The undesirable outcome is related to the non-respect of a stated compliance to religious or other beliefs (i.e. Halal, Kosher, vegetarian, biological, genetically modified organism free, and even fair trade). This outcome can be considered the fifth food contamination but cannot be classified as causing food related illness. The publicised case of McDonald's vegetarian mislabelled french fries (that where prepared in non pure vegetal oil) is a good example of the non respect of a stated compliance. It threatens the reputation of the firm.

3.4.1.6. Shortage

Simply said, shortage can be defined as a level of demand exceeding the level of supply. For example, the shortage can be a consequence of bad demand forecast, inability of a supplier to fulfill its promises or the impossibility to respond to demand because of food contamination.

3.4.1.7. Product Loss

Product loss includes any food that cannot be sold for any reason. It can be related to an optimistic demand forecast, to an event reducing drastically the demand level or to a possible food contamination.

3.4.2. Project Related Outcomes

Bourdeau and al. (2004) identified four undesirable outcomes related to projects: going beyond budget, going beyond schedule, non respect of the quality/performance level, and abandonment of the project. Non respect of the quality/performance level and abandonment of the project are already covered in the food related outcomes.

Non respect of the quality/performance in the context of the food industry is partially associated with outcomes of the processes and partially associated with taste issues.

Project abandonment refers to the cancellation of the mega event itself. The situation is exogenous to the supplier. As suppliers have little influence on the decision of cancellation, the inclusion of this element as an undesirable outcome is not relevant.

3.4.2.1. Going Beyond Budget

Going beyond budget is a possible undesirable outcome of any project. It is relevant to include this undesirable outcome even if it is not specific to the food industry or to mega events. Mega events, by definition, are out of the ordinary events of an incredible size. Supplying food in such environment represents an important challenge for any organization. In that sense, the consequences of going over budget for a supplier can be disastrous.

3.4.2.2. Going Beyond Schedule

Going beyond schedule is a possible undesirable outcome common to projects of any size. The inclusion of this undesirable outcome is relevant because, in mega events, deadlines are inflexible. No second chance or extended deadlines can be given to suppliers.

3.4.3. Other Outcomes

Two additional undesirable outcomes were identified and added to the list, namely pollution and unethical corporate behaviour. Harmful pollution and unethical practices are criticized more than ever by the media and considered unacceptable by the customer. The inclusion of those outcomes is relevant because of the possible consequences to the reputation of any organisation.

3.4.3.1. Pollution and Other Environmental Issues

Producing goods implies the consumption of resources and the creation of waste. This production process may have harmful consequences for ecosystems and populations. These effects can be observed at many levels. Global warming caused by excessive carbon dioxide emissions is probably the best example of a really high level consequence. Furthermore, environmental issues can also have negative consequences at the local level. Over-consumption of raw materials in a certain region, or the pollution of fresh water supplies used by local residents are two examples of local consequences. The more localized the undesirable outcome, the easier it is to relate it to a specific producer. For example, it is much easier to prove that polluted water caused a disease in a specific area than to relate global warming to an individual company. The high visibility resulting from being a supplier to a mega event and the potential for disastrous consequences associated with environmental damages, more than justify the inclusion of this undesirable outcome.

3.4.3.2. Ethical Breach

An ethical breach can be defined as any action taken by a company or even a business partner that is considered unethical or immoral. This undesirable outcome is not related to the legality of actions taken, even if in some cases actions that are unethical or immoral are also illegal. Public opinion decides what is ethical and what is not. As mentioned previously, the high visibility resulting from being a supplier to a mega event and the possible damage to a one's corporate image due to unethical behaviour justify the inclusion of this undesirable outcome.

3.5. Risk Factors

Identifying risks which cause undesirable outcomes and measuring their likelihood is a difficult process. Firstly, the food supply chain is highly reliant on a wide range of service providers, in many different industrial sectors, for the continuity of production, manufacturing, and supply. These include water, transport, energy and communications, to name but a few. Significant disruption in any of these sectors has the potential to impact the food supply. Recognizing the importance of these dependencies and fully understanding them is essential in order to define the appropriate mechanisms which can manage these risks. Secondly, the probability distributions are unavailable to measure precisely the likelihood of a given undesirable outcome, so risk factors are used as proxies. Finally, the list of risk factors to consider go beyond the boundaries of a single organization. Those factors have been organized into three categories: event, business, and business partners.

3.5.1. Event

3.5.1.1. Host Country

Factors in this section are directly related to the host country of the event. Specificity of a country will have an influence on the event itself. It will modify the ease with which an organization can implement optimal processes.

Country Risk Classification

The Country Risk Classification Method measures, on a scale from 0 to 7, the country credit risk, i.e. the likelihood that a country will service its external debt. The Country Risk Classification is produced by the OECD solely for the purpose of setting minimum premium rates for transactions covered by the Export Credit Arrangement. For the purpose of risk management, this classification is used as a high level indicator of economic development and political stability.

Human Development Index

The Human Development Index (HDI) measures the average achievements in a country in three basic dimensions of human development: a long and healthy life, knowledge, and a decent standard of living. It is computed for 177 countries and areas for which data is available. This composite index produced by the United Nations Development Program directly measures the accessibility and quality of health and education systems to the populations.

Trade Policy

Trade policy measures, on a scale from 1 to 5, the degree to which government hinders access to markets. It is measured using three separate variables: (1) weighted average tariff rate, (2) non-tariff barriers, and (3) corruption in the customs service. A high score for this index means that the trade policy is somehow restrictive (Miles and al., 2006).

Monetary Policy

The value of a country's currency is largely shaped by its monetary policy. With a stable monetary policy, people can rely on market prices for the foreseeable future. A weighted average inflation rate from 1995 to 2004 is used and is transposed on a scale from 1 to 5 (lower scores are better). Inflation not only confiscates wealth, but also distorts pricing, misallocates resources, raises the cost of doing business, and undermines a free society (Miles and al., 2006).

Capital Flow and Foreign Investments

Restrictions on foreign investment limit the inflow of capital and thus hamper economic freedom. By contrast, little or no restriction of foreign investment enhances economic freedom because foreign investment provides funds for economic expansion. For this factor, the more restrictions a country imposes on foreign investment, the lower its level of economic freedom and the higher its score on a scale from 1 to 5 (Miles and al., 2006) . Free capital flow and foreign investments are desirable for any company interested in doing business abroad including in the case of a mega event.

Banking and Finance (stability, efficiency)

Heavy bank regulation reduces opportunities and restricts economic freedom; therefore, the more a government restricts its banking sector, the lower its level of economic freedom and the higher its score. Banks provide the essential financial services that facilitate economic growth (Miles and al., 2006).

Property Rights (legal system)

The ability to accumulate private property is the main motivating force in a market economy, and the rule of law is vital to a fully functioning free market economy. Secure property rights give citizens the confidence to undertake commercial activities, save their income, and make long-term plans because they know that their income and savings are safe from expropriation. This factor examines the extent to which the government protects private property by enforcing the laws and how safe private property is from expropriation. The less protection private property receives, the lower a country's level of economic freedom and the higher its score (Miles and al., 2006).

Regulation (adequate protection and control)

Regulations and restrictions are in effect a form of taxation that makes it difficult for entrepreneurs to create and/or maintain new businesses. In some countries, government officials frown on any private-sector initiatives; in a few, they even make them illegal. Although many regulations hinder businesses, the most important are associated with licensing new companies and businesses. Once a business is open, government regulation does not always subside; in some cases, it increases. Interestingly, two countries with the same set of regulations can impose different regulatory burdens. If one of them, for instance, applies its regulations evenly and transparently, it lowers the regulatory burden because it enables businesses to make long-term plans more easily. If the other applies regulations inconsistently, it raises the regulatory burden on businesses by creating an unpredictable business environment. In addition, the existence of excessive regulation can support corruption as confused and harassed business owners attempt to navigate the redtape (Miles and al., 2006).

Informal Market

Informal markets are the direct result of some kind of government intervention in the marketplace. An informal market activity is one that the government has taxed heavily, regulated in a burdensome manner, or simply outlawed in the past. This factor captures the effects of government interventions that are not always fully measured elsewhere. For the purposes of this Index, the informal market reflects restrictions, taxes, or imperfections in the private market. Hence, the larger the informal market, the lower the country's level of economic freedom; and the more prevalent informal market activities are, the worse the country's score. Conversely, the smaller the informal market, the higher the country's level of economic freedom; and the less prevalent these activities are, the better the country's score (Miles and al., 2006). This factor relies on Transparency International's Corruption Perceptions Index (CPI) and is measured on a scale from 1 to 10, 10 being the most corrupt country.

Level of Economic/Industrial Development of the Host Country

The total value of goods and services produced by a country, i.e. its Gross Domestic Product (GDP), is probably the easiest way to measure the level of economic and industrial development of a country. On a per capita basis, this measurement allows the comparison of different countries. Higher GDP per capita means higher level of development.

Infrastructures of the Host Country

Infrastructure can be defined as the stock of basic facilities and capital equipment needed for the functioning of a country or area (WordNet® online lexical). It includes elements such as transportation, energy, telecommunication, and water and sanitation. Quantity and quality of infrastructures will have an important impact on the venue of a mega event. Infrastructures facilitate the free flow of people and merchandises.

Sanitary Conditions in the Host Country

Sanitary conditions can be defined as the quality of being safe and healthy, characterized by an absence of disease or risk of disease, ensured and maintained as a result of conformity with human, hog

and material hygiene requirements (granddictionnaire.com). Sanitary conditions are highly correlated with the probability of a contamination.

Disease Outbreaks in the Host Country

Epidemics and pandemics can place sudden and intense demands on health systems. They expose existing weaknesses in these systems and, in addition to their morbidity and mortality, can disrupt economic activity and development[5]. In the context of a mega event, disease outbreaks could lead to a pandemic. A disease outbreak in the host country before the happening of the mega event could lead to a lower attendance or even the cancellation of the event.

Cultural Fit

Cultural fit seeks to determine compatibilities, complementariness, and similarities between two or more different cultures that will minimize conflicts, confrontations and misunderstandings ascribable to cultural divergences (Aubert and Bernard, 2004). Culture is observed at many levels including: within organizations, regions, countries, populations, age groups, etc. Thus, cultural fit can be measured at any one of these levels. A high level of cultural fit is likely to reduce risk.

3.5.1.2. Organizing committee of the event

Experience in large events

Experience can be defined as the accumulation of knowledge or skill that results from direct participation in events or activities (WordNet® online lexical). In this particular case, the event or activity is the organisation of the mega event itself. Experience is a factor of success widely discussed in the literature.

Existence of a Business Partner Selection Process

The existence of a business partner selection process within a company creates a objective framework which evaluates business

[5] http://www.who.int/csr/en/

partners and standardizes the selection criteria. Consistent implementation of such a process will have a positive impact on business partner quality, and thus reduce risk.

Type of Employees (full time, part time, or volunteer)

An organizing committee can be staffed by full-time, part-time, temporary or even voluntary workers. Most employers define full-time employees as those who work 35 to 40 hours a week on a regular basis. These employees are often entitled to benefits such as paid sick leave, insurance coverage and vacations. Part-time employees, are employees who work less than a full-time schedule and may receive some benefits. Generally, they receive less training. Temporary employees may work either a full or part-time schedule but are usually hired for a specific project or for a finite period of time and do not receive any benefits.[6]

Each type of employee has different characteristics and therefore do not represent the same level of risk.

History of Unethical Behaviour

This factor concerns unethical behaviour that was perpetrated by the organizing committee of an event. Even if the life or an organizing committee is somewhat limited, a breach in ethics can occur. For example, past investigations on bids for Olympic Games found that the rules established by the International Olympic Committee were often broken[7].

3.5.1.3. Prestige of the Event

Prestige can be defined as a high standing achieved through success, influence, wealth, etc. (WordNet® online lexical). In the context of a mega event, prestige is tightly associated with high visibility. Any safety or security flaws in the context of a prestigious event would amplify the consequences of undesirable outcomes as they will be more publicised.

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[6] http://www.ppspublishers.com/articles/bulletin_part-time_employees.htm
7 http://news.bbc.co.uk/1/hi/world/297030.stm

Prestige does not have any influence on the probability of a safety breach but do have a significant influence on the probability of a security breach. There is a positive correlation between the level of prestige and the probability of a security breach as maximum consequences are targeted.

Sponsorship Incomes

Sponsorship can be defined as the act of supporting an event, activity or organisation by providing money or other resources that is of value to the sponsored event. This is usually in return for advertising space at the event or as part of the publicity for the event.[8]

Sponsoring is one of the main sources of revenue for organizing committees. For the International Olympic Committee, sponsoring revenue represents 34% of their total revenue[9]. Sponsoring revenues is preferred over number of sponsors, as it is a better indicator of the value sponsors place on an event.

Broadcast Revenues

Events such as the Olympic generate substantial broadcast revenues. For the Beijing Olympic Summer Games, the broadcast revenues are estimated at more than 1.7 billion USD.[10] Broadcast revenues are a very good indicator of the prestige of the event as it indirectly represents the amount the broadcasters think they will get from publicity. The higher the broadcast revenues are, the more prestigious an event is.

Number of Countries in which the Event Is Broadcasted

This factor captures the international character of an event. An event that is broadcasted in many countries will be considered more prestigious than an event that is broadcasted only in one country.

Number of Reporters Covering the Event

[8] http://www.tutor2u.net/business/marketing/glossary_s.htm
[9] http://www.olympic.org/uk/organisation/facts/revenue/index_uk.asp
[10] http://www.olympic.org/uk/organisation/facts/revenue/index_uk.asp

The number of reporters is a good indicator of the prestige of an event as it is highly linked to the level of visibility that this event will get in the media. The more reporters covering an event, the more prestigious it will be considered.

Number of Offsite Spectators (TV, radio, newspaper)

This factor measures the number of offsite spectators i.e. the number of people that, in a way or another, will be reached through the media. There is a positive correlation between the level of prestige and the number of offsite spectators.

Type of Event

According to Gwinner (1997), events can be categorized into one of at least five types: sports related, music related, festival/fair related, fine arts related (e.g., ballet, art exhibit, theatre, etc.), and professional meeting/trade show related.

The level prestige of any given event type will likely vary, that is, the level of prestige of the most prestigious event of each type are not necessarily equal.

Professional Status of the Participants

According to Gwinner (1997), professional status of the participants might have a positive influence on the perceived image of a given event.

Tradition / History of the Event

In the same manner, recurring events, especially those with a long tradition, might be perceived as more prestigious than a one time event (Gwinner 1997).

Recognition by a Governing Body

Recognition by a governing body is similar to the professional status of the participants, inasmuch that it increases the level of legitimacy and prestige of the event.

Country of Origin of the Spectators

This factor will have an influence on the probability of a security breach in two ways. First, an attack targets an event regardless of the country of origin. In this case, maximum impact will occur if the number of countries of origin of the spectators is high. Second, an attack can target a specific country or a specific group within a country. In that case, the number of countries of origin will have less influence, whereas the proportion or number of spectators from the targeted country will be considered.

3.5.1.4. Size of the Event

Event size will influence both food safety and food security. Food safety is affected in two ways. Firstly, if one meal in a million served is contaminated, and assuming constant probability, it is more likely to have cases of food contamination in an event where millions of meals are served daily than in an event where only a few hundreds are served. The second way is related to the probability itself. A mega event, by its magnitude, puts important pressure on the delivery process, increasing the probability of contamination itself.

With regards to food security, bigger events increase the consequences of a possible undesirable outcome as more people might be affected by any contamination. As it is exactly what is targeted by terrorism, bigger events entail higher probability of occurrence.

Number of Participants

A participant can be defined as someone who takes part in an activity (WordNet® online lexical). Athletes at a sporting event or performers at a music industry event would be considered participants.

Participants might be the primary target of a deliberate contamination as maximum visibility could be obtained. The media coverage of a single athlete contaminated at the Olympics could be substantial.

Number of Spectators on Site

Number of tickets sold, number of visitors per day, number of different people and many other metrics are used to measure the attendance of a given event.

Number of Staff Members and Volunteers

The occurrence of a mega event requires a significant number of employees and volunteers. For example, the Olympic Games of Torino employed more than 2,500 remunerated staff and 18,000 volunteers.[11] Number of staff is a good indicator of the size and complexity of an event.

3.5.1.5. Site of the Event

The site of the event can be defined as: the physical space occupied by the event and its surrounding area. For example, the site of an event such as the Olympics would not only include all the competition sites but will also include the city or region around the sites. This wider definition of event site is explained by the fact that food will not only be supplied to athletes and spectators at the competition sites, but also because elements outside competition sites could have an influence on food delivery to the customer.

Number of point of services and distance between them

This factor pertains to the physical disposition of the site. For example, the FIFA World Cup games are played in several cities across the host country. In the same way, Olympic competitions can be spread over many sites over a vast area. Number and distance between points are positively correlated with the level of complexity, which increases the probability of safety and security breaches.

Quality of the Site Infrastructure

Quality of site infrastructure is similar to the risk factor "infrastructure in host country" but measures specifically the site itself. Infrastructure includes elements such as transportation,

[11] http://www.torino2006.org/ENG/OlympicGames/gare_e_programma/numeri_di_torino_2006.html

energy, telecommunication, water and sanitation. The World Bank collects data on infrastructures.[12]

Traffic Congestion

Traffic congestion can jeopardize the timely delivery of goods to sites. Also, it can have a negative impact on emergency response times. Since traffic level during the event can be somewhat difficult to predict, actual traffic level can be used as a proxy. The Texas Transportation Institute uses the travel time index to estimate traffic congestion levels.[13] The travel time index is the ratio of travel time in the peak period to the travel time at free-flow conditions.

History Record of Vandalism for Events in Host Country

Some countries do have a history of vandalism regardless of the type of event. Vandals can wreak any infrastructure, and could harm the movement of goods and the food production process. In certain cases, it is even possible that the suppliers are targeted directly.

History Record of Vandalism for the Particular Event Type

In some case, the history of vandalism is directly related to the type of event. The best example would probably be the presence of hooligans at several FIFA World Cup finals. In those events, vandals were not local citizens but came from abroad specifically for the event.

3.5.1.6. Complexity of the Event

Number of Languages Spoken

This factor contributes to the increase of complexity while making the communication between the various people involved difficult. The number of languages can generate complications on several levels. In the context of a mega event, local authorities, local population, tourists, athletes, and all the actors across the food chain

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12 http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/0,,menuPK:476823~pagePK:64165236~piPK:64165141~theSitePK:469372,00.html

13 http://mobility.tamu.edu/ums/congestion_data/tables/national/table_5.pdf

might speak different languages. A lack of comprehension could generate any number of difficulties, and even serious problems.

Number of Countries Involved

From the point of view of a supplier in the food industry participating in a mega event, a high number of countries involved can create increased complexity. This is explained by the fact that the number of intermediaries may be higher, whereas their accessibility and the ease of communication reduced.

Another important point is related to the complexity of fulfilling the needs of people from many origins. New processes and new products might be required and existing business partners might not be capable of fulfilling these needs.

3.5.1.7. Timeline of the Event

Presence of a Fixed Deadline

The presence of a fixed deadline could have safety implications as it puts pressure on deliveries to customers. In these events, no postponing is tolerated. This pressure is likely to generate additional tensions in the supply chain.

This factor also has an influence on food security. With mega events, dates and locations are known well in advance which provides additional time to plan a malicious attack.

Recurrence of the Event

From a risk point of view, recurrence of the event is similar to the *tradition and history of the event*, covered in a previous section. Both factors are based on the fact that the public success of the event is predictable using the success of previous events of the same type. It is known that every four years, a summer Olympics or a FIFA World Cup final will take place. It is also known that in both cases, millions of people will converge making it an inviting target.

Event Duration

The duration of the event can easily be measured in days. Duration will have an influence on the risks associated with food safety and

food security. Short events require a high level of coordination, and on the other hand, long events generate more possibilities for errors that can cause contamination. Similarly, food security will also be affected by the duration of the event. For example, longer events mean more opportunities to perpetrate an attack.

3.5.2. Organization

3.5.2.1. Business expertise

Up-to-Date Technology Utilization

Technological improvements of the food production, conservation and distribution process, now make it possible to grow, process, store and transport food much more safely and efficiently. Food suppliers can now provide their customers with fresh fruits and vegetables, or even raw fish, from around the world at any given time of year.

This factor evaluates how up-to-date technology contributes to making food safer, throughout the supply chain by keeping it contaminant free. The factor is not related in any way to taste or the long term effects of consuming a specific food.

Certification (ISO 9000/22000, quality label, HACCP…)

An organisation that is certified, by an international standard such as ISO or HACCP, guarantees that a minimal level of quality compliance has been reached. ISO standards make the development, manufacturing and supply of products and services more efficient, safer and cleaner. They make trade between countries easier and fairer. They provide governments with a technical base for health, safety and environmental legislations.[14] One element common to all certifications is the documentation of processes. Documenting cannot be done without reflecting on the processes, and will usually flag breaches to safety and security levels. Without being an absolute protection, certifications are a good indicator of the quality of processes.

[14] http://www.iso.org/iso/en/aboutiso/introduction/index.html

Certification (Kosher, bio, GMO free)

In the same manner, certification such as Kosher, Halal, bio or GMO free guarantees that the organization is able to prove the compliance of their process to the standard. As many of these certifications require years to be obtained, they also signal a commitment from the organization.

Quality of Work

The best way to evaluate the quality of work is through the quality of actual outputs, i.e. the products or services provided by the organization. Evaluation methods vary greatly from one product to another, which means that measures will have to be adapted to each product considered.

Productivity

Productivity can be defined as the ratio of the quantity and quality of units produced to the labour per unit of time (WordNet® online lexical). In the context of a mega event both quantity and quality are crucial as the quantity needed will be higher than usual, while the level of quality must be maintained. Productivity problems can cause shortages, lower quality and even affect the level of food safety.

Quality of Process

Higher quality processes are deemed more reliable and more predictable. They help to ensure that the food delivered is up to standards. High quality processes are easier to control and to secure. An organisation that has high process quality will have lower food safety related risks and security related risks.

Availability of skills within business staff

This factor measures the availability of a sufficient level of qualified employees within an organization. Qualified employees are less likely to be the cause of a safety breach and are more likely to meet deadlines and satisfy quality controls.

3.5.2.2. Business experience

Experience in Large Events

Experience can be defined as the accumulation of knowledge or skill that results from direct participation in events or activities (WordNet® online lexical). In that particular case, the event or activity is the organisation of the mega event itself. Experience is a success factor widely discussed in the literature that will reduce risk.

Number of Years in Business for Business

The number of years in business is a good indication of the experience of the organization. Without being an infallible criteria, a long lasting company generally has lower risk. It indicates that the company is able to maintain an acceptable level of quality that will generate enough sales to ensure its survival. It also indicates, in the case where problems have occurred, that the management team was able to overcome them.

Business survival rates show the percentage of businesses that are still trading a certain number of years after they first started. The statistics for the United Kingdom show that for businesses started in 1994, 86.4%, 62.7%, 49.9% and 31.4% were still trading after one, three, five and ten years respectively. [15]

Available Production Level Capacity

This factor measures the unused production capacity of an organization, and it can be obtained by subtracting current production from total production capacity.

During a mega event, more goods and services are required. The fact that an organization has a high production level does not necessarily mean that it has the capacity to fulfill additional demand requirements. If an organization does not have sufficient unused production capacity, part of the production may have to be outsourced.

[15] http://www.sbs.gov.uk/sbsgov/action/layer?topicId=7000011767

Capability of JIT

Forecasting the level of demand for a mega event, can be hard to do prior to the event, particularly when supplying the general public. Overestimating the level of demand can lead to product loss, whereas, underestimating can lead to shortages which could have an even greater effect as the company image will suffer. Having a supply chain that reacts quickly can alleviate the problems related to estimation accuracy.

Relative Project Size

This factor is a ratio of the workload requested to fulfill quantities needed for the mega event compared to work that the organization usually carries out. This factor helps to determine how well the organization can manage heavy workloads. A workload much higher than usual might generate safety issues due to abnormally high production levels. It is also possible that the organization will not be able to fulfill the requested quantities entirely.

3.5.2.3. Organization Management

Knowledgeable Leadership

Knowledgeable leadership is associated with information sharing and adequate response from higher management. If there is any problem, it will be easier to get quick responses. This factor reduces the probability and the impact of an undesirable outcome, since knowledgeable leadership is directly related to an organization's ability to prevent and solve problems.

Use of Foreign Labour

In the food industry, the use of foreign labour for seasonal farm work is well known. This practice is often used to fill shortages in the local labour market, and could be used during a mega event. This practice has the advantage of reducing the risk of worker shortage. However, if foreign workers do not speak the local language, it can also be a disadvantage since it makes communication more complex, which could lead to food safety

being compromised. It is also harder to get proper references for foreign workers, making the screening of unwanted workers more difficult.

Ethical Standards of Business

Infamous corporations such as Enron, or WorldCom come to mind when discussing unethical business practices. These highly publicized corporate scandals were widely discussed and people are now increasingly intolerant of that kind of behaviour.

Large companies and organizations involved in mega events are often the target of extra scrutiny. They must maintain very high standards of integrity since the firm's reputation is at stake.

Existence of Coordination Mechanisms

Coordination mechanisms are established linkages between departments inside the organization. Once established, they can be used to prevent problems by circulating appropriate information. They also can be used to solve problems once they have occurred. They ensure a quick response between the various components of the organization. This factor reduces the probability and the impact of all undesirable outcomes because the existence of coordination mechanisms is related to the organization's ability to prevent and solve problems.

Clear goals / objectives / scope

Clear goals and objectives serve two major purposes. First, it gives guidance in differentiating between what is important and what is not important. If performance measurements are set according to clear goals and objectives, workers will adjust their actions to be inline with them. Second, clear goals and objectives facilitate performance review at all levels (employees, processes, departments, plant, business, etc.), helping to identify weaknesses that could be the cause of safety or security issues.

Effective Communication Mechanisms

Effective communication mechanisms guarantee that the right message will reach the appropriate target. In stressful situations,

such as when supplying a mega event, it ensures that everyone gets the right information to correctly perform their tasks. It also ensures the free flow of information, which will contribute to preventing the occurrence of problems and accelerate the resolution process in case they do occur.

Clarity of role definition

Clarity of role definition is critical to any effective risk management strategy. If roles are ambiguous, some actions might not be taken at the right moment, by the right person, or even not taken at all. Once actors know their roles they can respond when they are required to do so. This factor reduces the probability and the impact of undesirable outcomes since clear role definition is related to an organization's ability to prevent or solve problems.

Strikes and Labour Disputes, Conflict, etc.

Strikes, lockouts, or any other labour dispute can jeopardize the organization's ability to deliver food on time and at the specified level of quality. Both food security and food safety can be affected by this risk factor.

3.5.2.4. Business Processes

Existence of a Risk Management Plan (general)

The Australian Department of Environment and Heritage (2006) defines risk management plan as a plan that imposes management tools to reduce the risks to an acceptable level.[16] The existence of a plan implies that an analysis of risks has been done and that some actions have been taken or planned to mitigate the risk. A good risk management plan should include all facets of risk.

Existence of a Risk Management Plan (food safety)

The plan should address specifically the presence of elements related to food safety.

[16] http://www.deh.gov.au/settlements/biotechnology/glossary.html

Existence of a Risk Management Plan (food security)

The plan should address specifically the presence of elements related to food security.

Existence of a Crisis Management Plan

- A crisis management plan can be defined as the overall coordination of an organization's response to a crisis, in an effective, timely manner, with the goal of avoiding or minimizing damage to the organization's profitability, reputation, or ability to operate (Johns Hopkins Institutions, 2006). A crisis management plan is likely to reduce the impact of an undesirable outcome.

Traceability Capability of Products Sold

In logistics, traceability refers to the ability to trace goods along the distribution chain using a batch number or barcode. Traceability is important in many industries. For example, in the automotive industry, it makes recalls possible. In the food industry, it also contributes to food safety (Wikipedia, 2006b). In case of food contamination, traceability will accelerate the identification of all contaminated products throughout the supply chain.

Existence of a Recall Plan

Food Standards Australia New Zealand defines food recall as action taken to remove from sale, distribution, and consumption food which may pose an unacceptable safety risk to consumers (Food Standards Australia New Zealand, 2006). A recall plan is intended to reduce the consequences of an undesirable outcome.

Existence of a Quality Control Process

ISO defines Quality control as the operational techniques and activities that are used to fulfill requirements for quality (all that is done to be sure that the product is what it should be). Quality control involves operational techniques and activities aimed both at monitoring a process and at eliminating causes of unsatisfactory performance at all stages of the organization's operation in order to result in economic effectiveness (Bizmanuals, 2006). A quality

control process will lower the likelihood of contamination, deliberate or not, throughout the process and in the case where a contamination occurs, will reduce the probability that the contamination remains undetected.

Existence of a Quality Audit Process

ISO defines quality audit as a systematic and independent examination in order to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives (Bizmanuals, 2006). Any audit will, in all likelihood, identify flaws, and recommend action to reduce the probability of an undesirable outcome related to food safety and food security.

Existence of a Human Resources Selection Process

The human resources selection process can be defined as the structured actions taken by a company to fill their short and long term employee needs. The existence of this process inside a company creates a structure that standardizes hiring practices. The establishment of this process determines the appropriate selection criteria, and helps managers make the best possible decisions regarding new employees.

The primary goal of a standardized selection process is to ensure that employees are able to fulfill the job requirements, the existence of such a process will have a positive impact on employee quality and reduce risk.

Existence of a Human Resources Training Program

An HR training program seeks to maintain employee qualifications at a sufficient level in order to ensure that they can fulfill their job requirements over time. The existence of such program contributes to the reduction of risk level by keeping employees up to date on new technologies, standards and procedures.

Existence of a Human Resources Evaluation Process

Once employed, employees need to be evaluated periodically to make sure that they still meet job requirements. A structured human resources evaluation process will ensure that workers meet job requirements and reduces the risk of contamination.

Existence of a Business Partner Selection Process

The existence of a business partner selection process inside a company creates a structure that standardizes the selection process. The existence of this process forces the determination of selection criteria and the implementation of the corresponding decision-making activities.

The implementation of such process will have a positive impact on the business partner quality, which reduces risk.

Existence of a business partner evaluation process

The existence of a business partner evaluation process within a company creates a structure that standardizes the evaluation process. The existence of this process forces the determination of evaluation criteria and the implementation of the corresponding decision-making activities.

Existence of an escalation process

An escalation process provides a consistent way to solve problems quickly and efficiently by defining triggers for escalation and defines the roles and responsibilities of each of the actors. In the case where a problem occurs within an organization, it will result in swift problem solving and reduce the probability of occurrence of undesirable outcomes and their impact.

Existence of Communication Mechanisms

The existence of communication mechanisms supports the free flow of vital information within an organization and between the organisation and its business partners. It contributes to the prevention of risks and accelerates problem solving in the case where a problem occurs.

Task Complexity

Wood (1986) defines the three dimensions of complexity: component complexity, coordinate complexity and dynamic complexity. Component complexity is a function of the number of distinct acts and distinct information cues or information elements that are needed to perform the task. Coordinative complexity is a function of the form and strength of the relationships between the components of the task and the sequencing of the inputs. Dynamic complexity is a function of the need to adapt to potential changes in the means-ends hierarchy during the performance of the task.[17]

3.5.2.5. Organization Employees

Number of Employees

There is more than one way to measure the number of employees. One way to measure the number of employees is by Full Time Equivalent (FTE). New York State defines Full Time Equivalent FTE as a unit of measure which is equal to one filled, full time, annual-salaried position (Citizen's Guide, 2006). The main advantage of this measurement is that it puts all businesses on the same level regardless their utilization of part versus full time employees.

Larger companies are more able to meet demand fluctuations since they are more likely to have slack.

Employee Turnover

Employee turnover can be defined as the ratio of the number of workers that had to be replaced in a given time period to the average number of workers (WordNet® online lexical). High employee turnover is a direct threat to productivity and can have important consequences for food safety and food security. It is especially true when the pressure to deliver is high, such as during a mega event.

Level of Awareness

[17] Wood, 1986 R.E. Wood, Task complexity definition of the construct, Organizational Behavior and Human Decision Processes 37 (1986) (1), 60–82.

Awareness can be defined as "having knowledge of" (WordNet® online lexical). Awareness does not necessarily mean understanding. Awareness in food industry means that employees realize that their actions or inaction could lead to a food contamination. Employees do not necessarily need to understand all the implications of food contamination to be considered aware. A high level of awareness is desirable and will likely reduce risk.

Level of Absenteeism

Absenteeism can be defined as a habitual pattern of absence from a duty or obligation (Wikipedia, 2006a). Absenteeism is a direct threat to productivity that can have important consequences for food safety and food security. It is especially true when the pressure to deliver is high, such as during a mega event.

Food safety will be affected if the absent employee is replaced by a less qualified or less experienced employee. If an employee is not replaced, his job will have to be shared by the remaining employees, increasing their workload and the likelihood for errors. Food security will be affected as each replacement employee represents an additional opportunity for a malicious individual to be hired. This is especially true if the level of security check is reduced to quickly fill the shortage.

Type of Employees (full time, part time, contractual)

Organizations can hire full-time, part-time, temporary, or contractual employees. Most employers define full-time employees as those who regularly work 35 to 40 hours a week. These employees typically are entitled to benefits such as paid sick leave insurance coverage and vacations. Part-time employees are employees who work less than a full-time schedule and may receive some benefits. Temporary employees may work either a full or part-time schedule but are usually hired for a specific project or for a finite period of time and do not receive any benefits (Personnel Policy Service Inc. 2006).

All those types of employees have different characteristics and thus do not represent the same level of risk.

3.5.2.6. Products

Reliable Sourcing Channels

Reliable sourcing channels will contribute to the quality (contaminant free) of products delivered at the event. The reliability of sourcing channels will also contribute to the timely delivery of products at the event.

Number of Sourcing Channels

This factor measures the number of suppliers able to fulfill a particular need of the organization in a short amount of time. A higher number of sourcing channels decreases the risk level as it reduces the likelihood of a shortage of raw materials due to the incapacity of a specific supplier to deliver. From an organization's point of view, a high number of sourcing channels reduces the risk of shortage.

Reliable Production Sites

Reliable can be defined as worthy of reliance or trust (WordNet® online lexical). Having reliable production sites will contribute to a high level of quality (less possibility of contamination) and will reduce the risk of shortage.

Number of Production Sites

This variable counts the number of production sites available to fulfill the organization's requirements for the event. If production is distributed over more than one site, the risk of non-delivery is reduced as if an incident occurred in one production site, production can be redistributed to the other ones.

Reliable Storage Sites

Having reliable storage sites will help maintain the quality of the products during the time between production and delivery to the event (less possibility of contamination). It also reduces the risk of shortage since it reduces the probability of product loss.

Number of Storage Sites

This variable counts the organization's storage sites which are available to store products required for the events. If storage is distributed over more than one site, the risk of shortage is reduced. If an incident occurred in one storage site, storage can be redistributed to the other ones.

Type of Products

This factor looks at the type of goods produced or stored in the same facilities that are used to fulfill the event requirements. Some products and ingredients that compose products are more likely to become contaminated. Even if products required for the event are considered safe (low probability of contamination) cross contamination can occur (non contaminated product that enters in contact with a contaminant). The best example would be contamination by peanuts. The only way to ensure that products are peanut free is to make the whole production, storage, and distribution process peanut free.

Number of Different Products

This factor measures the number of goods produced or stored in the same facilities by the organization. A higher number of products is likely to increase the probability of cross contamination. It also can increase the complexity of production and storage as different conditions (temperature, humidity, etc) might be required.

Number of Ingredients in Products

This factor measures the number of ingredients in the goods being supplied. As each ingredient has to be sourced, the number of ingredients represents the number possible shortages which could lead to non-delivery to the organization. Ultimately it could threaten the capacity the organization to deliver goods for the mega event.

Also, it can increase the complexity of production and storage as different conditions (temperature, humidity, etc) might be required for different ingredients. Cross contamination is also more likely to happen when a high number of ingredients are required for production.

3.5.2.7. Organization Financial Situation

Financial Stability

This risk factor represents the capacity of the organization to meet its financial obligations and to face unforeseen events (Aubert and Bernard, 2004). Credit ratings, earnings before interest tax depreciation and amortization (EBTDA), and other metrics can be used to measure an organization's financial stability. A financially unstable organization is less likely to fulfill its obligations, which increases risk.

Lack of Funds to Proceed with Work

This factor measures the financial capacity of the organization to proceed with work related to the mega event. A business partner may have a good credit rating but is unable to make the investment required to carry out the work. This can be especially true when the investments required are large. The "current ratio" can be defined as "current assets divided by current liabilities" (Industry Canada). This ratio is a good indicator of the capacity of the business partner to cover short-term claims using assets that can be converted to cash in the near future.

Capability to Afford Adequate Labour

This factor measures the capacity of the organization to give competitive salaries to employees. As employers want the best employees and employees the best conditions, employers that give better work condition are likely to hire the best employees. An organization unable to afford qualified labour is more likely to have higher absenteeism, turnover and labour conflicts which can threaten its capacity to deliver on time (risk of shortage) at the specified level of quality (risk of contamination).

3.5.2.8. Transportation

Number of Transportation segments

This factor measures the number of successive transportation links used to carry products from the organization to the event site. Every transportation segment represents a possible food safety or food

security breach. A high number of transportation segments is riskier.

Number of Handling

Any goods that have to go from one mode of transportation to another will need to be handled. Each handling represents a possible security or safety breach as goods are accessible to the handler. A high number of handling is riskier.

Minimum Transportation Time

The minimum transportation time represents the minimum amount of time it will take to ship goods from a business partner to the production site. In the case of an unexpected shortage of an ingredient, this time represents the minimum interruption time to the production chain for a given product.

Transportation Mode

Goods coming from business partners can travel via many different modes of transportation, mainly road, railway, maritime, and air. Any of these modes of transportation represent a different level of risk. The Defence Logistics Information Service in the United-States makes publicly available through The Hazardous Material Information Resource System statistics on accidents by mode of transportation.[18] The level of risk is a function of volume transported, distance carried and, the number of accidents likely to occur per kilometre using that mode of transportation. More specifically, it can be calculated by multiplying distance (in kilometres) and volume (in tons) and dividing the result by the number of accidents (per kilometre). The result will give the average number of kilometres a ton of goods travels on average between two accidents. Higher distance means lower risk.

Distance between Organization and Event

This factor measures the distance between the organization site and the event site. It affects the probability of an incident while

[18] http://www.dlis.dla.mil/hmirs/

transporting goods required for the mega event. If everything else is equal, i.e. volume and probability of accident (distance carried between two accidents for one unit of volume), increasing the distance will increase the probability that an incident occurs for a given time interval.

Volume of Goods

This factor measures the relationship between the volume of goods carried and the probability of an incident while transporting goods required for fulfilling requests related to the mega event. If everything else is equal, i.e. distance and probability of accident (distance carried between two accidents for one unit of volume), increasing the volume will increase the probability that an incident occurs for a given time interval.

3.5.3. Business Partners

When a company outsources elements of its supply chain, such as a foreign facility, conveyance, domestic warehouse, or other services, it is imperative that the company works with its business partners to ensure that security measures are in place and adhered to throughout its supply chain. (US Custom and Border Protection, 2006)

Both suppliers and subcontractors are considered business partners. Emphasis should be placed on the partners that are in direct contact with food since they are the ones through which contamination is more likely to occur.

3.5.3.1. Business Partners (general)

Number of Business Partners

The number of business partners is likely to affect both safety and security. A high number of business partners might require sophisticated coordination mechanisms. It is also more demanding to evaluate an large number of business partners. This could lead to safety and security breaches.

Availability of Qualified Business Partners

The availability of qualified business partners can be defined as the availability of a sufficient number of partners capable of fulfilling each need at the right level of quality, at the right time, at the right place for the appropriate price. The interpretation of this definition will vary across industries, businesses, and even products or services. This factor will likely affect food security and food safety since doing business with less qualified partners might generate problems. It can also affect the delivery of goods to the customer.

Dependence on a Specific Business Partner

Being dependent of a single supplier or subcontractor generates obvious risks as the capacity of the partner to fulfill the needs of the business is highly correlated with capacity of the business to fulfill the needs of their clients. In the cases were no alternative is available, there is an important risk transfer from the partner to the organization.

Existence of Preferred Business Partner

A business partner can be qualified as preferred partner when the fulfilment of a particular need is systematically entrusted to him. Having a preferred business partner is the result of a business decision. In this case, there is no question of dependence as alternatives are available. Many reasons, including having a long lasting relationship, increased flexibility, better prices, and good customer support can justify the fact that a business will have a preferred partner.

3.5.3.2. Country of the Business Partner (for each business partner)

To have the list of risk factors related to the country of the business partner, please refer to section 3.5.1.1.

3.5.3.3. Business partner expertise (for each business partner)

Up-to-Date Technology Utilization

Technological improvements of the food production, conservation and distribution process, now make it possible to grow, process,

store and transport food much more safely and efficiently. Food suppliers can now provide their customers with fresh fruits and vegetables, or even raw fish, from around the world at any given time of year.

This factor evaluates (for the business partner) how up-to-date technology contributes to making food safer, throughout the supply chain by keeping it contaminant free. The factor is not related in any way to taste or to the long term effects of consuming a specific food.

Labels and standards (ISO 9000/22000, quality label, HACCP…)

Doing business with partners that are certified, by an international standard such as ISO or HACCP guarantees that a minimal level of quality compliance is reached. ISO standards make the development, manufacturing and supply of products and services more efficient, safer and cleaner. They make trade between countries easier and fairer. They provide governments with a technical base for health, safety and environmental legislations (International Organisation of Standardization, 2006). One element common to all certifications is the documentation of processes. Documenting cannot be done without reflecting on the processes, and will usually flag breaches to safety and security levels. Without being an absolute protection, certifications are a good indicator of the quality of processes.

Certification (Kosher, bio, GMO free)

In the same manner, certification such as Kosher, Halal, bio or GMO free guarantees that the business partner is able to prove the compliance of their process to the standard. As many of these certifications require years to be obtained, they also indicate a commitment from the business partner.

Quality of Work

The best way to evaluate the quality of work is through the quality of outputs, i.e. the products or services provided by the business partner. Evaluation methods vary greatly from one product to

another other, which means that measures will have to be adapted to each product considered.

History with the business partners is the ideal indicator for quality. Reputation, when well known can also be a good indicator.

Productivity

Productivity can be defined as the ratio of the quantity and quality of units produced to the labour per unit of time (WordNet® online lexical). In the context of a mega event both quantity and quality are crucial as the quantity needed will be higher than usual, while the level of quality must be maintained. Productivity problems might cause shortages, lower quality and even affect the level of food safety.

Quality of Process

Higher quality processes are deemed more reliable and more predictable. They help to ensure that the food delivered is up to standards. High quality processes are easier to control and to secure. Working with a business partner that has high process quality will lower food safety related risks and food security related risks.

Availability of skills within business partner staff

This factor measures the availability of a sufficient level of qualified employees in the business partner company. Qualified employees are less likely to be the cause of a safety breach and more likely to meet deadlines and satisfy quality controls.

3.5.3.4. Business partner experience (for each business partner)

Experience in Large Events

Experience can be defined as the accumulation of knowledge or skill that results from direct participation in events or activities (WordNet® online lexical). In that particular case, the event or activity is the organisation of the mega event itself. Experience is a success factor widely discussed in the literature that will reduce risk.

Number of Year in Business for Business Partner

The number of year in business is a good indication of the experience of the business partner. Without being an infallible criteria, a long lasting company will generally have lower risk. It indicates that the company is able to maintain an acceptable level of quality that will generate enough sales to ensure its survival. Issues (lawsuits, financials problems, recalls, strikes, etc.) regarding a company are likely to be documented. Even in the case where problems have occurred, the survival of the business indicates that the management team was able to overcome them.

Business survival rates show the percentage of businesses that are still trading a certain number of years after they first started. The statistics for United Kingdom show that for businesses started in 1994, 86.4%, 62.7%, 49.9% and 31.4% were still trading after one, three, five and ten years respectively.[19]

Available Production Level Capacity

This factor measures the unused production capacity of the business partner, and it can be obtained by subtracting the actual production level from total production capacity.

During a mega event, more goods and services are required. The fact that an organization has a high production level does not necessarily mean that it has the capacity to fulfill additional demand requirements. If suppliers do not have sufficient production capacity available, other suppliers will have to be found.

Capability of JIT

Forecasting the level of demand for a mega event can be hard to do prior to the event, particularly when supplying for the general public. Overestimating the level of demand can lead to product loss, whereas, underestimation can lead to shortages which could have an even worst effect as the company image will suffer. Business

[19] http://www.sbs.gov.uk/sbsgov/action/layer?topicId=7000011767 [ref. January 16th, 2007]

partners that have a supply chain that reacts quickly can alleviate problems related to estimation accuracy.

Relative Project Size

This factor is a ratio of the workload requested from a specific business partner compared to work that the partner usually carries out. This factor helps to determine how well a business partner can manage a heavy workload. A workload much higher than usual might generate safety issues due to abnormally high production levels. It is also possible that the business partner will not be able to fulfill the requested quantities entirely.

3.5.3.5. Business Partner Management (for each business partner)

Knowledgeable Leadership

Knowledgeable leadership is associated with information sharing and adequate response from higher management. If there is any problem, it will be easier to get quick responses from business partners. This factor reduces the probability and the impact of an undesirable outcome, since knowledgeable leadership is directly related to the business partner's ability prevent and solve problems.

Use of Foreign Labour

In the food industry, the use of foreign labour for seasonal farm work is well known. This practice is often used to fill shortages in the local labour market, and could be used during a mega event. This practice has the advantage of reducing the risk of worker shortage. However, if foreign workers do not speak the local language, it can also be a disadvantage since it makes communication more complex, which could lead to food safety being compromised. It is also harder to get proper references for foreign workers, making the screening of unwanted workers more difficult.

Ethical Standards of Business Partners

Infamous corporations such as Enron, or WorldCom come to mind when discussing unethical business practices. These highly

publicized scandals were widely discussed and people are now increasingly intolerant of that kind of behaviour.

Large companies are often the target for extra scrutiny. They have to maintain high standards of integrity and ensure that their partners do the same, since the firm's reputation is at stake.

Existence of Coordination Mechanisms

Coordination mechanisms are established linkages between the organization and its business partners. Once established, they can be used to prevent problems by circulating appropriate information. They also can be used to solve problems once they have occurred. Furthermore, they ensure a quick response between collaborators. This factor reduces the probability and the impact of all undesirable outcomes because the existence of coordination mechanisms is related to the business partner's ability to prevent and solve problems.

Clear goals / objectives / scope

Clear goals and objectives serve two major purposes. First, it gives guidance in differentiating between what is important and what is not important. If employee performance measurements are set according to clear goals and objectives, workers will adjust their actions to be inline with them. Secondly, clear goals and objectives facilitate performance review at all levels (employees, processes, departments, plant, business, etc.), helping to identify weaknesses that could be the cause of safety or security issues.

Effective Communication Mechanisms

Effective communication mechanisms guarantee that the right message will reach the appropriate target. In stressful situations, such as when supplying a mega event, it ensures that everybody gets the right information to correctly perform their tasks. It also ensures the free flow of information, which will contribute to preventing the occurrence of problems and accelerate the resolution process in case they do occur.

Clarity of role definition

Clarity of role definition is critical to any effective risk management strategy. If roles are ambiguous, some actions might not be taken at the right moment, by the right person, or even not taken at all. Once actors know their roles they can respond when they are required to do so. This factor reduces the probability and the impact of undesirable outcomes since clear role definition is related to a business partner's ability to prevent and solve problems.

Strikes and Labour Disputes, Conflict, etc.

Strikes, lockouts, or any other labour dispute can jeopardize the ability of a business partner to deliver food on time and at the specified level of quality. Both food security and food safety can be affected by this risk factor.

3.5.3.6. Business Partner Processes (for each business partner)

Existence of a Risk Management Plan (general)

The Australian Department of Environment and Heritage defines risk management plan as a plan that imposes management tools to reduce the risks to an acceptable level (The Australian Department of Environment and Heritage, 2006). The existence of a plan in the business partner's organization implies that an analysis of risks has been done and that some actions have been taken or planned to mitigate the risk. A good risk management plan should include all facets of risk.

Existence of a Risk Management Plan (food safety)

The plan should address specifically the presence of elements related to food safety.

Existence of a Risk Management Plan (food security)

The plan should address specifically the presence of elements related to food security.

Existence of a Crisis Management Plan

A crisis management plan can be defined as the overall coordination of an organization's response to a crisis, in an effective, timely

manner, with the goal of avoiding or minimizing damage to the organization's profitability, reputation, or ability to operate(Johns Hopkins Institutions, 2006). A crisis management plan for the business partner is likely to reduce the impact of an undesirable outcome.

Traceability Capability of Products Sold

In logistics, traceability refers to the ability to trace goods along the distribution chain using a batch number or barcode. Traceability is important in many industries. And in the food industry, it contributes to food safety (Wikipedia, 2006b). In case of food contamination, traceability will accelerate the identification of all contaminated products throughout the supply chain.

Existence of a Recall Plan

Food Standards Australia New Zealand defines food recall as action taken to remove from sale, distribution, and consumption food which may pose an unacceptable safety risk to consumers (Food Standards Australia New Zealand, 2006). A recall plan is intended to reduce the consequences of an undesirable outcome.

Existence of a Quality Control Process

ISO defines Quality control as the operational techniques and activities that are used to fulfill requirements for quality (all that is done to be sure that the product is what it should be). Quality control involves operational techniques and activities aimed both at monitoring a process and at eliminating causes of unsatisfactory performance at all stages of the business partner's operation in order to result in economic effectiveness (Bizmanuals, 2006). A quality control process will lower the likelihood of contamination, deliberate or not, throughout the process and in the case where a contamination occurs, will reduce the probability that the contamination remains undetected.

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these arrangements are implemented effectively and are suitable to achieve objectives (Bizmanuals, 2006). Any audit will, in all likelihood, identify flaws for a business partner and recommend action to reduce the probability of an undesirable outcome related to food safety and food security.

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Existence of a Human Resources Training Program

An HR training program seeks to maintain employee qualifications at a sufficient level in order to ensure that they can fulfill their job requirements over time. The existence of such program in the business partner company contributes to the reduction of risk level by keeping employees up to date on new technologies, standards and procedures.

Existence of a Human Resources Evaluation Process

Once employed, employees need to be evaluated periodically to make sure that they still meet job requirements. A structured human resources evaluation process for the business partner will ensure that workers meet job requirements and reduces the risk of contamination.

Existence of a Business Partners Selection Process

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selection practice. The existence of this process determines selection criteria and the implementation of the corresponding decision-making activities.

The implementation of such process will have a positive impact on the business partner quality, which reduces risk.

Existence of a business partners evaluation process

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Existence of an escalation process

The existence of an escalation process within a business partner company provides a consistent way to solve problems quickly and efficiently by defining triggers for escalation and defines the roles and responsibilities of each of the actors. In the case where a problem occurs at the business partner's site, it will result in swift problem solving and reduce the probability of occurrence of undesirable outcomes and their impact.

Existence of Communication Mechanisms

The existence of communication mechanism within a business partner company supports the free flow of vital information within that organization and between themselves and their business partners. It contributes to the prevention of risks and accelerates problem solving in the case where a problem occurs.

Task Complexity

Wood (1986) defines the three dimensions of complexity: component complexity, coordinate complexity and dynamic complexity. Component complexity is a function of the number of distinct acts and distinct information cues or information elements that are needed to perform the task. Coordinative complexity is a function of the form and strength of the relationships between the components of the task and the sequencing of the inputs. Dynamic

complexity is a function of the need to adapt to potential changes in the means-ends hierarchy during the performance of the task.[20]

3.5.3.7. Business Partner Employees (for each business partner)

Number of Employees

There is more than one way to measure the number of employees for a business partner. One way to measure the number of employees is by Full Time Equivalent (FTE). New York State defines Full Time Equivalent FTE as a unit of measure which is equal to one filled, full time, annual-salaried position.[21] The main advantage of this measurement method is that it puts all businesses on the same level regardless their utilization of part versus full time employees.

Larger companies are likely to face demand fluctuation more easily as they are likely have more slack.

Employee Turnover

Employee turnover can be defined as the ratio of the number of workers that had to be replaced in a given time period to the average number of workers (WordNet® online lexical). High employee turnover at the business partner's company is a direct threat to productivity and can have important consequences on food safety and food security. It is especially true when the pressure to deliver is high, such as during a mega event.

Level of Awareness

Awareness can be defined as "having knowledge of" (WordNet® online lexical). Awareness does not necessarily mean understanding. Awareness in food industry means that employees realize that their actions or inaction could lead to a food contamination. Employees do not necessarily need to understand all

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[21] http://www.budget.state.ny.us/citizen/financial/misc.html

the implications of food contamination to be considered aware. A high level of awareness is desirable for business partner employees and is will likely reduce risk.

Level of Absenteeism

Absenteeism can be defined as a habitual pattern of absence from a duty or obligation (Wikipedia, 2006a). Absenteeism within the business partner organization is a direct threat to productivity that can have important consequences for food safety and food security. It is especially true when pressure to deliver is high, such as during a mega event.

Food safety will be affected if the absent employee is replaced by a less qualified or less experienced employee. If an employee is not replaced, his job will have to be shared by the remaining employees, increasing their workload and the likelihood for errors. Food security will be affected as each replacement employee represents an additional opportunity for a malicious individual to be hired by the business partner. This is especially true if the level of security check is reduced to quickly fill the shortage.

Type of Employees (full time, part time contractual)

Business partners can hire full-time, part-time, temporary or contractual employees. Most employers define full-time employees as those who regularly work 35 to 40 hours a week. These employees are typically entitled to benefits such as paid sick leave insurance coverage and vacations. Part-time employees are employees who work less than a full-time schedule and may receive some benefits. Temporary employees may work either a full or part-time schedule but are usually hired for a specific project or for a finite period of time and do not receive any benefits (Personnel Policy Service Inc. 2006).

All those types of employees have different characteristics and thus do not represent the same level of risk.

3.5.3.8. Business partner products (for each business partner)

Reliable Sourcing Channels

Reliable sourcing channels will contribute to the quality (contaminant free) of products delivered by a business partner. The reliability of sourcing channels will also contribute to the timely delivery of products by the business partner.

Number of Sourcing Channels

This factor measures the number of suppliers able to fulfill a particular need of the business partner in a short amount of time. A high number of sourcing channels decreases the risk level as it reduces the likelihood of a shortage of raw materials due to the incapacity of a specific supplier to deliver. From an organization's point of view a high number of sourcing channels for the business partner's suppliers reduces the risk of shortage.

Reliable Production Sites

Reliable can be defined as worthy of reliance or trust (WordNet® online lexical). Having business partners that have reliable production sites will contribute to a high level of quality (less possibility of contamination) and will reduce the risk of shortage.

Number of Production Sites

This variable counts the number of production sites available to fulfill the business partner's needs. If production is distributed over more than one site, the risk of non-delivery is reduced as if an incident occurred in one production site, production can be redistributed to the other ones.

Reliable Storage Sites

Working with business partners that have reliable storage sites will help ensure product quality during the time between production and delivery to the event (less possibility of contamination). It also reduces the risk of non-delivery since it reduces the probability of product loss at the business partner site.

Number of Storage Sites

This variable counts the number of storage sites belonging to the business partner which are available to store products required by the business. If storage is distributed over more than one site, the

risk of non delivery is reduced. If an incident occurred in one storage site, storage can be redistributed to the other ones.

Type of Products

This factor looks at the type of goods produced or stored by the business partner in the same facilities that are used to fulfill the business partner's obligations to the organization. Some products and ingredients that compose products are more likely to become contaminated. Even if products bought by the organization are considered safe (low probability of contamination) cross contamination can occur (non contaminated product that enter in contact with a contaminant). The best example would be contamination by peanuts. The only way to ensure that products are peanut free is to make the whole production, storage and distribution process peanut free.

Number of Different Products

This factor measures the number of goods produced or stored by the business partner in the same facility. A large number of products is likely to increase the probability of cross contamination. It also raises the complexity of production and storage as different conditions (temperature, humidity, etc) might be required.

Number of Ingredients in Products

This factor measures the number of ingredients in the goods being supplied by the business partner. As each ingredient has to be sourced, the number of ingredients represents the number of potential shortages which could lead to non-delivery. Ultimately it could threaten the capacity to deliver goods for the mega event.

Also, it could increase the complexity of production and storage as different conditions (temperature, humidity, etc) might be required for different ingredients. Cross contamination is also more likely to happen when a high number of ingredients are required for production.

3.5.3.9. Business partner financial (for each business partner)

Financial Stability

This risk factor represents the capacity of a business partner to meet its financial obligations and to face unforeseen events (Aubert and Bernard, 2004). Credit ratings, earnings before interest tax depreciation and amortization (EBTDA), and other metrics can be used to measure a business partner's financial stability. A financially unstable business partner is less likely to fulfill its obligations, which increases risk.

Lack of Funds to Proceed with Work

This factor measures the financial capacity of the business partner to proceed with work related to the mega event. A business partner may have a good credit rating but is unable to make the investment allowing him to carry out work. This can be especially true when the business partner has to make large investments. The "current ratio" can be defined as "current assets divided by current liabilities" (Industry Canada). This ratio is an indicator of the capacity of the business partner to cover short-term claims using assets that can be converted to cash in the near future.

Capability to Afford Adequate Labour

This factor measures the capacity of the business partner to give competitive salaries to employees. As employers want the best employees and employees the best conditions, employers that give better work condition are likely to hire the best employees. A business partner that is unable to afford adequate labour is more likely to have higher absenteeism, turnover, and labour conflicts which can threaten its capacity to deliver on time (risk of shortage) at the specified lever of quality (risk of contamination).

3.5.3.10. Transportation (for each business partner)

Number of Transportation segments

This factor measures the number of successive transportation links used to carry products from the business partner to the production

site. Every transportation segment represents a possible food safety or food security breach. A higher number of transportation segments is riskier.

Number of Handling

Any goods that have to go from one transportation mode to another will need to be handled. Each handling represents a possible security or safety breach as goods are accessible to the handler. A higher number of handling is riskier.

Minimum Transportation Time (business to event)

The minimum transportation time represents the minimum amount of time it will take to ship goods from the business partner's production site to the organization's site. In a case of a major issue such as an important product loss or an unexpectedly high demand, this factor will determine the minimum interruption time to the production chain for a given product.

Transportation Mode

Goods coming from business partners can travel via many different modes of transportation, mainly road, railway, maritime, and air. Any of these modes of transportation represent a different level of risk. The Defence Logistics Information Service in the United-States makes publicly available through The Hazardous Material Information Resource System statistics on accidents by mode of transportation.[22] The level of risk is a function of volume transported, distance carried and, the number of accidents likely to occur per kilometre using that mode of transportation. More specifically, it can be calculated by multiplying distance (in kilometres) and volume (in tons) and dividing the result by the number of accidents (per kilometre). The result will give the average number of kilometres a ton of goods travels on average between two accidents. Higher distance means lower risk.

Distance between Business Partner and Organization

[22] http://www.dlis.dla.mil/hmirs/

This factor measures the distance for transporting goods between the business partner site and the organization. If everything else is equal, i.e. volume and probability of accident (distance carried between two accidents for one unit of volume), increasing the distance will increase the probability that an incident occurs for a given time interval.

Volume of Goods

This factor measures the relationship between the volume of goods carried and the probability of an incident while transporting goods required for fulfilling requests related to the mega event. If everything else is equal, i.e. distance and probability of accident (distance carried between two accidents for one unit of volume), increasing the volume will increase the probability that an incident occurs for a given time interval.

3.5.3.11. Business partner outsourcing chain (for each business partner)

Existence of a Business Partners Selection Process

The existence of a business partner selection process within a business partner's outsourcing chain creates a structure that standardizes their selection practice. The existence of this process determines selection criteria and the implementation of the corresponding decision-making activities.

The implementation of such process will have a positive impact on the business partner quality, which reduces risk.

Existence of a business partners evaluation process

The existence of a business partner evaluation process for their outsourcing chain creates a structure that standardizes their evaluation practice. The existence of this process determines evaluation criteria and the implementation of the corresponding decision-making activities.

4. Consequences for the Food Industry

The major risk factors and their associated undesirable outcomes have been outlined. Consequences resulting from the occurrence of an undesirable outcome are now described in the following section.

The consequences of an undesirable outcome can be a major threat to organizational continuity and survival. To some extent, a major disaster can even threaten a whole industry. The terrorist attacks on the World Trade Centre, and the subsequent airline crisis, illustrates how a single event can have a major impact on an entire industry.

Statistics from the United States show how important business continuity is. Using an analysis of all businesses that interrupt their operations due to a disaster, researchers found that 43% never reopen, and an additional 29% close less than 2 years after reopening.[23] Thus managers interested in preserving their businesses must work hard to prevent disasters, such as a large food contamination.

4.1. A Classification of the Consequences

All types of damages can have an impact on the level of business, on the company's image or on its assets.[24] Consequences (or losses) include direct damages to people and indirect losses that are generated by the consequences of undesirable outcomes, such as temporary unemployment and product loss.

Consequences are one of the main drivers of risk management. However, there is only a limited amount of information specific to the consequences of undesirable outcomes that occur during mega events, therefore finding more information about them is essential.

The following figure presents the anatomy of risk in four levels. This classification helps to understand the different consequences of an undesirable outcome.

[23] Institute for Business and Home Safety, at www.ibhs.org/business_protection.
[24] Assets represent anything that has value to the organization, its operations and their continuity, including Information resources that support the organization's mission. (ISO/IEC PDTR 13335-1)

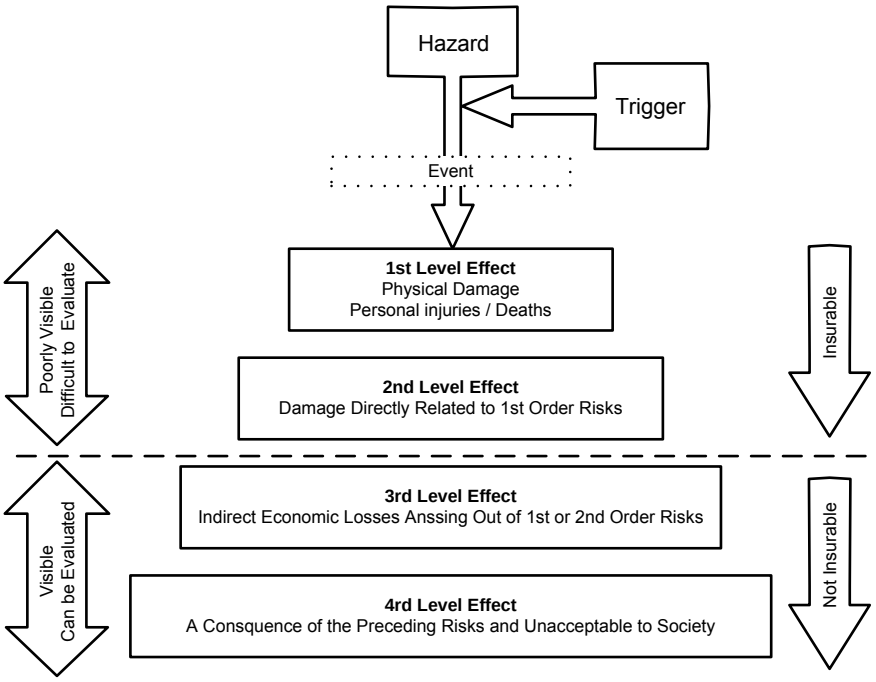

Figure 4 : The four levels of consequences (Source: Zurich Risk Management Group, 2000)

4.1.1. Direct Damages: First and Second Levels

The first two levels presented in Figure 4 are clearly visible and damages are generally easy to evaluate in terms of number of injuries, number of deaths, loss of products, etc. They regroup all the direct damages generated by an undesirable outcome. These negative effects are usually transferable by purchasing insurance.

4.1.2. Indirect Damages: Third and Fourth Levels

The last two levels represent damages which are not easily quantifiable because they are usually more intangible. Examples of indirect damages include: loss of reputation, loss of income, and more difficult access to financing. These effects are generally not transferable (insurable) because they are poorly visible and difficult to evaluate.

The following table summarizes the four levels of consequences.

Effects	***Description***	**Examples**
1st level	Physical damage Personal injuries/deaths	Loss of 15 million bottles of milk.

2nd level	Damage directly related to 1st level effect	Hundreds of consumers are sick.
3rd level	Indirect economic losses	Loss of income, production loss, severe drop in profits, production disruption (downtime) due to decontamination of affected facilities.
4th level	Consequence of the preceding risks and unacceptable to society	Loss of image, increase in third party liability claims

Table 3: Examples of consequences

This document focuses primarily on the consequences of food related undesirable outcomes. Therefore we will examine the agent, the medium and the economic impacts of food contamination. In a second part, the consequences of the other undesirable outcomes (for example those related to shortages, pollution or unethical behaviour) will also be described.

The information in this section does not only apply to mega events, but does give some indication as to what can happen in the case of food contamination during a mega event. Unfortunately, nothing in the literature reviewed, dealt solely with the consequences of food contamination during a mega event. Furthermore, some indirect consequences are often forgotten or misevaluated by companies which are victims of a food contamination. However, these consequences, such as damage of corporate reputation are often more damaging than the direct ones.

4.2. Consequences of Food Contamination

The potential agents for both food safety and security belong to four classes: biological agents, chemical agents, radiological agents, and physical agents.

Whether the case is intentional or unintentional influences the proportion of agents of contamination used. In the case of an unintentional threat, it's more an inherent risk to the product of a physical contamination. However, food might also be used deliberately as a vehicle for disseminating chemical, biological or radioactive agents to harm civilians.

Some examples will be provided to better understand what can be an agent of contamination and its effects on the population. The concept of inherent risk is also documented. Finally, some examples of the economic costs associated with the impact of both unintentional and deliberate food contamination are given.

4.2.1. The Case of Unintentional Threat

4.2.1.1. Example of Agents in Case of Unintentional Threat

A study conducted by Reid, Edwards, Sturgeon and Murray (2006), based on six years of data from National Poisons Information Centre of London, presents a description of cases where food safety was compromised. There was a wide range of contaminating agents reported. The list includes cases referred by telephone to the centre (since 1991), and encompasses a total of approximately 1.7 million enquiries. Table 4 lists the top 20 agents involved whenever food safety is compromised.

Food / Drink	*Number of incidents*	% of total
Tea and coffee	1,190	31.8
Drink not specified	318	8.5
Baby feed / baby food	305	8.2
Food not specified	222	5.9
Soft drinks and formulated soft drinks	147	3.9
Alcoholic drinks	133	3.6
Pasta, noodles and rice	116	3.1
Vegetables and vegetable products	112	3.0
Fruit juices and fruit concentrates	105	2.8
Fruit and fruit products	83	2.2
Milk, milk products, dairy and cheese	72	1.9
Gravy	70	1.8
Biscuits, cakes and doughnuts	69	1.8
Breakfast cereals and other cereal products	64	1.7
Soup	64	1.7
Sandwiches	61	1.6
Pizza	57	1.5
Sweets, chocolate and other confectionery	55	1.4
Breads	43	1.1
Meat and meat products	39	1.0
Total for top 20	3134	83.8
Total number of incidents	3741	

Table 4: Top 20 food and drinks involved in food safety breakdown incidents (Source: Reid and al., 2006)

4.2.1.2. Point at which Food Breakdown Occurred

An undesirable outcome could occur at any point along the food supply chain (from farm to fork). Table 5 shows the stages in the food chain at which the breakdown in safety occurred in case of chemical contamination:

Stage Name	*Number of incidents*	% of total
Primary production	48	1.3000
Component handling - preparation	2	0.0050
Component handling – treatment	7	0.0020
Manufacture handling - preparation	1	0.0002
Preparation / sale	57	1.5000
Consumer handling	3360	89.7000
Not known	266	0.0700
TOTAL	**3741**	

Table 5: Stage at which breakdown occurred (Source: Reid and al., 2006)

It's important to note that depending of the type of contamination (biological, chemical or physical), the point at which breakdown occurred could be different. For example when we consider a physical contamination by a foreign product, it occurred mostly during component handling – preparation (see Table 6).

Stage Name	*Number of incidents*	% of total
Component handling – not specified	17	0.7
Component handling – preparation	35	1.5
Component handling – treatment	5	0.2
Consumer handling	29	1.3
Manufacture handling - not specified	12	0.5
Manufacture handling - preparation	5	0.2
Manufacture handling - treatment	6	0.3
Preparation / sale	6	0.3
Primary production	21	0.9
Not known	2164	94.0

Table 6: Stage at which breakdown occurred (Source: Edwards and al., 2006 in Food control)

Thus it is important to identify the stages of processing – cutting, washing, bagging – during which the risk of contamination is the highest. These findings help product processors to target their efforts to prevent contamination by pathogens such as *E. coli* or others.

These findings are also more important in the context of a mega event where the food supply chain is more complex. Many stakeholders are present for each link in the food chain. Thus, it is critical for a company involved as a supplier in a mega event to evaluate the risk along the entire chain and especially the weaker link. The company has to choose the best possible business partner for the activity in the chain at which breakdown is most likely to occur. The analytical grid can help them to do such an analysis by ensuring that all the risk factors are considered.

4.2.1.3. Product Inherent Risk

In addition to the processing stage, there is inherent risk associated with the product being processed. Simply stated, some products have more potential to cause illness than others, regardless of the plant where they are processed and regardless of their nature. The

next table illustrates the association between some food and specific microbes. It shows that raw food is more risky than cooked food and that food containing milk or cream is more favourable to the development of microbes.

The next Table can help companies who are involved in a mega event to target the food and drinks which have a high potential to cause illness. Thus it enables the companies to avoid producing or distributing too risky products. It permits a better allocation of resources to further supervise the ingredients which cause problems, or to set up additional measures to prevent illness due to them.

Food\Microbe	*Aeromonas Hydrophila*	*Bacillus Cereus -TIAC-*	*Campylobacter - Jejuni*	*Clostridium - Botulinum*	*Clostridium– Perfringens TIAC*	*Escherichia Coli*	*Yeasts*	*Listeria*	*Mould*	*Pseudonoma*	*Salmonella TIAC*	*Shigella*	*Staphylococci TIAC*	*Vibrio Parahaemolyticus*	*Yersinia Enterocolitica*
Delicatessen				Raw Ham					Rillette, pâté				Boiled ham		
Spice Vegetables		Rice, farna-ceous food				Raw Vege-tables							Cooked Vege-tables in salad		Raw
Fruits							Nuts, Juice, Sirop								
Cheese, Milk and Milk food	Raw Milk			Cheese		Milk		Milk, Soft cheese			Milk				
Eggs															
Pastry / Sweets							Biscuit, Jam				Made of cream		Ice-cream and Cream		
Fish/ Clams/ Shellfish		Raw Fish						Smoked			seldom	Peeled Shell-fish			
Meat / Variety meats		Minced Meat	Minced meat, Pork, Sheep			Little cooked					Pork, Veal	Distinct and Cold meat	Little cooked		Pork
Poultry											Viscus	Chicken			

Deterioration **Severity +** **Severity ++** **Severity +++**

Table 7: Cross table food/microbes (translated from Lydie ROMEZIN, Thomas SANNEJAN, Valérie DUONG, Pierre ROHFRITSCH et Laurent BLANC, Dossier, site Internet IDECQ (http://idecq.fr/nos_dossiers/rapports/haccp.htm)

Agent	*Availability*	*Minimum infectious dose, secondary transmission*	*Clinical syndrome*	*Case-fatality*	**Other characteristics of microbe or illness**
Botulinum toxin	Organism ubiquitous in environment; cultures need anaerobic conditions	LD_{SC}=0.001 µg/kg	Descending paralysis, respiratory compromise	5% (treated)	95% of patients need hospitalisation; 60% of patients need intubation
Salmonella serotypes (excluding Salmonella tiphy)	Clinical and research laboratories, culture collections, poultry, environmental sources	10^3 organisms Limited secondary transmission	Acute diarrhoeal illness, 1-3% chronic sequelae	>1%	Organism hardy, lengthened survival in the environment
Salmonella tiphy	Clinical and research laboratories	10^5 organisms Secondary transmission possible	Acute febrile illness, protracted recovery, 10% relapse, 1% intestinal rupture	10% untreated 1% treated	Clinical syndrome unfamiliar in the USA; long incubation period (1-3 weeks); produces asymptomatic carrier rate in 3% of cases
Shigella spp	Clinical and research laboratories	10^2 organisms Secondary transmission possible	Acute diarrhoea, often bloody	For most common species in U.S., <1%	
Shigella dysenteriae type 1	Clinical and research laboratories	10-100 organisms Secondary transmission possible	Dysentery seizures	Up to 20% (treated)	Causes dysentery, toxic megacolon, haemolytic-uraemic syndrome, convulsions, in children
Escherichia coli 0157:H7	Clinical and research laboratories, bovine sources, farms	>50 organisms Secondary transmission possible	Acute bloody diarrhoea, 5% HUS, longer-term complications	1%	Long-term sequelae; hypertension, stroke, renal insufficiency, neurological complications
Vibrio cholerae	Clinical and research laboratories	10^8 organisms Secondary transmission possible	Acute life-threatening dehydrating diarrhoea	Up to 50% untreated 1% treated	Historically, causes massive waterborne epidemics in areas with poor sanitation

Table 8: Panel. Leading food-borne biological terror agents and selected characteristics (Source: Sobel and al., 2002)

Depending on the biological agent and contaminated food, an outbreak could either materialize as a slow, diffuse, and initially unremarkable increase in sporadic cases, or as an explosive

epidemic suddenly producing many illnesses. Table 8 shows the consequences and the characteristics associated with some agents of contamination (or microbes).

To further analyze the inherent risk of products, the Food Safety and Inspection Service (FSIS) of the US/Department of Agriculture is developing a new system of inspection which will better allocate Agency resources to control the risks posed to public health by meat and poultry products. To do that, they rely upon two measures of risk:

- Inherent Risk Measure: a measure of the inherent risk posed to the public health by each type of processed meat and poultry product, assuming typical process controls by the producing establishment, and
- Risk Control Measure: a measure of the amount of actual risk control achieved by each establishment.

What is especially interesting is the inherent risk concept and measure. It provides a relative value for the risk posed to the public by each category of processed food.

A crucial part of that system was the establishment hazard coefficient (HC) or inherent risk, developed by FSIS, the Research Triangle Institute (RTI), and researchers from Texas A&M University. The HC is a measure of the inherent biological, chemical, and physical hazards associated with the production of meat and poultry products in a given establishment. It is computed as:

HC (or Inherent Risk) = (Species Hazard[25] + Process Hazard[26]) X Volume

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[25] The species variable would be designed to reflect, as closely as possible, the inherent biological, chemical, and physical hazards in meat and poultry arriving at inspected establishments.

[26] The process variable would capture the inherent hazards (biological, chemical, and physical) of the establishment's operations. It would take into account how a process normally works, the likelihood of fluctuations or deviations from the norm, the effect these fluctuations or deviations may have on hazards in the product, and the potential resulting implications for public health as the product leaves the establishment.

FSIS has determined the initial values for 24 meat types + process categories through expert elicitation. Each category represents a type of finished product (a product that will reach the consumer in the same form it is in when it leaves the producing establishment). Median ranking of the relative, proportional risk of illness per serving posed by the various species process/combinations ranged from 1 through 10. The experts in general identified raw ground or otherwise non-intact meat as posing the greatest risk. They ranked ready-to-eat products not exposed to the environment after lethality treatment as posing the least risk. Table 9 summarises the median Species/Process values:

Finished Meat Product Type	**Median Score**
Raw ground, comminuted, or otherwise non-intact beef	10.0
Raw ground, comminuted, or otherwise non-intact chicken	10.0
Raw ground, comminuted, or otherwise non-intact turkey	10.0
Raw ground, comminuted, or otherwise non-intact poultry-other than chicken or turkey	10.0
Raw ground, comminuted, or otherwise non-intact meat-other than beef or pork	9.7
Raw intact turkey	9.0
Raw intact chicken	8.0
Raw intact poultry –other than chicken or turkey	8.0
Raw ground, comminuted, or otherwise non-intact pork	8.0
Raw otherwise processed meat	7.0
Raw otherwise processed poultry	7.0
Raw intact beef	5.0
Raw intact meat-other than beef or pork	5.0
Raw intact pork	4.0
RTE fully-cooked meat	3.0
RTE fully-cooked poultry	3.0
RTE acidified/fermented meat-without cooking	2.0
RTE acidified/fermented poultry-without cooking	2.0
RTE dried meat	2.0
RTE dried poultry	2.0
RTE salt cured-meat	2.0
RTE salt cured-poultry	2.0
RTE meat fully cooked without subsequent exposure to the environment	1.0
RTE poultry fully cooked without subsequent exposure to the environment	1.0

Table 9: Median Species/Process Values for calculating inherent risk (Source: US Department of Agriculture, 2006, "Measurement of Inherent Risk in Processed Meat and Poultry Products", Food Safety and Inspection Service, 19 July)

Once again, these findings help companies determine which finished product has a higher inherent risk, considering both the species and the process variables. Risk management strategies could be different for different products. In the context of a mega event it is probably better to focus on one product instead of spreading the production out between many different products.

4.2.1.4. Economic Impact

The economic impact of an outbreak of food related disease could be significant. Different cost factors have to be taken into account, because there can be both direct economic loss and indirect economic consequences due to the outbreak:

- Cost of food that was not purchased,
- Property damage,
- Human illness costs,
- Repair costs of the building,
- Productivity loss,
- Corporate reputation damage,
- Property and facility disruption (downtime) …

For example, a study estimated the economic impact of an outbreak of food related diseases occurring from elementary school lunches in 1996 in which 268 persons in Iwate prefecture, Japan were infected with *Escherichia coli* O157:H7. This study assessed the impact of direct economic losses and indirect economic consequences due to this outbreak. The economic impact of the outbreak was estimated to be approximately one million Canadian dollars[27].

Different cost factors are taken into account and the approximated proportion of each cost (compared to the total cost) of this outbreak is provided in parenthesis:

- Laboratory costs (26%),
- Cost of food that was not purchased during the suspension of the lunch service (19%),
- Personnel expenses paid to lunch service employees (17%),
- Human illness costs (15%), and

[27] Estimated to 82,686,000 yen, with an exchange rate in 1996 (January) of 0.0129 (1 yen = 0.01297 Canadian dollar).

- Repair costs of facilities (15%)

Because all patients were children the estimated productivity losses were low, as children were considered as dependants with no income. Instead, the lost income of the mothers was estimated. The source of the contamination could not be identified. Therefore, no specific food vendor suffered from direct setbacks.[28]

4.2.2. The Case of Intentional Threat

When food safety is considered, there are different means of contamination. When food security is considered, the only medium of contamination is a person. Aggressors could be disgruntled insiders, criminals, protestors or terrorists.

4.2.2.1. Example of Agents in Case of Intentional Threat

According to a recently published guide by the United States Air Force on Food Safety and Security, there are four primary classes of agents that pose a potential threat to food products. Those agents are:

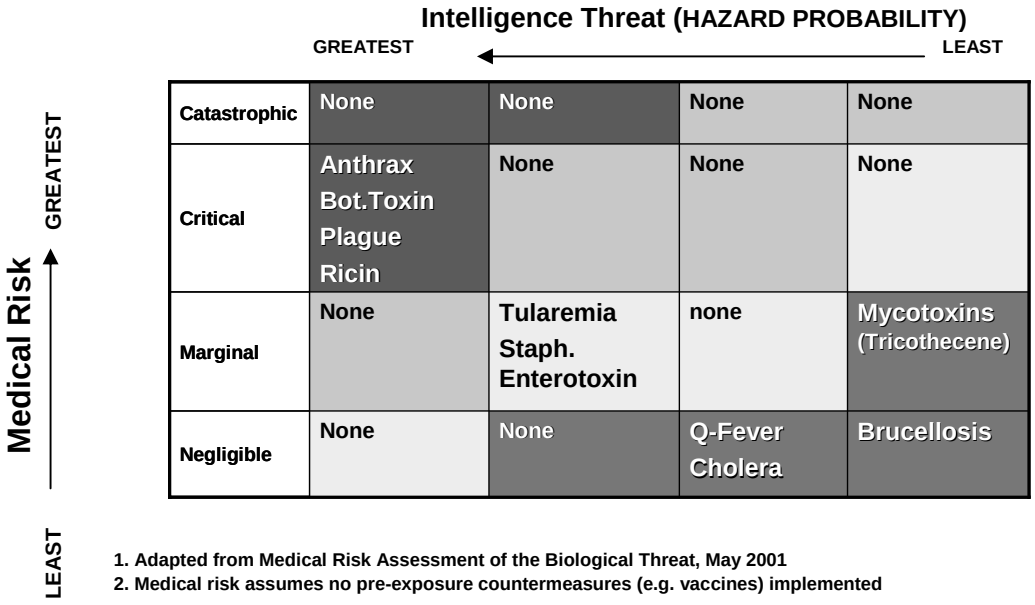
Biological agents

Biological agents are delivered in the form of liquids, aerosols or solids. The US Centers for Disease Control and Prevention has cited the following biological agents as potential weapons that could be used to deliberately poison the food supply: *Clostridium botulinum*; *Salmonella* spp., *E.coli* O157:H7, *Vibrio cholerae*. Biological attacks would generally be silent at the time of occurrence and become apparent only later through the observation of severe illnesses in the population.

The Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health & Human Services classify the biological agent in three categories (U.S. Department of Health & Human Services, 2005):

[28] Source: Abe K.; Yamamoto S; Shinagawa K., 2002, "Economic Impact of an *Escherichia coli* O157:H7 Outbreak in Japan", Journal of Food Protection, Volume 65, Number 1, 1 January 2002, pp. 66-72(7)

- Category A agents, as classified by the U.S. Department of Health and Human Services' (HHS) Centers for Disease Control and Prevention (CDC), are included because they are of the highest concern as potential threats. They have the potential for a major impact in public health and social disruption and have been identified by some countries for use in biological warfare.
- Category B agents, which are defined as the "second highest priority" by CDC, are also included. Although these agents are fairly easy to disseminate, they generally cause moderate illness and low death rates.
- Category C agents, which are considered to be the "third highest priority" by CDC, are not included because they are currently not major bio-terrorism threats. However, these agents are emerging as infectious disease threats that CDC believes could, in the future be engineered to produce biological weapons. Examples of Category C agents include yellow fever, drug-resistant tuberculosis, and Hantaviruses.



1. Adapted from Medical Risk Assessment of the Biological Threat, May 2001
2. Medical risk assumes no pre-exposure countermeasures (e.g. vaccines) implemented

Table 10: Matrix for agents in food (Source: Us Air Force, 2001)

Chemical agents

Chemical agents can be delivered as airborne droplets, liquids, aerosols, or solids. They are generally classified as classical chemical warfare agents (nerve, blister, blood and choking agents)

and toxic industrial chemicals (e.g., pesticide, rodenticides and heavy metals). Some characteristics of food contaminated by chemical warfare agents include:

Agent	*Taste*	*Odour*	Color
Mustard	Affected	Garlic	Meat discoloured
N-Mustard	Affected	Fishy	No discoloration
Arsenicals	Acidic	Unpleasant	Meat and vegetables discoloured
Nerve	Not affected	None	No color change
Cyanide	Bitter almond	Bitter almond	No color change
White phosphorous	Acidic	Garlic	Glows in the dark

Table 11: Characteristic of food contaminated by chemical warfare agents (Source: SYSCO Operational Risk Management, 2005)

As an example, between 1981 and 1988, Iraq used mustard gas and nerve agents in the Iran-Iraq war. Another example occurred in 1995 when the Aum Shinrikyo cult in Japan released sarin in the Tokyo subway.

Radiological agents

Radiological agents are radioactive elements that can be delivered in liquid or solid form. The Litvinenko poisoning is an example of the use of such product[29]. The following Table proposes an example of the effects of different radiation emergencies (not necessarily associated with food emergencies).

[29] Oziewicz Estanislao, Polonium is costly, undetectable, trillion times more toxic than cyanide, Globe and Mail, Print Edition 02/12/06 Page A23

	Nuclear power plant attack	***Radiological dispersal device***	***Radiation-Emitting Device (RED)***	***Improvised Nuclear Device (IND)***	**Nuclear Weapon**
Type of event	***Radiological***	***Radiological***	***Radiological***	***Nuclear***	***Nuclear***
Examples of Radiological Dispersal	• Possible escape of radioactive material from attack on plant	• Conventional explosives laced with radioactive material (e.g., dirty bomb) • Aerosols or sprays	• Hiding radioactive material in a populated area	• Smaller nuclear weapon (e.g., suitcase bomb)	• Nuclear weapon developed for strategic military purposes
Nuclear blast	• No	• No	• No	• Smaller nuclear explosion of varying size • Can be as large as the bomb dropped on Hiroshima	• Highly destruction nuclear explosion • Can be in the order of 100 times the bomb dropped on Hiroshima
Amount of Radiation Exposure	• Less than a nuclear event • Although unlikely, radioactive materials could escape/contaminate the area and the environment	• Limited • Dirty bomb blast could spread contamination around area the size of several city blocks	• Limited • Depends on the size of the source and speed of detection	• Varying • May or may not include fallout	• Large • Radioactive particles from the fallout could be carried long distances
Consequences	• Death toll could be limited • Plants are built to sustain extensive damage without releasing radioactive material • Psychological impact could be severe	• Limited death toll • In the case of a dirty bomb, initial explosion could kill or injure people in the immediate area • Psychological impact could be severe	• Depends on the size of the source how early it is detected and other factors • Psychological impact could be severe	• Depends on the size of the blast, whether there is fallout and population of area • Psychological impact could be severe	• Catastrophic damage to people, buildings and the environment • Psychological impact could be severe

Table 12: Example of effects of different radiation emergencies (Source: U.S. Department of Health and Human Services, 2005)

Physical agents

Physical agents represent materials that could cause adverse health effects if eaten (e.g., bone slivers, glass fragments and metal filings).

An attack could occur at any point along the food supply chain from farm to fork. Terrorists could create harm through: (1) final product contamination using either chemical or biological agents with the intent to kill or cause illness among consumers, (2) disruption of food distribution systems, (3) damage to the agricultural economy by introducing devastating crop pathogens or exotic animal diseases such as foot-and-mouth disease, or (4) hoaxes, using the mass media or Internet, which create anxiety and fear.[30]

4.2.2.2. Link between Consequences and Volume

Moreover, the consequences of a food attack increase with the volume of food contaminated. Therefore, production volume is used in the calculation as a proxy for exposure to risk. This is extremely relevant in the context of mega events. Attackers will choose an event in order to have the maximum impact associated with their action. This suggests that the probability function is not independent from the loss function. In statistics, decision theory, and economics, a loss function maps an event onto a real number representing the economic cost or regret associated with the event.

The loss function is usually modeled as a linear regression with many variables x_1, x_2, etc. and their associated weight β_1, β_2.

[30] « Is the food supply safe from terrorist attacks?",Food Safety Network, March 2003.

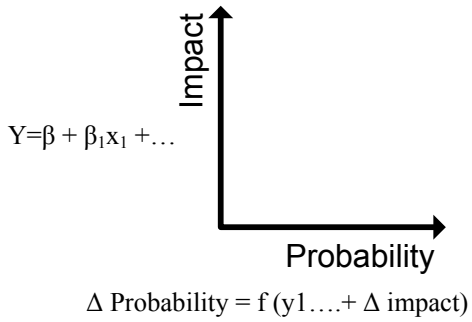


Figure 5 : Loss and probability functions

4.2.2.3. Economic Impact

The economic impact of an attack on the food supply is categorically similar to the terms of the economic impact as seen in an unintentional threat.

The case of the Rajneeshee religious cult in The Dalles, Oregon[31] in September and October 1984 offers an interesting example of such an event. The cult planned to infect residents with *Salmonella* on Election Day to influence the results of county elections. To practice for the attack, they contaminated salad bars in ten restaurants with *S*. Typhimurium on several occasions before the election. A communitywide outbreak of salmonellosis resulted; at least 751 cases were documented in a county that typically reports fewer than five cases per year. Losses were imposed on the customers (lost days of work).

Economic impacts of a Bioterrorism Attack:

Part of the appeal of using infectious disease as a weapon is the economic hardship that can be caused (Hoyle, 2006). A 1997 report from the United States Centers for Disease Control and Prevention (Kaufmann and al., 1997) conservatively estimated that the costs of dealing with the aftermath of an anthrax outbreak in a major urban center would be approximately $26.2 billion (U.S.) per 100,000 people. In a city such as New York, the tally could be in the thousands of billions of dollars. Several such attacks might literally

[31] Torok TJ, Tauxe RV, Wise RP, Livengood JR, Sokolow R, Mauvais S, et al. A large community outbreak of salmonellosis caused by intentional contamination of restaurant salad bars. JAMA 1997;278:389-95

bankrupt a country. This economic drain would be on top of the already excessive economic burden that countries face in dealing with natural disease outbreaks. The cost of dealing with a long-lasting disease such as tuberculosis can be thousands of dollars per person. Moreover, hospitalization is frequently required, which strains a nation's health care infrastructure.

To go further in estimating costs, Kaufmann and al. (1997) give an evaluation of the economic impact of a bioterrorist attack. However, it is important to note that this attack was conducted by contaminating food with the release of three classical but different biological warfare agents in aerosol form (*Bacillus anthracis*, *Brucella melitensis*, and *Francisella tularensis*) in the suburb of a major city.

Kaufmann used three cost factors to evaluate the economic impact of an attack: (1) the direct costs (the costs of hospitalization), (2) the productivity loss and finally (3) the cost of premature human death. Table 13 gives some order of magnitude of different costs associated with hospitalization and outpatient visits following a bio-terrorist attack.

	Anthrax		*Tularemia*		Brucellosis	
	Base	***Upper***	***Base***	***Upper***	***Base***	***Upper***
Hospitalized patient						
Days in hospital	7	7	10	10	7	7
Cost ($) per day[a]	556	669	556	669	556	669
Lost productivity ($\day)	65	65	65	65	65	65
Follow-up OPVs (no)	2	2	2	2	7	7
Cost 1st OPV ($)	28	44	28	44	28	44
Cost other OPVs ($)	13	24	13	24	13	24
OPV laboratory ($)[b,c]	87	174	87	174	131	261
OPV x-rays costs ($)[d]	66	66	0	0	0	0
Lost productivity ($/OPV)[e]	16	16	16	16	16	16
Total costs ($)	4541	5380	6338	7582	4584	5587
Avg.cost/day ($/day)	649	769	634	758	655	798
% increase base to upper estimate	18	18	20	20	22	22
Nonhospitalized patient						
Number of OPVs	7	7	12	12	14	14
Cost 1st OPV ($)	28	44	28	44	28	44
Cost other OPVs ($)	13	24	13	24	13	24
Lost productivity ($/OPV)[e]	16	16	16	16	16	16
Laboratory costs ($)[b,f]	131	174	261	522	261	522
X-rays costs ($)[d]	66	66	66	66	66	66
Drugs used[g]	D	C	D+C	D+C	D+R,	D+R+C
Cost of drugs ($)	6	181	29	29	220	246
Total costs ($)	422	810	722	1120	972	1418
Avg.cost/day ($/day)	60	116	60	93	69	101
% increase base to upper estimate	93	93	55	55	46	46

Notes: All costs rounded to the nearest whole dollar.
[a]Hospital costs assumed to include all costs such as drugs, laboratory tests, and x-rays.
[b]Laboratory tests consists of general health panel (CPT code 80050) and an antigen or antibody test (modeled on the cost of a
Streptococcus screen, CPT code 86588).
[c]Follow-up OPVs for hospitalized patients included two laboratory test sets for anthrax and tularemia patients and three
laboratory test sets for brucellosis patients.
[d]X-ray costs (CPT code 71021), included two sets taken at different OPVs.
[e]Productivity lost due to an OPV was assumed to be one-quarter of an unspecified day's value.
[f]For OPVs of nonhospitalized patients, one set of laboratory tests is assumed for every two visits.
[g]Drugs used: D = doxycycline; C = ciprofloxacin; R = rifampin.

Table 13: Costs of hospitalization and outpatient visits (OPVs) following a bioterrorist attack (Source: Kaufmann and al. (1997))

The cost of a premature human death was nominally valued at the present value of expected future earnings and housekeeping

services, weighted by the age and sex composition of the work force in the United States[32]. The undiscounted average of future earnings is $1,688,595 per person. As recommended by U.S. Public Health Service Panel on Cost-effectiveness in Health and Medicine[33], the stream of future earnings was discounted at 3% and 5%, to give values of $790,440 and $544,160, respectively. The present value of expected future earnings was estimated with 1990 dollars, adjusted for a 1% annual growth in productivity[10].

	Antrax	*Tularemia*	Brucellosis
Direct costs ($M)			
Medical:base estimates[b]			
Hospital	194.1	445.8	170.3
OPV[c]	2.0	10.5	48.9
Medical: upper estimates[d]			
Hospital	237.1	543.3	211.7
OPV[c]	4.4	18.5	78.3
Lost productivity			
Illness[e]			
Hospital	21.6	50.9	18.8
OPV[c]	0.7	3.9	15.0
Death			
3% dicount[f]	25,985.7	4,891.2	326,5
5% discount[f]	17,889.3	3,367.3	224,7
Total costs			
Base estimates			
3% dicount[f]	26,204.1	5,402.4	579.4
5% discount[f]	18,107.7	3,878.4	477.7
Upper estimates			
3% dicount[f]	26,249.7	5,507.9	650.1
5% discount[f]	18,153.1	3,983.9	548.4

a : Assuming 100 000 exposed.
b : Medical costs are the costs of hospitalization and outpatient visits.
c : OPV = Outpatient visits
d : Upper estimates calculated with data in Table 1 from Kaufmann and al. 1997
e : Lost productivity due to illness is the value of time spent in hospital and during OPVs.
f : Discount rate applied to compute the present value of expected future earnings and housekeeping services, weighted by age and sex composition of the US workforce, lost due to premature death.

Table 14: Costsa ($ millions) of a bioterrorist attack with no post exposure prophylaxis program (Source: Kaufmann and al., 1997)

[32] Haddix AC, Teutsch SM, Shaffer PA, Dunet DO, editors. Prevention effectiveness: a guide to decision analysis and economic evaluation. New York: Oxford University Press, 1996.
[33] Lipscomb J, Weinstein MC, Torrance GW. Time preference. In: Gold MR, Siegel JE, Russell LB, Weinstein MC, editors. Cost-effectiveness in health and medicine. New York: Oxford University Press, 1966:214-35.

The model shows that the economic impact of a bioterrorist attack can range from an estimated $477.7 million per 100,000 persons exposed (brucellosis scenario) to $26.2 billion per 100,000 persons exposed (anthrax scenario).

What is interesting in the study is that it emphasizes different factors which affect the estimate of the economic impact of a bioterrorist attack. The Table below summarizes these factors.

Factor	***Potential impact on net savings***	**Relative magnitude of impact**
Higher than projected case-fatality rate	Increase	++++
Long term illness (physical and psychological)	Increase	++
Decontamination and disposal of bio-hazardous waste	Increase	++
Disruptions in commerce (local, national and international	Increase	++
Animal illness and death	Increase	+
Lower than projected effectiveness of prophylaxis	Decrease	− − −
Adverse drug reactions due to prophylaxis	Decrease	−
Post-attack prophylaxis distribution costs, including crowd control and security	Decrease	−
Training and other skill maintenance costs	Decrease	−
Procurement and storage of antimicrobial drugs and vaccines before attack	Decrease	−
Criminal investigations and court costs	Variable	+/−

Table 15: Potential factors affecting the economic impact of a bioterrorist attack (Source: Kaufmann and al., 1997)

This Table shows that some factors have an influence on the consequences of an attack. Having preventive measures in place against an attack could decrease the potential impact associated to the attack. It is even more relevant in the context of a mega event.

4.3. Consequences of Undesirable Events Related to Food Quantity

Shortage and product loss are two undesirable outcomes in addition to food contamination. Shortage and product loss always lead to a loss of income. Shortage could have an impact on the image and the reputation of the company, especially given the visibility of mega events. This undesirable outcome could cause a drop in the market share. Another consequence could be a loss of trust from

shareholders and suppliers. Reacting to a shortage, a company could have recourse to competitors, which would not be a good sign for the industry.

The consequences of product loss are limited to the company, in terms of the impacts of its own finance. Product losses do not affect the reputation of the organization in the same way that product shortages do.

4.4. Other Undesirable Outcomes

4.4.1. Consequences of Pollution/Environmental Outcomes

The high visibility resulting from being a supplier in a mega event increases the potential consequences, for the organization, of pollution and environmental disaster. The following Table illustrates the impacts for the company in terms of public image if its environmental assessment is poor.

Assessment perceived by	**Impacts on company**
Investors and creditors	Business Risks, difficulty of obtaining capital
Competitors	Political and Strategic Advantages and disadvantages
Clients / Suppliers	Drop of reputation as a partner
Employees	Lower sense of belonging
Regulatory body, lobby	Loss of credibility and loss of room for manoeuvre

Table 16: Pollution and Environmental Impact

4.4.2. Consequences of Ethically Undesirable Outcomes

An ethical breach has been defined as any action taken by a company or even a business partner that could be considered unethical or immoral. Public opinion decides what is ethical and what is not. The high visibility resulting from being a supplier in a mega event increases the potential consequences of an ethical breach.

A number of factors will affect the individual's perception of risk which may be value based (section 3.4.3.2). The interaction of these factors is complex and it is the consumer's reaction to a combination of these factors that will ultimately impact the decision making process. The food industry must recognise that the general public wishes both food science and the probability of risk to be balanced against values which may be deemed irrational or emotive, otherwise a sense of suspicion and mistrust of either the government and/or the food industry could arise (Manning and al., 2006).

Factor	***Conditions associated with increased public concern***	**Conditions associated with decreased public concern**
Catastrophic potential-trend in fatalities and injuries	Grouped in time and space or identifiable pattern	Scattered and random
Familiarity	Unfamiliar hazard	Familiar hazard
Understanding of mechanisms and processes	Lack of understanding	Understood
Certainty about risk	Risk unknown to science	Risk known to science
Controllability (personal)	Uncontrollable	Controllable
Method of exposure	Involuntary	Voluntary
Effects on children	At risk	Not at risk
Effects manifestation	Delayed effects	Immediate effects
Effects on future generations	Risk	No risk
Victim identity	Identifiable as individuals or groups	Statistical victims
Dread	Effects dreaded	Effects non dreaded
Reversibility of effects	Irreversible	Reversible
Trust in institutions	Lack of trust	Institution trusted
Media attention	Large amount of attention	Minimal attention
Origin	Caused by human actions or failures	Causes by act of God or Nature

Table 17: Factors affecting risk perception and evaluation (Source: Manning and al., 2006)

5. Process Flow

The assessment of the food safety and security system helps identify potential gaps and vulnerabilities in the event of a contamination of the food supply. It forms the basis for the development of a strategy and work plan for industries to ensure the resilience of the food safety and security system.

Before conducting any risk analysis, a company has to develop a simple diagram that shows the steps the company uses when it receives, produces, stores, and distributes the product.

The first element of a food security assessment is the characterization of the company operations:

- Characterize facility operations
- Identify and prioritize potential adverse consequences
- Determine critical components that might be subject to criminal actions (Risk Factors)
- Evaluate existing preventive measures and the need for additional countermeasures
- Develop a prioritized plan for corrective actions to reduce or mitigate potential vulnerabilities

A flow diagram illustrates with simple blocks or symbols the steps required to manufacture and distribute a food product. This step provides an important visual tool that the HACCP[34] team can use to complete the remaining steps of the HACCP development plan. The flow diagram provides a clear, simple description of the steps involved in the processing of the product and its associated ingredients as they "flow" from receipt to distribution. A flow diagram should (U.S. Food and Drug Administration, 2001):

- Cover all of the steps in the process that your firm performs.
- Include receiving and storage steps for each of the ingredients, including non-fishery ingredients.
- Be verified on-site for accuracy.

[34] Explanation of HACCP Method is given on section 8.2.

- The flow diagram should be clear enough so that people unfamiliar with the process can quickly understand processing stages[35].

Figure 6 is an example of a generic process flow diagram for import establishments that includes: receiving, unloading, staging, re-inspection, storage, loading and shipping/distribution.

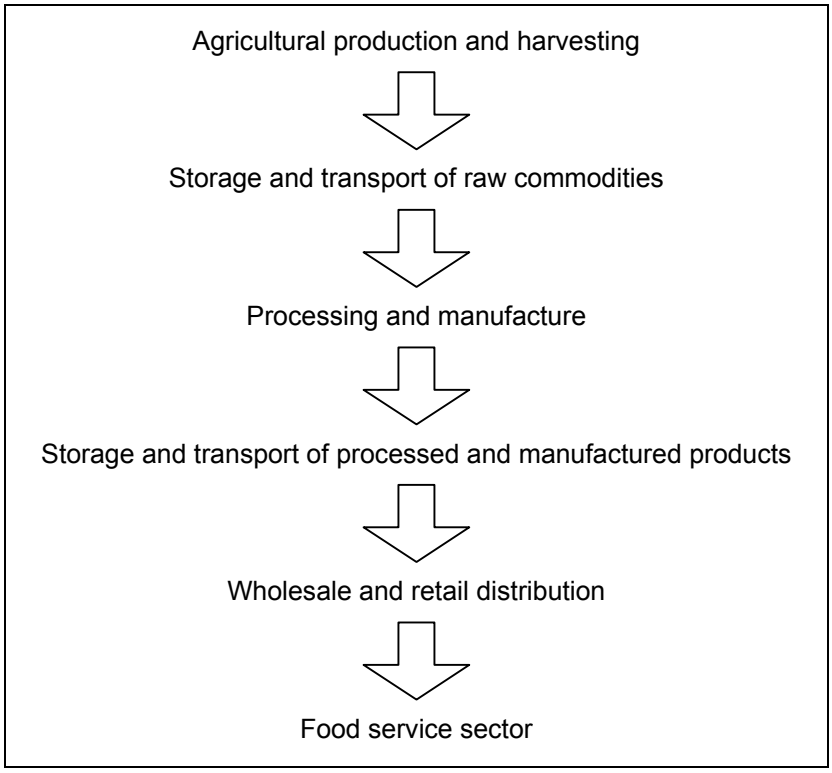


Figure 6 : General Overview of The Typical Food Chain (source: World Health Organization, 2002)

To conclude this section, it is important to underline the usefulness of the flow diagram to better identify risk factors and possible associated undesirable outcomes. In fact, each step of the food process is potentially associated with one or more risk factors. Schematizing the process will help a company to determine critical components that might be subject to criminal actions and assist in putting a risk management system in place. The diagram helps

[35] "*Juice HACCP Training Curriculum*", First edition August 2002, Developed by the Juice HACCP Alliance as recognized by the Food and Drug Administration.

capture complex processes or systems in an image that can be analysed in its parts and as a whole – exploring, for example, how change in one element may have effects on others. Once the diagram is complete, questions can be asked about how to improve the system, where it is failing and what actions would most effectively improve it. Often, key points of leverage become clearer.

Moreover, the food flow diagram also allows for the highlighting of all the suppliers and subcontractors implicated in the food process. It helps the company to take their risks into account.

6. Complementary Tools

6.1. The Positioning of the Risk Analysis Grid in the Food Industry

In the previous pages, a tool helping a company who wants to be a supplier in a mega event to identify risk factors was proposed. The analytical grid has a double utility. On the one hand, before obtaining a contract, the grid is used to assess the situation of the company with respect to the risks in the context of a mega event. It's a decision making tool that evaluate the capacity of the company to go forward with the contract (or to give it up) and it also permits a better estimation of the pricing. On the other hand, the grid is very useful for a company that already has a contract for a mega event to better detect the critical point in their supply chain. They can do a better allocation of resources to improve the prevention, the preparation, and the intervention in the case of an emergency.

Organizations in the food sector that already manage risks, demonstrate good corporate responsibility, and meet legal requirements to remain competitive, protect their reputation and enhance their brand. An effective food safety management system based on a proven standard helps organizations achieve these goals.

Different food standards already exist such as HACCP, ISO 22000 and Safe Quality Food, which apply almost exclusively to food safety. There are also food security methods such as Carver and Operational Risk Management (better known as ORM). These methods or standards are not specific to mega events. However, the analytical grid presented in this report is specific to mega events. It also includes some aspects of operational and contractual risks. Consequently, the analytical grid provides reinforcement and a complement to the existing methods and standards of food safety and food security. The goal of this report is not to provide an exhaustive description of the food safety and the food security methods. The objective of this report is to offer an overview of possible methods to support adequate risk management practice.

That is why a more detailed description of methods can be found in Appendices 8.2 to 8.6.

6.2. Short Description of Complementary Tools

This section presents a short description of each method. It is followed by a comparison of the methods.

HACCP (Appendix 8.2)

Hazard Analysis and Critical Control Points (HACCP) is a systematic preventive approach to food safety that addresses physical, chemical and biological hazards as a way to prevent problems instead of inspecting finished products. HACCP is used in the food industry to identify potential food safety hazards, so that key actions, known as Critical Control Points (CCP's) can be taken to reduce or eliminate the likelihood of hazards being realised. The system is used at all stages of food production and preparation processes.

ISO 22000:2005 – Food Safety Management System Standard (Appendix 8.3)

ISO 22000:2005 is an international standard that defines the requirements of a food safety management system. It covers all organizations in the food chain and for organizations involved in the food chain, materials and services that could impact on the food safety.

The standard combines generally recognized key elements to ensure food safety along the food chain. It includes interactive communication, system management, and control of food safety hazards through pre-requisite programs and HACCP plans, and continual improvement and updating of the management system.

The Safe Quality Food (SQF Program) (Appendix 8.4)

The SQF Program, owned by the Food Marketing Institute (FMI), is a retail trade association. Both standards (SQF1000 and SQF2000) are recognized by the Global Food Safety Initiative (GFSI), an international retail organization, as meeting or exceeding their

benchmark for requirements for food safety and quality management systems. The SQF standards are based on the National Advisory Committee on Microbiological Criteria for Foods (NACMF) and Codex Hazard Analysis and Critical Control Point (HACCP) principles and guidelines. They cover all the food supply chain.

The SQF Program consists of:

- SQF 1000 Code (for primary producers) and the
- SQF 2000 Code (for food manufacturers).

Carver Method (Appendix 8.5)

Developed by the Department of Defence for the military's target prioritization purposes, the CARVER method is a target prioritization tool that identifies vulnerabilities from a terrorist's point of view. The CARVER method is interested in conditions associated with terrorism targeting the food sector and therefore public health. The evaluation of the risks/vulnerability couple in the sectors of production, transport and food distribution as well as the research for critical nodes that are the most likely targets for terrorist attack make this method a tool well adapted to food security.

CARVER is an acronym for the following six attributes used to evaluate the attractiveness of a target for attack (USDA, 2005b) :

- Criticality - measure of public health and economic impacts of an attack
- Accessibility – physical access to the target
- Recuperability - ability of system to recover from an attack
- Vulnerability - ease of accomplishing attack
- Effect - amount of direct loss from an attack as measured by loss in production
- Recognizability - ease of identifying target.

In addition, the modified CARVER tool evaluates a seventh attribute, the combined health, economic, and psychological impacts of an attack, or the SHOCK attributes of a target.

Operational Risk Management Process (Appendix 8.6)

Operational Risk Management (ORM) is a method helping companies to enhance food safety and security by minimizing risk at each step in food production from farm to fork. The concept was inspired by efforts to improve safety and reduce losses in aircraft, space vehicles, and nuclear power plants. The goal is to have the best food safety and security measures at the lowest cost possible. It is a 6-step sequence to increase operational effectiveness by anticipating hazards and reducing the potential for loss. The purpose of ORM is to minimize risks to acceptable levels. ORM allows more effective use of resources to reduce mishaps and can be used to improve food safety and security (U.S. Department of Health and Human Services, 2001).

6.3. Comparison of the Tools

Methods and tools of food safety and food security management were compared (standard as ISO 22000 were not included in the comparison). Many similarities can be observed between the methods:

	Steps		***HACCP***	***CARVER***	**ORM**
1	Creation of a specialized team		✓	✓	✓
2	Development of a plan		✓	✓	✓
3	Flow Diagram		✓	✓	✓
4	Product Description		✓		
5	Regrouping products by categories		✓		
6	Hazard analysis		✓	✓	✓
7	Identification of Critical Control or Vulnerable Points		✓	✓	
8	Establishment of Critical Limits		✓		
9	Risk assessment	Probability/gravity/vulnerability		✓	
		Probability/gravity (matrix)			✓
10	Assignation of scores			✓	✓
11	Assessment of risk exposure				✓
12	Control	Monitoring system	✓		✓
		Alert system			✓
		Security system			✓
		Employee formation	✓		✓
13	Establishment of corrective actions, verification		✓	✓	✓

Table 18: Comparison of Steps for the HACCP, Carver and ORM Methods

ORM appears similar to HACCP. However, it is a more useful tool because it gives companies a standardized methodology for performing a risk assessment and prioritizing mitigation efforts.

The HACCP method considers the hazard as a central element, which, by its nature, and the range of its consequences on human health, determines the policies and measures set up in order to ensure food safety. The CARVER method is interested in conditions and consequences associated with terrorism targeting the food sector and by extension, public health. The evaluation of the risks/vulnerability couple in the sector of production, transport and food distribution as well as the research for critical modes that are the most likely targets for terrorist attack make the CARVER method a tool more specific and adapted to food security. The attribution of a scale for each factor considered (Criticality, Accessibility, Recoverability, Vulnerability, Effect, Recognizability), and the interest for the entire food supply chain as well as the sequential analysis of food security risks (specifically related to malevolent and terrorist activities), makes the CARVER method complementary to the HACCP system.

The CARVER method simplifies and standardizes the process. It breaks down “exposure” and “hazard” into characteristics that are easily defined and can be examined independently. It provides a measurable scale for each of the characteristics to facilitate quantitative assessment. What is very specific to the CARVER method is the examination of public health, as well as the economic and psychological consequences of an attack. It is definitely an offensive targeting tool.

ORM is developed on two axes, the analysis and estimation of hazards/risks on the one hand, and the implementation of risk controls (reject, avoid, delay, transfer, spread, compensate, reduce) on the other hand. The preventive character of the ORM method is doubled by an operational view, developed to intervene in case of attack on a nodal point. The planning, the design, and the implementation of safety and security alert systems define its main objective, which is to plan operations or conceive systems without hazards. The ORM approach is similar to HACCP as it recognizes that some risk is inevitable. However, it tolerates no unacceptable

risk. ORM is different from other methods because of its proactive character. Indeed, the key when using ORM is being proactive, anticipating what might occur and the associated consequences. Here is a table summarizing the differences:

Traditional risk management	**ORM**
Random, individual dependent	Systematic
Common sense	Methodical
Uniformed decision	Decision based on risk vs. benefit
Compliance based	Involvement and empowerment
Reactive	Proactive

Table 19: Risk Comparison (Source: U.S. Department of Health and Human Services, 2001)

7. CONCLUSION

Although information on risk management does exist, no in-depth research had been done on risk management of the food production chain (including food safety and food security) in the context of mega events.

This report presented the first findings of an integrated risk management methodology for the food industry in the context of a mega event. The proposed methodology is innovative by specifically targeting mega events and by integrating safety risks and security risks.

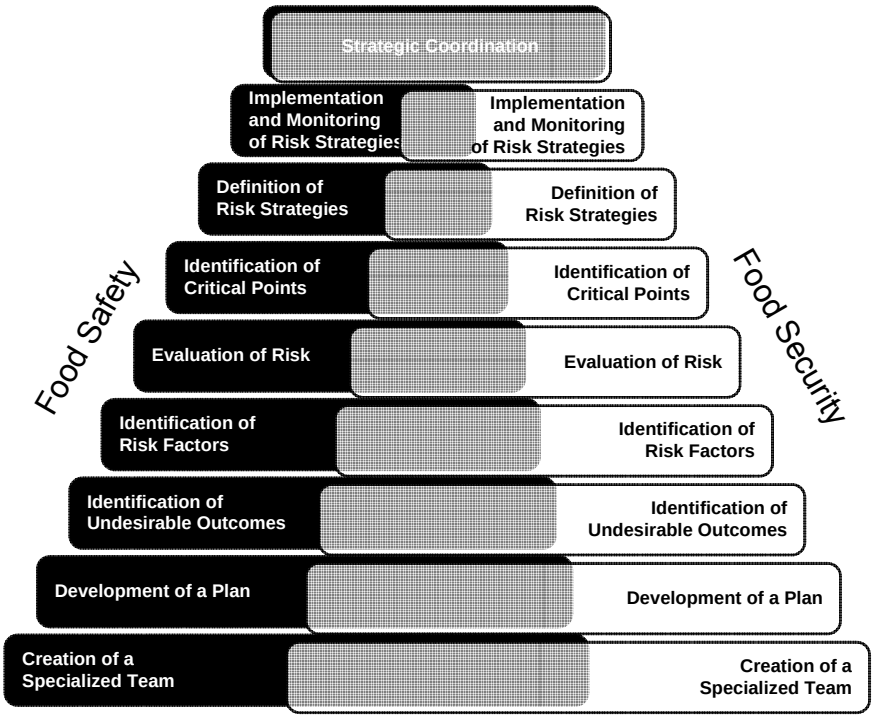
The associated tool, the risk analysis grid, can assist suppliers in the context of mega events by helping them in identifying, evaluating, and managing risks. The methodology specifically targets risk associated with mega events. It does not focus on normal operations. It is complementary to other existing methodologies and standards such as HACCP, ORM, ISO 22 000 and, CARVER.

An important element presented in the report about food safety and food security existing methods and the risk analysis grid can be illustrated by the following figure, whose structure defines:

- Some elements are common to both food safety and food security. These elements are included in the methodology process integration. It is illustrated in the figure by the gray area in the middle. It is the overlap between security and safety activities.
- Some knowledge, expertise and skills is specific to food safety and food security. It is illustrated by the black and white areas. On the safety side, the expertise to consider is a food processing one. How is the product transformed from farm to fork? However, on the security side, it requires expertise in logistics.
- At the strategic level, food safety and food security efforts have to be coordinated in an integrated manner. Such integration is the only way to guarantee that the overlaps (gray areas) are managed adequately.

The risk evaluation of food safety and food security in the context of a mega event has to be integrated even if the strategies used to

deal with security and safety will differ on some aspects. These two facets of risk management cannot be dissociated.



Methodology

This report is a first take on the integration of food safety and food security risk management. It enabled the development of the risk analysis grid, which complements existing tools (such as HACCP, ORM, CARVER, etc.).

Future research

This preliminary study has to be extended. The grid will be validated by systematic interviews conducted at selected companies involved in mega-events. The grid will be refined by conducting surveys seeking to better understand how much attention was recently allocated to hazard reduction and risk management, in the context of a mega-event.

Future research should also document several examples of case studies to identify the lessons that could be learned from these cases. The evaluation of other aspects of mega events could also be documented. By identifying risk management practices applicable to mega events in areas other than food, some methods and

approaches might be identified and transferred to the food industry. All these avenues suggest that risk management in the context of mega events is a promising area for future research.

8. Appendices

8.1. Risk analysis grid

Event	**Microbiological food contamination**		**Chemical food contamination**		**Physical food contamination**		**Presence of allergens**		**Stated compliance with religious or other beliefs**		**Shortage**		**Product loss**		**Going beyond budget**		**Going beyond schedule**		**Pollution and other environmental issues**		**Ethical breach**		**Favourability of the factor (2007-01-01)**
	Safety	**Security**	**Safety**	**Security**	**Safety**	**Security**	**Safety**	**Security**	**Safety**	**Security**	**Safety**	**Security**	**Safety**	**Security**	**Safety**	**Security**	**Safety**	**Security**	**Safety**	**Security**	**Safety**	**Security**	
Host Country (3.5.1.1.)																							
Country Risk Classification																							
Human Development Index																							
Trade Policy																							
Monetary Policy																							
Capital Flow and Foreign Investments																							
Banking and Finance (stability, efficiency)																							
Property Rights (legal system)																							
Regulation (adequate protection and control)																							
Informal Market																							
Level of Economic/Industrial Development of the Host Country																							
Infrastructures of the Host Country																							
Sanitary Conditions in the Host Country																							
Disease Outbreaks in the Host Country																							
Cultural Fit																							

Table 20: Risk Analysis Grid

Event	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Failed compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Organizing committee of the event (3.5.1.2.)																							
Experience in large events																							
Existence of a Business Partner Selection Process																							
Type of Employees (full time, part time, or volunteer)																							
History of Unethical Behaviour																							
Prestige of the Event (3.5.1.3.)																							
Sponsorship Incomes																							
Broadcast Revenues																							
Number of Countries in which the Event Is Broadcasted																							
Number of Reporters Covering the Event																							
Number of Offsite Spectators (TV, radio, newspaper)																							
Type of Event																							
Professional Status of the Participants																							
Tradition / History of the Event																							
Recognition by a Governing Body																							
Country of Origin of the Spectators																							

Table 20 (continued): Risk Analysis Grid

Event	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Size of the Event (3.5.1.4.)																							
Number of Participants																							
Number of Spectators on Site																							
Number of Staff Members and Volunteers																							
Site of the Event (3.5.1.5.)																							
Number of point of services and distance between them																							
Quality of the Site Infrastructure																							
Traffic Congestion																							
History Record of Vandalism for Events in Host Country																							
History Record of Vandalism for the Particular Event Type																							

Table 20 (continued): Risk Analysis Grid

Event	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Complexity of the Event (3.5.1.6.)																							
Number of Languages Spoken																							
Number of Countries Involved																							
Timeline of the Event (3.5.1.7.)																							
Presence of a Fixed Deadline																							
Recurrence of the Event																							
Event Duration																							

Table 20 (continued): Risk Analysis Grid

Organization	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Business expertise (3.5.2.1.)																							
Up-to-Date Technology Utilization																							
Certification (ISO 9000/22000, quality label, HACCP…)																							
Certification (Kosher, bio, GMO free)																							
Quality of Work																							
Productivity																							
Quality of Process																							
Availability of skills within business staff																							
Business experience (3.5.2.2.)																							
Experience in Large Events																							
Number of Years in Business for Business																							
Available Production Level Capacity																							
Capability of JIT																							
Relative Project Size																							

Table 20 (continued): Risk Analysis Grid

Organization	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Organization Management (3.5.2.3.)																							
Knowledgeable Leadership																							
Use of Foreign Labour																							
Ethical Standards of Business																							
Existence of Coordination Mechanisms																							
Clear goals / objectives / scope																							
Effective Communication Mechanisms																							
Clarity of role definition																							
Strikes and Labour Disputes, Conflict, etc.																							

Table 20 (continued): Risk Analysis Grid

Organization	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Business Processes (3.5.2.4.)																							
Existence of a Risk Management Plan (general)																							
Existence of a Risk Management Plan (food safety)																							
Existence of a Risk Management Plan (food security)																							
Existence of a Crisis Management Plan																							
Traceability Capability of Products Sold																							
Existence of a Recall Plan																							
Existence of a Quality Control Process																							
Existence of a Quality Audit Process																							
Existence of a Human Resources Selection Process																							
Existence of a Human Resources Training Program																							
Existence of a Human Resources Evaluation Process																							
Existence of a Business Partner Selection Process																							
Existence of a business partner evaluation process																							
Existence of an escalation process																							
Existence of Communication Mechanisms																							
Task Complexity																							

Table 20 (continued): Risk Analysis Grid

Organization	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Organization Employees (3.5.2.5.)																							
Number of Employees																							
Employee Turnover																							
Level of Awareness																							
Level of Absenteeism																							
Type of Employees (full time, part time, contractual)																							
Products (3.5.2.6.)																							
Reliable Sourcing Channels																							
Number of Sourcing Channels																							
Reliable Production Sites																							
Number of Production Sites																							
Reliable Storage Sites																							
Number of Storage Sites																							
Type of Products																							
Number of Different Products																							
Number of Ingredients in Products																							

Table 20 (continued): Risk Analysis Grid

Organization	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Organization Financial Situation (3.5.2.7.)																							
Financial Stability																							
Lack of Funds to Proceed with Work																							
Capability to Afford Adequate Labour																							
Transportation (3.5.2.8.)																							
Number of Transportation segments																							
Number of Handling																							
Minimum Transportation Time																							
Transportation Mode																							
Distance between Organization and Event																							
Volume of Goods																							

Table 20 (continued): Risk Analysis Grid

Business Partner	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Business Partners (general) (3.5.3.1.)																							
Number of Business Partners																							
Availability of Qualified Business Partners																							
Dependence on a Specific Business Partner																							
Existence of Preferred Business Partner																							

Table 20 (continued): Risk Analysis Grid

Business Partner	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
Country of the Business Partner (for each business partner)	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Country Risk Classification																							
Human Development Index																							
Trade Policy																							
Monetary Policy																							
Capital Flow and Foreign Investments																							
Banking and Finance (stability, efficiency)																							
Property Rights (legal system)																							
Regulation (adequate protection and control)																							
Informal Market																							
Level of Economic/Industrial Development of the Host Country																							
Infrastructures of the Host Country																							
Sanitary Conditions in the Host Country																							
Disease Outbreaks in the Host Country																							
Cultural Fit																							

Table 20 (continued): Risk Analysis Grid

Business Partner	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Business partner expertise (for each business partner) (3.5.3.3.)																							
Up-to-Date Technology Utilization																							
Labels and standards (ISO 9000/22000, quality label, HACCP…)																							
Certification (Kosher, bio, GMO free)																							
Quality of Work																							
Productivity																							
Quality of Process																							
Availability of skills within business partner staff																							
Business partner experience (for each business partner)(3.5.3.4.)																							
Experience in Large Events																							
Number of Year in Business for Business Partner																							
Available Production Level Capacity																							
Capability of JIT																							
Relative Project Size																							

Table 20 (continued): Risk Analysis Grid

Business Partner	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Failed compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Business Partner Management (for each business partner)(3.5.3.5.)																							
Knowledgeable Leadership																							
Use of Foreign Labour																							
Ethical Standards of Business Partners																							
Existence of Coordination Mechanisms																							
Clear goals / objectives / scope																							
Effective Communication Mechanisms																							
Clarity of role definition																							
Strikes and Labour Disputes, Conflict, etc.																							

Table 20 (continued): Risk Analysis Grid

Business Partner	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Business Partner Processes (for each business partner)(3.5.3.6.)																							
Existence of a Risk Management Plan (general)																							
Existence of a Risk Management Plan (food safety)																							
Existence of a Risk Management Plan (food security)																							
Existence of a Crisis Management Plan																							
Traceability Capability of Products Sold																							
Existence of a Recall Plan																							
Existence of a Quality Control Process																							
Existence of a Quality Audit Process																							
Existence of a Human Resources Selection Process																							
Existence of a Human Resources Training Program																							
Existence of a Human Resources Evaluation Process																							
Existence of a Business Partners Selection Process																							
Existence of a business partners evaluation process																							
Existence of an escalation process																							
Existence of Communication Mechanisms																							
Task Complexity																							

Table 20 (continued): Risk Analysis Grid

Business Partner	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Business Partner Employees (for each business partner)(3.5.3.7.)																							
Number of Employees																							
Employee Turnover																							
Level of Awareness																							
Level of Absenteeism																							
Type of Employees (full time, part time contractual)																							

Table 20 (continued): Risk Analysis Grid

Business Partner	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Business partner products (for each business partner) (3.5.3.8.)																							
Reliable Sourcing Channels																							
Number of Sourcing Channels																							
Reliable Production Sites																							
Number of Production Sites																							
Reliable Storage Sites																							
Number of Storage Sites																							
Type of Products																							
Number of Different Products																							
Number of Ingredients in Products																							
Business partner financial (for each business partner)(3.5.3.9.)																							
Financial Stability																							
Lack of Funds to Proceed with Work																							
Capability to Afford Adequate Labour																							

Table 20 (continued): Risk Analysis Grid

Business Partner	Microbiological food contamination		Chemical food contamination		Physical food contamination		Presence of allergens		Stated compliance with religious or other beliefs		Shortage		Product loss		Going beyond budget		Going beyond schedule		Pollution and other environmental issues		Ethical breach		Favourability of the factor (2007-01-01)
	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	Safety	Security	
Transportation (for each business partner) (3.5.3.10.)																							
Number of Transportation segments																							
Number of Handling																							
Minimum Transportation Time (business to event)																							
Transportation Mode																							
Distance between Business Partner and Organization																							
Volume of Goods																							
Business partner outsourcing chain (for each business partner)(3.5.3.11.)																							
Existence of a Business Partners Selection Process																							
Existence of a business partners evaluation process																							
Localisation of Business Partner																							
Existence of Business Partners Selection Process																							

Table 20 (continued): Risk Analysis Grid

8.2. HACCP

Hazard Analysis and Critical Control Points (HACCP) is a systematic approach to food safety that looks at physical, chemical and biological hazards as a way to prevent problems instead of simply inspecting finished products. HACCP is used in the food industry to identify potential food safety hazards, so that key actions, known as Critical Control Points (CCPs) can be used to reduce or eliminate the likelihood of hazards. The system is used at all stages of the food production and preparation process.

HACCP forms the basis of formal food safety management systems such as the SQF and ISO 22000 (These standards are discussed in section 8.3). The development of a HACCP system, by a business is the first step towards the implementation of either of these formal food safety management systems .[36]

The programs that are used most often to enhance food safety and quality fall into three categories: Good Manufacturing Practices (GMPs), sanitation, and Hazard Analysis Critical Control Points (HACCP) programs. HACCP programs specifically reduce food safety risks; while GMPs and sanitation are "prerequisite" programs to the HACCP approach (see Figure 7).

[36] Website of BSI, [ref. January 16th, 2007], http://www.bsiamericas.com/Food/Overview/index.xalter

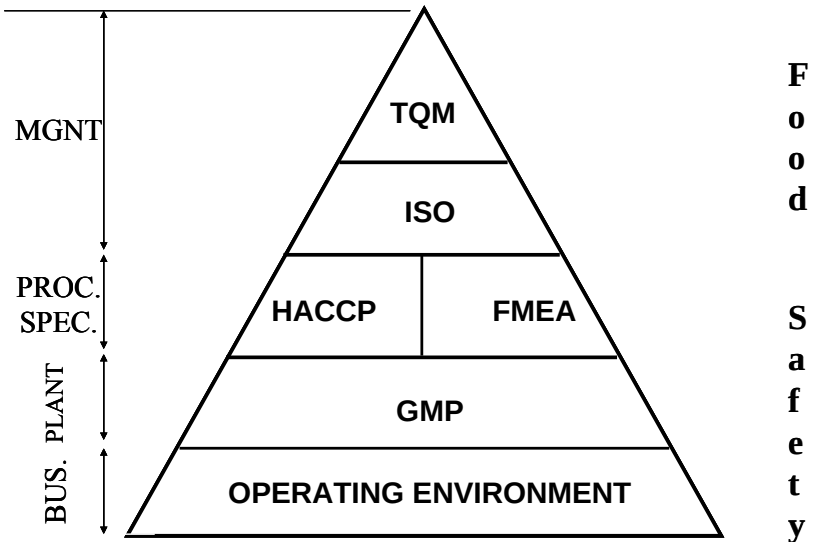


Figure 7 : Food Safety Structure (Source: Serban Teodoresco, 1999)

In the next subsection, Prerequisite programs to HACCP are presented, followed by the seven principles involved in developing a HACCP plan.

8.2.1. Prerequisite Programs

HACCP systems must be built on a solid foundation, and be compliant with current Good Manufacturing Practices (GMPs) (Code of US Federal Regulations, Title 21, Part 110) and acceptable Sanitation Control Procedures (SCPs).[37] GMPs and sanitation control procedures affect the processing environment and are considered prerequisite programs to the HACCP system.

Prerequisite programs are procedures, such as Good Manufacturing Practices, which address operational conditions in order to provide the foundation for the HACCP system. Prerequisite programs must

[37] The Good Manufacturing Practices define measures of general hygiene as well as measures that prevent food from becoming adulterated due to unsanitary conditions. The GMPs are broadly focused and encompass many aspects of plant and personnel operations. The SCPs are usually specified as Sanitation Standard Operating Procedures (SSOPs). SSOPs are procedures used by food processing firms to help accomplish the overall goal of maintaining GMPs in the production of food. Typically, SSOPs describe a particular set of objectives associated with sanitary handling of food and the cleanliness of the plant environment and the activities conducted to meet them. Source: National Seafood HACCP Alliance for Training and Education, (2001), "HACCP: Hazard Analysis and Critical Control Point Training Curriculum", 4th edition, November.

be developed, implemented, and documented before conducting the hazard analysis and implementing a HACCP plan.

Prerequisite programs typically outline universal steps or procedures to control the operational conditions within a food establishment. More specifically, they promote environmental conditions that are favourable to the production of safe food.[38]

A list of subjects covered by the prerequisite programs include the following:

- Facilities
- Production equipment
- Standard operating procedures
- Supplier controls
- Production specification
- Personnel policies
- Traceability and recalls

8.2.2. The HACCP Seven Principles

HACCP is often associated with its seven basic principles. However, it also includes preliminary steps (HACCP team assembly, description, food and distribution, identify intended use and consumers of food, develop flow diagram, verify flow diagram). Failure to properly address the preliminary steps may lead to ineffective design, implementation, and management of the HACCP plan. These preliminary steps become even more critical when formulating a plan for a mega event.

HACCP is "product specific," which means that a plan is developed for each specific product manufactured by a company. Thus, before proceeding with the seven principles, the team describes the product and draws a flow diagram of the entire process. The flow diagram should represent reception of incoming ingredients, as well as all the processing, packaging, and storage steps. The team applies the seven principles of HACCP to each step of the flow diagram, which

[38] Website of the Canadian Food Inspection Agency http://www.inspection.gc.ca/ [ref. January 16th, 2007]

are documented in the following paragraphs (Codex: *Alimentarius Commission, 2003*).

Principle 1: Conduct a Hazard Analysis

In this first step, the organization assesses hazards associated with growing, harvesting raw materials and ingredients, processing, manufacturing, distributing, marketing, preparing, and consumption of the food. They identify all significant hazards (biological, chemical, and physical) that need to be controlled to assure food safety through each step in the process. (Linton, 2001)

Principle 2: Identify Critical Control Points (CCP)

The organization identifies points in the flow of a food product with critical limits that must be met to control the identified hazards. These are the CCPs. If loss of control occurs at a CCP, it could lead to an unacceptable health risk. (Linton, 2001). The next Figure shows an example of a decision tree used to identify critical control points:

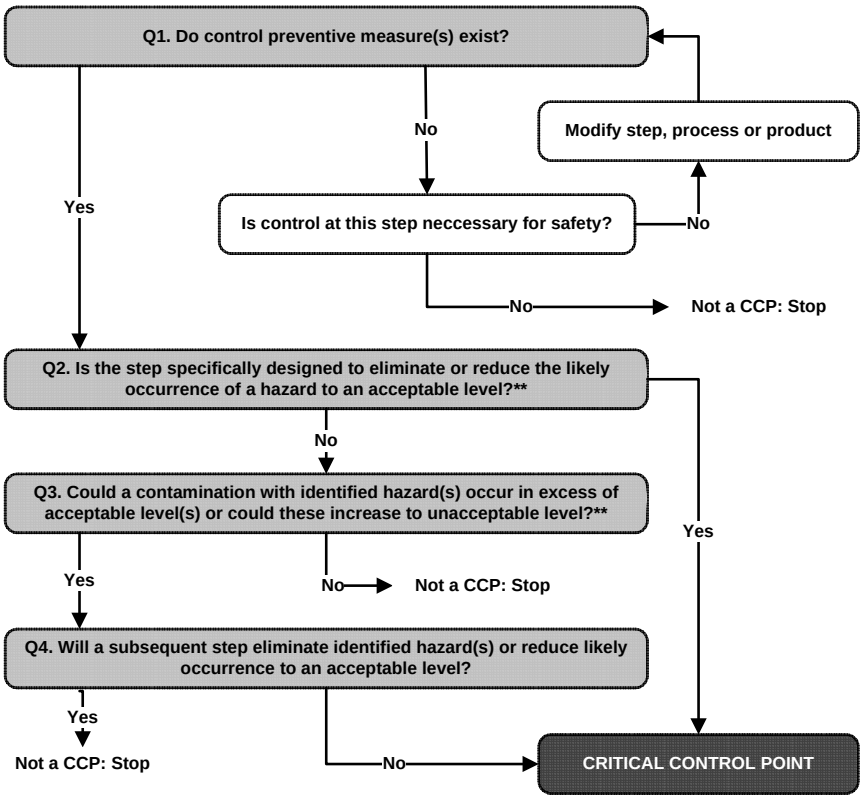


Figure 8 : Decision tree to identify CCP (Source: FAO, 1998)

Principle 3: Establish Critical Limits for Each Critical Control Point

A critical limit is the maximum (or minimum) value tolerable for a physical, biological, or chemical hazard when controlled at a critical control point. Staying within the established limit will prevent, eliminate, or reduce to an acceptable level the risk. CCP limits are usually based on time, temperature, pH, or moisture content of food.

Principle 4: Establish Critical Control Point Monitoring Requirements

Monitoring activity is necessary to ensure that the process is under control at each critical control point.

Principle 5: Establish Corrective Actions

Whenever food companies note an unacceptable deviation from the critical limits for a CCP, they must take corrective action. Actions may include changing the process, reprocessing, or discarding the product. (Linton, 2001)

Principle 6: Establish Record Keeping Procedures

HACCP regulations require that all plants maintain sufficient documentation, including the hazard analysis and written HACCP plan. Furthermore, the monitoring of critical control points, critical limits, other verification activities, and the handling of processing deviations must also be well documented.

Principle 7: Establish Procedures for Verifying the HACCP System

Once the HACCP system is in place, a company must ensure that it is effective. In order to accomplish this, management may request an internal or external food safety audit to verify that their HACCP plan is working. And it may include laboratory testing for absence of food-borne hazards in the finished product. (Linton, 2001)

8.2.3. Limits of the HACCP Method

This method is used to identify potential hazards, and establish the means to control them during the fabrication process. However, this method does not take into account the changing nature of the work environment during a mega event. Increased stress, tight supply

deadlines, or working in an unfamiliar environment can all reduce the effectiveness of the HACCP method.

8.3. ISO 22000:2005 – Food Safety Management System Standard

ISO 22000:2005 is an international standard that defines the requirements of a food safety management system. It covers all the organizations and any materials and services that could have an impact on food safety.

The standard combines generally recognized key elements to ensure food safety along the food chain. It includes interactive communication, system management, and control of food safety hazards through pre-requisite programs and HACCP plans, and continuous improvement and updating of the management system. ISO 22000:2005 defines the requirements for companies that seek to exceed the regulatory requirements for food safety.

The standard combines key elements to enable the management of food safety along the food chain including (BSI, 2005) :

- Integration of the HACCP principles and application procedures developed by the Management Codex Alimentarius Commission
- System management
- Control of food safety hazards through prerequisite programs and HACCP plans, including interactive communication with suppliers, customers, regulators and consumers.

Developed in collaboration with food sector experts, ISO 22000 incorporates the principles of HACCP and covers the requirements of key standards developed by various global food retailer syndicates, in a single document. Thus, ISO 22000 makes it easier for organizations worldwide to implement the Codex HACCP system for food hygiene on a consistent basis, which does not vary by country or food product.

To pursue this objective, ISO/TS 22004 includes a flow chart on the planning of safe food that combines steps addressed by the Codex HACCP guidelines and steps specific to ISO 22000. The following

Table shows the links between Codex HACCP and ISO 22000:2005.

Codex HACCP		**ISO 22000:2005 element**	
Step	***Description***	***Number***	***Description***
Preliminary step 1	Assemble the HACCP team	7.3.2	Food safety team
Preliminary step 2	Describe the product	7.3.3	Product characteristics
		7.3.5.2	Description of the process steps and control measures
Preliminary step 3	Identify intended use	7.3.4	Intended use
Preliminary step 4	Construct a flow diagram	7.3.5.1	Flow diagram
Preliminary step 5	On site review of the flow diagram	7.3.5.1	Flow diagram
Principle 1	Conduct a hazard analysis	7.4	Hazard analysis
Principle 2	Determine CCPs	7.6.2	Identification of the critical control points (CCP)
Principle 3	Establish critical limits	7.6.3	Determination of critical limits for CCP
Principle 4	Establish a monitoring system for the CCP	7.6.4	Systems for the monitoring of critical control points
Principle 5	Establish corrective action to be taken when monitoring indicates that a particular CCP is not under control	7.6.5	Actions when monitoring results exceed critical limits
Principle 6	Establish procedures to check that the HACCP system is effective	7.8	Verification planning
		8.2	Validation of control measures combinations
		8.4	Food safety management system verification
Principle 7	Establish documentation and record keeping	4.2	Documentation requirements
		7.7	Updating preliminary information and documents specifying the PRPs and the HACCP plan

Table 21: Links between Codex HACCP and ISO 22000:2005 (Source: BSI, 2005, "What is ISO 22000:2005?")

8.4. The Safe Quality Food (SQF Program)

The SQF Program is owned by the Food Marketing Institute (FMI), a retail trade association. Both standards (SQF1000 and SQF2000) are recognized by the Global Food Safety Initiative (GFSI), an international retailer organization, as meeting or exceeding their benchmark for food safety and quality management systems. The SQF standards are based on the National Advisory Committee on Microbiological Criteria for Foods (NACMF) and Codex Hazard Analysis and Critical Control Point (HACCP) principles and guidelines. They cover the entire food supply chain.

The SQF Program consists of:

- SQF 1000 Code (for primary producers) and the
- SQF 2000 Code (for food manufacturers).

The SQF 2000 Code is a HACCP food safety and quality management program designed primarily for the processing and manufacturing sector. More recently, suppliers in the food industry such as food packaging manufacturers, pest control contractors, crop harvest and crop spray contractors have also implemented SQF 2000 systems. The methods used to manage food safety are documented in a Food Safety Plan and the methods used to manage quality are documented in a Food Quality Plan. The SQF 2000 Code is divided into three certification levels. Each level indicates the stage of development of a Supplier's food safety and quality management system (SQF Institute, 2006):

Suppliers can implement a management system which meets any of the following three levels of certification[39]:

- Level 1: Food Safety Fundamentals: Indicates that pre-requisite programs and fundamental food safety controls have been implemented to provide a sound foundation for

[39] Website of BSI, [ref. January 16th, 2007], http://www.bsiamericas.com/Can+Produits+Alimentaires/Normes/SQF.xalter

the further development of the supplier's management system.

- Level 2: Certified HACCP Food Safety Plans: Incorporates all Level 1 system requirements, and indicates that a food safety risk assessment of the product and its associated processes have been completed. This assessment must identify the hazards and the actions taken to eliminate, prevent, or reduce their occurrence.

- Level 3: Comprehensive Food Safety and Quality Management System: Incorporates all Level 1 and Level 2 system requirements, and indicates that a food quality risk assessment of the product and its associated processes have been completed. Additionally, at Level 3 organization must show that the actions taken to prevent the incidence of poor quality have been implemented and that the remaining quality management system procedures outlined in the standard have been implemented.

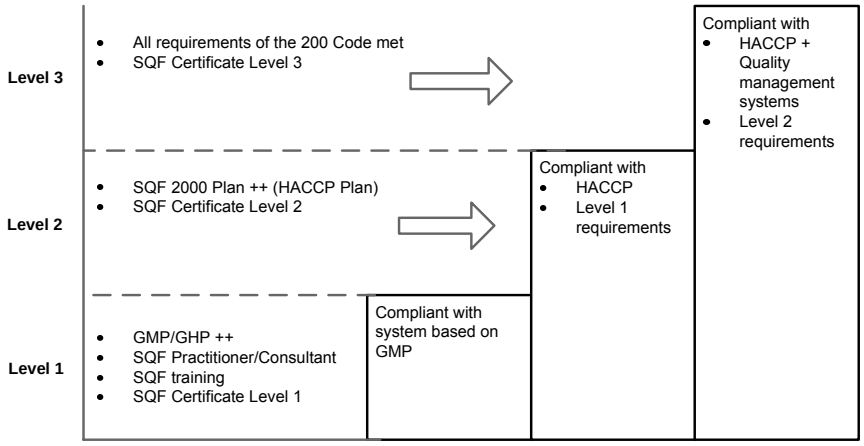


Figure 9 : Staged Approach - SQF1000/2000 Code (Source: Larry L. Hood, Ph.D., Johnson Diversey, 2006 Safe Quality Food Conference presentation)

8.5. Carver Method

Developed by the Department of Defence for the military's target prioritization purposes, the CARVER method is a target prioritization tool that identifies vulnerabilities from a terrorist's point of view. HACCP method considers the hazard as the central element which, by its nature and the range of its consequences on human health, determines the policies and measures set up in order to ensure food safety. Whereas, the CARVER method is interested in conditions and consequences associated with terrorism which targets the food industry and public health in general. The evaluation of the risks/vulnerability couple in the sectors of production, transport, and food distribution as well as the research for critical nodes that are the most likely targets for terrorist attack make this method a tool well adapted to food security.

- CARVER is an acronym for the following six attributes used to evaluate the attractiveness of a target for attack (USDA, 2005b):
- Criticality - measure of public health and economic impacts of an attack ;
- Accessibility – physical access to the target ;
- Recoverability - ability of system to recover from an attack
- Vulnerability - ease of accomplishing attack ;
- Effect - amount of direct loss from an attack as measured by loss in production ;
- Recognizability - ease of identifying target.

In addition, the modified CARVER tool evaluates a seventh attribute, the combined health, economic, and psychological impacts of an attack, or the SHOCK attributes of a target.

This tool[40] can be used to assess ones vulnerabilities to an attack. It allows the food industry to think like an attacker by identifying the most attractive targets for attack. By conducting such a vulnerability assessment and determining the most vulnerable

[40] A CARVER Software Tool is under development by the FSIS/USDA and should be available early 2007.

points in the infrastructure, a company can channel its resources into securing its most vulnerable points. (USDA, 2005b)

Here are the Six Steps of the Carver Method:

1. Establishing Parameters - parameters can be the type of food supply chain considered, the type of attack, type of attacker a company is trying to protect against, and the type of agent which can be employed during the attack.
2. Assembling Experts.
3. Detailing Food Supply Chain - It consists in developing a flow diagram for each product "farm to table" (Section 5).
4. Assigning Scores to each node (production step) - to determine vulnerability to introduction from an agent
5. Analyze the "theoretical threat" using Carver + shock scale
6. Determine research needs, mitigation strategies and lessons learned.

8.5.1. The Six Attributes of Carver Method plus Shock

The attractiveness of a target can be ranked on a scale from one to ten on the basis of scales that have been developed for each of the seven attributes listed in the previous section. Conditions associated with lower attractiveness (lower vulnerability) are assigned lower values (e.g., 1 or 2), whereas conditions associated with higher attractiveness as a target (higher vulnerability) are assigned higher values (e.g., 9 or 10). Evaluating the various elements of the food sector infrastructure for each of the CARVER-Shock attributes helps identify where, within that infrastructure, an attack is most likely to occur.

The following section defines the attributes used by Food and Drug Administration (FDA) and United States Department of Agriculture to conduct their vulnerability assessments and provides the scales used by the agencies for scoring each attribute. The subsequent section uses different sources such as Carson, 2005; USDA, 2005b; Ware, 2005.

8.5.1.1. Criticality - Measure of Public Health and Economic Impacts of an Attack

A target is critical when the introduction of threat agents into the food at this location would have significant health or economic impact. The criteria considered are related to the number of deaths or the economic losses.

How important is the target? Importance is determined by the impact of its destruction on operations and whether or not substitutes or back-ups exist for the target.

Here is an example of a scale used to evaluate the criticality.

Criticality Criteria	Scale
Loss of over 10,000 lives OR loss of more than $100 billion	9-10
Loss of life is between 1,000 – 10,000 OR loss between $10 billion and $100 billion	7-8
Loss of life between 100 and 1000 OR loss between $1 billion and $10 billion	5-6
Loss of life less than 100 OR loss less than $1 billion	3-4
No loss of life OR loss than $100 million	1-2

Table 22: Example of scale for criticality (source: USDA, 2005b)

8.5.1.2. Accessibility – Ability to Physically Access to the Target

A target is accessible if an attacker can reach it without being noticed. This measure is independent of the probability of successful introduction of threat agents. Therefore it includes the ability to gather intelligence, conduct reconnaissance, conduct the attack and leave the target undetected. One must ask: What are the barriers to an attack?

Accessibility criteria	Scale
Easily Accessible (e.g., target is outside building and no perimeter fence). Limited physical or human barriers or observation. Attacker has relatively unlimited access to the target. Attack can be carried out using medium or large volumes of contaminant without undue concern of detection. Multiple sources of information concerning the facility and the target are easily available.	9-10
Accessible (e.g., target is inside building, but in unsecured part of facility). Attacker has access to the target for an hour or less.	7-8

Attack can be carried out with moderate to large volumes of contaminant, but requires the use of stealth. Only limited specific information is available on the facility and the target.	
Partially Accessible (e.g., target is inside building, but in a relatively unsecured, but busy, part of facility). Under constant possible human observation. Some physical barriers may be present. Contaminant must be disguised and time limitations are significant. Only general, non-specific information is available on the facility and the target.	5-6
Hardly Accessible (e.g., inside building in a secured facility). Human observation and physical barriers with a established means of detection. Access generally restricted to operators or authorized persons. Contaminant must be disguised and time limitations are extreme. Limited general information available on the facility and the target.	3-4
Not accessible. Physical barriers, alarms, and human observation. Defined means of intervention in place. Attacker can access target for less than 5 minutes with all equipment carried in pockets. No useful publicly available information concerning the target.	1-2

Table 23: Example of scale for accessibility (source: USDA, 2005b)

8.5.1.3. Recoverability – Ability of System to Recover from an Attack

How long will it take to replace or repair the target once it is damaged or destroyed? The level of recoverability is determined by the requisite time for the contaminated production system to restore acceptable productivity.

Recoverability Criteria	**Scale**
> 1 year	9-10
6 months to 1 year	7-8
3-6 months	5-6
1-3 months	3-4
< 1 month	1-2

Table 24: Example of scale for recoverability (source: USDA, 2005b)

8.5.1.4. Vulnerability – Ease of Accomplishing Attack

Vulnerability is a measure of the ease with which threat agents can be introduced in quantities sufficient to achieve the attacker's purpose once the target has been reached. Vulnerability is determined both by:

- the characteristics of the target (e.g., ease of introducing agents, ability to uniformly mix agents into target) and
- The characteristics of the surrounding environment (ability to work unobserved, time available for introduction of agents).

The scale takes into account the probability, determined by the characteristics of the target, so that a sufficient quantity of agents of contamination is added to achieve aim.

Vulnerability criteria	**Scale**
Target characteristics allow for easy introduction or sufficient agents to achieve aim.	9-10
Target characteristics almost always allow for introduction or sufficient agents to achieve aim.	7-8
Target characteristics allow 30 to 60% probability that sufficient agents can be added to achieve aim.	5-6
Target characteristics allow moderate probability (less than 10 %) that sufficient agents can be added to achieve aim.	3-4
Target characteristics allow low probability (10 to 30%) that sufficient agents can be added to achieve aim.	1-2

Table 25: Example of scale for vulnerability (source: USDA, 2005b)

8.5.1.5. Effect – Amount of Direct Loss from an Attack as Measured by Loss in Production

What impact will the target's destruction have on the public, including psychological, domestic and international ramifications? For instance, will it undermine the public's confidence in the enterprise's systems, policies, processes? Effect is a measure of the percentage of infrastructure (daily productivity) damaged by an attack at a single facility.

Effect Criteria	**Scale**
Greater than 50% of the system's production impacted	9-10
25-50% of the system's production impacted	7-8
10-25% of the system's production impacted	5-6
1-10% of the system's production impacted	3-4
Less than 1% of system's production impacted	1-2

Table 26: Example of scale for effect (source: USDA, 2005b)

8.5.1.6. Recognizability – Ease of Identifying Target

A target's recognizability is the degree to which it can be identified by an attacker without confusion with other targets or components.

There are different factors that influence recognizability such as the size of the target, the complexity of the target and the existence of distinguishing characteristics.

Recognizability Criteria	**Scale**
The target is clearly recognizable and requires little or no training for recognition.	9-10
The target is easily recognizable and requires only a small amount of training for recognition.	7-8
The target is difficult to recognize or might be confused with other targets or target components and requires some training for recognition.	5-6
The target is difficult to recognize. It is easily confused with other targets or target components and requires extensive training for recognition.	3-4
The target cannot be recognized under any conditions, except by experts.	1-2

Table 27: Example of scale for recognizability (source: USDA, 2005b)

8.5.1.7. Shock – final attribute

Measured at the national level, shock gives the aggregate measure of health, psychological and collateral economic impact of a successful attack on the targeted system. Shock is evaluated using the following factors:

- the historical, cultural, religious, or other symbolic importance of the target;
- the number of deaths;
- the effects on the sensitive segments of population (children and old people);
- economic losses

Shock	**Scale**
Target has major historical, cultural, religious, or other symbolic importance. Loss of over 10,000 lives. Major impact on sensitive subpopulations, e.g., children or elderly. National economic impact more than $100 billion.	9-10
Target has high historical, cultural, religious, or other symbolic importance. Loss of between 1,000 and 10,000 lives. Significant impact on sensitive subpopulations, e.g., children or elderly. National economic impact between $10 and $100 billion.	7-8

Target has moderate historical, cultural, religious, or other symbolic importance. Loss of life between 100 and 1,000. Moderate impact on sensitive subpopulations, e.g., children or elderly. National economic impact between $1 and $10 billion.	5-6
Target has little historical, cultural, religious, or other symbolic importance. Loss of life less than 100. Small impact on sensitive subpopulations, e.g., children or elderly. National economic impact between $100 million and $1 billion.	3-4
Target has no historical, cultural, religious, or other symbolic importance. Loss of life less than 10. No impact on sensitive subpopulations, e.g., children or elderly. National economic impact less than $100 million.	1-2

Table 28: Example of scale for shock (source: USDA, 2005b)

The following Table is an example of the final step of the Carver method. (Carson, 2005)

Target	***C***	***A***	***R***	***V***	***E***	***R***	***Shock***	***Score***	***Rank***
Processing Plant									
ABC receiving									
Vitamin receiving/storage									
Raw ABC silo									
Pasteurizer/Closed System									
Pasteurized ABC silo									
Fillers									
Cold storage									
Distribution									
Shipping									
Warehousing									
Retail									
Receiving									
Food Service									
Display									

Table 29: Example of synthetic table for Carver + Shock Method (Source: Carson, 2005)

8.6. Operational Risk Management Process

Operational Risk Management (ORM) is a method which helps companies enhance food safety and security by minimizing risk at every step in the food production chain. The concept was inspired by efforts to improve safety and reduce losses in aircraft, space vehicles, and nuclear power plants. The goal is to have the best food safety and security measures at the lowest possible cost. It is a 6-step sequence to increase operational effectiveness by anticipating hazards and reducing the potential for loss. The purpose of ORM is to minimize risks to acceptable levels. ORM allows more effective use of resources to reduce mishaps and can be used to improve food safety and security (U.S. Department of Health and Human Services, 2001).

The ORM approach is similar to HACCP as it recognizes that some risk is inevitable, but tolerates no unacceptable risk.

However, ORM is different from other methods because of its proactive character. Indeed, the key to applying ORM is being proactive, anticipating what might occur and the consequences associated with them. Here is a table summarizing the differences:

Traditional risk management	**ORM**
Random, individual dependent	Systematic
Common sense	Methodical
Uniformed decision	Decision based on risk vs. benefit
Compliance based	Involvement and empowerment
Reactive	Proactive

Table 30: Risk comparison (Source: U.S. Department of Health and Human Services, 2001)

ORM is defined through the following elements:

- Operational risk management rules;
- Operational risk management implementation
- Operational risk assessment matrix

8.6.1. Operational Risk Management Rules

According to U.S. DHHS (2001), the company has to follow these rules:

Accept no unnecessary risk: unnecessary risk, is any risk which comes without a commensurate return in terms of real benefits or available opportunities.

Make risk decisions at the appropriate level: making risk decisions at the appropriate level establishes clear accountability. Those accountable for the success or failure of the product must be included in the risk decision process.

Accept risk when benefits outweigh the costs: all identified benefits should be compared to all identified costs. For example, a lock on a door, lighting and alarms cost less than a 24-hour guard for the door. We accept the risk of entry by an aggressor because we have put in redundant controls and the benefits of the 24-hour guard do not outweigh the additional cost.

Integrate ORM into policies and planning at all levels: To effectively apply ORM, managers must dedicate time and resources to incorporate ORM principles into the planning process. Important risk decisions should be pre-planned whenever possible.

8.6.2. Operational Risk Management Implementation

The implementation process consists of six successive stages. These steps are described in the following pages, along with a few examples. (Source: US Air Force, 2001)

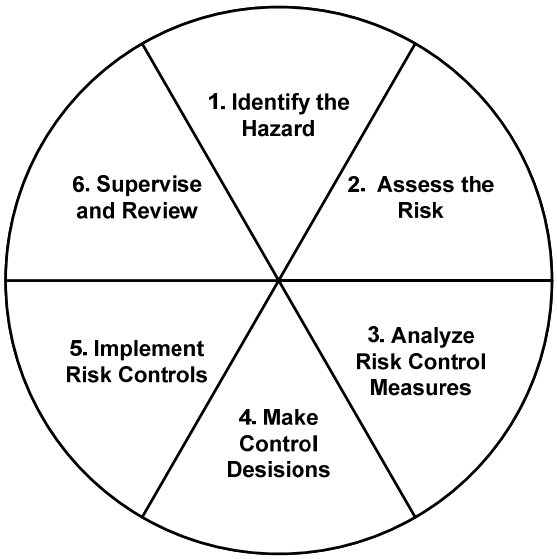


Figure 10 : Operational Risk Management Implementation (Source: U.S. DHHS, 2001)

Step 1: Identify the Hazards

The first step when conducting ORM is to identify the hazards for each phase of an operation (like in HACCP). It is recommended to conduct on site review for each activity or event in food production process, using either the "What If" Tool to capture input of operating personnel or by detecting root systemic cause factors. Hazards can be due to people, environment, and machines.

Here is an example of hazards that may be occurred along the food supply chain.

Activity/Event	**Hazard identified in operation**
1. Fresh vegetables grown on farm	a. Many employees with multiple tasks and no ID badges
2. Transported in refrigerated truck	a. Trucks are not secure; no security in hiring drivers
3. Food Processor/transport	a. Water used to clean product is not potable
4. Stored in restaurant	a. No locks, exterior door unsecured b. No tracking system to identify lot numbers on dry food sources that may have been recalled
5. Food preparation	a. New employees without background check, on midnight shift, given locker required to have own lock b. Only one backup person if food handler is ill. Can result in inadequate staffing and use of

	unauthorized personnel

Table 31: Identification of hazards (Source: US Air Force, 2001)

Step 2: Assess the Risk

The next step is to assess the risk of each hazard. Risk is the probability and severity of loss to the food product from exposure to the hazard. Hazards or vulnerabilities must be ranked by a standardized assessment method (U.S. Air Force, 2001).

Probability and severity are the two parameters taken into account for construction, for each identified hazard, of the matrix of qualitative risk evaluation. This method allows then for a ranking of the risks according to their importance (scale of low to extremely high):

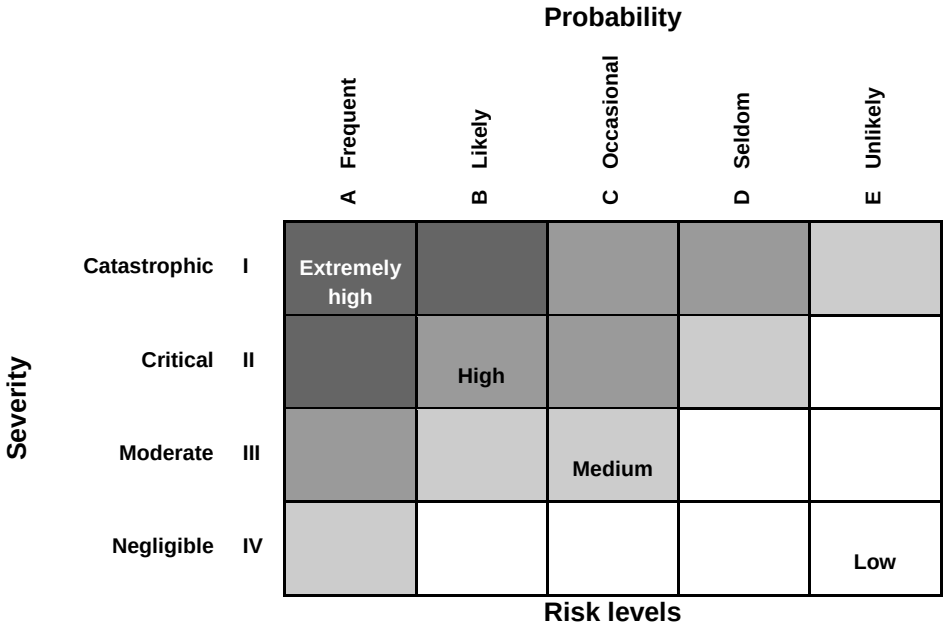


Figure 11 : Risk Matrix (Source: US Air Force, 2001)

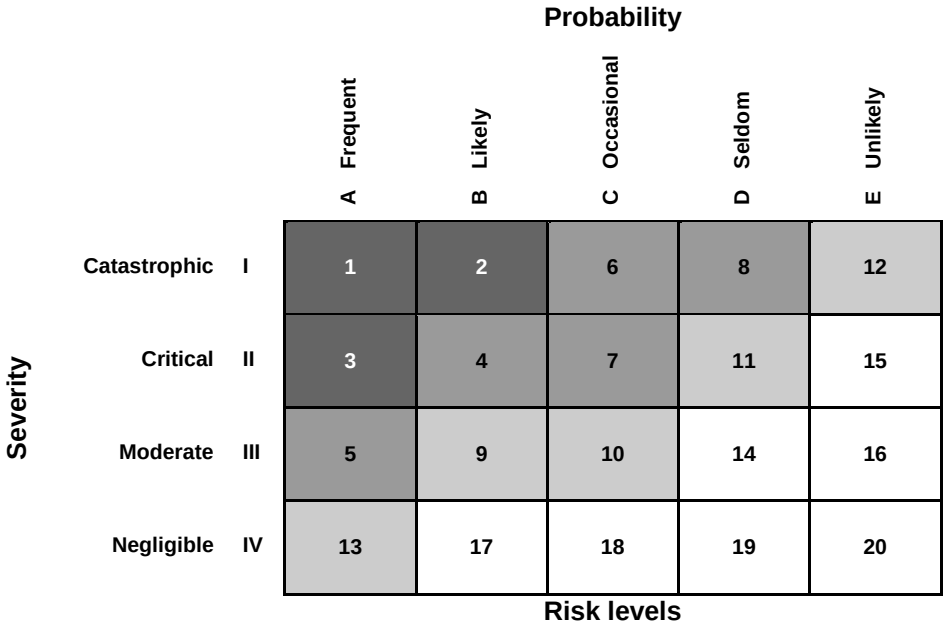


Figure 12: Risk Matrix2 (Source: US Air Force, 2001)

The next step after hazard identification in the ORM example above would be to conduct a risk assessment of each of the hazards and identify a risk level and ranking for each hazard as identified below:

Hazard identified	***Assess the risk***	**Risk level**
2a. Trucks are not secure, no security in hiring drivers	New employees hired could be aggressors. Could contaminate product harm people, machines, facility	Critical seldom Medium 11
5a. New employee no background check, on midnight shift, given locker required to have own lock	New employees hired could be aggressors. Could contaminate product harm people, machines, facility	Critical seldom Medium 11
3a. Water used to clean product is not potable	Could result in contaminated product	Critical Likely High 4
4a. No locks, exterior door from kitchen is unsecured	Aggressors could enter from exterior door contaminate product, harm people, Machines, facility	Critical Likely High 4

Table 32: Example of Risk Assessment (Example of step 2a, 3a, 4a and 5a from our previous table) (US Air Force, 2001)

Step 3: Analyze Risk Control Measures

The third step is to analyze risk control measures for the potential hazards that could be introduced into the operation and consequently identified through the risk assessment step above. Action is taken to investigate specific strategies (see section **3.2** for more details on risk management strategies).

Risk control measures seek to reduce or eliminate the elements that define the risk. It is also important to consider the costs associated with risk control and how various risk control options work together.

Hazard	***Risk Control***	**Rank**
4a. Aggressors could enter from exterior door contaminate product, harm, people, machines, facility	• Post no signs on the door that identify an exit	2
	• Put up security cameras	3
	• Put guard on door	4
	• Provide warning device and install a panic button	1
5a. New employees hired could be aggressors. Could contaminate product, harm people, machines facility	• Reject the risk. Put new hires on day shift for first 90 days. Do periodic background checks and provide locks.	1

Table 33: Example of Risk Control Measures (US Air Force, 2001)

Step 4: Make Risk Control Decisions

Benefits have to outweigh risks (costs), which require an appropriate allocation of resources to control risk. Available resources are time, money, personnel, and/or equipment. Moreover, if the risk is too great for the decision-maker to accept, the decision has to be brought to the attention of a higher authority.

Step 5: Implement Risk Control

Once the risk control decision is made, resources must be made available to implement the controls. That requires making assets available to implement specific controls, to inform personnel in the system, and finally to provide management support (an awards program for example).

Step 6: Supervise and Review

People responsible for supervision need to ensure that controls are effective, in place, and that required changes are detected. Moreover, they have to correct ineffective risk control procedures.

To conclude with the ORM method, a final table shows an additional example of the application of the ORM method in a Food Processing environment.

Hazard Facility security	*Assess risk*	*Risk Level/ Rank*	*Risk Control Measure*	*Rank*	**Control decision**
a. No one is assigned responsibility for security	No accountability for security Procedures	Med/5	Assign person in charge of security	1	Implement
b. No procedures for investigating unusual activity	No procedures prevents appropriate, consistent follow-up of unusual activity	Med/8	Written procedures to document investigation and follow-up to of unusual activity	1	Implement
c. Unrestricted access into building	Access to foods and intentional Contamination possible	Med/2	Allow only controlled access to food and ingredient areas:		
			• Locks on doors/windows, storage tanks	1	Implement/1
			• Secured vents, fresh air intakes, and roof openings	2	Implement/2
d. Access to building not monitored	Access to foods and intentional Contamination possible	Med/4	Monitor access:		
			• Sign in/out	4	Implement/2
			• Account for all keys to establishment	3	Implement/1
			• Surveillance cameras	2	Implement/3
			• Security patrols	1	No
			• Adequate lighting exterior and interior	5	Implement/4
			• Limit potential hiding places for intentional contaminants	6	No
e. Employees have unrestricted access to all areas of plant	Access to chemicals, lab, and food (ingredients, processing, and finished products) with potential for intentional contamination	Hi/1	Restrict employee access to only areas of plant related to their function	1	Implement

Table 34: ORM in a Food Processing Environment (Source: Brooks Scott W., 2002, "Operational Risk Management Ensuring Security for Food Systems »)

Hazard Facility security	*Assess risk*	*Risk Level/ Rank*	*Risk Control Measure*	*Rank*	**Control decision**
f. No supervision of contractors (cleaning, maintenance, construction, etc.) or visitors (tours, sales, auditors, truck drivers, regulators, mail, delivery, etc.	Access to foods and intentional contamination possible	Med/3	Allow no unsupervised access to plant by contractors or visitors	1	Implement
g. Contractor tools, equipment, vehicles not inspected prior to entering facility	Could provide concealed means to bring agents into facility	Med/6	Inspect all tools, equipment, and vehicles entering plant	1	Implement
h. Laboratory (QA/R&D) chemical and culture access not restricted	Could provide ready source of intentional contaminants	Med/9	• Lock up reagents and microbial positive control cultures • Restrict laboratory materials to the laboratory • Keep timely and accurate inventory of reagents and positive control cultures • Investigate missing reagents or cultures and document findings	1 2 3 4	Implement all concurrency
i. Hazardous chemical (e.g. cleaning/sanitizing agents, pesticides) storage access not restricted	Could provide ready source of intentional contaminants	Med/7	• Lock/limit access to chemical storage areas • Supervise maintenance and sanitation staff • Keep timely and accurate inventory of hazardous chemicals • Investigate missing chemicals and document findings	1 2 3 4	Implement all concurrency

Table 34 (continued): ORM in a Food Processing Environment (Source: Brooks Scott W., 2002, "Operational Risk Management Ensuring Security for Food Systems »)

8.7. Elements to Consider in Food Security Management with ORM

The following Table presents basic actions recommended for each stage of the food supply chain. These actions will prevent an attack or mitigate the risk in the event that an attacker attempts to introduce contaminants into the food. The elements in the Table are provided by the article "Food Safety and Security: Operational Risk Management System Approach", DHHS, US Food and Drug Administration and Center for Food Safety and Applied Nutrition (2001).

Stage	*Sub categories to consider*	**Prevention and Control Measures for Food Safety and Security**
Management for Food Security	Security procedures	• Assign responsibility for security • Reward and hold all staff accountable for being alert to and reporting signs of tampering with product or equipment, other unusual situations, or areas that may be vulnerable to tampering
	Procedure for investigating unusual activity	• Immediately investigate all reports of unusual activity • Document all investigations • Report all problems to Security Forces
	Employees	• Pre-hiring screening for all employees, including seasonal, temporary and contract workers • Obtain work references • Perform criminal background checks • Place new employees on day shifts with increased monitoring during probation • During hiring process obtain authorization to conduct random drug testing
	Daily Rosters for employees	• Make them specific to shift • Know who is and who should be on premises, and where they should be located
	Employees' Identification	• Issue photo identification badges with identification number; limit employee access to those areas necessary for the employee's position
	Restricted access for employees	• Limit access to those areas necessary for the employee's position (e.g. card entry to sensitive areas, cipher locks)
	Personal items of employees	• Restrict personal items allowed in establishment • Prohibit personal items (e.g. lunch containers, purses) in food handling areas • Reduce the amount of personal belongings brought to the facility. Examples include purses, gym bags, thermoses, and drink containers, etc. • Management should provide locks for locker areas and establish authority (during hiring process etc.) to enter lockers for periodic safety and security reviews. Metal mesh lockers provide additional security because content is visible.
	Training in security procedures for employees	• Provide staff training in food safety and security procedures and inform them to report all unusual activities. • Place new employees on day shifts

		with increased monitoring during probation;

Table 35: Elements to Consider in Food Security Management with the ORM Method

Stage	*Sub categories to consider*	**Prevention and Control Measures for Food Safety and Security**
Farm Source		• Promote participation in industry quality assurance programs. Examples include the FDA guidelines for Microbiologic Safety in Produce and shell egg QA production program • Develop plans for isolation, cleaning and disinfect ion • Keep records on animals, feed, seed and other products purchased and brought onto the farm • Restrict entry to farm. For high confinement livestock production could even include employees showering in and out, vehicles being sprayed with disinfectant and other bio-security precautions • Conduct work reference checks on all employees • Illuminate building exteriors and exterior sites where feed and other products are stored
Food Processor		• Improve onsite security programs, such as restricting rights of entry and exit, locking up storage bulk ingredient containers and mounting video surveillance at key internal processing hubs. • Verify work references for seasonal employees. Conduct random basic criminal and drug checks on all employees • Develop clearly documented well-rehearsed product recall plans, with crisis management teams that can quickly asses the scope of potential problems and contain them • Written plans for deciding upon and evaluating the scope of a recall • List containing the names and numbers of primary and secondary contacts of all regulatory agencies • Minimize the need for signs or other indicators of food product storage • Provide metal or metal-clad doors on facilities. • Eliminate potential hiding places within the facilities where a contaminating agent could be temporarily placed before introduction

Table 35 (continued): Elements to Consider in Food Security Management with the ORM Method

Stage	*Sub categories to consider*	**Prevention and Control Measures for Food Safety and Security**
Retail Food Service	Raw materials, dry goods and packing	• Use only known, secure, state or locally licensed or permitted sources for all ingredients, compressed gas, packaging, and labels. • Include in purchase and shipping contracts a requirement that suppliers and transporters practice appropriate food security measures • Conduct work reference checks on all employees and random criminal background checks and have authority to conduct random drug testing • Restrict access to food preparation areas to authorized personnel only
	Physical security	• Secure doors, windows, roof openings, vent openings, trailer bodies, railcars, and bulk storage tanks (e.g. locks, seals, sensors, warning devices) • Use metal or metal-clad doors • Account for all keys to establishment • Have security patrols of the facility and video surveillance • Minimize number of entrances to restricted areas and post areas that unauthorized personnel should not have access to • Eliminate potential temporary hiding places for intentional contaminants • Provide adequate lighting both interior and exterior • Keep parking areas away from storage and water facilities
	Storage of hazardous chemicals	• Secure storage areas and keep away from food storage area • Limit access to storage areas • Supervise maintenance and sanitation staff • Keep timely and accurate inventory of hazardous chemicals • Investigate missing stock or other irregularities immediately

Table 35 (continued): Elements to Consider in Food Security Management with the ORM Method

Stage	*Sub categories to consider*	**Prevention and Control Measures for Food Safety and Security**
Transportation Distribution	Suppliers	• Inspect incoming ingredients, compressed gas, packaging, labels, and product returns for signs of tampering or counterfeiting • Require transportation companies to conduct background checks on drivers and other employees with access to the product (comply with state and local laws in doing this) • Require locked and sealed vehicles/containers, and require seal numbers to be identified on shipping documents. Verify shipping seals with shipping papers.
	Traceability of ingredients, compressed gas, packaging, and, salvage products, rework products and products returns	• Include in purchasing contracts a requirement that suppliers will have commodity codes and expiration dates with written explanations provided for recalls and other food safety actions • Use operating procedures that permit subsequent identification of source of ingredients, compressed gas, packaging, labels, • Keep timely and accurate inventory of ingredients, packaging, labels, Investigate missing stock or other irregularities and report any problems to OSI
Security of Finished Products		• Keep timely and accurate inventory of finished products • Investigate missing stock or other irregularities and report any problems to local legal authorities • Include in contracts for shipping (vehicles and vessels) a requirement that appropriate security measures are in place • Perform random inspection of storage facilities, vehicles • Require transportation companies and warehouses to conduct background checks on staff (drivers/warehouse personnel; state and local laws may apply) • Require locked and sealed vehicles/containers, and identify seal number on shipping documents

Table 35 (continued): Elements to Consider in Food Security Management with the ORM Method

Stage	*Sub categories to consider*	**Prevention and Control Measures for Food Safety and Security**
Security Plans	Action Plan for tampering or terrorist event	• Include step-by-step SOP for triaging the event • Include evacuation plan • Maintain floor and flow plan in secure location and in cooperation with local fire officials • Include strategy for continued operation (e.g. at alternate facility) • Include investigation procedures
	Communication protocol	• Have internal, fire, and police emergency phone numbers available • Identify critical decision-makers • Identify local, state, and federal government contacts
	Computer security	• Restrict access to computer process control systems for food products and critical data systems to those with appropriate clearance (e.g. passwords)
	Security of water	• Secure water wells, storage and handling facilities • Test for sanity levels regularly • Identify alternate sources of potable water (treat on-site or on-site storage)

Table 35 (continued): Elements to Consider in Food Security Management with the ORM Method

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