CHAPTER 2
LITERATURE REVIEW

The previous research on Food Quality Management System (HACCP) are explained on this chapther.

2.1. Previous Research on Hazard Analysis Critical Control Point

The HACCP concept is over 40 years old. It was developed as a joint project between the Pillsbury Company, U.S. Army Natick Laboratories and NASA and has been supported by National Academy of Science to ensure the safe production of food for the manned spaced program. The origin of HACCP had three principles such as: Identification and Assessment of Hazard, Determination of Critical Control Points, and Establishment of a system to monitor critical control points which were presented to the public at the 1971 National Conference on Food Protection. Futhermore, Surak (2005) has explained that the seven principles of HACCP was published in 1989 and had two times of revisions. In 1997, a third revision was conducted by merging seven principles with five preliminary steps of HACCP which are known as the 12 steps of HACCP as seen in table 2.1. it was published by The National Advisory Committee on Microbiological Criteria for Food HACCP and have become de-facto US standard for HACCP.

Table 2.1. 12 Steps of HACCP

Step 1	Conduct HACCP team
Step 2	Describe the food and its distribution
Step 3	Describe the intended use and consumers of the food
Step 4	Develop a flow diagram which describes the processes
Step 5	Verify the flow diagram
Principle 1	Conduct a hazard analysis
Principle 2	Determine the critical control points
Principle 3	Establish critical limits
Principle 4	Establish monitoring procedures
Principle 5	Establish corrective actions
Principle 6	Establish verification procedures
Principle 7	Establish record-keeping and documentation procedures

Source: NACMCF, 1997

HACCP is a management system in which food safety is addressed through the analysis and control in biological, physical and chemical hazards from raw material, production, procurement, and handling to manufacture, distribution, and consumption of the finished product. Hence, HACCP is an effective and rational of assuring food safety from harvest consumption (Kumar, et al., 2009).

Moy, et al., (1994) defined Hazard Analysis Critical Control Point (HACCP) as a system identifies spesific hazards and measures for their prevention and control to ensure the safety of food. Futhermore, the level of safety assurance offered by HACCP system is fast becoming the standard for the food industry. Besides Food Safety authorities in the USA, Canada and the European Union (EU) had promote the use of HACCP. HACCP is also being incorporated into the Codex Codes of Practice for a number of food commodities.

According to Jiang & Putra, (2016) in his research has conducted HACCP system in an Indonesian restaurant by incorporating halal requirements namely Haram Hazard Analysis Critical Point (HHACCP). In the research, seven principal of HACCP is developed by adding a Presence on Haram Substance as a factor to be analyzed in order to providing safety and halal food assurance to consumers.

Diaz-Maldonado, et al., (2014) in the research at Municipal Slaughterhouse Michoacan Mexico, using the HACCP system to reduce the risk of pollution which is applied in primary production without impairing the Federal Animal Health Law. HACCP system allows identify and prevent hazards & risks of biological, chemical and physical contamination which can affect the integrity of the goods of animal and / or public health. This study was develop in 180 days under the methodology of HACCP by using the inspection and assessment of 16 points represent the compliance areas of slaughterhouse throuh observation and data analyzed.

Wallace, et al., (2005) defined Hazard Analysis Critical Control Point is designed to control significant food safety hazards. In his research, HACCP is effectively supported by Good Manufacturing Practice (GMP)/prerequisite Programmes that control the genral hygiene and environmental conditions in a food processing operations. GMP is one of the several basic requiements which contained in a good management practical guidance.

The research had conducted in infant food company, author expalined that the manufacture of infant food is highly complex process and needs an effective quality control beyond classical in process parameters and a final microbiological analysis.Therefore, Hamrin & Hoeft, (2012) defined HACCP breaks down the food manufacturing process inton logical steps to identify possible physical, chemical, and biological. Hamrin & Hoeft, (2012) used HACCP system to check up all the ingredients intended to prevent the physical, chemical and biological hazard during the process production to assure product quality as well as product safety. Moreover, author expalained the ingredient manufacturer's quality management system must be set up so that any issue or deviations can be detected as early as possible and before the finished product reaches the consumer.

2.2. Theoretical background

2.2.1. Food Quality and Safety

Quality as an issue is present in all areas of society, including enterpreneurship, and the modern understanding of management (Sasa, et al., 2017). Futhermore, Sasa, et al., (2017) have explained in study that the quality of products and services have a competitive influence on customer satisfaction. In addition, quality catering services are a standard used by consumers to assess the quality of services provided, including the need and commitment to food quality.

Kumar (2012) stated that food service operations involve several processes such as of raw material purchasing, production and serving process. Futhermore,Preserving food quality is a major factor in both food safety and quality. Food that is stored, prepared, and served properly is more likely to retain its quality. The standard of food's quality include its safety, appearance, chemical properties, texture, consistency, nutritional value and flavor.

According to Rihastuti & Soeparno, (2014) Food Industry maintains quality assurance with quality control system. Generally, quality assurance is a real effort and earnest to give satisfaction dan trust against the product produced. Customer satisfaction and trust as the benchmark of successful quality assurance. A company takes the wisdom of quality assurance to produce quality image. There are three

quality assurance policies such as: Quality Assurance, coorperation of three parts (Marketing, Production and Quality Assurance), and Quality Control System.

a. Quality Assurance

   Known as Quality Control Department, this section is in charge of maintaining product quality and responsible againts the company's product quality image.

b. Coorperation of Three Parts: Marketing, Production and Quality Assurance

   In each departments of this part have its own purposes to achieve company's objectives. Marketing is responsible for setting product quality to meet customer needs. Moreover, Production is obliged to produced the product based on the customer needs. Meanwhile, Quality Assurance is responsible for analyzing customer and data from marketing to be translated into criteria and quality spesification for becoming company product's quality standard. By this cooperation of three parts: Quality assurance of the company is reflected into three points such as company effort to serve and satisfy customer, The company ability of managerial and application of science technology in carrying out production, and company's ability in order to control process and product quality.

c. Quality Control System

   In QC system involve many parts, steps, aspects, processes and employees of the company in order to increase quality service towards the company product quality image.

2.2.2. Principles of HACCP

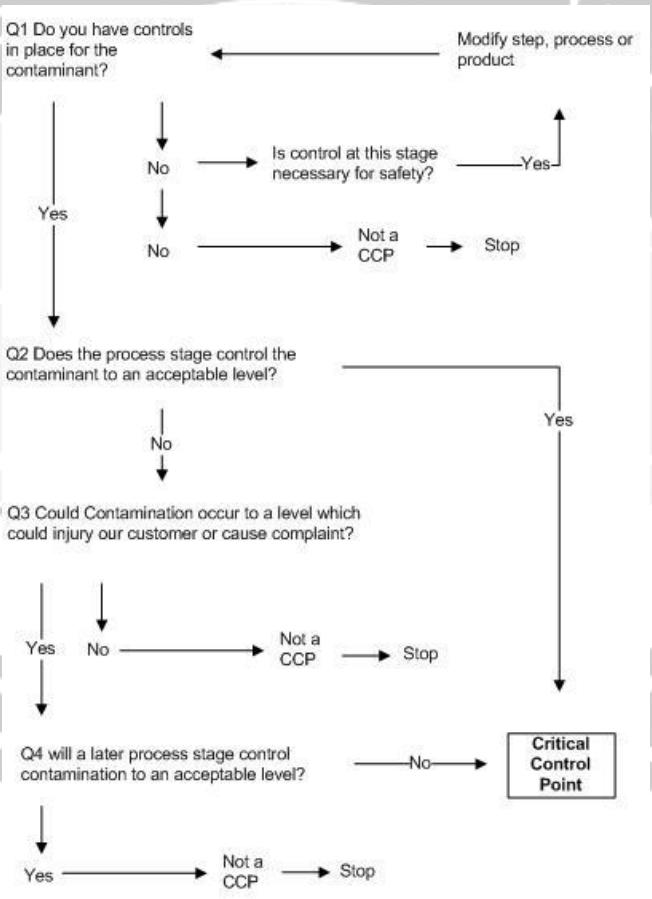
HACCP system principles was adopted from SNI 01-4852-1998 accordingly to Codex (Thaheer, 2005). The seven principles of HACCP have been universally accepted by Govt. Agencies, trade associations and food industry around the world (Kumar, et al., 2009). The following principles as mentioned below:

a. Principle 1 : Conduct Hazard Analysis

   Hazard analysis is systematically analysis into food spesification and raw materials to determine the risk. Food safety risks to be examined includes: safety aspect of chemical, physical and biological (microbiological) contamination.

b. Principle 2 : Determined the Critical Control Points

According to definition of US National Committee on Microbiological Criteria for Food, (1990) Control Points is every points within spesific food system, where the loss of control point cause economics & quality defects, also low occurrence of health risks. Meanwhile, Critical Control Points is every points within specific food system, where the loss of control point cause a high occurrence of probability of health risks. Critical control points can be applying by using decision tree that can be seen in figure 2.1.



Source: Fellows *et al*, 1995

Figure 2.1. Decision Tree of Critical Control Limits

c. Principle 3 : Establish Critical Limits in each Critical Control Points

Critical limits or critical control points have to be specifically set and validated. Critical limits complete some expectations, such as:

1. Critical Limits shows the differences of safe or unsafe products to be produced.
2. Critical limits have to be fulfiled to ensure that a critical control points effectively control the hazards.
3. All factors according to safety have to be identified.
4. The level when each factors become the safety limit and unsafety limit are critical limits.

d. Principle 4 : Establish Monitoring Procedures

NACMCF, (1997) Monitoring is the sequence of observation or planned measurement of critical limit which designed to gathering an accurate information and showed to ensure the critical limit for maintaning the product safety. Surak, (2006) The activity of monitoring CCP is essential to the success of HACCP based system. Furthermore, an appropriate monitoring procedures must be established and used to ensure that the critical limit are not exceeded.

e. Principle 5 : Establish Corrective Actions

The coorective actions is needed when control is lost then the product is not meets the requirements. An application of system is failed when the corrective actions is not done. An effective corrective actions meets some criterias, such as:

1. Able to handle and remove the problem completely
2. Prevent the repeatation of mistakes
3. Easy and rational to be held.
4. Eficient in used of resource.
5. Quickly problem solve.

f. Principle 6 : Establish Verifiaction Procedures

Verification is consists of four types of activities, such as: HACCP validation, Reviewing the result of monitoring, product tested, and auditing. Thaheer, (2005) internal auditing can be done independently by an organizations formed specifically for it, consist of some personal internal from company who has the

audit competence. Internal auditing can also use the external auditing service by inviting independent audit institutions for evaluating the system.

g. Principle 7 : Establish Record-Keeping and Documentation Procedures
An efficient and accurate recording and bookkeeping is important in application of HACCP. By applying the documentation and recording sistem will help the company to provide the efidence of food safety related to the processes and procedures, ensure the safety products, monitoring and controlling products produced.

2.2.3. Aspects of Food Provision

2.2.3.1. Food Contamination

Food Contamination is the entry of unwanted foreign substances into the food which is affected the health of consumer. Thaheer, (2005) stated that food contamination is classified into three i.e. microbiological contamination, chemical contamination, and physical contamination.

a. Microbiological Contamination is the contamination that easy to remove through heating, inactive using acid solution and washing, it is depending on the type of contamination. Sources of contaminations are come from the raw material, workers, improper processing, and insects. Some of microbiological contaminations caused by : Infective organisms, and Bacterial Spores

b. Chemical Contamination is contamination which is difficult to remove and its levels must be under the terms. Source of chemical contamination contained in the surrounding air pollution caused by waste disposal and fuel product of vehicle, storage area, preparing area, and cooking area. Some examples of chemical contamination, such as: Toxin microorganism, Food toxin, Food additives, Intentional/Unintentional Chemical added, Allergic ingredients for consumer, and Ingredients from packaging.

c. Physical Contamination is the entry of foreign substance into the food which generally caused by raw materials, human, and preparation process.

According to Thaheer, 2005; Sugiono, 2013, The possibility of contamination is classified into three groups such as: Direct contamination, Cross contamination and

Recontamination.

a. Direct Contamination occurs when unwanted substances enter the food caused by ignorance/omission whether intentional or untintentional.
b. Cross Contamination happens when bacteria are spreaded among foos, surfaces, or equipments.
c. Recontamination occurs against the fresh food caused by the improper food protection and environmental pollution.

2.2.3.2. Poisoning

Food Poisoning is the emergence of symptoms of a disease or health disorder due to consuming non-hygienic food. Causes of poisoning food are as following below:

a. Natural food ingredient is the ingredients which naturally contain a potential toxic such as a poisonous mushroom, yams and bloated fish.
b. Microbial infection is bacteria in food which enter into body in large quantities that can cause poisonings or diseases such as diarrhea, cholera and dysentery.
c. Toxic/Microbes toxin is a toxin produced by microbes contained the food that enter human body in dangerous level. Example: Staphylococcus, Clostridium, and Aspergillus.
d. Chemical substances are dangerous ingredients contained food that enter the body with dangerous doses. Example: Pesticide residues inside the vegetables and fruits, or metal inside the fish.
e. Allergen is ingredients inside the food that might be cause a sensitive reaction to vulnerable people.

2.2.3.3. Decay

Decay is a food decomposition process either half or as a whole from normal condition become unwanted circumstances. This condition is caused by maturation, contamination, or deliberately done fermentation. Decay is caused by:

a. Physic, decay which is caused by dehydrate, collision (broken, bruised) or eaten by insects or mice.

b. Enzyme, is decay caused by activity of chemical substances during maturation or post-harvest.

c. Microbes, is a bacteria that grows and thrives inside the food so the food become damages as well as changing taste and smell.

2.2.3.4. Forgery

Food counterfeiting is an attempt to mask the appearance of food by adding additional ingredients that can be disruptive or harmful to health. Falsification that occurs in food such as:

a. Use of textile dyes, example: *rhodamin B, sunset yellow,* and *wantex* which is commonly found in children's snack.

b. Sweeteners, such as the additional of artificial sweeteners to food, with no sugar contained in the product.

c. Preservatives such as the use of preservatives that are overdose

d. Substitutes such us the use of papaya for making tomato sauce and soy sauce made from coconut water

e. Miss-labeling such as products that claimed beef but it contained pork or products that claimed salmon but it contained a mixture of horse meet.

2.2.4. Personal hygiene

According to (Thaheer, (2005) & Sugiono, (2013)) Sanitation for personal hygiene includes washing hands, body celansing before and after food production process, taking off all the jewelry, use of a clean clothes, covering hair, hand, clothes, and foot.

Personal hygiene is must be considered, such as clean the hair, shower, washing hand and clean the nail. Clean and healthy behaviour from employee is very supportive of produced product celanlines including reporting themselves while sick. The completeness of employee's clothes such as hat, mask, glove, apron and shoes are influence the cleanliness of product. A sanitation standard operating procudures must be coducted as the basis of monitoring resouces and documentaion.

2.2.5. Waste management

A waste from food industry is dominated by an organic material which is suitable for microorganisms. A waste management is an effort to resolve a waste generated by production activities is not harmful. Context of HACCP application system is focus to safeguarding the prerequisites of the HACCP program. Waste as the contamination resource, such as (Thaheer,2005):

a. Transit of Microorganisms, some live bacteria come from a dirty soil and the result of human digestion. A waste also consist of virus, yeasts, molds, algae, mosses, and various microorganisms. A stagnant water is a growing place for some bacteria such as Clostridium botulinum and Clostridium perfringens.
b. Xenobiotic Transfer, a vector (flies) is a source of xenobiotic transfer from waste/disposal. Liquid waste causing more casess of xenobiotics transfer. Group of heavy metals often moving from liquid waste. However, generally through the food chain such case of mercury and cadmium. Xenobiotics that is moved from air matters through an events that involved heat. Another case is used of aerosol perstisida in salted fish to kill flies causing product contamination.
c. Physical contamination, meat and fish are often causing the physical contamination of material components that should be waste, such as bones, scales, and fur. Dust and soot is an example of physical contamination from air waste.

There are three sources of waste in food indusrty, such as: Solid waste source, Liquid waste source, and Air polluted source.

2.2.6. Hazard Analysis

2.2.6.1. Food Safety Hazard

Acccording to (Thaheer, 2005; Surak & Wilson, 2006) Hazard is classified into three groups such as chemical hazard, bilogical hazard and physical hazard. Chemical hazard is known fro mostly consumer, eventhough in fact it does not give a fatal risk for healhty. Biological hazard have possibility of greater hazard that might cause a poisoning. Futhermore, physical hazard is more easily recognizable and avoided by consumen. The explanaition of these three hazard, as following below:

a. Chemical hazard

Many researches found some chemical material inside the food either from the identified environment is contaminated or unidentified environment. Cases of pesticide contaminated inside the vegetables also founded. Otherwise, pesticide that is used for plants and the plants are used for animals(cattle) feed it causes the produced meat are contaminated by the chemical material. According to a finding by previous researcher (Connel & Miller, 1983) there is a consist of pesticide such as dieldrin and toksafen in some species of fish.

b. Biological hazard

Pathogens and microbial toxins are such hazards contain in many foods. Either some individual igredients or finished products have the potential to contains pathogens and microbial toxin that cause illness and death. There are two types of pathogenic microorganism, such as: (1) Non-Spore_Forming that cause ilness or death to humans and (2) Spore-Forming. Include viruses, parasite and bacteria.

Cases of the spread of food disease because of fish is recorded by Shahidi and Botta in 1994, 76% causes by tocxin, 11% by microorganisms, 10% unidentified and 3% by the chemical and parasit. In the group of microbes innate which potentially causes a food disease are virus, bactery and parasit. Some tocxin produced by algae are Anabaena, Aphanizemeon, Microcystis, Nodularia, and Oscillatoria.

Biological hazard from mold family are Aspergillus spp., Aspergillus flavus with the aflatoksin and Eurotium spp. Which are mostly found in salted fish Indonesia. Some toxcin in fish are Candida, Cryptococcus, Debaromyces, Hansesiaspora, Pichia, Rhodotulura, and Torulopsis.

In the frozen fish contains of Pseudomonas, Vibrio cholerae, Aeromonas hydrophila, Staphylococcus aureus, Salmonella spp., Listeria monocytogenes, Escherichia coli (E.Coli), and Bacillus spp.

Staphylococcus aureus can be found in some animals such as cattle and goat. The bactery of Staphylococcus aureus easily died from heat at 66˚C for 10 minutes, the tocxin can survive at 100˚C for 30 minutes. However, it can be

prevented by sanitation in food processing, raw material have to be storage below 4˚C to prevents the growth.

Salmonella can be found in meat, poulty and egg aroung the shell. Cross contamination can be happpen between raw meat and cooked meat during the storage and processing. However, it easily die by heat since it does not produce heat-resistence spores.

Salmonella spp., Shigella spp., and E.coli are stick with food poisoning cases, especially related to the food processing hygiene. Camplyobacter jejuni is the bactery founded in the poultry. Parasitic larvae such as roundworms and tapeworms has long been known to enter into food when consume a meat or fish. Taenia saginata, Trichinella spiralis and Clonorchis sinensis have been found in many fish in Asia.

c. Physical hazard

Physical contamination during the fish production generally come from material and used of tools or remaining pieces of bone. Broken glass, metal flakes, sand, stones, and plastic debris are generally obtained from the environment and processing infrastructure. The main material to be considered in physical harm and general sources can be seen in table 2.2.

Table 2.2. The Main Material in Physical Hazards and General Sources

Material	Danger of accidents	Sources
Glass	Scratched, bleeding, may need surgery to find and throw it	Bottle, light bulb, engine button cover
Wood	Scratched, infected, choked, may need surgery to find and throw it	Pallets, boxes, building materials and twigs
Stones	Choked, broken tooth	Soil, building
Metal	Cut off, infected, may need surgery to find and throw it	Soil, personal
Insects or other impurities	Pain, trauma, choked	Soil, from harvest

Source : Pierson & Corlett, 1992

Table 2.2. The Main Material in Physical Hazards and General Sources (Continue)

Bones	Choked, trauma	Soil, poorly processing
Plastic	Choked, cut off, infected, may need sugery to find and throw it	Soil, package, pallets and labor
Due to people	Choked, cut off, broken teeth, may need sugery to find and throw it	Labor

Source : Pierson & Corlett, 1992

2.2.6.2. Aspects of Hazard Sources

According to Thaheer (2005), Generally there are five aspects that potentially become sources of hazards in manufacture activity, such as:

a. Materials

Materials produced by agricultural generally sensitive against microorganisms. Raw materials of meat and fish become a good media for microorganisms to growth when it is placed in the room temperature. Chemical material often added agricultural products, especially preservatives. The weighting scandal towards agricultural produced founded by adding sands/stones into seeds. The most dangerous case is wire insertion on the shrimp's back as a weight gain.

b. Methods

Processing methods is a hazard source and have to be evaluated step by step. The contamination might be appears because of development of used methods. Generally process that has to be evaluated includes procurement of materials, materials preparation, processing, packaging and distribution. A control is done as early as possible to give a better result rather than final control.

c. Machines

Machine operation and maintanance have considerable potential for contamination of material/foodstuff.

d. Manpower

In industrial food, potential hazards are likely to arise from workforce. Clothes and device used by workforce are the sources of contamination. Moreover, some parts of worlforce's body also become the sources of contamination.

e. Infrastructure and environment

Bad ceiling construction, unclean walls, broken floors, improper sanitary facilities are the potential sources of contamination

2.2.7. Risk Analysis

(Covello & Merkhofer, 1993) Define risk analysis as a systematic process to disclose and spell aout the risk that related with hazardous material, process, action, or events. Risk process evaluation is done against microbiological, chemical and physical hazards. Source of hazard can be controlled to remove/prevent hazard or reduce the hazard. An example of determination of hazard criteria in case study for fish controlling by Pierson & Corleet's Matrix can be seen in table 2.3.

Table 2.3. Determination of Hazard Criteria by Pierson & Corleet's Matrix

Products	Microbiological hazards related to Food						
	1 = Yes, 0 = No						
	High risk for special population	Microorganisms-sensitive material	No microorganisms removal stage on process	Recontamination between prepackaging process	Negligence of distribution or consumption handling	No heat/cold treatment by consumen	Risk Level
	A	B	C	D	E	F	
Fresh fish	0	1	1	1	1	1	5
Water	0	1	1	1	1	1	5
Ice cube	0	0	1	1	1	0	3

Source : Thaheer, 2005

Risk Level is accumulated from weight of hazard characteristic (column A to F). According to the table above, the greater number of risk level is the higher risk level within the process. Hereafter, the determination of risk categories is obtained from the accumulation of the hazard category. An example of hazads and risk category for food and raw material by Pierson & Corlett can be seen in table 2.4.

Table 2.4. Hazards and Risk Category for Food and Raw Material by Pierson & Corlett

Products/raw material	Hazard characteristic (A,B,C,D,E,F)	Risk Category
T	A + (Speciall Kategory)	VI
U	Five + (B to F)	V
V	Four + (B to F)	IV
W	Three + (B to F)	III
X	Two + (B to F)	II
Y	One + (B to F)	II
Z	0	0

Source : Thaheer, 2005

HACCP team makes a hazard list which may be present at each stage of production, begin from the receiving of material to the final products. In this stage HACCP team doing risk analysis which are consist of two steps, such as hazard analysis and determination of risk category. Hazard analysis is a systematically evaluation to food and raw material to determine the risk. Food safety risk that have to be checked including chemical contamination, physical kontamination, and biological contamination include the microbiological.

There are two steps in hazard analysis as follows:

a. Step 1
   1. Rank the food/raw material/ingredient according to the six hazards as presented in table 2.5.
   2. Give usage score, 1/+ if the food contains the hazards and 0 if the food does not contains the hazards.

b. Step 2

   Set the risk category against the food/raw material/ingredient according to the rank result with hazard characteristics. Table of Risk Category is presented in table 2.6.

Risk analysis will generate a document containts list of registered risks based on the weights that support it. The list of risk will be continously used in the application of risk control program.

Table 2.5. Determination of the characteristic and hazard level

Hazards	Microbiological hazard characteristic	Chemical and physical hazards characteristic
A	Products specially made and intended for the consumption of at-risk populations (infants, elderly, sick, pregnant women, and immune endurance)	Products specially made and intended for the consumption of at-risk populations (infants, elderly, sick, pregnant women, and immune endurance)
B	The products is sensitive to microbiological	Products contains potential hazard known as chemical and physical hazards.
C	The process does not contain a controlled step that prevents, destroys or reduce the microbiological hazards	The process does not contain a controlled step that prevents, destroys or reduce the chemical and physical hazards
D	There is possibillity of contamination during the process	There is possibillity of contamination during the process
E	There is possibility of mis-handling the product during processing or distribution	There is possibility of chemical and physical contamination of the product during processing or distribution
F	There is no controll step by consumen after packaging and distribution.	There is no controll step by consumen after packaging and distribution.

Source : Thaheer, 2005

Table 2.6. Risk Category

Risk Level	Risk Category
4	High Risk
3	Medium Risk
2	Low Risk
0-1	Very Low Risk

Source : Jiang & Putra, 2016

2.2.8. Chilling

Chilling is the unit operation which the temperature of food is reduced to between -1˚C and 8˚C. It is used to reduce the rate of biochemical and microbiological changes, and hence to extend the shelf life of fresh and processed food. Chilling is

often used in combination with other unit operation to extend the shelf life of mildly processed foods.

According to (P.Fellows, 2000) A precise temperature control is essential at all stages to avoid the risk of food spoilage or food poisoning. The rate of biochemical changes caused by either microorganism or naturally occurring enzymes increases logarithmically with temperature, therefore chilling reduces the rate of enzymes and microbiological changes and retards respiration of fresh foods. The factors that control shelf life of fresh crops in chill storage include:

a. The type of food and variety or cultivar
b. The part of the crop selected
c. The condition of the food at harvest (for example: Presence of mechanical damage or microbial contamination, and the degree of maturity)
d. The temperature of harvest, storage, distribution and retail display
e. The relative humidity of the storage atmosphere, which influences dehydration losses.

Table 2.7. is given a summary of the optimum storage condition for fruit and vegetables according to some sources (P.Fellows, (2000); Warsito et al).

Table 2.7. Optimum Storage Condition for some Fruits and Vegetables

Food	P.Fellows, (2000)	Warsito, et al, (2015)
	Temperature (˚C)	
Kale	-	5 - 8
Brocoli	-	
Carrot	-	
Cucumber	10-15	
Eggplant	7-10	
Potato	3-10	
Beans	-	
Tomato	4-10	
Watermelon	4-10	

Chilling prevents the growth of *thermophilic* and *mesophilic* microorganisms. The main microbiological concerns with chilled food are the number of pathogens that can grow during extended refrigerated storage below 5˚C, or as a result of any

increase in temperature (abuse) and that cause food poisoning. According to Sugiono, (2013) in order to limit the growth of bacteria/spora that might be occurs in the food, thefore a food have to be stored into chiller as soon as possible. Furthermore, in order to control the growth of pathogens in food that caused product damage then the recommended effective temperature is 5˚C-8˚C.

2.2.9. Freezing

Freezing is the unit operation in which the temperature of a food is reduced below its freezing point and a proportion of the water undergoes a change in state to form ice crystals. Preservation is achieved by a combination of low temperatures, reduces water activity and, in some foods, pre-treatment by blanching. Storage at low temperature is necessary to prevent bacterial damage. There are only small changes to nutritional or sensory qualities of food when correct freezing and storage procedures are followed.

The major groups of commercially frozen food are as follows:

a. Fruits (Strawberries, oranges, raspberries, blackcurrants) either whole or pureed, or as juice concentrates.
b. Vegetables (peas, green beans, sweet-corn, spinach, sprouts, and potatoes)
c. Fish fillet and seafood including fish fingers, fish cakes or prepared dishes with an accompanying sauce
d. Meats (beef, lamb, poultry) as carcasses, boxed joints or cube, and meat products
e. Baked goods
f. Prepared food (pizza, desert, ice cream, and complete meals)

The following table is shown the freezing points of selected food.

Table 2.8. Freezing Points of Selected Food

Food	Freezing Points (˚C)
Meat	-1.7 to -2.2
Fish	-0.6 to -2.0

Source : Fellows, 2000

According to the food hygiene principle in raw material storage, improper food storage especially in large quantities (for catering industry) can cause the raw material damage. The following table is the summary for good storage temperature regarding to the food hygiene and sanitation (P.Fellows, (2000); Warsito et al, (2015);).

Table 2.9. Storage Temperature of selected food

Food	**P.Fellows, (2000)**	**Warsito, et al, (2015)**
	Temperature (˚C)	
Meat, chicken, and processed food	-18˚C – (-24˚C)	-17˚C – (40˚C)
Fish, Seafood		-25˚C