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Quality Management in the Food Industry

1.1 Introduction

The importance of quality in the food industry has grown significantly over recent decades as consumers have become more critical. Apart from that, this is also attributed to the increasing expectations of consumers, stricter governmental regulations, changes in consumption patterns, continuous development of technologies and expanding market competition. Compared to other industry, food quality management is challenging due to the complex character of food products with the unpredictable and evolving behaviour of people involved in the food chain. Therefore, food companies are seeking more efficient and effective managerial approaches to improve or sustain the quality aspect of their processes and products. The key forces that drive the food companies to seek quality management practices may be dictated by internal or external circumstances or maybe both. The key purpose of effective quality management is to boost the competitiveness of the business and offer strategic advantages in the market (Anderson, Rungtusanatham, and Schroeder 1994). Similarly, food quality management is crucial to assure the quality of the process and subsequently the products in food businesses.

Although the food industry is aware of the negative public opinion, not all companies are committed to improving the industry's image

Mike Doyle, PhD, Director of the Center for Food Safety

1.2 Definition of Quality Control

The term 'quality control' (QC) is initiated from the field of engineering where the quality of the product is constructing the quality of the product instead of inspecting the quality. Scoping down to the core of quality control, it is understood as a procedure designed to ensure that the product conforms to a designated set of criteria as set out by the consumers.

Quality control has been prioritised after the World War II where mass production manufacturing was developed despite the fact that quality is always being integrated into the businesses since the industrial revolution in Europe. Therefore, the quality control activities took a significant turn where the demand for more inspectors in ensuring the quality of the product increased. Another major advancement of quality control is when a physician, Dr. Walter Shewhart introduced a statistical approach to quality control in 1924. It started after World War II, when Statistical Quality Control has been widely applied to assist in quality control and production.

The key objectives of quality control are:

- to achieve a consistent quality of the product;
- to maintain the product at the quality at levels and tolerance limits acceptable to the consumers while minimising the cost for the vendors;
- to manage and continuously sustain the expected level of the product quality; and
- to ensure that produced items are fulfilling the highest possible quality.

Quality control can be categorised as off-line quality control and on-line quality control. The key purpose of the quality control is to satisfy the standard of quality in the product being produced as is compatible with the market for which the product is designed and at a price the product will be sold. Thus, the best approach of quality control is to initiate the efforts in the product design phase and continuously apply such efforts through the production operation phases.

1.3 Quality Control in the Food Industry

In modern food manufacturing settings, the quality control systems are the supporting programs that are outcrops of the Hazard Analysis Critical Control Point (HACCP) program. A clear indication of the product conformance to their specification are based in the documentation required in the HACCP program.

Typically, any quality control program in this industry is documented in the program general overview and being verified on a monitoring form. The data gained through documentation, observation, measurement, data analysis and documentation from the programs provided a clear picture of the product conformance to a specification. The common approach to document the overall control system, a form for the quality control scheme should be completed. Thus, this document provided a concise indication of all the quality related programs established by the company (e.g. quality parameters, the specification limits, sampling plan, action plan, critical control point (CCP), and correction action).

Quality control of food refers scientifically to the utilisation of technological, physical, chemical, microbiological, nutritional, and sensory parameters to achieve wholesome food. These quality factors depend on specific attributes, such as sensory properties (e.g. flavour, colour, aroma, taste, texture), quantitative properties (e.g. percentage of sugar, protein, fibre) and hidden attributes (e.g. peroxides, free fatty acids, and enzyme) (Edith and Ochubiojo 2012). Quality control is commonly in the raw material, process control, and finished product in the food industry.

Most large food businesses establish a quality control department in the organisation as they have a crucial role in driving quality efforts. A team of Quality Control (QC) staff promotes quality in the department, assists, and closely consults with the production. Typically, the production department is directly responsible for the quality of the products. Nevertheless, unlike most people's perception, quality assurance (QA) is not directly responsible for the quality of the products the business delivered to its customers.

The professionals of the QC department:

- assist the production in quality-related matters;
- report to the division director of QA;
- seek direction and assistance from the vice president of QA; and
- support for QA programs.

1.3.1 Quality Control (Raw Material)

In producing the products, the food manufacturers have to purchase other products in different forms and services to ensure the business maintains production. The products in the food industry are enormously diverse including raw materials from processed food ingredients, minor and major ingredients in food production.

In the chain of food production, especially in handling the production of the consumer foods, it requires the manufacturers who purchase the ingredients, raw materials and food packaging to ensure the materials are safe and fit for use. Apart from that, the food manufacturers have to identify the impact of supplies and services purchased on quality and subsequently confirm the supplier's capability to meet the requirements of the specification. Thus, many food companies categorised the quality control of these ingredients as being under supplier and purchasing control. Despite purchasing services are not as important as many of the ingredients, services such as pest control, calibration, laundry, plant cleaning and quality consultancy need to be considered. Therefore, the disruption of the food production commonly stemming from the supplier problems may impact the production, customers and the business bottom-line. Food companies should have a systematic control plan in place. Such a systematic control plan is the key focus of the quality management

system (QMS) in a company which prevents problems and ensures consistency within the manufacturing process.

Typically, the supplier provides the raw materials, which means the quality of the raw materials is not under the direct control of the manufacturer. Nevertheless, the manufacturers can overcome this through their purchasing power where the manufacturers have significant opportunity to select suppliers. The company takes the initiative to have a clear understanding of what is required. Thus, these demands have to be translated into criteria for selecting the suppliers and requirements for them to fulfil.

According to the ISO9001 requirement on the suppliers (i.e. external provider), the companies are only required to define the process, identify the authorised people, and ensure that the practice is implemented and adequately controlled. Nevertheless, the organisation needs to develop and establish procedures that work efficiently for them.

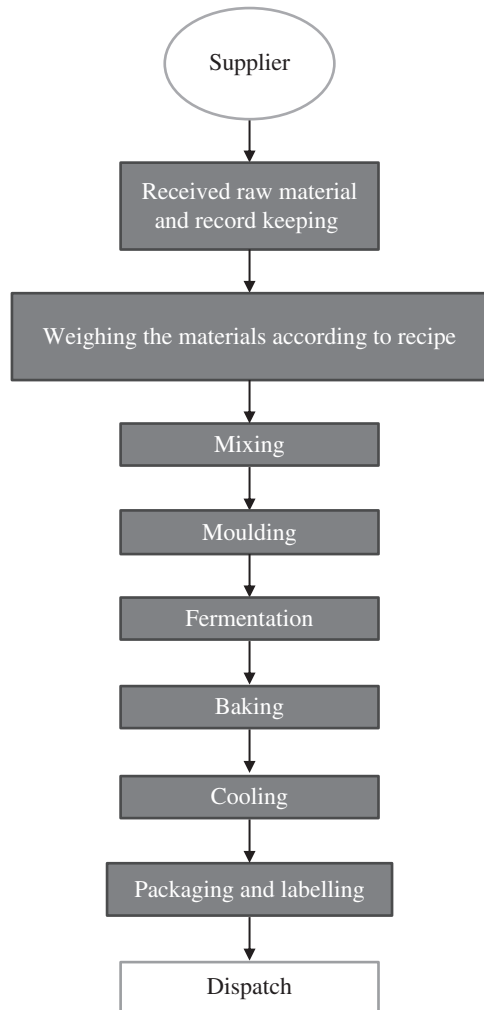
1.3.2 Quality Control in Production (Processes and End Product)

The actual processing approaches are critical in-house factors that may adversely affect quality. The most common process control involved in the food manufacturing process is in the area of the production process despite some operators using the term 'production' and 'processing' interchangeably. The quality programmes in food industry increase the awareness relating to the values of quality of production and production control strategy as their fundamental elements. Quality control activities in the food industry mainly emphasise the production area of the business function.

Controls in production processes are critical in the food businesses as process variation contributes to the total variation of production. Such principles necessitate producer strategies in the manufacturing process in such a manner that the process can be run in controlled conditions at all steps of the food production. Furthermore, such an element of process control in a food quality programme is identified as being critical for the excellent capability of the process and consistent quality of the products. The food manufacturer should plan a process control scheme. Thus, in this book, we have specifically guided the manufacturers in implementing process control through the statistical approach in Chapter 9. The common process control scheme planning should include process mapping, identification of critical points, a monitoring plan and correction plan. It is very efficient to list the sequence of the steps in the process such as in process map or flowchart approach in controlling the process (Figure 1.1).

Based on the process map in the example above, there are several important critical areas which require sampling and 'checkpoint' for quality control activities. A process is a collection of mutually related resources and activities,

Figure 1.1 Example of process map of bread production.



which transforms input into output. Process control covers all activities from the conversion of customers' demands into manufacturing instructions through the production and subsequently to the packaging, delivery, and sales of the products. Thus, in the industry, the use of process control can be regarded as a bigger or smaller extent of the operation management.

In this book, quality control of the process refers at the production process of the food and also covers in any activities that involved processes associated towards the quality of the product and services in the food industry. The inspection of the finished product is considered as the main approach

for quality control in the conventional quality control of the processes. The example of service processes in the food industry are:

- handling customer complaints;
- the time needed to handle customer demand;
- human resource;
- erroneous billing; and
- time for certification.

Inevitably, the success of any food manufacturing operation is highly based on the degree of control exerted on the different steps in the food production.

1.3.3 Issues Related to the Quality Control

1.3.3.1 Late Adopters

The food industry mainly comprises of small and medium-sized companies, which results in the late adoption of quality management approaches in the industry. The industry has lagged behind and suffered a severe food quality crisis despite the food industry being the pioneer in the field of quality assurance and quality management. The lack of priority in updating quality management approaches may also cause the industry quality management practices to fall behind other industries. The principal occurrences of the food crises arise from the vague responsibilities for food safety, where it is arbitrarily divided between government, public authorities, private businesses and politicians.

1.3.3.2 Difficulties Identifying and Prioritising Hazards (Microbiological and Chemical)

In the food industry, there are many points that could contribute towards the food quality and food safety attribute. Nevertheless, it is financially impossible to implement a quality control assessment at all points in the real practice. Therefore, it is highly suggested to implement the prioritisation of the control point to provide the food company with a correct direction of their quality control strategy (i.e. by monitoring and controlling the most critical points towards food safety and quality of the food production). Identification of critical points is commonly conducted based on experiences of the staff. The manual or guidelines for the certification process (e.g. HACCP) often provide approaches to identify these critical points.

1.3.3.3 Lack of Scientific and Quantitative Method to Assess Critical Points

The critical points in the food processes may or may not have direct measurement parameters. The root of the problem has been identified as:

- lack of scientific data;
- different approaches to monitoring the critical points;
- variation in standards resulting in different assessments on safety; and
- lack of awareness on the systematic control technique.

1.4 Quality Assurance

Generally, the quality system can be defined as the organisational structure, responsibilities, processes, procedures, and resources that facilitate the achievement of quality management. On the other hand, the organisational structure is the formal form of functions and tasks and the connection between them and the order of the processes within the organisation (Ren, He, and Luning 2016). QA systems only cover different aspects of the complete quality system in an organisation.

Over the last few years, the outcome of food crises has been a dramatically increased awareness by consumers and has alerted government bodies on food safety issues. The implementation of the control system under the food safety system has become an emerging issue for all stakeholders in the sector. QA standards and guidelines are increasingly implemented by many food organisations to regain consumer trust in food quality and safety and to establish their company-specific food safety management system.

If quality is the key goal of a food company, the director of quality assurance commonly holds a top management position, and quality matters should be reported directly to the president of the company. Food production systems have to be controlled by technological and managerial measures by applying QA (Ren, He, and Luning 2016).

Moreover, QA outlines and manages the activities of control, audits, evaluation, and regulatory aspects of a food production system. For instance, it covers an in-house consulting organisation, evaluates the quality program and offers advice, suggestions, and instructions for safety and quality improvement. Apart from that, instead of blaming culture practices which occur in some companies through the QA, QA does in fact, have the advisory function in the QMS of a company.

In a food QMS, a number of common quality assurance systems (QASs) are available such as:

- Current Good Manufacturing Practice (cGMP)
- Good Hygiene Practice (GHP)
- Hazard Analysis Critical Control Points (HACCP)
- International Organisation for Standardisation (ISO)
- British Retail Consortium (BRC)
- Food Safety System Certification 22000 (FSSC22000)

1.4.1 Current Good Manufacturing Practice (cGMP)

Good manufacturing practice (GMP) has a legal status in the USA where it is codified in the Food and Drug Administration (FDA) cGMP Regulations for foods (which cover all foods and specific regulations for specific food categories).

This certification is highly concerned with the hygiene requirements for food producers to supply safe food. Nevertheless, there is no absolute assurance of

food safety as hazards abound to exist at each food process. The key target is to ensure the absence of unacceptable risks of the processes and environment in manufacturing the products, or a few academics borrow the term from the World Trade Organisation, 'An Appropriate Level of Protection' (ALOP). Various criteria are used as the basis for GMP complement assessment which includes personal hygiene, food production facilities sanitation and design, process control and pest control.

The fundamentals of GMP for food are:

- *Quality control.* Product meets specifications.
- *Quality assurance.* Systems ensure control and consistency.
- *Documentation.* If it is not documented, it did not happen, or it is a false alarm.
- Verification and self-inspection.

HACCP augments and refines codes of Good Manufacturing Practices in that it concentrates effort and priorities for control on those requirements that are essential for safety.

Baird-Parker and Mayes (1989)

The term 'good manufacturing practice' is not defined, despite it being used widely around the world. and it is assumed to consist of the sum total of the stated regulatory requirements, policy, procedures, and guidelines for complying with the food regulations. The FDA has announced the plan and processes involved in modernising the GMP for food safety (last revised in 1986).

The five important factors of production and food processes that affect quality and safety while following GMPs, are as follows:-

- *Place.* Premises should be clean, and equipment should be orderly arranged. Food preparation surfaces should allow for regular cleaning and should be designed to prevent food contamination.
- *Primary materials.* Materials should be assessed, controlled, tested, and recorded where the contaminated, adulterated, impure raw materials should be rejected and returned.
- *People.* Number of personnel must be in sufficient numbers, equipped with sufficient knowledge and training, qualified by education, and mature with experience to perform their respective tasks.
- *Process.* The sanitation plan should include procedures for effective premise cleaning, equipment, handling the health and hygienic behaviour of personnel.
- *Product.* Every product has its own specifications, which may include quantity, purity, potency and test methods.

1.4.2 HACCP (Hazard Analysis of Critical Control Point)

The application of HACCP to food manufacture was pioneered in the 1960s by the Pillsbury Company in conjunction with the United States Army Natick

Laboratory and NASA, the National Aeronautics and Space Administration to manufacture safe food for the astronauts. In the early 1970s, a considerable number of HACCP applications extended to the food industry.

The HACCP system is currently adopted by food companies worldwide as it is a logical, structured and scientific system that can monitor, control, and verify safety problems in food production. It involves a prevention process by which the hazards and risks associated with the manufacture, storage, and distribution of foods are identified and assessed and appropriate controls of CCPs, which either eliminate or reduce the hazards, are implemented at specific points.

1.4.3 ISO

ISO 22000 is one of the most renowned and well-established QMSs in the food sector. It is a system that focuses on food safety management suggesting the critical requirements for all food producers. Apart from that, it also involves the ability of companies to control hazards in terms of food safety, to conform to the regulatory requirements and to communicate food safety issues to all involved stakeholders. Thus, the implementation of the system makes the customer have confidence in the products.

1.4.4 British Retail Consortium

In the similar light, BRC standards were developed for food safety by the BRC. BRC standards are widely used, and it was used as the benchmark for best practice in the food industry. The standard response to the industry needs to provide the quality and operational criteria for suppliers, manufacturers, and global retailers to ensure compliance with legal and statutory requirements. The core requirements of this standard are the implementation of HACCP, documenting the quality management practices, processes, and personnel, and control of plant environment. Indicative examples of BRC standards include issues for food safety, consumer products, packaging and materials, storage and distribution, and best practice guidelines.

The nature of the QA system in the food industry may differ in several aspects where the system is developed by combining or integrating the aspects to ensure the food quality. There is no standard formulation on which the QAS should be integrated into a food business as each product, commodity, and company have different priorities.

1.5 Quality Management System in the Food Industry

QMS consists of the activities and decisions performed in an organisation to produce and maintain a product with the desired quality level against minimal costs (Luning and Marcelis 2009). QMS is highly related to the formalising of

quality assurance policies, strategy, standards and specifications from a documented QAS (Early 2012). Moreover, QMS is a comprehensive approach to the quality assurance program in the food industry. The implementation of QMS is considered as the development of a food QAS that is heading to more systematic and structured quality assurance.

The 'food quality management' refers to dealing with the food safety and quality, food regulations, and quality management issues, which concerns with the system in production and also with the system of people. The system thinking hierarchy developed by food quality management (belongs to the higher system level) is known to be a complex system but assumed to be a controllable process. The food industry quality system introduces and uses a straightforward mechanism of control to manage the variation. It is represented by the great emphasis on the implementation of the QM (Quality Management) which are commonly based on the control circle to assure the food quality.

In the food industry, certification or third-party control has come to the fore as one of the quality management approaches. Food companies are entitled to use the certificate awarded to them in their marketing strategy. Therefore, the applicants (companies) are accredited or inspected for the main characteristics of certification systems by the independent bodies grounded on standards laid down by different external organisations (standard owners) of the key characteristics of the certifications. The figure below indicated the three main certifications in the food industry and highlighted the amount of statistical process control (SPC) usage (Figure 1.2).

1.6 Statistical Thinking

Various tools for quality improvement under the quality management belong to the application of statistical methods and the philosophy of statistical thinking. The process of adapting the fundamental change in the business in terms of economic, political, technological, and social character is connected to the quality management and the demand on the management of the modern organisation.

Snee (1990) stated that the principle of statistical thinking is:

- All works occur in a system of interconnected process;
- Variation exists in all processes; and
- Understanding and reducing variation are keys to success.

Based on the principle of statistical thinking, it is clear that statistical thinking is process-oriented thinking which provides a fundamental philosophical framework for quality improvement activities. Such activities focus on the processes, and identify and reduce the variation and the application of relevant data to understand the trend of the variation Cox and Efron (2017).

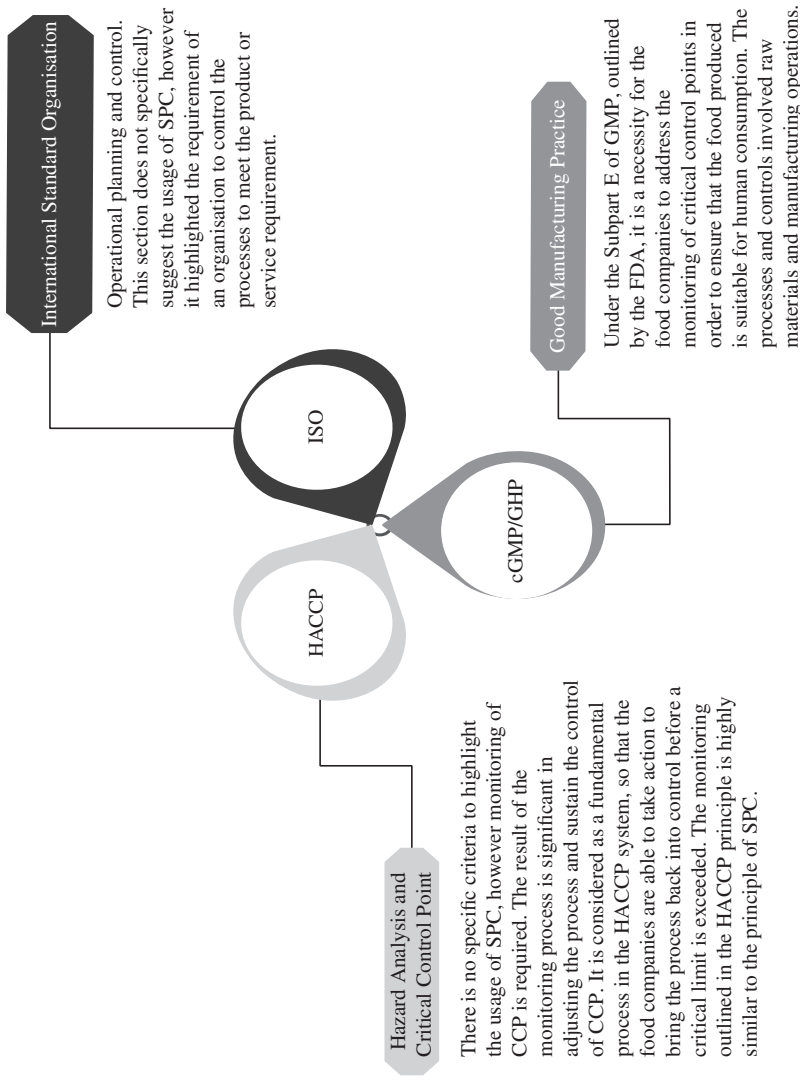


Figure 1.2 SPC in food certifications.

1.7 Summary

- Quality in the food industry is considered as the most important aspect of the processes and production, and food safety is considered the most crucial aspect of the food quality.
- Quality control in the food industry is used to satisfy the standard of product quality and comply with the regulations and rules in ensuring the food is safe to be consumed.
- Quality control in the food industry is typically being implemented at raw material inspection, processes, and end product.
- The businesses in the food industry are lagging behind in adopting techniques in quality control and suffered a food quality crisis.
- Quality control involves inspection, monitoring, testing, measurement, and analysis of data.
- Quality assurance activities involve planning, audit projects and analysis of the quality programme.
- QMS refers to a formalised internal system that records the processes, procedures, and responsibilities for conforming to quality policies and objectives.
- QMS includes quality strategy, quality planning, and improvement activities in the business.