A 14-Step Strategy of HACCP System Implementation in Snack Food Manufacturing

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Abstract: Food safety is a significant part of the manufacture of any food product. The use of the International Standard of Hazard Analysis Critical Control Points (HACCP) is to identify preventive steps to reduce hazards at each Critical Control Point. HACCP is widely accepted as a food safety management system. This study presents an implementation case of the HACCP system for a snack food manufacturer in Trinidad and Tobago. The company has been implementing HACCP on a trial basis for one product, with an intention to extend it to other product lines. A 14-step implementation strategy was developed. The trial led to good manufacturing practices and improvements in personal hygiene and sanitation. Results showed that reductions of the Total Non-Conformances were achieved by 54.6% and the Total Customer Complaints by 42.3%, respectively for the studied company. Future research could investigate a holistic paradigm that aligns HACCP measures for attaining safety performance goals in the snack industry sector.

Keywords: Hazards, Critical control Points, HACCP, Food Safety

1. Introduction
With many changes in food production and consumption, the risk of food borne illnesses is continuously increasing. In response to these changes and threats, countries are becoming more stringent in their surveillance and regulations in an effort to protect consumers. Almost every country around the world has been focusing on food safety in intense and multifaceted ways (Pun and Bhairo-Beekhoo, 2008). The Hazard Analysis Critical Control Points (HACCP) system and ISO 22000:2005 are examples of International Food Safety Quality Management systems that have been introduced to assist in improving operations of stakeholders along the food chain. HACCP is an umbrella term used to describe various activities that affect food safety. It concentrates prevention strategies on known hazards and the risk of them occurring at specific points in the food chain.

In Trinidad and Tobago, the importance of controlling food poisoning outbreaks has been increasingly recognised owing to the increasing number of meals consumed outside the home, in parallel with the ever-expanding range of snacks, pre-prepared meals, and meal substitutes. Nevertheless, there has been a lack of public awareness to the seriousness of, and no authoritative body and regulations to which the public can address any issues or cases of food poisoning.

Snacks are classified as ‘impulse foods’. This basically means that these items are not usually included in a grocery list, but are bought primarily by sight in the supermarket, pharmacy and any other place where people shop. Tortilla chips, potato chips, nuts and cheese snacks are altogether called the ‘salty snack’ category. This paper investigates into the HACCP implementation in a leading snacks manufacturer in Trinidad and Tobago. It describes the methodology (i.e. How?) and the reasons (i.e. Why?), whereby the HACCP system is implemented in the company. The customer complaint and non-conformance data was analyzed and the root causes for the hazards were identified. The paper then discusses the findings and achievements of the
HACCP implementation with respect to the study objectives. The potential applications to other product lines are also discussed.

2. Determinants of Safety Practices in Snack Industry Sector

According to the World Health Organisation (WHO), disease can either be food, air or water borne. As such, food borne disease is any disease of an infectious or toxic nature caused by, or thought to be caused by the consumption of food or water. It can either be of a microbiological, chemical or physical nature (Griffith, 2006a). Food safety, synonymous with food hygiene, embraces anything in processing, preparation or handling of food to ensure that it is safe to eat (Griffith, 2006b). The responsibility of food safety encompasses various food sectors of people, including producers and processors of food, governments and the consumers themselves (Pun and Bhairo-Beekhoo, 2008).

Hazards in the process of manufacturing would constitute significant threats to the consumers because they could be passed on through the company’s operations from receipt of raw material and ingredients to the distribution of packaged products (FAO, 1998).

Hazard analysis can be defined as the process of collecting and evaluating information on hazards and conditions leading to their presence in foods to decide which are significant for that food’s safety (FAO, 1998). This is a two-step process, comprising hazard identification and hazard evaluation. Hazard identification involves analyzing each raw material, production process and consumer use, and identifying appropriate control measures to reduce or eliminate potential hazards. The identification requires systematic evaluation of raw materials used in the food and the steps identified in the production flow diagram. Hazard evaluation is the process of reviewing each hazard that is identified to determine the severity of the health risk to the consumer and the probability of occurrence (see Figure 1). This is a logical continuation of product description and flow chart construction.

Businesses must identify the potential hazards likely to be associated with its operations and develop systems to control. The contamination of a food source whether accidental or deliberate can have far reaching consequences. This is especially so in a society where increasing responsibility for the safety of the food that is eaten is entrusted in food processors, the retail sector and food services (Manning and Baines, 2004). The onus is on the individual food business to take positive action to ensure that food produced is safe and wholesome. This involves two key elements. They are, firstly, risk assessment coupled with hazard analysis; and secondly, training in food hygiene is absolutely critical, particularly for supervisors and managers.

A critical control point (CCP) is a location, procedure or process in a food production operation where chemical, microbiological or physical hazard can be minimized if proper control is maintained at that point. In food hygiene, control points and CCP are related to the HACCP system (Amjadi and Hussain, 2005). The application of HACCP is not limited to food manufactured and processed by medium to large-scale operations but may also be applicable to smaller operations where safety of foods is of critical importance. HACCP is the system of choice in the management of food safety, and is compatible with that of quality management systems, such as ISO 9000 series (Manning et al., 2006; Nguyen et al., 2004).

HACCP is the system of choice in the management of food safety, and is compatible with that of quality management systems, such as ISO 9000 series (Manning et al, 2006; Nguyen et al., 2004). Adopting HACCP assists companies to comply with legislation, supports due diligence and fulfills customer requirements for a food and safety management system. The objective of the HACCP system is to guarantee food safety by implementation of a quality system, which covers the complete food production chain, from the primary sector up to the final consuming of the product. Food manufacturers are not only responsible for the Good Manufacturing Practices within their respective organisations, but also address the possible hazards (Arnjadi and Hussain, 2005). For example, if there is a possibility

![Figure 1: Hazards Analysis](image-url)
that the raw materials are exposed to certain hazards, a manufacturer is responsible to check if and how the supplier of the raw materials controls these hazards. Besides, the manufacturer must supply the consumer with sufficient information about handling of the product to avoid hazards, which can occur during cooking and/or storage of the product.

HACCP is a proactive approach to building food safety into one’s food production or preparation process that depends on the common sense application of both scientific and technical methods in the plant (FAO, 1998; Nathai-Balkissoon and Arumugadasan, 2004). An efficient and accurate record keeping within HACCP is essential. This provides the manufacturer with confidence that their product is safe and allows auditors to do their job. Documentation includes details of the component raw materials, the processing and the requirements of final products. Additionally, details of the HACCP plan, staff training, audit and verification details are needed. Nevertheless, people’s resistance to change is the main obstacle to the HACCP implementation. Other barriers include inadequate support and facilities such as, the layout, space limitations, and poor design facility (Pun and Bhairo-Beekhoo, 2008).

A digest of the related literature helps develop a practical model for facilitating HACCP implementation. The authors have proposed a 14-step strategy model of HACCP system implementation. However, two basic pre-requisites are assumed. The first is that the user organisations are well versed in the food safety needs and requirements for their business operations. Second, they are reasonably aware of the HACCP principles. A schematic presentation of the strategy model is given in Figure 2. The sequence of individual steps may be altered with respect to varied business operations and nature of organisations.

In order to demonstrate the proposed strategy model, a trial implementation in a food manufacturer, HSL Company, in Trinidad and Tobago was used. The Company produces a large number of snacks (such as extruded corn-based puffs, corn-based tortillaz chips, potato chips and nut products) for sales in the Caribbean and aboard. In 2007, the trial implementation of HACCP was undertaken in one of its product lines (i.e. Tortillaz Chips). The 14 steps of the HACCP system implementation are elaborated below:

3. A 14-step Strategy Model of HACCP System Implementation

Many agencies, practitioners and researchers have suggested different strategies, models and frameworks to implement HACCP in food industry sectors. Some of them are adopting a generic approach, while others are company or industry specific to a particular environmental or application. For instance, the Canadian Food Inspection Agency developed a food safety enhancement programme in 1993 (CFIA, 1993). The Food and Agriculture Organisation of the United Nations published a training manual on food hygiene and HACCP systems in 1998 (FAO, 1998). Woolworths instituted a vendor quality management standard in 1995. The standard required: pre-requisites procedures – cleaning operations, good manufacturing practice (GMP), training (hygiene awareness), recall procedure, pest control procedures, factory inspection prior to commencement of operations; and the development of a HACCP plan following a 12-step process (Khatri and Collins, 2007). Nathai-Balkissoon and Arumugadasan (2004) also advocated a 12-step HACCP programme that was composed of five preliminary steps and seven basic HACCP principles for food plant operations.

3.1 Commitment to Food Safety Improvements

Top management is the main driver of safety efforts throughout the implementation process (Pun and Hui, 2002). Management leadership and commitment can bring about corporate-wide safety initiatives and management practices in compliance with the HACCP principles and related safety standards. Having a clear corporate vision and mission for HACCP system implementation is essential, so that people can understand management’s commitment and expectation. The management should nurture a safety culture, develop the objectives, goals and policy, define the safety responsibilities, and delegate authorities and assign resources to where appropriate for the preparation and execution of changes and improvements across the entire organisation.

3.2 Formation of a HACCP Team

In 2006, a multi-disciplinary HACCP team was formed at HSL. Members from a wide range of expertise were selected so as to ensure a company-wide participation and implementation. Their responsibilities include: 1) ensuring the Food Safety Management System requirements are established, implemented and maintained in accordance with the HACCP System and 2) reporting on the performance of the Food Safety Management System to
management for review, and as a basis for continual improvement. For this initiative at HSL, the Production Manager has been appointed as the Coordinator/Leader for the establishment and implementation of the Food Safety Management System. Other members were the Operations Manager, the Quality Assurance Manager, a Quality Systems Technician, a Production Supervisor, and a Warehouse Supervisor.

**Figure 2:** A 14-step Strategy Model for HACCP System Implementation

### 3.3 Conduct of Gap Analysis
A thorough Gap analysis examined objectively the current Quality Management System in place and related operations to the requirements of the HACCP system (such as material handling and storage, maintenance and equipment performance, personnel training, sanitation and personal hygiene, and heath and safety recall procedures). The results helped the company to compile a list of areas for improvement and develop action plans and deadlines. Several tasks could be completed simultaneously by team members or assigned to other members of staff with respect to the assigned priorities and responsibilities.

### 3.4 Description of the products
Begun with thorough understanding of the selected product, the HACCP Team should know the composition and processing of the food and the severity and risk of any hazards. The description of the product requires knowledge of 1) product characteristics and composition, 2) structure, 3) processing, 4) packaging, 5) storage and distribution conditions, 6) required shelf life, and 7) instructions for use. With the implementation of HACCP system, more details were required on microbiological characteristics, nutritional values, chemical and
3.5 Construction of Flow Diagram
Team members constructed the flow diagram to cover various steps in the operation for easy identification of routes of potential contamination and controls. Process flow diagrams include: 1) The sequence and interaction of various steps in the operation, 2) Any outsourced processes and subcontracted work, 3) Where raw material, ingredients and intermediate products enter the flow, 4) Where reworking and recycling take place, and 5) Where end products, intermediate products, by-products and waste would be removed. The objective was to visualize the flow of the production process and to make the process transparent. Once the flow diagram has been produced, it needed to be checked for accuracy. Variations in work practices often occur when different line supervisors are in control. This check involved members of the HACCP Team at different times with different shifts. The completed checklists form a record of the assessment and provided a baseline for the assessment of change.

3.6 Identification of Hazards and Control Measures
The hazard analysis consists of 1) listing all the hazards that can be present, 2) assessing the probability and severity of risk, and 3) identifying ways in which the hazards can be controlled. The HACCP Team should ensure that the team complies with the terms of reference. There should be identification of the hazards, operational malpractices and contamination points (such as improper cleaning). Once the hazards have been identified, the control measures based on knowledge of the hazards, their normal sources and contamination points would then be constructed.

3.7 Determination of Microbiological Hazards
The decision tree approach was used for the team to look at the products, with the intention of identifying the microbiological hazards at HSL. Decision trees were structured in sets of questions. Typical questions include:
- Are control measures in place?
- Is control at this step necessary for safety?
- Does the step eliminate or reduce hazard occurrence to an acceptable level?
- Will contaminations occur at unacceptable levels or increase to unacceptable levels?
- Will a subsequent step eliminate or reduce hazard to acceptable levels?

In order to establish the hazardous organisms that may be associated with a particular food product, this process usually starts with a list of human food pathogens, followed by an evaluation of raw materials, production process and the possibility of contamination. Named pathogens presenting a possible risk are evaluated in relation to epidemiology data and their ability to cause illness, associated with a specific or related product.

Immediate potential hazards include the remaining pathogens with low minimum infective dose or not requiring growing in the food. Those microorganisms with a higher minimum infective dose or requiring growth receive further consideration. Estimates need to be made of the likelihood of these organisms growing in the food for consumer use. The role of the consumer and reasonable expected consumer abuse (RECA), product consumption and intended storage are also to be considered. This would lead to the identification of some microorganisms that are deemed marginal, meaning that the risk is present but at a low level. Once the potential pathogens are listed, it becomes possible to identify their main sources and possible contamination routes, which in turn assists in establishing the control measures.

3.8 Determination of Physical and Chemical Hazards
Physical and chemical hazards are both important in food safety and amount to numerous complaints about product quality. Customer complaint records are the most useful source of information on physical and chemical hazards. Examples of chemical hazards include cleaning chemicals, pesticides, toxic metals, organic compounds and packaging plastizers. Contamination with chemical hazards can take place from farm to consumption. The minimum dose needed for some chemicals to cause acute illness is known but others have a chronic long-term effect following consumption of low levels over extended periods. Physical hazards can be classified into 5 major categories, namely glass, metal, wood, plastic and miscellaneous. Miscellaneous items include such as sand, paint stones, rubber and objectionable foreign matter that may not constitute a hazard.

It is important to consider how hazards can be present in the food product. Hazard analysis includes the identification of operational malpractices or events that lead to cross-contamination. The HACCP team verified the possible causes, identifying the
most important and prioritized action.

3.9 Conduct of Risk Assessment

Risk assessment is the process of evaluating food premises to decide if they need to be inspected frequently or not. Within HACCP, the risk concept is used to prioritize actions and determine level of control, and risk is defined as the likelihood or probability that a hazard will occur with consideration of severity. Risk can be quantified mathematically but this approach requires careful interpretation. Often the amount of raw data is inadequate or insufficient. An alternative is to consider food risk categories in high, medium or low degree (see Figure 3).

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Severity</th>
<th>Risk Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk</td>
<td>High</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Low Risk</td>
<td>Medium</td>
<td>10,000</td>
</tr>
<tr>
<td>Medium Risk</td>
<td>Low</td>
<td>1,000</td>
</tr>
</tbody>
</table>

![Figure 3. Risk Assessment and Severity Matrix](image)

3.10 Identification of Critical Control Points and Target Levels

Once the hazards and how they get into food (i.e. sources and contamination points) are identified, control measures can be decided. A control measure is the action or activity required to eliminate a hazard or reduce its impact or occurrence to an acceptable level. More than one control measure may be required to control one hazard and more than one hazard may be controlled by one particular control measure. The work on risk assessment in combination with the damage potential (i.e. hazard severity) can assist to decide upon the level of control to be implemented. The control measures are also included in the Product Hazard Analysis.

In order to identify the control points, there are controllable steps in production within which: if an error happens the quality of the final product can be negatively influenced. Control measures are implemented at each critical point that is identified in the decision tree. A brief description of the action is included at this stage.

Results from control measures should be obtained rapidly and in time for remedial action to be taken. Statistical Process Control (SPC) is based on controlling the process to ensure the product consistently conforms to agreed specification. The SPC charts can monitor the performance of agreed HACCP critical limits. For each stage of the process for manufacturing Tortillaz Chips at HCL, quality audit sheets were used including the critical control limits and the cut off limits for the process parameter.

3.11 Monitoring of Safety Measures

Monitoring is the series of observations or measurements to ensure that controlled measures are being implemented correctly and within critical limits. Monitoring enables management to detect loss of control at a CCP. Hence, it is important to specify who, how and when monitoring is to be performed and recorded. Results from monitoring should be used proactively and illustrate how SPC can be incorporated into HACCP.

Monitoring can be continuous where important data is constantly being recorded, for example temperature graphs can be discontinuous with observations made and recorded at specific time intervals. Several types of monitoring activities are identified. These are:
• Physical checks are manual and take the form of a simple test or following a standard operating procedure, and then a calculation followed by comparison to the set specifications for the process parameter. The measurement of percentage flavour of a product is a typical example. This requires weighing the flavoured and unflavoured chips and then a simple calculation.

• Observation/Visual checks are best performed after training and testing for reliability and reproducibility against very specific criteria, which may include photographs, chart and timings. Visual inspection of surface cleanliness is the first part of an integrated approach to monitoring.

• Microbiological checks require an outsourced laboratory or the establishment of an internal laboratory for testing under controlled environment.

• Chemical checks usually involve a laboratory test. This is a technical procedure usually requiring the Quality Department staff to conduct this test.

3.12 Planning for Corrective/Improvement Actions

A Quality Plan shows the areas in which tests are carried out, with reference to the test procedure, who does the testing, the frequency, and the disposition of the product when out of specification. A Corrective/Improvement Action Plan describes what should happen if a deviation is found, meaning if the value of a measurement lies outside the critical limit. If this were to happen, there must have been a loss of process control (e.g. failure to achieve a specified pasteurization temperature or failure to clan properly). These plans are also used to specify what should happen if the results obtained at a critical control point are within a critical limit or not. Besides, documentation of the incident and the defective product is recorded on a Non-Conformance Report. This document is only completed when an investigation has been done, the defective product has been tested and a decision has been made on the release and outcome of the product.

Types of corrective/improvement actions that can be specified depend upon the hazard, the product and degree of deviation. This includes activities designed to ensure that the product is back under control and that control of the process is regained. If the investigation findings from the non-conformance report are such that the reasons for the non-conformance are ‘major’ leading to a breakdown in systems, a Corrective/Improvement Action (CIA) Request is issued. This document states the nature of the problem, the reason for the occurrence and the root cause and the actions to be taken to avoid another occurrence. This CIA request is issued to the departmental manager and has to be answered by a certain number of days and action to be implemented. Thereafter the area is audited for action being completed and verification of effectiveness of actions, meaning that there has not been a re-occurrence of the problem.

3.13 Verification of the HACCP Process and Documentation

Auditing is an important way of verifying HACCP plans. This is a systematic and independent examination to determine whether 1) HACCP activities and related results comply with planned arrangements, and 2) those arrangements are implemented effectively and are suitable to achieve objectives. There are basically three types of HACCP Audits - namely Internal (e.g. In-house auditors), External (e.g. Supplier or Contracted body) and Regulatory (e.g. Chemistry, Food and Drug inspectorate).

The management should coordinate the safety audits, maintain the safety records consistently, and reinforce the safety practices for HACCP audits. Organisations should document systems and add in the requirements for activities affecting food safety, quality and customer satisfaction. In this context, HSL has integrated its HACCP documentation into existing quality policies, procedures work instructions and record or reference a separate HACCP manual of its ISO 9001:2000 under Section 4.2: Quality Systems.

3.14 Reinforce Continuous Performance Improvements with HACCP

The management and the HACCP team should review the HACCP system at defined intervals sufficient to ensure its continuing suitability and effectiveness in satisfying the safety requirements and the company’s stated safety policy and objectives. Moreover, maintaining the safety culture with committed management and efficient management reviews would ensure that organisations stay ahead with continuous performance improvements (Pun and Hui, 2002).

4. Methods and Analysis of Findings

Customer Complaints and Non-Conformances were
two yardsticks by which the implementation of HACCP system was measured at HSL. It was through analysis of this information that the need for this implementation came about. A review on Customer Complaints lodged in the year prior to HACCP, and the year in which the work was done, was compared in order to investigate their impact on the system.

4.1 Customer Complaints
Customer complaints are major non-conformances and as such occur when issues are not detected and resolved in the manufacturing plant. Customer complaints are currently being measured as a key performance indicator (KPI) for the Company. Hence, this information is readily available and is analyzed and compiled as a monthly report. Table 1 shows the customer complaints for fiscal years 2004-2007 (data available up to April for 2007).

The three leading areas of concern were 1) foreign matter, 2) sensory or organoleptic issues, and 3) underweight and empty packs. Foreign matter was divided into metal and non-metal categories. For the metal category, this basically included such items as metal wields pieces of equipment. Screws, nuts and bolts etc originate from plant equipment, with the odd exception not being identified from the plant. The foreign matter category included items such as pieces of plexi-glass, paper napkins, wood, and other odd miscellaneous items. Besides, foreign matter was inclusive of products manufactured in the plant found in a pack of another product. This was a result of cross contamination due to a poor cleaning and sanitation of conveyors.

The sensory or organoleptic category included complaints such as soft or stale product, hard product or other texture issues, too salty and other characteristics with respect to the taste of the product. The under weight and empties category referred where a consumer obtained a pack of product which was not completely full or empty and was not detected by the manual packers on the packaging line. This was a result of negligence or human error. Moreover, the category of ‘Other’ included issues, which might have come from sales such as bad driving, incorrect sale of product or mistake with pricing. This category also included the complaints from outsourced products, in possibly the same areas identified for this manufacturing plant. These complaints were not under the control of this Company but the responsibility was accepted and conveyed to the country of manufacture.

<table>
<thead>
<tr>
<th>Criteria for customer complaints</th>
<th>F’05 Sept ‘04 – Aug ‘05</th>
<th>F’06 Sept ‘05 – Aug ‘06</th>
<th>F’07 Sept ‘06 – April ‘07</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># of complaint</td>
<td>% of total</td>
<td># of complaint</td>
</tr>
<tr>
<td>Foreign Matter</td>
<td>118</td>
<td>30.2</td>
<td>137</td>
</tr>
<tr>
<td>Sensory / Organoleptic</td>
<td>97</td>
<td>24.8</td>
<td>92</td>
</tr>
<tr>
<td>Under weights / empties</td>
<td>96</td>
<td>24.6</td>
<td>110</td>
</tr>
<tr>
<td>Other</td>
<td>80</td>
<td>20.5</td>
<td>63</td>
</tr>
<tr>
<td>Total # of complaints</td>
<td>391</td>
<td></td>
<td>402</td>
</tr>
<tr>
<td>Tortillaz Chips complaints</td>
<td>125</td>
<td>32.0</td>
<td>172</td>
</tr>
</tbody>
</table>

4.2 Non-Conformances
Non-Conformances are defined as any incidents or occurrences, which are not within the documented specifications. These are divided into two categories, namely 1) major non-conformances and 2) minor non-conformances. Information collected is analyzed and compiled into a monthly report, as for customer complaints. Table 2 depicts a summary of non-conformances for fiscal years 2005, 2006 and 2007 (data available up to April for 2007).
The top three areas of concern for the past years were 1) personnel, 2) equipment or utilities malfunction, and 3) contamination or infestation. The area of personnel can be defined as persons not following the normal standard operating procedure, lack of process control or negligence. This basically deals with the human aspect of the operation, for which there always existed a problem, but needs constant attention in the way of training reminders via notices, posters.

The next area of concern was equipment and utilities malfunction. This referred to any incident that caused loss of time in the manufacturing process (or Non-Productive time), as well as defective product. This could be the root cause for the aesthetic or texture issues with the product. Besides, contamination might mean one product mixed with another product during the process or a situation where due to inadequate cleaning particles from a previously manufactured product was brought into the current manufacture of a product.

The issue of infestation could occur in two areas: the raw material storage, where raw materials could be plagued by mould with incorrect storage conditions. Besides, insects such as weevils could manifest in products such as corn meal, corn masa or potato pellets. The next area of infestation is in the manufacturing plant itself, where there was always the possibility of pest infiltration into the process, whether they were flying or crawling insects.

The category of ‘Other’ included such issues as poor handling causing damage to the raw material or packaged product. Supplier issues was another area of concern, meaning defective product delivered to the plant, which needed special instructions for use rather than the standard parameters for processing or the product could not be used at all. In the latter case, this also implied the loss of storage space to the defective product, as well as the incurred demurrage costs. These areas of Non-Conformances were directly related to the Customer Complaints.

The major non-conformance classified as personnel was directly related to the areas of concern in Customer Complaints. Foreign matter inclusion such as paper napkins, hair and other miscellaneous items could be attributed to negligence in cleaning procedures or poor manufacturing practices such as not covering hair properly. For issues such as product mix-up, which was also in the area of foreign matter contamination that this can be as a result of equipment malfunction causing an overflow. As a customer Complaint, this was a very critical issue as it could cause further implications with consumers and allergens. For occurrences such as wood, this again could be caused by improper use of wooden pallets in the plant.

For foreign matter metal inclusion, the improper preparation of equipment for start up or insufficient maintenance checks could cause a metal bolt or nut for instance to be included in a pack. The category of sensory or organoleptic was also directly related to personnel, where procedures were not followed with respect to the product specifications. It could also imply no detection of an issue with raw materials before its use in the manufacturing process, this was attributed to negligence.

The complaint area of under weights and empties was another area that could be as a consequence of equipment malfunction with respect to the packaging machines as well as this was a personnel issue, whereby the defective packs should be detected by the packers on the packaging line as

<table>
<thead>
<tr>
<th>Criteria for Non Conformances (N.C.)</th>
<th>F'05 Sept ’04 – Aug ‘05</th>
<th>F'06 Sept ’05 – Aug ’06</th>
<th>F’07 Sept ’06 – April ’07</th>
</tr>
</thead>
<tbody>
<tr>
<td># of N.C.</td>
<td>% of total</td>
<td># of N.C.</td>
<td>% of total</td>
</tr>
<tr>
<td>Personel</td>
<td>280</td>
<td>45.1</td>
<td>309</td>
</tr>
<tr>
<td>Equipment / utilities malfunction</td>
<td>205</td>
<td>33.2</td>
<td>201</td>
</tr>
<tr>
<td>Contamination / Infestation</td>
<td>85</td>
<td>13.7</td>
<td>92</td>
</tr>
<tr>
<td>Other</td>
<td>51</td>
<td>8.2</td>
<td>71</td>
</tr>
<tr>
<td>Total # of N.C.</td>
<td>621</td>
<td>673</td>
<td>325</td>
</tr>
<tr>
<td>Tortillaz Chips N.C.</td>
<td>289</td>
<td>46.5</td>
<td>329</td>
</tr>
</tbody>
</table>
the packs were manually put into the inner bags and then into cartons. Findings showed that there was the direct relationship between the non-conformance issues occurring in the plant and the customer complaints received by the Company.

4.3 Highlights of Accomplishments
The implementation of the HACCP system has been proven to assist in the prevention of food contamination at HSL. Customer Complaint have been reduced from 402 in Fiscal year 2006 to 232 in Fiscal Year 2007 (up to April), a 42.3% reduction. For Non-Conformances, there has been a reduction of 51.7% from 673 in Fiscal year 2006 to 325 in Fiscal Year 2007. Besides, this was evident by the reduction of Total Non-Conformances by 54.6%. This was seen by the 71% reduction of issues in the area of Non-Conformances. The area of personnel issues have been reduced by 66.6%, equipment and utilities malfunction reduced by 75.6% and contamination or infestation reduced by 71.7% from Fiscal year 2006 to 2007. This can be attributed to a greater focus on following the standard operating procedures, and holding people accountable for their actions, so that there were fewer instances of negligence.

There was also stability and trust in the Company by the consumers as well as strength and confidence brought to the Brands. The main area of improvement was in the area of sensory/organoleptic, where there has been a 58.7% decrease. The foreign matter criteria were also drastically decreased (i.e. 56.2%). The issue of under weights and empty packs was reduced by 33.6%. This can be attributed to the increased focus put on training for the packers and extra checks or audits on the finished goods area.

5. Discussion
While food hygiene is concerned with a wide range of activities within a food and beverage operation and is ultimately the responsibility of the management, one cannot overlook the role that each employee plays in the implementation of the food hygiene system. By integrating food hygiene into the operational systems (manufacturing and checklists), a powerful message will be sent to the personnel that food hygiene is a primary function of the establishment and must at all times be enforced. The development of the HACCP system to a snack industry is based on this principle of importance of food hygiene.

The purpose of this trial implementation of the HACCP system on product line is to establish whether this approach is feasible for the implementation of the system to other production lines. This can be determined by the analysis of the measureables (such as, Customer Complaints and Non-Conformances). This can also be assessed by identifying the setbacks during the implementation process and the areas of improvement identified by the various steps or procedures taken. The HACCP system was incorporated into the existing ISO 9001:2000 Quality Management System (QMS) in the company. Training, enforcement, verification, product safety checks and audits of the HACCP system were conducted under the area of the QMS.

The steps of implementation and principles of HACCP were addressed separately and with details of the processing operation. These steps enforced proper investigations, root-cause analysis and documentation. The Product description was more detailed with emphasis on physical, chemical and microbiological aspects of the product. The process steps description and the flow diagram also showed clear guidelines of the product manufacture.

With respect to the Hazard Analysis of the product, CCPs were identified and the respective actions were described in the product hazard analysis. Severity and risk assessment of each critical area in the process was also evaluated. The major areas of concern, identified from the Customer Complaint data are foreign matters (i.e., metal versus non-metal), sensory or organoleptic and under weight or empty packs. These are directly related to the major issues in non-conformances in the plant, personnel, equipment or utilities malfunction and contamination and infestation. The data shows a gradual decreasing trend for both customer complaints and non-conformances with the implementation of the HACCP system.

While food hygiene is concerned with a wide range of activities within a food and beverage operation and is ultimately the responsibility of management, one cannot overlook the role that each employee plays in the implementation of the food hygiene system. By integrating food hygiene into the operational system, a powerful message is sent to the personnel that food hygiene is a primary function of the establishment. These areas identified will bring a greater value to the currently implemented system to the Tortillaz Chip product line as well as all the other product lines intended for HACCP implementation.

6. Conclusion
Many practitioners and researchers advocate that
achieving safety performance can help organisations foster their competitive edge (see, for example, Arnjadi and Hussain, 2005; Khatri and Collins, 2007; Pun and Hui, 2002). This is attributable to the minimization of financial loss, compliance with legislation, effective allocation of safety responsibilities, and promotion of community goodwill (Pun and Bhairo-Beekhoo, 2008).

This paper described the implementation of a 14-step strategy of HACCP system implementation for snack food manufacturing at HSL, where the work was limited to one product. Based on the results of the gap analysis, improvement was required in several areas, the most urgent being sanitation. Hence, a cause-and-effect diagram of poor sanitation was identified and this also contributed to the reduction of non-conformances in the plant.

Over the studied period, the HACCP implementation has made a tremendous contribution to improved personal hygiene of staff, manufacturing practices and sanitation and cleaning schemes. These are the key areas which have impacted on the reduction of Non-Conformances and Customer Complaints. HACCP concentrates prevention strategies on known hazards and the risks of the occurring at specific points in the food chain. Evidence shows that the trial implementation of the HACCP system for one product could be applicable to other product lines.

HSL has implemented HACCP for its own benefits and for obtaining the HACCP certification. Acquiring HACCP certification is not a condition of sale in Trinidad and Tobago. However, achievements from the implementation will promote the product, the quality and safety standards of the company in the eyes of the consumers. This also strengthens the brands of the company as well as promotes trust in the production of safe food to the consumers.

In order to attain safety performance for competitive edge, snack food manufacturers should expand hazard assessments to quantify consumer risks and potential hazard reduction. The HACCP system should be continuously revised to reflect ongoing changes to operating systems, work force, plant facilities and environment, as these would impact on the end product to the consumers.

The 14-step strategy model serves as a practical reference for snack food manufacturers to establish, implement and maintain their HACCP system. The model provides a process-oriented approach for helping organisations to go through the HACCP implementation in line with the safety management requirements and HACCP principles. This also assists them in maintaining the HACCP system and reinforces continuous improvement in safety performance.

Future research using comparative studies is suggested to investigate the determinants of the HACCP system implementation and a holistic paradigm that aligns HACCP measures for attaining safety performance goals in the snack industry sectors. Moreover, future work could be enhanced through improvements in the acquisition of timely and properly processes data, and the methodologies used to elicit empirical information.

References


CFIA (1993), Food Safety Enhancement Program, Vol. 2., Canadian Food Inspection Agency, Ottawa


Pun, K.F. and Hui, I.K., "Integrating safety dimension in quality management systems: a process model", Total
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