Quality Management Applied on a Food Industry

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Abstract – *The research project was focused in transforming the quality engineering perspective from one that solves problems directed to engineers to one that solves routine problems that affects the entire society. Therefore, the implementation of quality techniques into a future state business based on the Sushi food was analyzed. The proposal intent is to change the perception of this particular food that often is presented on formal restaurants. The sushi process was evaluated as the production of a product required by a customer and must be completed in a specific range of time considering and maintaining the quality standards pre-established by the customer. The sushi food process was analyzed in their regular basis preparation and the methodology was rearranged using Lean Manufacturing techniques; in order to transform the process into one faster achieving in all instances the voice of the customer that reacts as the quality input. A production line layout was implemented by benchmarking the business against a commerce that shares an equal way to deliver a product. More quality techniques were implanted to glimpse this business as one prosperous and effective.*

Key Terms *– Fast Food, Lean Manufacturing, Process Improvement, Sushi.*

PROBLEM STATEMENT

Quality Management on today's world is not an alternative, is a complete solution for the worldwide economy crisis, offering accurate responses for most of the economic issues on each industry and real solutions with an overview plan. Many people relates Quality Management and Manufacturing procedures with engineering daily basis work and as part of their own dialect but, the worldwide economy crisis is not impacting just the government and the big companies, is affecting every people or entity that manage money. Therefore, the food industry is not the exception. Puerto Rican society is best known as a multicultural mixture with an excellent adaptation to different food selections, many cultures has come to Puerto Rico implementing their food and Puerto Rico has serve as a good judge by accepting or neglecting some food sources. This research is seeking to understand how the society will react about implementing a fast production sushi food into an establishment that will work using quality management techniques to ensure the customer satisfaction.

Research Description

The intent of this research is to demonstrate how the manufacturing procedures can be used not just on an engineering related industry (quick changeover, visual management, Pareto Chart and others) but on any food industries. As a usual practice on the Sushi style food, it is very traditional to find this kind of food on a specific establishment such as a classic restaurant with waiters that serves as the direct person that will deliver a quality service. This methodology does not guarantee a product quality and on much of these establishments the lead time tends to be extensive due to the queue. Therefore, implementing a visual production line prepared to work under a high volume of demand maintaining and ensuring high quality standards is an innovative idea that will demonstrate how this food style can be implemented as a "fast food" option offering the most popular dishes per customer's feedbacks and an unique concept that will blend two different

cultures such as the Japanese food and the traditional American "fast food" concept into one.

Research Objectives

This research's objectives are to offer an alternative solution to the food industries by supplying quality managements techniques that will contribute in a positive way to battle the economy recession, demonstrating a reduction in the production time by at least of 50% of the traditional food methodology, the implementation of an intelligent production line, a business layout that will ensure an appropriate quality service and a business option that will be aligned with the customer voice.

Research Contributions

During the course of time, it has seen that the world has changed and modernized. The societies are seeking a common goal, the welfare and peace of mankind but, nevertheless the economic collapse has been constantly a challenging factor for people that need to explore real and viable alternatives to achieve good results considering the resources that they have at the moment. Skills and disciplines, largely adopted globally from successful companies, are the structural basis of the quality management study. Quality is often related to an efficient product that carries important characteristics established by each individual. However, it is important to understand that these skills are not only used in solid products that have undergone a manufacturing process and evaluated by engineers. Moreover it is something that can be used on important and vital things to the lives of people, for instance the food. This research work seeks the following:

- Changing the image of Quality Management as a resource aimed at companies with engineering problems to be a resource that offers real solutions to the global economic crisis driving problems in general.
- Implement an innovative concept which focuses on a style of food, this concept seeks to change the way of presenting a product for a more versatile and fast method.
- Demonstrate how this process reduces production time and at the same time maintaining appropriate quality standards.
- Illustrate the logistics and layout of this system and see how it can work in a high demand condition.

LITERARURE REVIEW

The world in general has made dramatic changes in recent years; the economy has suffered episodes of suspense and terror in which the uncertainty is the main nightmare of all economists. Multimillion dollars companies, industries and businesses had to be forced to reduce staff and to minimize unnecessary consumption in order to stabilize their businesses due to the diversity in the economy. Therefore, it's important to clarify that the crisis doesn't discriminate against any industry; it affects us all equally including the food industries. The food is the heart of the culture of a country; it is where you can feel many unique features of each society. The spread of people around the world have made that the migration carry a feature flawless with their culture, food. It is for this reason that our society knows different food styles. Puerto Rican society comprises people from all over the world and is for this reason that fast foods, pizzas, steak house, Chinese food and many other popular dishes such as the Japanese food have come popular. According to the census conducted in 2010, reflected a reduction of 14.2% of the Asian population on the island, this group includes people from China and Japan [1]. Despite this reduction, the Asian culture has been revealed in the island in so many ways, for instance, throughout the food style, the marital union between citizens of Puerto Rico and Asians.

The Luncheon Sushi Place

It's often known and associated to eat sushi in a place similar to a formal restaurant with chairs and waitress. Tedeschi, wrote an interesting section

on the New York Times saying, want to take someone down a notch? Take them to a sushi bar and ask them to order [2]. Definitely, this is a blameless comment since it targets to the often seen on these places, a server fluent in Japanese or even a Japanese or Chinese person. Mara Santori Lopez described a charming restaurant which involves the teppan-yaki style and the sushi style in one place [3]. This place was created by the entrepreneur David Wong on the Hotel San Juan located on Isla Verde, Puerto Rico. The editor provided some details about the decoration, tables and the mode that sushi was elaborated. Basically it has two chefs that by the way are Orientals without forgetting the whole Orientals staff described by the editor. The Sushi chefs have their own workplace and any orders to make are through the waitress. These are the common and most seen sushi places on Puerto Rico and as well on America. This is one of the gadgets to explore and scrutinize using Lean Manufacturing tools in order to tweak it to a versatile and prosperous practice.

Lean Manufacturing in Quality Management

Ironically the study of this research involves entirely the Japanese culture. Lean Manufacturing is a quality technique that was born on Japan or was optimized by Japanese creating then a culture that companies adopted as their daily work. The Manufacturing Engineering Handbook provides a brief story of the Lean Manufacturing origins [4]. Lean manufacturing is a system whose techniques aim to significantly eliminate waste in the manufacturing process. Japan had learned management and improving techniques and methods such as industrial engineering (IE) and quality control (QC) from Europe and America. Those methods were further developed in Japan and resulted in the technique known throughout the world as KAIZEN. During this movement, Toyota developed their own unique methods in manufacturing. The concept was completely different from the mass production method represented by Henry Ford. In Ford, they produced one type of automobile as a batch. That's why it is referred to as mass production. However Toyota started to produce automobiles one by one when it was actually needed. This Lean thinking was developed by Taiichi Ohno however; contributions to this philosophy were also driven by many Japanese engineers like Shingeo Shingo. They all develop a systematic approach to implement some of the good production practices that go back to the beginning of the 1900's.

Fast Food Industries Culture

Swart ET all stated that James McLamore opened the first Burger King in Miami in 1954 with a simple concept; he served a few variations of the basic hamburger, and did not need a traditional kitchen [5]. This changed across the time when McLamore sells the franchise and the business expands. But it is very important to understand how the fast foods works in order to maintain a similar approach of serving the food fast. Swart ET all defined the model development for a traditional fast food [5]. They stated that in order to develop a general purpose restaurant model, it was decided to view the restaurant as an operating system composed of three inter-related subsystems: The Customer System, The Production System and The Delivery System. In a typical store, a customer order is generated in the customer system. This order is transmitted to the kitchen. The four production areas in the kitchen (drinks, fryers, main sandwich preparation line and specialty sandwich preparation line) respond if the order contains a product made in that area. The production action can be to replenish inventory of standard product, or to prepare a custom sandwich for a waiting customer. Simultaneously, in process inventories of fries, preassembled hamburgers, drinks, fish, chicken, lettuce, mayonnaise, etc., have to be checked to determine whether a replenishment action must take place. Concurrent with the production activity, the delivery system is active in processing the customer by making change and assembling the order from inventories, whenever possible. The amount of time a customer waits, referred to as speed of service, is held to a

minimum by using inventories whenever possible and by maximizing the lead time the kitchen has to produce special orders. The equation at the end is simple. The faster the service, the more people can be served, the higher the restaurant's potential sales volume. But how fast a restaurant should be to be categorized as a fast food? Kirchner, stated that a fast food usually deliver a product with a lead time of 5 to 7.5 minutes, however as mentioned before it all will depends with service speed while producing an order [6].

METHODOLOGY

To incorporate a high production sushi line into a satisfactory business it is important to understand how the actual methodology works; for then incorporate Lean Manufacturing processes in order to reduce significantly the time creating as a result an exotic fast food enterprise. To do so the following steps were followed:

1. Perform a single minute exchange of die (SMED): This technique focus in minimizing or eliminating the stations that has the higher turnover. This technique requires as the first step to analyze an entire setup operation in a videotape for then share it with the coworkers and obtain their feedback that will be use it as an improvement to the current method. But, since this project is expected as a future business for now it will be implemented just by the originator that start the business using a chronometer to identify possible Muda on the process.
2. Value Stream: Value stream are the actions required to bring a product through the three critical management tasks of any business:
    - Problem solving tasks intent to address discrepancies in this particular case between preface preparation and product delivery.
    - Information Management tasks intent to design accurately the order taking process, an accurate bill of material and process demand against capability.
    - Physical Transformation intent to offer a gently atmosphere that will be on the same page with the customer voice.

Is highly important to emphasize that during the value stream process typically four types of actions are categorized, these actions are:

- Steps that unambiguously create value.
- Steps that create no value but are unavoidable.
- Steps that create no value but are unavoidable with current technology, these are best known as Type 1 Muda.
- Finally are steps that create no value and are feasible to be immediately avoidable, these are best known as Type 2 Muda.

Batch and Queue are terms directed to describe a process that basically incurs into long inactivity periods of time. In the typical food industry that sells particularly this exotic food has the usual methodology that consist in the queue step while waiting to be sit, another queue step while waiting to be attended. Another queue step while waiting to be served and finally another queue step while waiting to be charged. Flow is a terminology characterized by the time to setup between products and reacts inversely to the Batch and Queue process creating as a result a process known as Pull. For instance, it is contradictory believe that in a food industry a Pull process occurs since actually the customer eats what he want. But many times the customer receives what he ordered but not how he ordered or not necessary meets the customer quality standards. Contrary to an industrial company some customers paid just for what they requested and if they received a product that not meets their standards they unapproved that product and simply doesn't paid for that. However it is often said that this should be the same on the food industry, the customer is always right, but not in all the occurrences this happened. People are scared to reject a meal

that is already ordered because the customer loses visibility on his product without knowing the new course that his meal will take before it arrives back again on his table and this has been seen even on television commercials. This is why is so important to have a Flow/Pull process in this revolutionary exotic fast food industry.

3. Voice of the Customer: A sample size of 75 questionnaires was filled to understand the sushi popularity and likeness considering three residential zones in Puerto Rico, rural, urban and suburban. These questionnaires will provide the customer feedback and feelings that will help on the decisions making process.
4. Visual Management or 5S: is a method used as a cleanup activity at the workplace to enhance a higher productivity probability and a safer place to work.
5. Bill of material (BOM): is a diagram that visually helps to identify the basic components to produce one single product.
6. Benchmarking: Benchmarking is nothing more than a fair comparison between two or more industries that shares the same business. The company that shares the same style of making business is Subway. The Benchmark will use the best practices from Subway and will incorporate it on the business looking to achieve the same results.
7. Project Management in Action: Table 1 presents the detailed schedule planned to finalize this research.

RESULTS AND DISCUSSION

The first phase was the performing (SMED) on the traditional methodology to build a sushi. The Figure 1 shows the results of the first phase of SMED. The whole process took an hour and forty two minutes. This time is the cycle time in make a single sushi roll.

During the process, was identified a number of activities that have been performed as internal activities but easily can be external. The following table demonstrates how the process is currently performed and how each activity has been identified within the categories of "SMED".

SMED technique splits each of the activities to make a sushi roll in internal or external activities. Table 2 represents both activities and clearly shows that there are more activities within the category of internal activities than in the externals activities. It is important to find a way to convert internal activities to external activities. The Table 3 demonstrates a series of corrective actions that were taken to implement the transformation of internal to external activities.

Table 1
Tasks to Perform the Design Project

Tasks	*Task 1*	*Perform SMED to the current process.*
	Task 2	*Value Stream map for current process.*
	Task 3	*Prepare questionnaire to determine business demand.*
	Task 4	*Deliver questionnaire and colect the results.*
	Task 5	*Analyze questionnaire to understand demand.*
	Task 6	*Plot the BOM for final product.*
	Task 7	*Benchmarking process.*
	Task 8	*Prepare a schematic of the optimized production line.*
	Task 9	*Prepare establishment layout.*
	Task 10	*Develop the article.*
	Task 11	*Deliver the article to the mentor for review*
	Task 12	*Deliver the article with corrections to an external supplier for review.*
	Task 13	*Deliver the article to the program coordinator.*
	Task 14	*Work on poster board.*

Table 2
SMED for the Traditional Methodology

Internal Activities	External Activities
Pour the rice in a colander	Find equipment and materials
Wash the rice companions	Find the companions
Cook the rice	
Make a mixture of vinegar, sugar and salt	
Mix the mixture with rice	
Cool the rice	
Chop the companions	
Wash the knife after each cut to the companions	
Roll the sushi along with it companions	
Wash your hands every time you touch the rice to fit it on the nori sheet	
Wash the knife with vinegar after each cut the roll	
Make Soy Sauce	
Make the Spicy Mayo	

Marked in red are the activities that cannot be transformed within the process and corrective actions that were taken on those who can be transformed from internal to an external activity.

Table 4 displays how the process will flow from now on. The process of producing a sushi roll can be categorized as “Lean" by implementing all the corrective actions.

Lean Process Outcome

At the end of this preparation, the time was taken to make the "Lean" roll and the time was reduced by 38 minutes as shown on Figure 2. Certainly in mass production numbers is a real breakthrough since it practically could produce almost twice implementing the process of "SMED" within a sushi production line.

- **Value Stream:** Based on the process flow after implementing SMED a Value Stream can be map it in order to understand more easily using the visual aids how the process behave compared across the time.

  As showed in Figure 3 the cycle time for the process is 64 minutes. This amount of time is not feasible due to the fact that doesn’t comply with a usual cycle time of a fast food industry. Therefore, the business should concentrate in attacking the sushi roll preparation phase which is the lead time for a final product. All the other phases are going to be moved to external activities by implementing an intelligent production line that will talk to the operator when exactly an action based on the 3 other phases is required.

Table 3
Internal to External Transformation Corrective Actions

Internal Activities (Before "SMED")	Processing (Corrective Actions)	Eliminated activities
Pour the rice in a colander	Buy sushi rice	Pour the rice in a colander
Wash the rice companions	Buy sushi rice	Wash the rice
Cook the rice	Can't be transformed	Wash the knife after each cut to the accompanying
Make a mixture of vinegar, sugar and salt	Make the mixture while cooking rice	Wash the knife with vinegar after each cut the roll
Mix the mixture with rice	Can't be transformed	
Cool the rice	Can't be transformed	
Chop the companions	Chop the companions while the rice cools	
Wash the knife after each cut to the companions	Add a set of knives	
Roll the sushi along with it companions	Can't be transformed	
Wash your hands every time you touch the rice to fit it on the nori sheet	Add bowl of water next to the preparation	
Wash the knife with vinegar after each cut the roll	Add a set of knives	
Make Soy Sauce	Make sauce while the rice cools	
Make the Spicy Mayo	Make "Spicy Mayo" while rice cools	

- **Voice of the Customer:** 159 inputs were received of 75 persons that participated in the questionnaire. Based on Table 5, each person collaborated with more than two criteria when defining their quality standards. A Pareto Chart will help to analyze the data by providing an

accurate results that will be critical in the decision making phase.

Table 4
Process after SMED

Internal Activities (After "SMED")	External Activities
Cook the rice	Find equipment and materials
Mix the mixture with rice	Search for companions
Cool the rice	Make a mixture of vinegar, sugar and salt
Roll the sushi along with its companions	Chop the accompanying
	Wash your hands every time you touch the rice to fit on the sheet of nori
	Make Soy Sauce
	Make the "Spicy Mayo"

Analyzing the Pareto Chart, the 80 percent of the votes goes up to the fresh food criteria. The results obtained are revealed on Figure 4. Therefore, by attacking the votes that come up to the fresh food the quality can be assure it in most of the cases.

- **Benchmarking the business:** Kirchner, stated on his report that a lean manufacturing case study will be demonstrated in a presentation that includes a production line that requires that every single order is a custom order [6]. Customers lead times approximate five minutes, waste due to rework on this line is next to non-existent, so the question would be where a customer can find all this options including a lean manufacturing case study, definitely on Subway restaurants.

Kirchner listed some of the lean manufacturing characteristics that Subway restaurants have such as; there is no batching and no mass production at Subway. Each and every unit is made one at a time. Motion waste is almost non-existent. All necessary inventories (bread, tomatoes, onions, peppers, gloves, etc.) are located right at its point of use and product flows perfectly from one end of the production line to the other. Work areas are kept clean; all necessary equipment (the toaster oven, etc.) is placed at the point of use. Likewise tools such as sandwich cutting knife are returned to the same location every time, so there's never any time wasted in finding them when are needed next.

Figure 2
Time after SMED

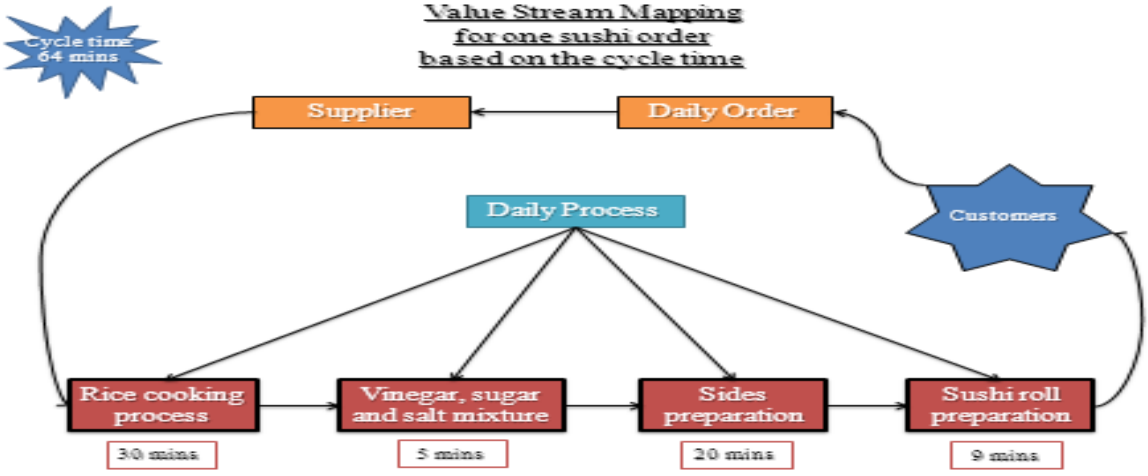

Figure 3
Value Stream Map

Table 5
Quality Perception on the Customer Eyes

Customer Voice	Votes
Cleanliness	42
Affordable prices	21
Good customer service	33
Parking space	1
Good taste	25
Fast serving	8
Knowledge on food	1
Healthy food	1
Fresh Food	11
Variety in the menu	3
Establishment conditions	5
Nice ambient	2
Food temperature	1
Quantity	2
Odors	1
Food Presentation	2
Total	159

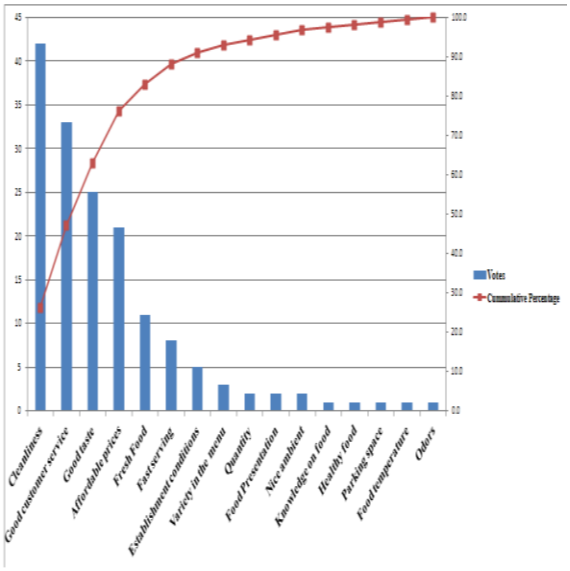

Figure 4
Pareto Chart

Kirchner remarks something very important for this business which is directly relative to the sushi production business. Is that what fascinated him the most was that he had the opportunity to observed attentively how works the assembly line of his sandwich. This makes him made the observation that the sandwich technicians instead of being idling when they finished with one customer they looked at which fixing bins were running low and feverishly replenished the bins with raw stock. Therefore, minimal non-value added or wasted labor is obtained. Kirchner finished his report by stating that he is sure that Subway is not alone by implementing some of the Lean Manufacturing techniques mentioned above but what makes Subway different compared with the world of burgers, fries and apple pies is that the customer can watch the entire production process as it takes place. Thus making it a fantastic learning opportunity and an alternative to validate with their own eyes the freshness, cleanliness and quality reflected on the production line. Table 6 will list the best practices of Subway and will compare it with what the sushi business has.

Table 6
Benchmarking with Subway

Characteristics	Subway	Sushi Business
Product Lead Time	5 minutes	5 - 10 minutes
Each product made one at a time	X	X
Inventories are where need it	X	
Work areas are kept clean	X	
Tools placed on original positions	X	X
Raw stock for replenishing	X	
Customer visibility to the production line	X	
Option for made an unique product	X	X
Prices range	$2.99 - $8.49	$5 - $10

- **Visual Management:** The establishment layout was analyzed considering the production line design, inputs received by the customers and with the benchmarking results. The Spaguetti diagram deployed on Figure 5 demonstrate how the customer flows across the establishment already minimizing the customer traveling distance.

The production line layout deployed on Figure 6 demostrates how the operator flows without having any dependency between the production lines. Every single piece on this layout was rigorously analyzed in order to avoid batch and queue, idleing and waste during the assembly. The line consist in a cold and hot sections that provides variety to our customers. It posses a glass window in which the customer can clearly sees what he/she will eat, if the food is fresh or if the surroundings are clean. Andom boards with an specific menu are going to be installed just above the line, on the middle portion. The versatility on this line allows the cutomer create his/her own sushi roll refining the taste based on the unique combination.

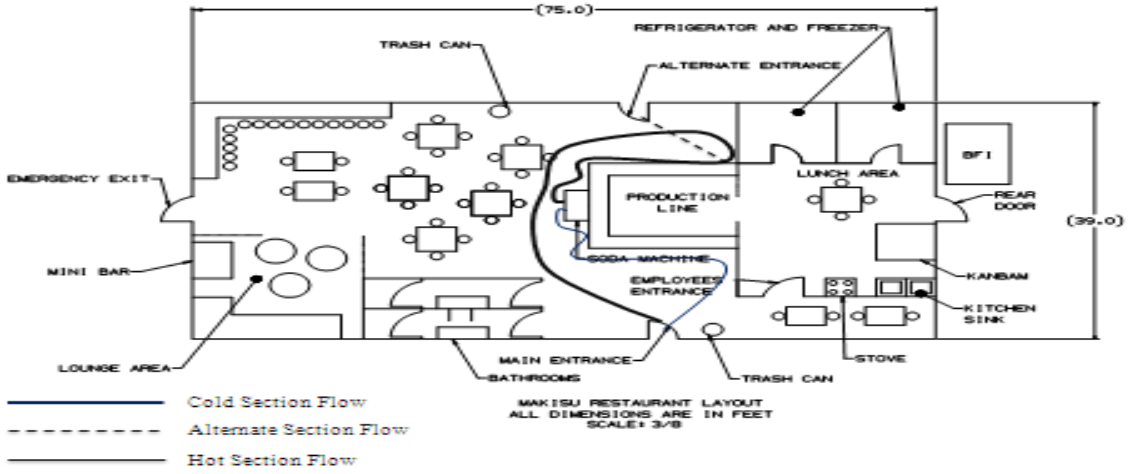

Figure 5
Spaghetti Diagram

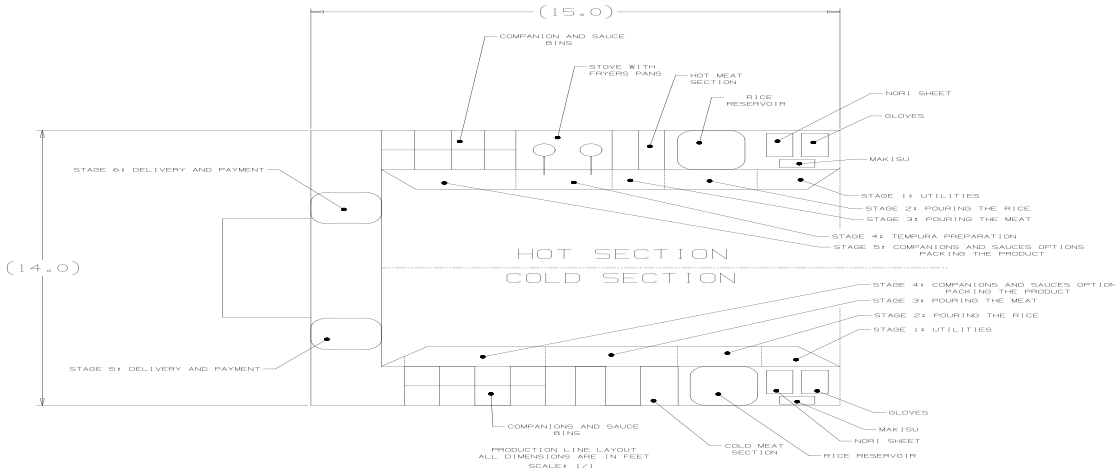

Figure 6
Line Layout

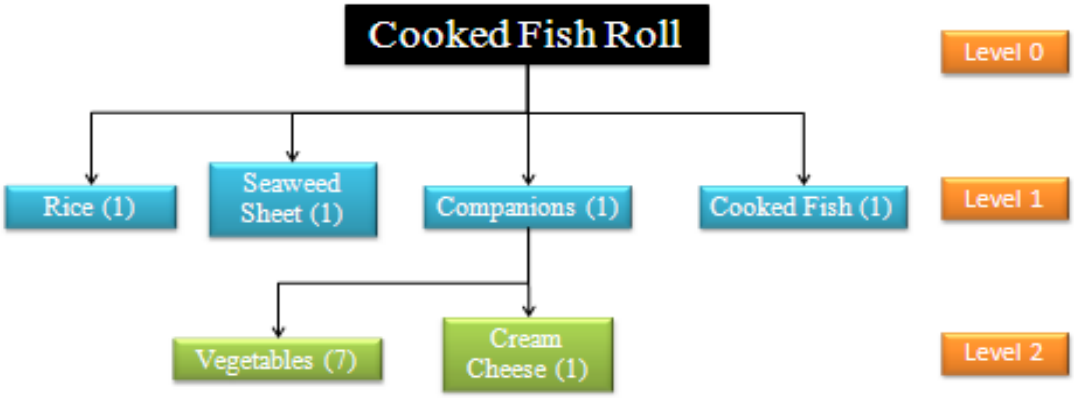

Figure 7
Sushi BOM

- **Bill of Material:** Since this is a future state business that requires a Master Production Schedule (MPS), Master Production Requirements (MRP) and so many others Quality Management techniques that help a business improve it outputs in terms of return of investment, a bill of material for the most acclaimed roll type will help to develop the other mentioned techniques. However the scope of this research will go up to bill of material, this technique will provide a sneak peak about the continuous perfection of this business. From the voice of the customer obtained on the results per Table 7 the most acclaimed roll was the cooked fish roll.

Table 7
Sushi Rolls Favorites

Sushi Roll Type	Amount of People
Raw Fish	9
Cooked Fish	24
No Fish (Veggie)	7
Spicy	6
Deep Fried Roll	6
Like all Styles	6
N/A	17
Total	**75**

The bill of material showed on Figure 7 was performed considering the alternative that the production line offers for making unique rolls.

CONCLUSION

Challenges, breakdowns and deseptions are many of the words that can define the recent years due to the ups and downs on the global economy. But victory, breakthroughs and optimism are many of the words that can be related with every quality management technique when succesfully applied. During this research many techniques were applied on a future state business which focused on a common good shared by the human society, a food business. This offer provides a safe, sorted, shine, standardized, set in order and sustainable place that has as a main commitment, comply with the customer satisfaction delievering a high quality product. After implementing quality management, respectable results were obtained. When referring to the production time, the effort was objectively to reduce it on a 50% but as a result the effort was reduced by 91.2% categorizing the business as a fast and lean market. In regards to the quality, the site and production line layout were designed with the customer first on mind, reducing at all instances the traveling distances of the customer and solving the 80% of the concerns to define quality based on the customer voice by implementing a visible production line in which the customer can judge with his quality perceptions. Lastly, the bill of material for the most acclaimed roll was builded in order to keep on mind how these materials will be reflected on the scheduling, requirements and orders to comply with a demand. Tangible results boost this, a feasible business that anyone of the society can implement and using as a guidence these quality techniques and many other can ensure viable results with a positive slope.

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