Robotic Transformation and its Business Applications in Food Industry

Chapter · January 2017

DOI: 10.4018/978-1-5225-1759-7.ch091

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Chapter 11
Robotic Transformation and its Business Applications in Food Industry

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ABSTRACT

The role of robots is becoming substantial for industrial applications and business competitiveness. The robot transformation in food industry has increased business productivity, reduced cost and enhanced customer experiences. The usage scale of robots has an increasing trend globally when industries modernize and increase the production capacities with ability in handling complex tasks. The objective of this chapter is to explore robotic transformation in literature and to investigate its business applications in food industry. There are two points raised in the discussion, would the robot technology which has been developed only capable owned by large scale food companies and the experiences gained in the restaurant which serves by robots can replace the human touch. At the end of this chapter, some solutions are given to shed light on the application of robot in food industry and deepen critical analysis for researchers, technocrats and business practitioners.

1. INTRODUCTION

In the modern competitive business the role of robots is becoming significant for industrial applications. The important factor for using robots in the industry aims at reducing human inference and to increase the productivity. According to Chiu-Chi (1995), the shortage of manpower led Taiwan industry to use more robots and it enhanced the annual growth rate of robots globally. Chiu-Chi (1995) also states that the robotic research have expanded the domestic industry, promoted the technological standard and the development of the small and medium manufacturers. The robot transformation in service sector has significantly increased business productivity and customer experiences.

DOI: 10.4018/978-1-4666-8693-9.ch011

Manshi and Shukla (2012) analyzed the market growth of industrial and service robots, mainly involving the growth of the two categories of robots in 21st century. The growth of service robots seems to be higher since they own a huge market share, out of which personal robots contributing the major share of growth. Manshi and Shukla (2012) compared the growth of robots in the industry in terms of sales and volume. The growth of service robots showed a higher percentage than the industrial robots depending on the areas of application. Manshi and Shukla (2012) concluded that the technological transformation and the huge requirement in various industries have raised the need for robots at a big scale there by developing the robotics industry during the early 21st century.

Robots are used in promoting product quality and reducing costs (Chiu-Chi, 1995). According to Gorle and Clive (2011) reported that there is a great potential for new job creation in the years up to 2016. According to Moran (2011) Shenzhen –Foxconn, the largest manufacturers of Apple products plan to replace workers with nearly one million robots in recent years. Low cost maintenance with high productivity in the business is considered as the prime advantage for the robots. Baxter, a new inexpensive robot is an example, which provides user friendly operations and performs various tasks in small manufacturing companies (Ben, 2012).

When looking into the food industry, the robots serve for much purpose, mainly in production systems for material handling and packaging operations (Wallin, 1997). The evolution of robotic applications in food industry evolved in 1980s and the growth was not effective due to high technology related costs. After realizing the consistency of robotic jobs, with improved efficiency and reduced work space, food industry expanded the use of robots for various applications which resulted in high productivity.

Although the investment required in the robotics was an obstacle to the development of the robotic application, Rene et al. (2010) outlined the design feature for low cost robots for the production in the food industry. Robots should fulfill the basic requirements like hygiene, speed and safety, cost, operational speed and ease of programming (Rene et al. 2010). Rene et al (2010) also suggested that low cost robots in the food industry will pose developments in the industry with reduced costs for the production. The objective of this chapter is to explore robotic transformation in literature and to investigate its business applications in food industry. This is can be seen than many restaurants have extended robot applications to increase business productivity, keep the loyal ones and to attract new customers.

2. LITERATURE REVIEW

A robot is an electro mechanical machine operated with the computer manipulating various functions. According to International Standard Organization (1997), a robot can be automatically controlled, reprogrammable multipurpose manipulator programmable in three or more directions. Basically robots can be categorized on the basis of degree of autonomy, industry or field where they are used and goals they are fulfilled. On the basis of degree of autonomy, it can be categorized as stationery, ground, underwater, and aerial. Robots under the category of goals fulfillment includes contest, personal enrichment, manufacturing and entertainment.

Based on the industry, robots can be divided into categories- Industrial, service and military robots, agricultural, mobile and telerobots. Engelberger integrated the first industrial Robot (Unimate) in 1962 at New Jersey General Motor's automobile factory. It was an automated die-casting mold, used to avoid human interference in holding car parts made of molten steel. Handling hazardous job is one of the most advantages of robots in the industry. The success of the first industrial robot, Unimate, shed light on the

robot welders in the auto industry in Japan; influence them to make use of robots for their operations in the future (Mickle, 2014). Robot automation is introduced in the industry to optimize efficiency and to reduce the costs (Bogue, 2009).

On the other side, service robots, which operates semi or fully autonomously are mostly used to aid human activities. Service robots are further divided into professional and personal service robots. The application of professional service robots is concentrated in the areas of logistics, transport, medical and health, education, security and surveillance and agriculture, whereas personal robots are used for domestic uses like daily chores, assistance jobs and for entertainment. The application of robots can be again categorized into many types. For example, professional service robots are used as waiter robots, guide robots and tour robots. The market research report on service robotics shows that service robotics segments the largest portion in the market by value. On the other side, personal service robots cover the maximum market in terms of volume (San Jos, 2010).

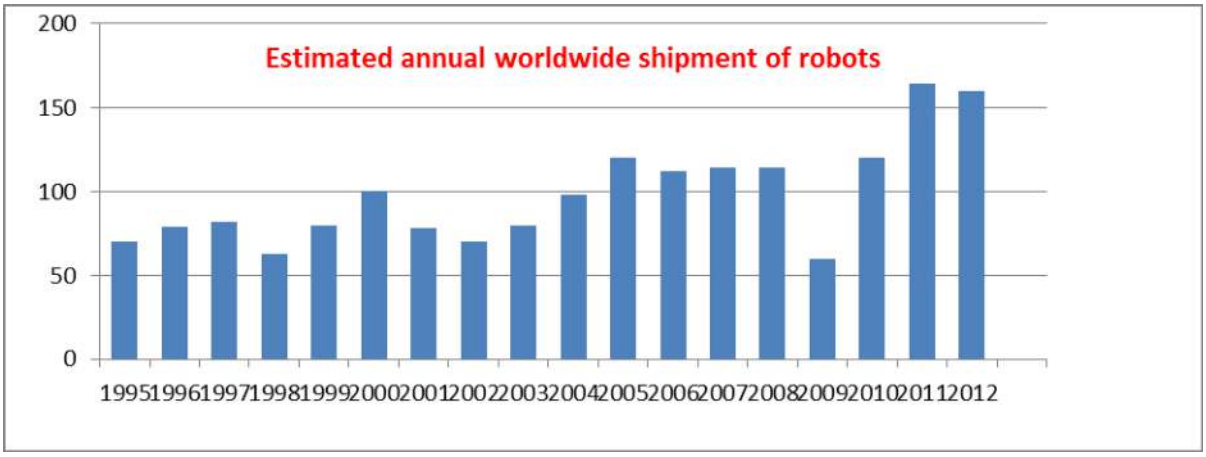
2.1 Robot Transformation in Business

According to Moore's (1970) law, today the computer devices are more powerful than it was 20 years ago, eventually with the increase in performance level. The observation made by Gordon Moore, founder of Intel, stated that the number of components used in the circuits increased at regular intervals of time and would increase at a higher pace in the future (Schaller, 1997). It is forecasted that the performance and applications for such devices cannot be predicted for the future. Unlike the computer devices, robots are also supposed to advance in the future as computers are today. Starting from the manufacturing operation, robots have now entered all the industries for numerous applications, even in helping humans at home to perform daily chore activities are some of the novel applications. Business owners and entrepreneurs were able to bulge their pockets by saving costs with the introduction of automated business operations. Where economies struggle against labor shortage and high labor costs, this electro mechanical machine (robots) were able to exterminate those issues rising to growth and profits everywhere.

"I cannot define a robot, but I know one when I see one". The remark was raised by the father of robots, Joseph Engelberger who founded the world's first robotics company (Kilbane, 2008), when robots represent remarkable inputs irrespective of the sectors in business. It even made an uncertainty in excerpting widely used definition of robots indicates that robotics evolved an enormous augmentation with advancements. While analyzing the transition made by the robots, it is essential to look at which areas they act as a cusp for the business growth. Relentless transformation is ongoing from the early 1960s until now, with the introduction of stunning innovations based on the needs. Whether it is for manufacturing or space or the nuclear industry, the applications of robots are inevitable. New market place have outpaced the use of robots, as the applicability has changed from caged to adjacent, static to portable, connected to autonomous and easily trainable device (Tobe, 2012).

Recently, industrial robots were put into more use and it is apparent that the manufacturing, repair and maintenance, makes the best use of the robots helps to transform growth level of the business. The usage scale of robots has an increasing trend globally when industries modernize and increase the production capacities. In addition, industries have realized the complexity of the tasks performed, which can be effectively enhanced by robots. Automotive industry increased the use of robots when the robot manufacturers come up with cutting edge technology robots. When looking into the annual shipping of industrial robots worldwide, it gives a clear cut for the significance of robotic application in the industry (Figure 1).

Figure 1. Robotic application in the industry Source: IFR Statistical Department (2012)



The global shipments of robots were dominated by Japan (28700 units) followed by US (22414 units), Asia and Australia (84645 units) and Europe (41200 units). Between 2007 and 2012, Asia records the maximum Compound annual growth of robots (CAGR) with an average of 8% while Europe has the least growth with 3% (World Robotics 2013). However the current business trend aims at providing flexibility and versatility which could not be implemented well by the traditional ones. Thus the need for reinvention was a necessity for the industry, which witnessed the growth of industrial robots presently by fulfilling the current innovative demands. Uncountable contributions have been dominated by the service industry with the passage of time.

For instance, Google has introduced various types of robots from seven tech companies that provide various applications ranging from supply chain to the distribution channels to the consumer's front door thereby creating a substantial breakthrough.

Several types of robots were put into use from those seven high tech companies. It is apparent that robotics will lead the giant companies like Google which aims at spurring innovation and investment in the future. In addition, Apple with an investment of 10.5 billion, in supply chain robots and automation equipment and Amazon (750 million) for delivering goods to a picker/packer robotically. Thus, the transformations followed by these giant companies will make the rest of the global companies to follow the same suit. When industries were confronted with rising labor costs, low production levels, outdated management methods and changing demographics, robotics acquisition helps to uncover all these challenges with a robust support by providing financial savings, time and space by ensuring top quality and production level. However the consistence and quality in the operation achieves efficiency, reduced injuries, waste reduction and maximum utilization of space.

Almeida et al. (2001) analyzed the significance of robots in e-business, by developing an analytical model for the interaction between robots and websites. With the increased dependence on websites for the business, the role of robots is momentous, as they perform task like mirroring, data mining and link maintenance. In e-business, robots form as an interface between the customers to find out the requested information. Crawlers, shop bots, price bots and autonomous software agents are the main categories of robots used in the interaction between the web and e-business, for providing top quality of service.

Crawler helps to generate the requests with the use of robots, pricebots set prices and shopbots seek prices that minimize costs for customers (Almeida et al., 2001). The impact of robots on websites was significant and it impacts the quality of service provided by the websites (Almeida et al., 2001).

Automotive industry was the largest to use robots in their operation (IFR statistical department, 2014). Robots have been utilized in the automotive industry used for welding, foundry operations, laser applications, painting and final assembly operations. Robotics has a significant role behind the continuous growth in the industry, with the advancements made by the Kuka Robotics, German manufacturer of industrial robotics. Automotive industry has transitioned to a great extent with the robotic advancement. For instance, robots in Tesla motors do multiple tasks such as welding riveting, bonding and installing a component in its assembly line, whereas the normal robots can perform single function only (Markoff, 2012)

With the flexibility attribute, robotization has extended its use over the automation industry. With the implementation of tricept robots, BMW utilized its flexibility for its innovative machining in the axle design (Kochan, 2004). Flexibility always costs money, *"but, you will get a return on your money if you take a long term view, and if you place a high value on innovation rate,"* says Konrad Pagenstert, Director of axle production, BMW (Kochan, 2004). With the intention of raising the productivity, General Motors (GM) has increased the rate of automation and efficient ways of parts handling (Mortimer, 2009). By investing to acquire Fanuc robots, the leading supplier of robots in North and South America, General Motors were successful in achieving the target of building 1,000,000 units of Van. Fanuc robots, with its high reliability and innovative and high quality solutions were used for welding operation in General Motors and it has raised the number of welds, leaving the traditional ones with less usage (Kochan, 2004).

However the robot utilization never tends to be ceased in the industry rather it comes up with the new innovative technologies a faster rate. Let's take the example of auto drive car, Robots have taken over the driver seat, with the introduction of new Google auto drive car auto industry will be revolutionized in the near future with this breakthrough. It is supposed to be the dominant contribution laid by the robotics involvement in the auto industry. When looking into the manufacturing industry robotic automation started in 1962 with the introduction of Unimate, a robotic arm attached to a steel drum used for pouring liquid metal into die casts, auto welding and controlling heavy loads (Lamb, 2013). Handling tedious jobs with consistent speed and precision was one of the main features of this robotic arm. Perhaps robots were successful in handling complex tasks; low productivity was a threat to the industry in the earlier decades since the operation was based on the human intervention and decision making.

Flexibility and growth were the main issue faced by the manufacturing firms, as a result of fierce competition and advanced technology by the global firms but it can be overcome by the incorporating automation that considers various disciplines in the manufacturing decisions. Although robots are being used in the manufacturing industry, the initial investment made for the robotics was high made a challenge for the small scale manufacturers. However small and medium factories and business was an unexploited area of robotic utilization, and looking forward to implement the automation at its fullest to remain competitive in the global business environment. With the innovations made by the robotics industry, the dilemma to create inexpensive robots was a major threat in the recent times. But rethink robotics, a splendid robotics company paved the way for robotics with the introduction of the new robot Baxter, cheap and user friendly robot with ensured safety for the manufacturers. In fact it made a revolution for the small and medium manufacturers who were in search for such an affordable product to fight with the low cost manufacturers in the world. It operates with presence of custom software or robotic experts, in the assembly lines to perform menial tasks (Duhamel et al., 2013). Baxter, with its affordability

helps to reduce the outsourcing for the small U.S manufacturers (Wang, 2013). Its application line has crossed more than a traditional robot with some of its pioneering features. Common sense, safety, user friendly, versatility are some of its features that even can complete any task in short time irrespective of the size of the manufacturers. Unlike the traditional robots, Baxter does not require any additional capital investment and custom software and ensuring a long term endure in the industry.

Manufacturing industry find it productive when they have incorporated robotic operation in lean manufacturing. According to International federation of robotics (IFR), certain characteristics of robots can enhance lean manufacturing, listed as follows

- Save Costs for operation
- Product quality and reliability
- Enhancing work environment quality
- Raise the production output level
- Increase product manufacturing flexibility
- Intensify the yield and waste reduction
- Ensures safety at the work place
- Employee turnover can be reduced
- Reduce capital costs
- Standard size for operation with maximum utilization

While scrutinizing the robotic impact in food industry, studies has been focused on the role of robots in palletizing, material handling and tertiary packaging (Wallin, 1997). When robotics opened the doors for food industry applications in 1980's, operations were limited to packaging assorted chocolates into trays and gradually evolved into pizza assembly, meat processing, cake decoration and cake and pie handling (Wallin, 1997). But companies could not encourage the high scale use of robotics as a result of lacking investment. According to Wallin, (1997), proposes that packaging, palletizing, depalletizing and labeling, carton loading will be the common areas covered by robots, and the complex applications can be handled with the introduction of sophisticated computerized systems in the future.

Now the current trends in food industry has witnessed the robotic operations including primary packaging and processing such as curd slicing, sausage packing, ultra-sonic cheese slicing and cheese multiplexing etc. However, with the recent developments in the food industry, different types of robots were put into operation for several purposes. The old model SCARA (selective compliance assembly robot arm) robots for pick and place, spider robots for high speed picking and placing of light weight objects are the recent examples of robots used in the industry. SCARA robots are one of the types of stationery robots also known as horizontal articulated arm robots, with motions same as human arm. Its reliability for fast and repeatable movements make it fit for packaging palletizing, loading and unloading purposes (Brumson, 2011).

Nevertheless, these robots have some kind of downsides in terms of efficiency as it was prone to heavy load pick and place operation. In 2006, the invention of five axis robots by Fanuc robotics, focused on increasing flexibility in pick and palletizing. The robotic operation in end of line packaging in the food industry can be differentiated with the traditional ones in terms of efficiency, safety, hygiene, risk consistency and reliability (Table 1).

Table 1. The robotic operation (Source: Fanuc Robotics America, 2013)

Traditional End-of-Line Methods	End-of-Line Methods Utilizing Robots
Manual Pick, Place, and Palletizing	Robots can pick primary and secondary product, place into cartoners, and palletize product efficiently and effectively
Unsafe process or a process that is at a significant risk for repetitive stress injury	Robots are precise, clean, and repetitive and can run without failure for several cycles
Hard automation is inflexible	Sudden product or packaging changes are handled with ease
Risk contamination	Are hygienic and sterilized
Risk product damage during packaging	Highly sophisticated sensors monitor pressure, and grippers that have been developed specifically for food processing can eliminate product or package damage
Tedious, repetitive, and heavy-handling tasks	Consistent movements and high payload capacity perform tasks with ease
Imprecise equipment handling can damage equipment	Precise, consistent handling can greatly increase the service life of the equipment.
Unreliable equipment	Reliable with Mean Time Between Failure rates > 90,000 hours
Large single-task equipment requirements	Small work cell footprints with robots that can handle multiple operations

According to Wilson (2010), the real business growth of the food industry lies at the implication of the concept- *"untouched by human hand "*will become the significant marketing differentiator for the food products in the future. Moreover, the robotic usage tends to be escalated in the future as a result of its revolution in the industry irrespective of its applications. Based on the global statistics in 2012, Andreas Bauer, chairman of IFR industrial robots supplier group propose that there is forecast of 6% future growth with three main sources (World robotics). Huge potentials growth in future growth for many sectors, growth based on innovative technological developments and usage scale escalation in emerging countries.

2.2 Business Productivity

Business operations are more productive when they produce more output from a given set of inputs (Brown & Dev, 2000), simply called the efficiency in production (Syverson, 2011). It is a notion that is easy to define but difficult to measure (Djellal, 2008). In a nutshell, it can be measured based on the relationship between the production of goods/services and the factors of production. However measuring productivity is crucial for the organization and it's a complex process (Johnston & Jones, 2004). Namely, single productivity and multi factor productivity are the two types of measures for gauging the productivity. Where single productivity relates with a measure of output to single measure of inputs and multi factor links with bundle of inputs (all factors of production). Measuring productivity is an essential task to monitor the progress of the firm, which in turn helps to make changes where necessary to stay competitive.

Relating with the current business issue, escalating the productivity has been crucial factor for firms, especially service oriented firms (Brown & Dev, 2000) as it allows to lower the costs associated, to increase the demand in return by providing more services. Since the concept of productivity was not paid attention in the service industry, it has been given much importance over the last two decades as a result of stiff competition and challenges. In addition, maintaining productivity has been viewed as a long-term strategy, especially for hotel industry (Kilic & Okumus, 2005).

Often, productivity is perceived as a measure of output towards input, in manufacturing context, while service industry holds different dimension such as quality as the main component of productivity (Kilic & Okumus, 2005). Johnston and Johnson (2004) study supports the fact that it was given little importance for productivity in service organizations. Furthermore it is revealed that the productivity is a hypernym of utilization, efficiency, effectiveness, quality, predictability and other performance dimensions. Service productivity differs a lot from the conventional productivity perspective (Johnston & Johnson, 2004).

Simply put, productivity can be measured with the input and out variables for the manufacturing and can obtain a certain level of measure in terms of ratios or units and so on. However to gauge service productivity is a complex task since measuring and managing the inputs/outputs will be inconsistent for the simultaneous consumption of services as well as its perishability and heterogeneity. In support of this, Biege et al. (2013) states that feature of services so called IHIP (Intangibility (I), heterogeneity (H), inseparability (I) and perishability (P)) characteristics are the major constraints for measuring the productivity. In addition, when measuring the productivity of service business, customer involvement (Li & Prescott, 2009) is an inevitable part as it is evaluated on the basis of customer satisfaction (Biege et Al., 2013). Normally when measuring service productivity, some sorts of challenges are being faced and it tends to be worse when incorporating innovation and knowledge intensity of services (Biege et Al., 2013) and the heterogeneous nature of inputs and outputs makes it difficult to measure (Li & Prescott, 2009).

2.2 Benefit and Shortcomings of Robot Application in Business

When computers were invented to use for the business years ago, they have been modified for the best suit for the diverging demands. By 2030, it has been forecasted that robots will dominate all the industries irrespective of the sector as computers are today. However novel uses have been identified for industries namely automobiles, manufacturing and service industries. According to Duhamel et al. (2013), robot sales have augmented with escalated demands as a result of auto industry expansion, wage inflation and enhanced robot capabilities. In a nut shell, benefits of robots can be categorized as follows (Figure 3).

The effort of robots to improve the productivity measure starts from its efficiency in operation. By providing a consistent job nature it can deliver the jobs with more accuracy when compared to manual workers. Moreover it can increase the throughput that which directly impacts production. However, the real potential lies at working with constant speed without breaks. Built in with high strength and weight of the electric motors inside, agile and consistent tasks can be performed by robots along with greater quality. When looking into manufacturing sector, robotic automation brought drastic changes by its efficiency in operation and hence raises the productivity. For instance, Drake trailers, largest manufacturers for trailers, based in Australia were successful to up their productivity as a result of robotic automation (Lamb, 2013). Productivity was one of the major benefits of robots (Orr, 1996).

According to Wei (1995) robots robotic automation in the industry can achieve higher productivity at optimum conditions with its efficiency in production operations. Moreover robotic operations are ample for handling tedious, filthy, and complicated jobs in unsafe environments (e.g. exposure to toxic fumes or extreme temperatures) which directly impacts the pace of production process. Safety operations by robots can increase the savings since there are no concerns for health care and insurance concerns for the employers.

"It is very difficult, labor-intensive work, often in intense heat or cold, which can make it a limiting factor to the overall efficiency of the warehouse. These working conditions, coupled with handling heavy product can also lead to injuries among warehouse personnel" says Kevin Ambrose, CEO of Wynright,

US based logistics engineering company. Indeed the robots manufactured by Wynright Corporation have transfigured the logistics and distribution centre jobs by using the Robotic Truck Unloader (RTU), for unloading trailers or containers from a dock. Moreover the robotic loader could reduce the number of shipments by increased utilization of trailers (Green, 2013).

Unlike financial savings, time saving is a major advantage of robots since it can perform the work diligently. More over the accuracy in operational movements also reduce the material waste which in turn is another advantage for business. Wei (1995) categorized the benefits of robots into social and economic based on its characteristics (Figure 2).The major attributes of robots provide economic benefits which is indirectly relating with some sort of social benefits. Flexibility in operation can raise the level of volume produced and therefore the productivity can be escalated. When manual workers are being utilized for the operation, there is certain limit they can mould the things within a specific amount of time. But when they are aided with the robotic assistance they can outperform he work with better outcomes. Besides that the utilization can be made at its best with high pace. The number of output production is greatly impacted by the precision and flexibility of the robots in operation. Moreover, since everything

Figure 2. The benefits of robots Source: Taiwan Industrial Robots (1995)

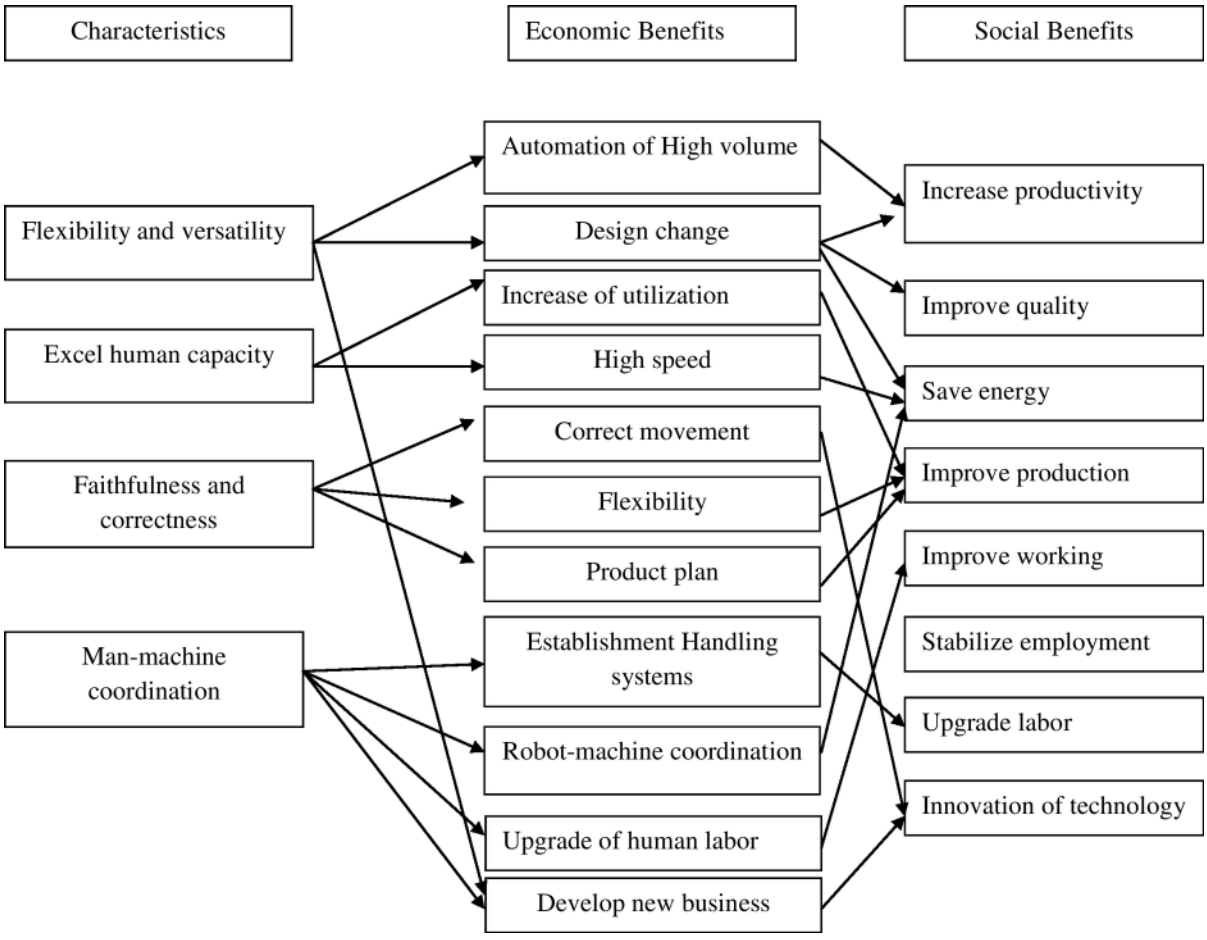
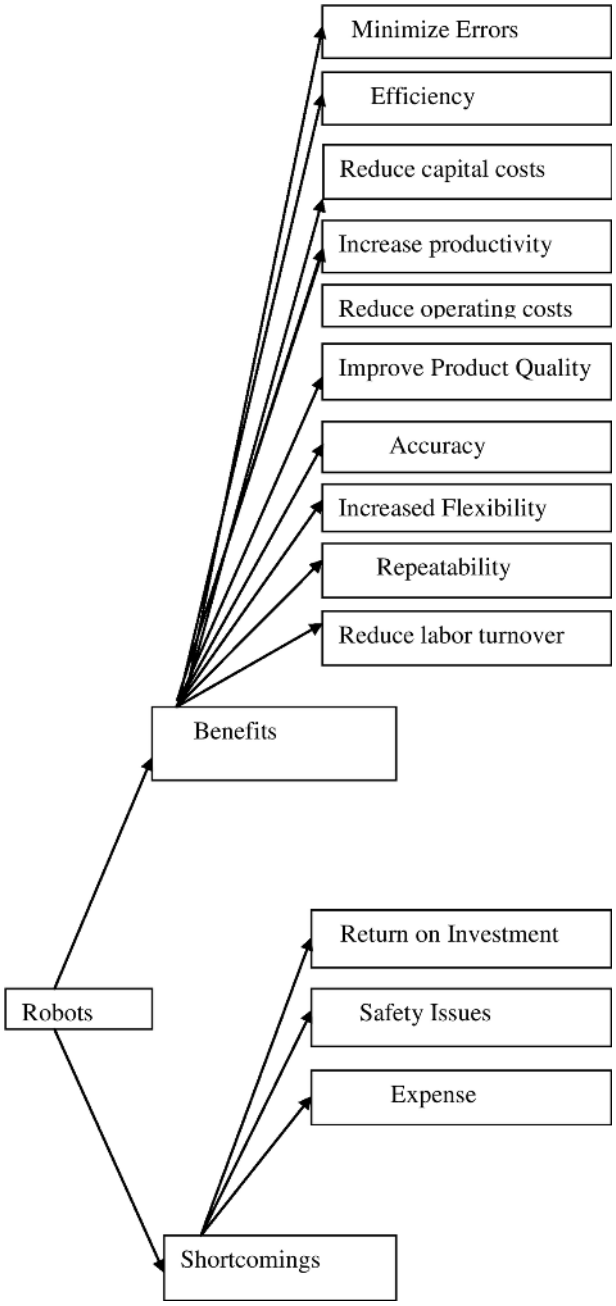


Figure 3. Benefits and Shortcomings of robots



is well designed under the robotic automation, the precise operation can save energy. It has been noted that quality attribute is one of the major advantage of robots. While operations are repeatable with high precision, it has a great impact on producing quality products.

According to Petrina (2010) the following are the drivers of the usage growth and production of industrial robots

- Provides an economic exposure for business against the rising labor costs
- Unavailability of skilled labor
- Nature of monotonous, heavy and intense work
- Safety attributes for workers with reduced effects for production and environmental protection
- Increased technological accuracy and quality improvement
- Ability to use machines 365 days a year
- Improvement in flow line production and elimination of human interface for repetitive tasks

2.2.1 Benefits of Robots in Food Industry

The reliance on robots became a necessity for the food industry when the robotic automation fulfilled the requirements for the industry. According to Mahalik and Nambiar (2009), food industry includes food production, food processing and food service; all of them incorporate robotic operations for different purposes (Erzincanli & Sharp, 1997). Remarkable changes have been taken place in food industry globally. Stringent work conditions, extreme temperature, speedy process to produce low cost goods were the main requisites for the industry. Moreover the perishability of food products has urged the manufacturers to maintain efficiency and reduce lead times (Mahalik & Nambiar, 2009). Reduced waste, elevated throughput, speedy changeover times, flexibility, and product quality are the reaping benefits by robots in the industry (Rene et al. 2010). In particular, robots provide a greater contribution in handling product with new designs and shapes without any need for extra configuration or reprogramming (Spreckly, 2011)

Due to the growing trend for health consciousness, food products need delicate handling and storage (Erzincanli & Sharp, 1997) for the reason that food products are agile and get spoiled easily. In addition food safety have been given much significance since it creates a positive impact on the quality of food products and it can be achieved by delicate processes with ensured safety measures (Fernando et al, 2014). The success of the food industry is always dependent on product quality, consistency and high return on investment, and robots are meant to achieve all these necessities. Therefore robots have a rising demands for the food and beverages industry. In addition, rising labor costs was the main justification for installing robots in food industry.

Basically, maintaining hygiene is the escalating concern for the food industry as it will affect the total sales and productivity of the sector. In an article by Green (2013), states that one in six persons get sick as a result of consuming contaminated food in United States. So it has been forecasted that the food packaging and processing can maintain hygiene when robots are incorporated. Moreover higher throughput and reduced expenditure and labor saving s are the main benefits of robots in food industry (Hoffman, 2012). Unlike the industrial manufacturing robots, are flexible, as they can be mounted in ceilings and can work form any direction from top to bottom there by reducing space.

According to Green (2013) robots in food material handling increase the pace of production with increased safety measures for the personnel. It has been discovered that, robots are fit for preventing food contamination since U.S department of Agriculture approved robots for its sanitary standards. Moreover the demand for robots is increasing the food industry when it was approved by Food safety Modernization Act 2011(Hoffman, 2012). In addition some of the features like reliability, high process control, speed, flexibility and dexterity provide much benefit for the food industries to maintain productivity, safety, and hygiene performance etc.

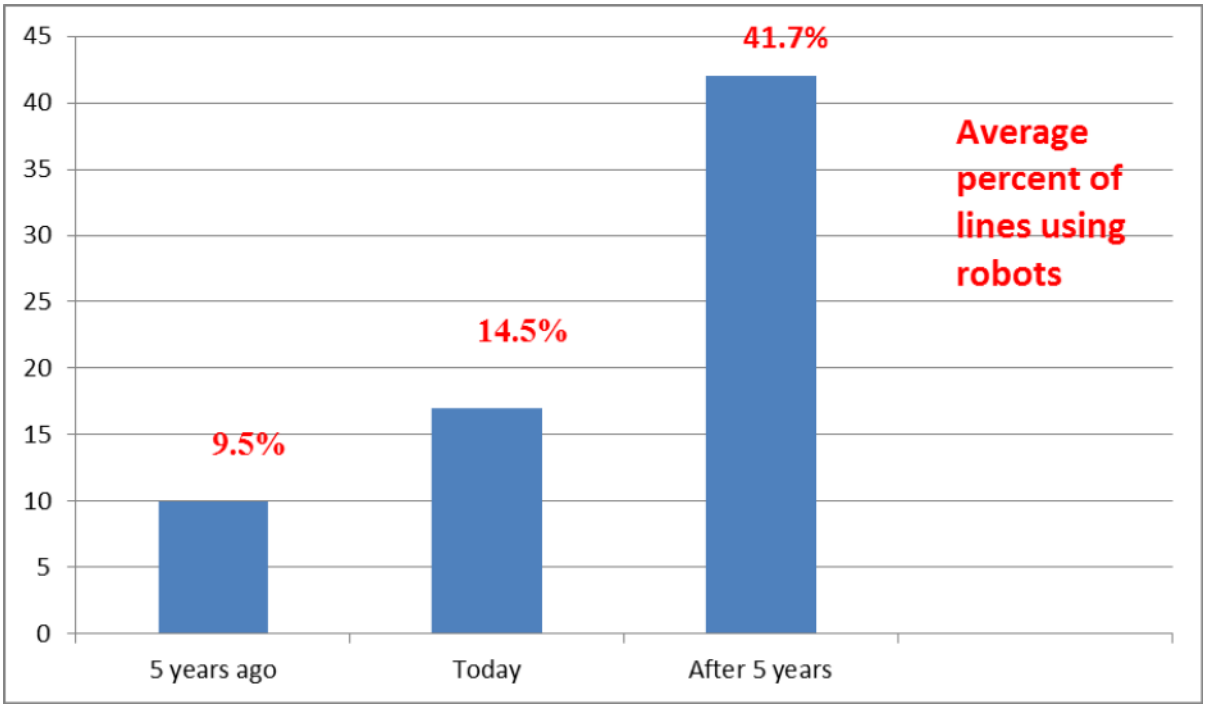
As noted earlier, robots are able to perform repetitive tasks to yield huge benefits. Notably, robotic automation helps to reduce repetitive strain injury (RSI) Purnell (1998) since chances are more for creating injuries for manual workers.

According to Purnell (1998) employees in meat industry have to work continuously in freezing temperature and causes fatigue and injuries. As far as food manufacturers are concerned, top priority is at producing with higher safety levels and better quality (Purnell, 1988, Erzincanli & Sharp, 1997). Nevertheless, contamination of food can be eliminated by the usage of robots when it is being used for packaging and palletizing. In addition, it has been discovered that the flexibility of robotics in food manufacturing is a proactive solution to eradicate repetitive motion disorders. Presently, novel uses in palletizing such as vision assisted robotic application for ensuring product quality and solutions to end of line packaging are greatly influenced by the robotics operation (Fanuc Robotics America, 2013). Moreover the robotic trend for packaging has been increased substantially in the recent years (Figure 4).

Robots have some attributes that are particularly well suited to the food industry," "they are very flexible and can be programmed to switch from one production task to another. And they do not breathe pathogens into the workplace, thus lengthening product shelf life" says Buxton, CEO, Processing and Packaging machinery Association (PPMA) in UK. According to Spreckly (2011), food manufacturing industry in UK has embraced the use of robotics technology to a greater extent and resulted in the growth of the sector by 300%. However, by understanding the significance of robots, manufacturers are amending the technologies that will dominate the industries by providing novel contributions.

Increased labor costs and reduced technology costs will drives the usage of robots in food industry and it is anticipated that robotics hold great potential for the industry in the future. It is clear from the

Figure 4. Association of packaging and processing technologies (PMMI) survey (2008)



statistics that usage level of robots has been escalating since the market growth of robots are witnessing a huge growth (expected to rise by 8.5 billion in 2015), according to New York-based technology market research firm ABI. According to BARA (British Automation and Robot Association), robots usage has been doubled (Marshall, 2013), however, robots paved the way for growth of companies by increasing the productivity by saving the costs associated with, it is essential to realize its potential and takes initiative for further investment for the long term viability.

2.2.2 Robots in Fine Dining Restaurant

Despite the wide use of robots in manufacturing and service sectors, the utilization in food service industry is a novel application. The motive behind implementing the robotic system by the restaurant operators was to strive against labor issues such as labor shortage and labor turn over. While narrowing down the application of robots in food service industry, it can be categorized under kitchen operation and front staff operation. A Chinese restaurant in Pasadena, California was the first to use robots for serving the customers. They use two robots, Tanbo R1 and Tanbo R -2 (costs around$20,000) was a novel introduction for the restaurant business (Davis, 2012). Currently, several restaurants throughout the world incorporated the use of robotic arms and robotic machine for preparing and serving dishes. Mostly, use of robots in restaurants is concentrated towards technologically advanced countries such as Japan and China. For instance, FuA-Men restaurant in Japan use the automated robots for preparing dishes. The autonomous robots are using the robotic arms to do the tasks such as boil water, pour soup into bowls, and place toppings on the dish. The two mechanical robot arms are working mutually to carry out the noodle preparation. While looking into the process design, robotic arms are used in an organized manner with its precise movements in adding toppings and ingredients, consistency in taste and temperature, and accuracy of timing for food preparation. Consistently, the robots in FuA-men are successful in delivering the dishes in 1 minute 40 seconds. Hence the patrons are ensured the delivery of the noodle within a preset time. The robot arms are capable of preparing 80 bowls of noodles per day which costs around seven dollars each. The sophisticated operation of the robotic arms in FuA-Men restaurant delivers the efficient operation in the food preparation without any intervention of human chef. However there is little intervention of manual chef such as taking the order and serving the customers.

Next, a cooking robot called AIKE, was developed by Shanghai Qi Ding Food Development Co., Ltd. in China (Yingying, 2011). This high tech robot can prepare 24 traditional dishes and can store 751 recipes and can prepare the food in three minutes with the authentic tastes. Moreover it can create a green and low-carbon cooking environment by the standardized preparation techniques, cold-chain distribution and non-polluting disposal of cooking fumes. The robot is designed like an ATM machine and the operation design involves simple steps that can be handled by any worker. The process of cooking initiates with the mixing of ingredients in the robots, which resembles like a refrigerator. The robot after reading the barcode will pour all the ingredients into the wok followed by stir frying the dish. Employees only need to press buttons on the robot to choose a dish and it will display the name of the ingredients and their quantities. The ingredients are prepared by the manual workers according to the customers' requirements.

The 'I Robot' restaurant, Nanning, China is an example of another robot restaurant. It uses two robots from a Shenzen-based technology company. The robots chefs are able to make hundreds of Chinese dishes within three minutes. The robotic chef is peculiar for its efficient operation and hygiene. The

ingredients are stored in the databases of the computers which monitors the robot movements. Unlike the other robot restaurant manual labor is necessary for adding the toppings and ingredients. The raw materials are prepared by the manual workers for assisting the robot operated cooking.

In addition, robot manufactured by the Japanese company MIK, designed for automatic cooking of dishes like fried rice and stir-fried vegetables is another exapmle. The wok is designed in a flat shape with an automatic stirrer, and the ingredients are mixed by the mixer, making the role of manual workers superfluous. The robot wok includes a well fixed stir fryer that provides the consistency of the operation. Precise and continuous movement of the robots avoids burning, charring, or distraction and the dishes are served with acceptable taste and flavors. The cost of the robot is US$ 10,900. Hence the owners are able to save the labor costs by the usage of the automatic wok. Moreover, the labor costs associated with the training can be another cost saving, since this automatic machine doesn't require any training to manipulate. On the other hand, Dalu robot restaurant in China and Hajime restaurant in Thailand use robots for serving the dishes. Preparing burgers round the clock without any human intervention is one of the other novel current applications of robots. Smarter restaurants, San Francisco based company has introduced robots for making burgers, with a capacity of preparing burgers with a high level of consistency and sanitation (Durden, 2014). Incorporating more automation will reduce the costs and increase profitability and it will positively impacts the successful operation of the food service industry (Stargardt, 2010)*"The benefits of using robots as ramen chefs include the accuracy of timing in boiling noodles, precise movements in adding toppings and consistency in the taste and temperature of the soup,"* says Kenji Nagaya, president of local robot manufacturer Aisei. On the other .hand, ruyi, a Chinese fast food restaurant in Singapore, have been using the robotic wok for preparing certain dishes.

As mentioned, labor shortage and labor turnover has been the main issue which drive the restaurant operators to implement robotic automated machines in their operation. In Singapore, there are 6400 food establishments, which are in surge of solving the labor shortage issues (Wong, 2013). Coupled with high labor costs and the tax for hiring foreign workers have questioned to achieve the business productivity. Tung Lok, a leading restaurant group has initiated the use of robtic wok to prepare instant dishes in its two outlets in Singapore. With its efficient operation, the robotic wok (an equipment used to cook dishes) were successful in preparing dishes by making the process less labor intensive (Spring 2012). Tung Lok Group was able to reduce 20 to 14 employees from each outlet as a result of robot automation. The wages of each worker costs an average of $24,000 annually, while the machine cost only $10,000 each. Moreover, the restaurants operating under this group consolidates the operation by using the pre packed ingredients and items hence the cooking is made easier without interrupting the taste buds of the customers.

Restaurants using the automated machines such as robots are successful in delivering dishes with consistent taste with reduced waiting time. Hence, customers who seek instant foods are always attracted to dine in such restaurants. Moreover, the machines are configured to prepare certain dishes or either help the employees to improve the pace of operation. However, food preparation using robotic machines always ensure safety and are less prone to create quality issues.

2.2.3 Shortcomings of Robots

Although robotics provides a better interface to raise productivity and decrease the cost, initial investment is the major drawback of robots, irrespective of the sectors. For instance, robots in earlier days were not confined to all industries since the initial investment was high (Figure 5). Eventually industries realized

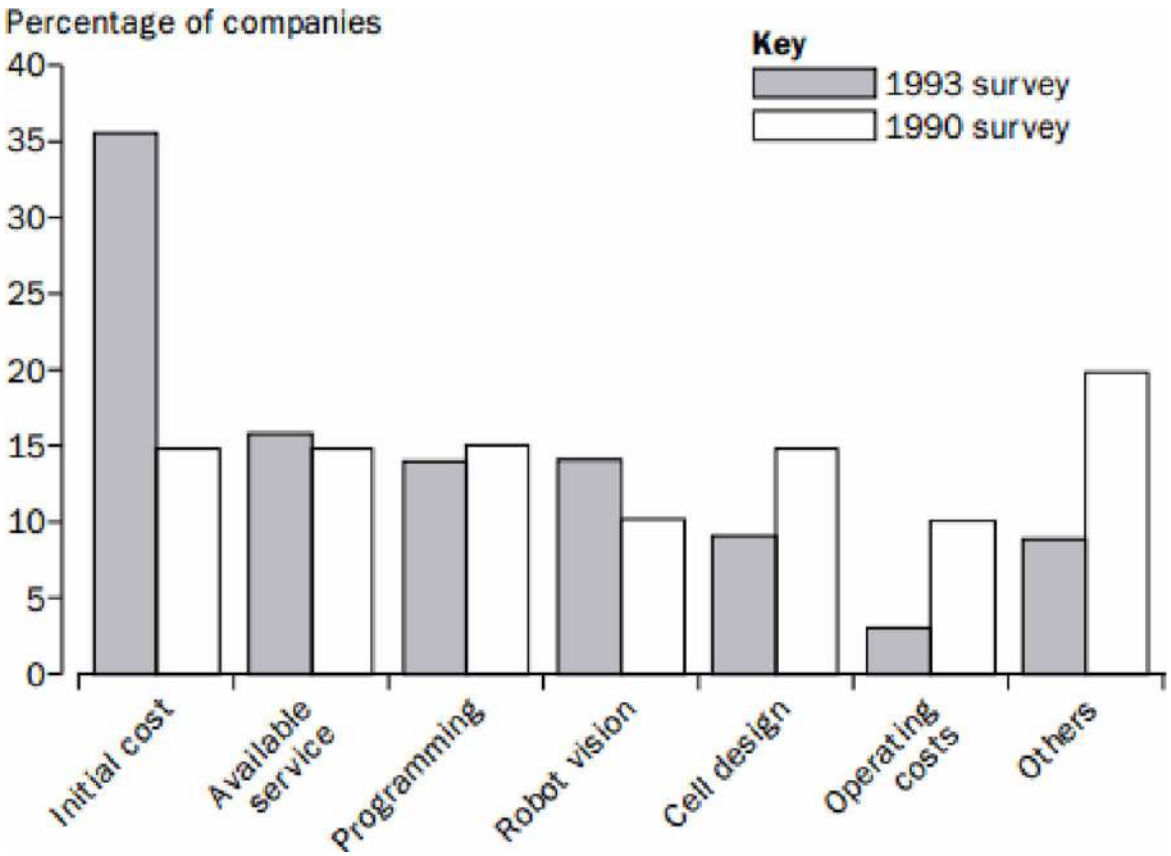
the usage benefit and invested in acquiring robotic machines for their operation. Recently, robots are being employed in restaurants for several purposes as the owners realized the use for a better service quality and productivity. However, small scale restaurants are often reluctant or unable to invest in robotics as a result of high investment.

In a survey conducted in Australia about the usage of robots, the major shortcoming of robots (Orr, 1996) was the initial investment. The survey compares the attributes of industrial robots between the year 1990 and 1993 and it was discovered the initial investment was the major drawback.

Industry needs low cost robot. For instance, consider a medium or small scale business, the cost of acquiring a new robot is expensive according to their budget, and hence they will be confronted with budget constraints in case if they bought a new one. Moreover, even after the purchase of robots, maintenance will be an expense for the business owners. Studies shows that the usage of industrial robots has an increasing trend throughout the world, but the real usage is mainly confined to Japan, European countries and North America. The situation for the rest of the economies, where there is a greater need for robots, will be facing with the price dilemma. Out of the total 75,000 units in world, Japan acquired 389,000 with 198,000 in Europe and 90,000 in North America (Sujan & Meggiolaro, 2010)

Revolution of robotization in the future is demanding that most of the jobs will be handled by robots. By 2025, half of the jobs will be handled by robots in United States. If the majority of jobs are handled by these machines it will create a profound impact on human resources globally, irrespective of the sectors

Figure 5. Shortcomings of robots Source: A longitudinal survey of robot usage in Australia (1996)



or industries. When global automotive and manufacturing industries increase the rate of robotics, job loss will became a global issue for the workers around. For instance, Google, Amazon and FedEx have started using more robotics technology for their business operation. On the flip side, it will indirectly affect the employment opportunities of prospective and experienced workers. In a nut shell, robotics is forming as an obstacle towards the income of the workers around the industries to an extent.

Moreover, when robots are introduced in to the business for novel applications, knowledge is necessary to operate it, Hence training will be required for the employees, emerging as an additional cost for the company. The production will be disrupted when robots are operated in absence of skilled employees for its programming. Besides that, innovation or creativity is not possible by this human manipulated machine.

3. CHALLENGES

3.1 Robot Application in Food Industry

It is interesting that the challenges of the food industry are common for global industries. To date, converging consumer demands, safety issues, competition and government regulations are the common challenges faced by the food and beverage industry (Thompson, 2005). Indeed the small and medium scale industries are the real fatalities as a result of these challenges. Provided with limited resources, they are reluctant or unable to compete with large scale industries. However some unique characteristics of the industry are the main drivers of the major issues. Involved with huge labor and requisite for safety and ergonomic issues (Brumson, 2011) with high turnover rate was one of the obstacles for sustained operation. To retain employees for performing mundane tasks and concern for hygiene, quality and consumer safety are the other major threats.

Moreover the above issues are solved to a great extent for the well existence of the industry. With the advancement in picking, palletizing and material handling, the demands rose for the robots for the food industry. Robots used in food industry are bit different from those in manufacturing industries. Ironically, using skilled labors was the main issue upon the introduction of robots in the industry. Although robots are used for pick and palletizing, the intelligent sensing is absent for picking variable size objects (Erzincanli & Sharp, 1997).

As such, much reliance on manual workers is needed. Robots are able to work according to the predestined function and therefore it lacks sense for decision making ability for certain circumstances. Moreover, robots can work in a limited envelope according to its design based on its number of arms or structure (Purnell, 1988). Another issue found with the robots was the unreliability of the gripper cylinders. Recently Unilever found some issues with the gripper couple of weeks after the installation (Bosch Rexroth UK, 2013). It was estimated that the cost for replacing cylinders are expensive (16000 pounds for 180 cylinders). Even though such issues can be solved to an extent, financial loss and time constraints are the effects of these issues.

3.2 Robot Application in Fine Dining Restaurant

According to Ruddick (2013), by 2025 restaurant industry will be in surge of fighting against technological challenges and efforts will be initiating to raise the profit margins, although robots will improve the

efficiency. While scrutinizing the efficiency of robots in automated restaurants, it is essential to analyze whether it's apt for enhancing the service quality and product quality in long term since it ensures customer satisfaction and hence raises sales revenue (Chow et al, 2007). For instance, robots in restaurants are fit for preparing the predetermined menu, it cannot make multiple varieties of food unless it's designed so.

Since human intervention is necessary for the food preparation, the taste will depend on the worker who adds the toppings and ingredients. Hence, the consistent taste cannot be achieved and it will affect the overall rating of the food of that particular restaurant. For instance, serious issues have arisen in preparing the fried rice by robotic wok at Ruyi restaurant Singapore. Customers were complaining about the inconsistent taste of the rice prepared by robotic wok (Open Rice Singapore, 2014). The method of preparing the food by workers depends on the employees such as the timing of adding toppings and ingredients. Primarily, the delivering the quality product is the factor that drives the success of restaurants (Stargardt, 2010). Apart from the ambiance of the restaurant, quality and price are the encouraging factors, keeping the operational excellence far away for the customers to remain loyal to the business. Although opportunities are available for automating the restaurants, deep understanding to implement the automation control is necessary to flourish the business (Stargardt, 2010).

In case of any breakdown of the robotic machine, it will result in the interruption of the whole operation. Moreover, quality and taste differences will affect the customer's preference of choosing the restaurant for the dining in future. As noted earlier, unlike the industrial robots, maintenance will be an issue with the robots in automated restaurant. While hiring the employees it is essential to provide training for them to be familiar with the machine to provide standardized operation. Normally, the economies which faces labor shortage in the restaurant industry hires foreign employees, who does not possess enough skills, resulting in additional costs for training and retaining them.

While it does not seem to create any issues with restaurants which fully depend on robots, chances are more for the semi-automated restaurants to face challenges with the food preparation. Nevertheless, restaurants employing robot waiter cannot delight the customers with high quality of service, usually in high tech restaurants. Robots in restaurants create an excitement for customers and tendency for dining will be increased. Ironically, some people still believes dining as a societal activity where they still need manual employees to serve for them. Moreover, the robot waiters still need the assistance of the employees to take the order since it will be a difficult task for the old people to communicate with the robotic machines. Industries are implementing more automation for reducing the work force, human power is still essential for food service operation (Canadian restaurant and food services association, 2006).

4. SOLUTION

4.1 Alternative Solution to Solve Labor Shortage Restaurants

Unlike other industries labor shortage is one of the prime issues of food industry, since much reliance on human power is essential for its operation. Labor shortage does not mean the reduction in the numbers of labor required, it can be the shortage of skilled employees for a particular work. However impact of labor shortage does not affect the food service industry along, rather it creates adverse effects to the global economy (Canadian restaurant and food services association, 2006). In point of fact, the shortage of labors will affect the service performance of restaurant which in turn will affect the customers to stop dining. It is essential to know what really causes the shortage of labor and to sustain the business in long

run. At any firm, labor shortage will occur when the number of required employees is more than the supply of available workers, who are educated enough or willing to do the job (Veneri, 1999). Moreover when the employer is not able to hire the caliber employee for a particular job, then it causes qualitative shortage of labors (Veneri, 1999). When the current business process are outsourced to the third party, less efforts are needed to strive against the labor shortage and therefore the restaurant industry will be exempted from this universal issue of labor . More over outsourcing operation will enable the industries to focus on core business activities (Fernando, 2013).

Several studies highlight the issues faced by food service industry, most notably with labor issues and productivity (Moss, 1969; Livingston, 1974). Food service industries are facing both the quantitative and qualitative shortage of labors. According to Canadian restaurant and food service association, 2006 quick service restaurant faces shortage of entry level workers, where table dining restaurant faces shortage of qualified cooks. Issues with the employees were the major concern for the industry apart from the energy, management, and production issues (Schaffer, 1984). Major issues dealt with employees were poor attitude, food service not considered as a career by many employees, high turnover, and low wages compared with other industries (Schaffer, 1984). According to Debrah (1994), rising education standard is one of the main factors since the educated youngsters are reluctant to work in the industry. Moreover, there prevails a poor image for the hotel industry to work for the new entrants, who are running behind to grab professional jobs in the advancing economy (Debrah, 1994). When firms face the labor shortages, it will be difficult for them to make the best use of the human capital advantage (Broek, 2012). Wage rate for entry level workers and promotional opportunities were the other main reasons for high turnover and labor shortage (Moss, 1969). To address these issues several suggestions has been listed as follows.

4.1.1. Training and Retention

The primary step to reduce the shortage of labor is to offer training for the employees. However sending full time employees for training creates adverse effect when they leave the job in the future (Debrah, 1994). Providing on job training will be an advantage to improve the skills of the employ for the particular job. As the food service restaurant is concerned, providing on job training for the front line workers and formal training for the chef will enhance the working capability. On job training is a widely used and effective training method in food service industry and it drives the success for the industry by the effective implementation (Gallaher, 1977). Moreover training is an effective device for affecting employee behavior, helps to reduce the anxiety of the employees, and alters the attitude of worker towards the job requirement (Gallaher, 1977). Although being cost effective method several issues such as absenteeism and labor turnover can be reduced to an extent by the training (Gallaher, 1977).

Moreover training has been paid higher attention in various segments of the food service industry. Training in food service industry comprises of levels according scale of the business. A new entry worker normally requires on job training, lasting for one or two weeks while workers in long chain operators are assigned for formal training, involves video training, seminars, short term subject based training, and computer training. A well trained employee offers advantages such as they can be assigned during the peak time or giving them extra shift will raise the efficiency of work in return for additional pay or bonuses for them.

When oriented properly, training helps to reduce the errors develops competence (Debrah, 1994), saves time, improve work flow, customer service and hence monetary savings for the business. In addition, maintaining the employees as humans rather than workers and encouraging them will promote the

standard of the job being performed. When workers are treated nicely with flexible working hours with proper payment (Chong et.al; 2001), the tendency of the people to attract the industry will be high. It is a notion that the working conditions in the restaurant industry are worse and it adversely affects the tendency of the employee to stick with the job. Hence, improving the work conditions by making some changes in the work design will have a positive effect on attracting and retaining sufficient personnel.

When employers are more concerned about the skills of new hiring, making use of exit interviews and job evaluation and occupational testing (Moss, 1969) is a best alternative. As of restaurant industry, to avoid hiring of unskilled labors, giving preference to experienced employees can helps in retaining the caliber employees. In addition, retaining multi skilled employees can ensure the quality service and hence reliance on a new worker can be reduced to a great extent.

4.1.2 Reliance on Part Time Workers

The major constraint with the full time employees involves the resigning of the job at any point of their work. When well trained workers leave the job on a sudden, they can get a job anywhere at any time, whereas the management will have to hire a new employee which incurs additional cost and literally they are not able to work as the old worker unless they have enough experience. According to Moss, 1969 increased reliance on part time workers will reduce the labor shortage issues and high turnover. Hiring part time workers in the food service industry reduced costs when compared to full timers. Hiring retired people, housewives and unemployed old age people is a better option to lay off the labor shortage issues. Hiring such employees provides a win-win situation for both the parties. Moreover, Additional costs such as insurance cost can be abolished by hiring part time employees and they can be trained without paying.

4.1.3 Use of Convenience Foods

According to Dungan and Lacey (1969) convenience food were put into more use in food industry as a result of following issues.

- Increasing labor costs
- Difficulty of getting and keeping skilled or unskilled personnel
- Declining productivity of kitchen and dining room employees
- Increasing capital investment in space and kitchen equipment
- Growing patronage in commercial and institutional food service establishments magnifying the problems of manpower and overhead costs,
- Profits, narrow and difficult to maintain

Literally convenience food can be any type of foods that are precooked processed, precooked frozen foods to (Dungan & Lacey, 1969). Use of convenient foods in restaurants will reduce the time required for preparing the food and with the growing concern for health for patrons; usage of such foods will ensure safety. Moreover usage of convenient foods will ensure a consistent taste. Food items can be prepared in a bulk quantity with the mix usage of convenience foods and they can be stored for re heating hence it saves the time for preparation. However, Restaurants operating 24 hours can make the best

use of convenience foods, hence increases efficiency ensuring a fast delivery of the food. Moreover fast food restaurants and other small scale restaurants in a crowded area ensure flexibility in preparing food with such foods. While intensifying the use of convenience foods, requirement of skilled labors is not essential to prepare the menu and it also ensures acceptance by the customers (Dungan & Lacey, 1969).

4.1.4 Automation and Technology

Introducing novel automation technology can resist the employee shortage in food service industry. With the advancement in the technology, introduction of automated machines can misplace the labors by ensuring the level of service and productivity. Food service industry has embraced lots of innovation and automated technologies to sustain the performance level and hence saves costs. According to Koutroumanis 2011, revolutionizing impact of technology in restaurant industry started in 1980s with the introduction of Point of Sale (POS) systems. With the POS system automation took over the job of kitchen and service staff, rather it enhanced the service quality level. Automated ordering system was one of the recent novel applications used by restaurant industry. However, technology transition in the restaurant has been increased at a steady rate hence maintained the competitiveness (Kotroumanis, 2011).

Equipments that are built in to manage the food preparation and serving will reduce the interface of the personnel to perform the tasks. Use of Vending machine, labor saving equipment, and computer assisted menu planning (Dungan & Lacey, 1969). Centralized food preparation and computer assisted menu planning, robotization of kitchen are the other suggested methods for reducing the interface manual workers in the restaurant. Furthermore, Robotic equipment such as fryer, noodle making robot, robot waiter also enhance the operation of restaurant without the involvement of much labor power. However, while the above suggestions can confronts the prevailing issues in restaurant industry, modifying the operational style can contribute to reduce the labor shortage, such as reducing the space for dining, except for the areas where crowd is high, stressing more on self-service, take away food and drive thru will minimize the required personnel for operating business

5. CONCLUSION

The objective of this chapter is to explore robotic transformation in literature and investigate its applications in food industry. Robotization in food industry aims at achieving economic benefits for the business operation along with the eradication of labor shortage issue. However the implementation of robots in restaurant industry still remains a novel application as a result of cost constraints. The level of robotic usage mainly concentrated towards developed countries with a very little consumption in the rest of the economies, where labor issues are high. Hence necessitating the fully automated restaurants can maintain the productivity and quality. In addition automated restaurants using robotic applications still confronts with various issues related with the quality of the food prepared by robots and still need reliance on manual workers. Moreover technological advancements should be made for the robotics in food industry to avoid such issues. Implementation of robotics along wouldn't be able to pioneer the business operations, while considering several alternatives will contribute for the sustained operation of industry. Labor shortage and cost constraints can be eradicated by proper training and outsourcing the robotic operations to third party, hiring part time workers and use of convenience foods. Globally, while

there is an increased usage of convenience foods, it will reduce the time for preparing foods with ensured safety. When restaurants intensify the usage of convenience foods, safety concerns will be reduced and thus helps in attracting new customers by still retaining the loyal ones. Moreover, implementing fully automation will eradicate the issues related with the quality of food products and hence the labor shortage wouldn't be a barrier for the sustained operation of business.

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KEY TERMS AND DEFINITIONS

Disrupted: When robots are operated in absence of skilled employees for its programming.

Food Safety: Approved robots for safety, sanitary standards and permissible according to Islamic law.

Low Cost Robot: Robot which does not require high and any additional capital investment and custom software to ensure a long term endure in the industry.

Productivity: It is efficiency, effectiveness, quality, performance and it can obtain a certain level of measure in terms of ratios or units and so on.

Robot: An electro mechanical machine operated with the computer manipulating various functions to be applied for optimizes business efficiency, reduce the costs and enhance organization productivity.

Robotic Performance: Automation of robot application reached the optimum level of productivity and efficiency in operations.