FOOD PRODUCTION LINE DEVELOPMENT FOR TEKME

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ABSTRACT

The main focus of this thesis was to identify problem areas in the current work process of the food production line at Tekme department of Kanta-Hämen central hospital in Hämenlinna and to find possible ways to increase cost efficiency striving towards impeccable work by applying innovation technologies.

The theoretical basis for this thesis consisted of information collected through visiting and observing the company and through personal conversations with the development manager, Nina Leino, as well as through studying and analyzing the documentation provided by her. Based on the collected information it became possible to write a detailed description of the current situation in the work process, to identify problem areas and to come up with goals, which should be achieved for an improvement of the production line

In the process, special attention was paid to solving the problem by using automation technology, such as robots, because the numbers prove that robotic systems are exponentially being incorporated into industry. This brings incredible flexibility, productivity and economic efficiency to the industry.

The outcome of the research work were several solutions with a detailed explanation of the advantages and disadvantages of each option and their approximately estimated costs.

Keywords Food production line, automatization, robot, development, food processing

Pages 28 pages

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1 INTRODUCTION

The thesis was undertaken for TEKME OY company in Kanta- Hämen central hospital in Hämenlinna. It is a company that specializes in multiple services such as food, catering, transport, cleaning, office support and in a wider aspect also provides real estate services. But the main discussion in this thesis is the catering services that TEKME provides in association with customer satisfaction and preferences derived from customers of all ages and their nutritional needs.

The aim of this thesis project was to find alternative methods of food production for TEKME OY within the Kanta- Hämen central hospital in Hämenlinna Finland, calculating the profitability and finding a method that would still remain in the timeframe required to execute the whole new idea. There were certain aspects that needed to be taken into account: have other companies been successful in the use of automated functions within the work place in the comparison to manual labor and what disadvantages that had been discovered in the process; profitable outcomes with financial advantages or shortfalls compared to other automated companies with similar projects.

The success of any company is the ability to produce at high volumes whilst sustaining of good financial income to the company. Nowadays technology has a huge influence to the way we run our lives, enabling today is society where it is much easier to prioritize and multitask.

Regarding this we were given the opportunity to examine the methodology and functionality of TEKME OY foods services, and suggest new more modern ways which would improve the work efficiency of food production. Nonetheless, the human input and supervision can never be superseded for the mechanical arm, so I will here try to look at this problem from different perspectives.

Before the beginning of this project, we first had to understand what we were coming up against. Niina Leino the development manager of the company familiarized us with the current working process in the kitchen. To further understand the process, a schedule was drawn up to calculate the timing required to successfully conduct this project. The whole project consisted of three phases. The first phase included exploring and collecting materials about the problem. The second phase included analyzing the collected materials, searching for possible solutions and making approximate calculations. The third and the most important phase was to come up with the solution, what would be the best solution in terms of economic feasibility and possibility of implementation.

2 BACKGROUND TO THE PROJECT

During an interview with Niina Leino, I got to know that the initial idea of this project came from to her. She started to work for this company in 2016, earlier she was an employee of Saarioinen OY which was more modernized and automated compared to Tekme. She came up with the idea of improving the food production line, which would lead to saving production costs. The first step was to present the idea to the management, who approved it. As a consequence, this research project was offered to Häme University of Applied Sciences (HAMK) due to the fact that Tekme has a contract with HAMK and students of our university already had conducted a research project for this company My thesis work was a continuation of the cooperation between HAMK and Tekme. The main objective of the was to study and analyze the current situation in the hospital kitchen in Kanta- Hämen central hospital in Hämenlinna, ponder the possible ways to reduce the production costs so that this would not affect the quality of the service provided and calculate the efficiency of modernization.

2.1 Tekme OY

The company Tekme OY belongs to the Kanta-Häme region and the main objective of the company is to generate maximum value for the customer. The company claims that they creating a good everyday life of the city with population more than sixty-six thousands of inhabitants and thousands of other customers from Kanta-Häme region. Tekme specializes in providing such services as:

- Cleaning and office support services, which takes care of pleasantness of the interior and the smooth flow of everyday life. This service includes maintenance cleaning, primary cleaning of work spaces and washing of windows; small repairs and maintenance; transaction services, such has mailing, copying and storing; cleaning in offices, housing cooperatives, schools and kindergartens, hospitals, clinics and nursing homes, business centers and stores.
- Real estate services, which making everyday life of people easier. Their duties include inspection, repairing, maintenance and monitoring. More than sixty experts take care of management and maintenance functions of more than five hundred properties on daily basis. There is a wide range of real estate services under the same roof: special carpentry; inspection services; outdoor work, such as maintenance, sand and snow removal from yard areas; interior work, such as maintenance, repairing and installation of engineering machines and equipment; property control and emergency services; control of building system work, such as electrical system.

- Transportation services manage the entire logistic chain and inventory management processes. This service manages over four hundred client's logistics operations every day and in average during the year they deliver twenty-three thousands of orders and store more than fifty-five hundred different items. This service is specialized on storage of customer's products, monitoring and maintenance of the product range; external and internal transportation; transferring of premises goods and furniture; maintenance of various types of supply stocks or crisis stocks; ordering and procurement of products; storing products and equipment covered with the agreement; courier, postal and distribution transportation.
- Food services provide customers with tasty and high-quality meals considering clients' specific needs. More than one hundred seventy professionals manufacture and deliver over fifteen thousand meals. Company has plenty of points of implementation of their production, such as schools, kindergartens, hospital kitchens, moreover, they have a home delivery service. Tekme offers a wide range of food services including: preparing and delivery of comprehensive catering; manufacturing versatile food packages in accordance with the nutrition recommendations for different customer groups; selection and ordering high-quality raw products.

2.2 **Food processing**

Food processing - the action of performing a series of mechanical or chemical operations on food in order to change or preserve it. (Food processing, n.d.)

Food processing is any kind of operations by which products are getting prepared for consumption, cooking or storage. In general, it includes basic operation with foodstuffs, the modification of product into another form, preservation and packaging techniques.

Food production workers are responsible for everything: from getting and storing food items to preparing actual meals. Main responsibilities of workers in food processing are: manufacturing of a wide variety of food stuffs, moreover, they are assisting to unload delivered products from delivery vans and making sure that they have been stored in proper conditions, after receiving food items, workers are expected to unpack them and according to their types (if it is frozen goods or canned goods) place them. Usually, food process workers work in a fast-moving production line, where food is being passed down on conveyor belts, through a variety of stages: mixing, cooking and packaging. (Food Production Worker Job Describtion, 2013)

There are plenty of places where workers of this industry can work: restaurants, hotels, healthcare residence facilities and hospitals. In each

place, they are expected to prepare meals in accordance to the organization's protocols, even though general job remains the same. For example, in a hospital, food production workers prepare food basing on nutritional needs of patients.

2.3 **Research methodology**

The model of this project is practice-based and the research methodology I have used is problem solving. In this thesis project plenty of methods were used to collect primary and secondary data. The main part of secondary materials from the theoretical part included basic desk research, information for analyzing was acquired from books, documents, the internet and brochures.

Primary data about the current situation in the company was collected through interviews. Interviews were arranged with Niina Leino, the development manager of Tekme's department in Kanta-Hämen central hospital during my visits there. I also interviewed other workers of the company to collect data on the current food production line.

2.4 **Definition of project**

Based on the results of observations and data collection, the following results were identified: currently the working process is organized in a way where work seems a monotone and labor-consuming process, which leads to time loss, lowering the level of quality and efficiency in production.

During the visit to the kitchen of Kanta-Hämen central hospital in Hämenlinna the whole process of food preparation was investigated. And during interview, all information flows inside the company and the organization of work were explained.

2.4.1 Order process

After arriving to the hospital and getting through a doctor's checkup patients have an interview, which is held by nurses, where they are asked for basic information, about allergies, special nutrition needs, preferences in meal size and after that all the information taken adds to the medical recommendation given by doctor, and based on a summary of these two documents: a questionnaire and a medical report, all the information about meal orders goes to the hospital's electronic database called Effica. After this, all the collected data passes through multiple services to the kitchen production control system Aromi, which is also used in plenty of other cities besides Kanta-Häme region. Aromi is kitchen software provided by CGI, but now the company is working on a new system, the first part of which will be presented in the autumn of 2017 and the next part will be ready by 2018.

After getting meal orders in to the Aromi system, kitchen workers print them and cut them into separate personal cards by hand. An order card as illustrated in Figures 1 and 2 contains the name and age of the patient, his/her department and room number, the size and a detailed description of his/her meal and notes about any special preferences, allergies or diets.

There is also a backup system, in case meal orders are not delivered to the Aromi service, the food service prints the patient's previous meal order and food is distributed based on it.

2.4.2 Order cards


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1 RU 1 V 1 KJ
PERUSRUOKAVALIO
EI: KALA
TUOTE:
LISÄTIEDOT: RE, SAPPI,EI APRIKOOSIA MISSÄÄN MUODOSSA, ei lauantaimakkaraa
JUOMAN LISUKKEET:
H01/02 [redacted] 56,10 V OSASTO: 2600
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Figure 1. Order card sample 1

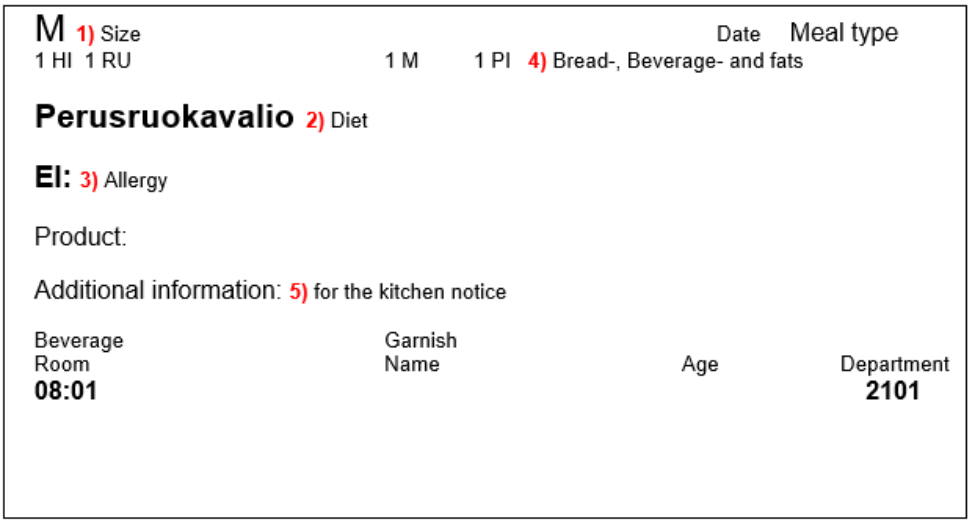
M 1) Size Date Meal type
1 HI 1 RU 1 M 1 PI 4) Bread-, Beverage- and fats
Perusruokavalio 2) Diet
EI: 3) Allergy
Product:
Additional information: 5) for the kitchen notice
Beverage Garnish
Room Name Age Department
08:01 2101

Figure 2. Order card sample 2

As it is visible in the examples Figures 1 and 2 a card with the order contains plenty of abbreviations. The letter in the top left corner (1) shows the size of the meal, which is calculated based on gender, weight, age and physical activity of the patient. The way it is calculated can be seen from Figure 3. Also, the dose of energy for each customer can be determined by diagnosis and doctor's statement.

WOMEN: The size of the basic diet meal

Current weight	Under 60-years		Over 60-years	
	Bed-patient	Walking patient	Bed-patient	Walking patient
>100	M	L	M	M
95		M	S	
90				
85				
80				
75				S
70	S			
65				
60		S		
55				
50				

MIEHET: The size of the basic diet meal

Current weight	Under 60-years		Over 60-years	
	Bed-patient	Walking patient	Bed-patient	Walking patient
>100	L	L	M	L
95				
90	M			M
85				
80		M	S	
75				
70				
65				
60				S
55	S			
50				

Figure 3. Definition of size of the meal

The level of energy for a basic diet per a small portion (S) = 1600 kcal, per a medium portion (M) = 1800 kcal and per a large one (L) = 2500 kcal. In a high energy diet (RE) it is 1400 kcal, 2000 kcal, 2500 kcal and 3000 kcal for extra small (XS), small (RE S), medium (RE M) and large (RE L) portions respectively. One more type of diet is high protein (RPROT) where the right amount of energy is distributed in the following order: extra small portion (XS) = 1700 Kcal, small (S) = 2200 kcal and the medium one (M) = 2400 kcal.

In the top right corner, there is the date when the order is prepared and delivered to the customer and the type of meal: breakfast, lunch or evening snack.

Under number 2 there is the diet chosen for the patient according to doctor's recommendations.

Next line contains information about allergies and additional dietary data. They appear in the diet summary list in the kitchen using dietary abbreviations.

Letters on the second line on the card (4) are designations for bread, beverages and fats. Each meal offers an alternative between one or two kinds of bread, drinks or fats. For orders for patients with special diets the bread and drinks will be provided in accordance with their diet.

RU = rye bread	MK = light milk	M =margarine
HI = yeast bread	MR = fat free milk	V = butter
NÄ = crispbread	ML = lactose free milk	
SÄ = roll	PL = sour milk	
RA = french bread	KJ = home-brewed beer	
PE = potato bread	ME = juice	
HA = rye crisps	VE = water	
	KI = mineral water	

Line six (6) is the "Distribution notice", additional information which may be provided for the departments own use to facilitate food distribution and to give guidance to the kitchen about it. Information about diets cannot be displayed in this field, because this does not appear in the kitchen summary list, that means it cannot be prepared.

At the bottom of the card the name and the age of the patient are indicated. On the same line, there is information about the department number and the room of the customer.

In the catering service the card is placed on a tray. On the department, it is removed from the tray after the patient's diet has been checked. Cards are placed in the order of hospital wards; this helps to implement the delivery smoothly.

2.4.3 Meals information

All meals are served on wooden trays and in total kitchen workers prepare around 800-1000 trays per day. About one third of all the meals are done for patients with special diets.
The following pictures presented in Figures 4-9 are used as a guidance for patients for choosing the right size of meal. These figures illustrate

differences in portion sizes, the portions are offered in S-, M- and L-sizes, and the most common diets of a sample of lunch.

Figure 4. Lunch S-size Basic diet

Figure 5. Lunch M-size Basic diet

Figure 6. Lunch L-size Basic diet

Figure 7. Lunch S-size High energy diet

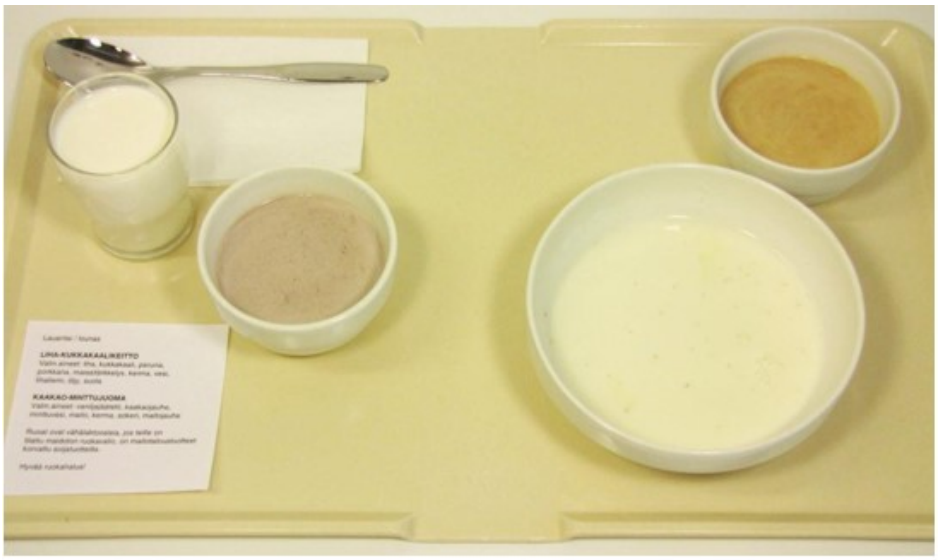

Figure 8. Lunch size S and size M Liquid diet

Figure 9. Lunch size S and size M Mashed/Pasted diet

It is visible from pictures above that the main difference in basic diet meals in amount of products: as for the small portion it should be one potatoes, three meatballs and on piece of bread, for the medium size meal it should be one potato, four meatballs and also one piece of bread, for large portion there are three potatoes, five meatballs and two pieces of bread. During the day staff have to prepare 3 types of meals, they are getting orders from departments one hour before the actual meal time and they have only 3 minutes to get food ready for each department.

- Breakfast distribution starts at 6am and lasts about one and a half hours and it takes around four to five people to prepare meals.
- The duration of lunch preparation is two hours, it starts at 9am and involves nine or ten people.
- Preparation of dinner takes around two hours, starts at 2pm and binds from six to eight people.

2.4.4 Organization of work process

On Figure 10 it is possible to see the current situation of work organization in the kitchen, the number of workers involved in lunch preparation and the positions and roles of workers in the process.

Figure 10. Work positions

The layout in Figure 11 illustrates the same, but already a more understandable schematic view. Workers are marked with circles and cubes represent tables.

- The first person in the beginning of the conveyor puts a tray, a glass and a patient's order card on to the moving belt.
- The second worker adds a plate and the cutlery.
- The third one adds the right amount of bread slices according to the order and butter or margarine.
- The next worker puts in hot sauce to the plate.
- The fifth worker is responsible for the salad and the salad sauce.
- After that vegetables are added to the plate.
- Later a food service worker prepares a hot side dish (potato).
- One more person puts desserts on the trays.
- The person at the end of the conveyor is the supervisor who checks the correctness of the order, covers it and place it onto the trolley in which food is delivered to departments.

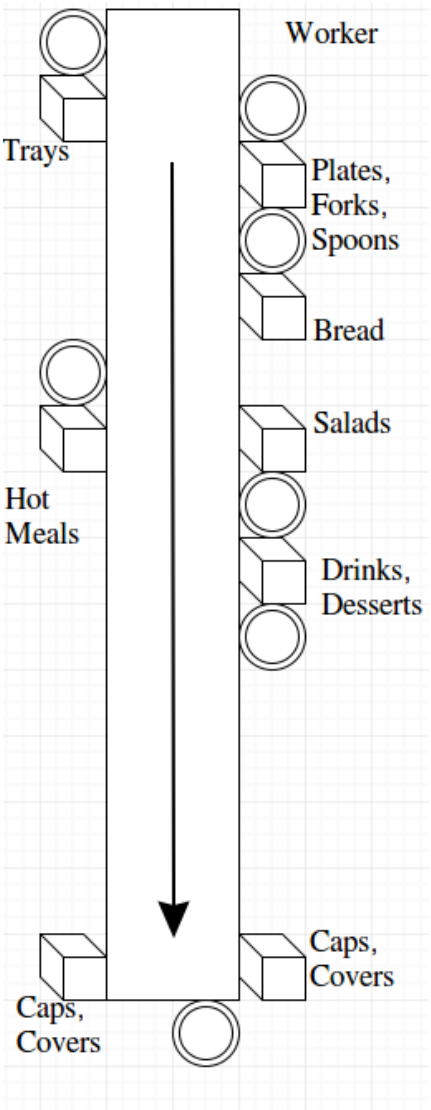

Figure 11. Layout of kitchen workers

2.4.5 Trolleys

Figure 12 demonstrates the trolley into which the meals are placed and delivered to departments. Each trolley is divided into two parts: the cold and the hot one to keep the meal at the same temperature as it has been done until it reaches the patient.

Figure 12. Trolley

2.4.6 Problems and goals

During the interview with the development manager of Tekme department Kanta-Hämen central hospital in Hämenlinna the following problems and weak points in production line were named:

- The distribution is carried out manually
- Problems with centralized food distribution:
    1. Delays in the shipping schedule
    2. Breaks between departments orders. There is a schedule for food distribution and if there are no obstacles in the process of distribution, sometimes employees have to take a break (around 5 minutes) before they can continue their work. It is not possible to work continuously, because there are some trolleys which cannot be warmed up and in case they will get ready in advance, food will get cold.

3. The conveyor belt stops often for the following reasons:
    - ♦ The replacement of trolleys takes time. When one trolley is filled up, the supervisor takes it to dock for warming up. It can take more time, than it is estimated, so the line stops till the supervisor gets back.
    - ♦ For the diet orders time is needed for looking for the right products. There are many specific diets and in case if cook does not know which product should be used for the order, he asks supervisor, what also takes time.
    - ♦ Some products are missing. There is a possibility that worker forgot something or there is lack of a certain product, then it has to be taken from the cold storage. This is also loss of time.
4. Errors, which happen due to adding wrong ingredients to the meal:
    - ♦ Supply should be proper every time.
    - ♦ Patient safety must be observed.

Taking into account these problems the following goals arise:

- Speed-up of centralized distribution, at least the line should work continuously.
- Reducing the amount of mistakes to a minimum, striving for flawlessness work.
- Replacing simple work processes with automation.
- Dosing such products as salad and dessert before distribution.
- Finding and applying innovation technologies.
- Increasing cost efficiency.

Based on the identified problems of the company and taking into account the set goals, a possible solution can be found in automation technology such as robots.

3 AUTOMATION ENGINEERING AND ROBOTS

3.1 Automation engineering

Automation is a field of engineering, which increases the efficiency of production equipment and the production process itself, making it more economical, while retaining the quality of products and following all external regulations. This area of engineering includes projecting, designing, modeling and simulating, installing and testing, managing electrical or mechanical automation. As a result of work of automation engineers many processes and works carried out manually can be replaced with machines or robotic elements. Automation is used in such

industries as pulp and paper, chemical and food, in medicine, transport and traffic control and electricity production. Automation is widespread and new ways of using it are constantly being introduced into production. (Electrotechnika I avtomatizacionnaya ingeneria, n.d.)

3.2 **Robots**

Paces of development technic and technology designate the modern way of evolution of society and development of automated systems. This raises the need for ability to solve problems by using robots and automatic machines, which can be projected in in real model, directly construct and program. Despite the fact that during next decade automation will eliminate very few occupations, it will affect all jobs more or less.

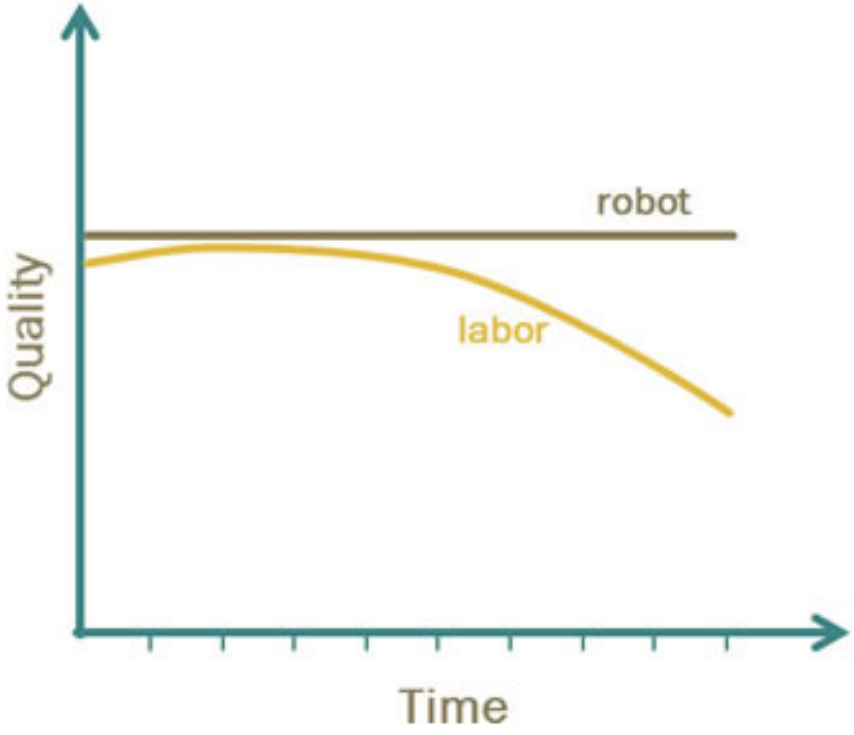

Figure 13. Robots VS human labor

It is becoming evident that computers, machines, robots, and algorithms are going to be able to do most of the routine, repetitive types of jobs: any monotone work, where a person needs to be careful and concentrated for a long time robots perform better as it does not get tired and bothered by doing it. Moreover, as it is shown in Figure 13 installation of robots is more profitable in a long run perspective and the quality of the work will not change with time, machines can work all year round in three shifts per day almost without interruption and the accuracy of its work will remain unchanged, what cannot be said about the manual work, the possibility of reject is reduced practically to zero. Proceeding from listed arguments it is

possible to be convinced that advantages of robots to people are obvious. (Rabota dlya robota: kto poleznee – mashina ili chelovek, 2015)

But, first of all, let's consider the definition of "robot":

- Robot – electromechanical, pneumatic, hydraulic device or combination of devices, designed for replacement of a human in industry, hazardous environments etc.
- Robot - a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer. (Definition of robot in English, б.д.)

3.3 **Types of robots**

Based on the definitions above, it can be concluded that there is no certain explanation of the term robot, so the major of automatic devices can be included to the class of robots.

I would like to examine the variety of robots, their classification and application. Analyzing various sources of information on this topic, I found that there is considerable amount of possible ways to classify robots, but we will focus on a division by their application.

1. Industrial robots – industrial robots are robots used in an industrial manufacturing environment for fulfilment work, which is hard, monotone, harmful and hazard for human's health. These robots are listed in Table 1.

Table 1. Type of robot

Type	Use	Example
Manufacturing	Automation of all types of manual and transport operations in various industries	Manipulators, robots for painting, assembly of parts, welding, metal cutting
Agricultural	Automation of labor-intensive and monotone processes in agriculture	Field robots, mowers
Transport	Automation of management of various vehicles	Autopilots, self-propelled trolleys, walking machines
Construction	Automation of auxiliary manual operations as well as main ones inherent in construction	Robots-demolishers, robots-plasterers

1. Domestic and household robots – robots used at home. Their general purpose is an automation of operations related to human's life and the service sector
2. Military robots – robots used in military. Automatic devices, which are used to replace a person in combat situations for the preservation of human life or for work in conditions which are incompatible with human capabilities in military purposes.

Each subsequent generation of robots has greater potential and perfection, but it does not exclude the previous one, they mutually complement each other and find application according to their functional capabilities and conditions of economic expediency.

4 HUMAN LABOR VS. MACHINES

The main contribution of technology development to the labour market is productivity increase. It becomes possible to produce more with less labour. For the last 20 years productivity has been growing due to high technology in developed industrial countries. This small and dynamic sector, connected with information and communication technologies (ICT), in which usually no more than 3% of the workforce is employed, moves the entire economy. It produces the technologies used in production equipment. In this way, ICT positively affects all sectors of production, due to the impact on the quality of new capital. As a result, the productivity of production is growing everywhere. (Robots Will Change the Job Market to our benefit, 2016)

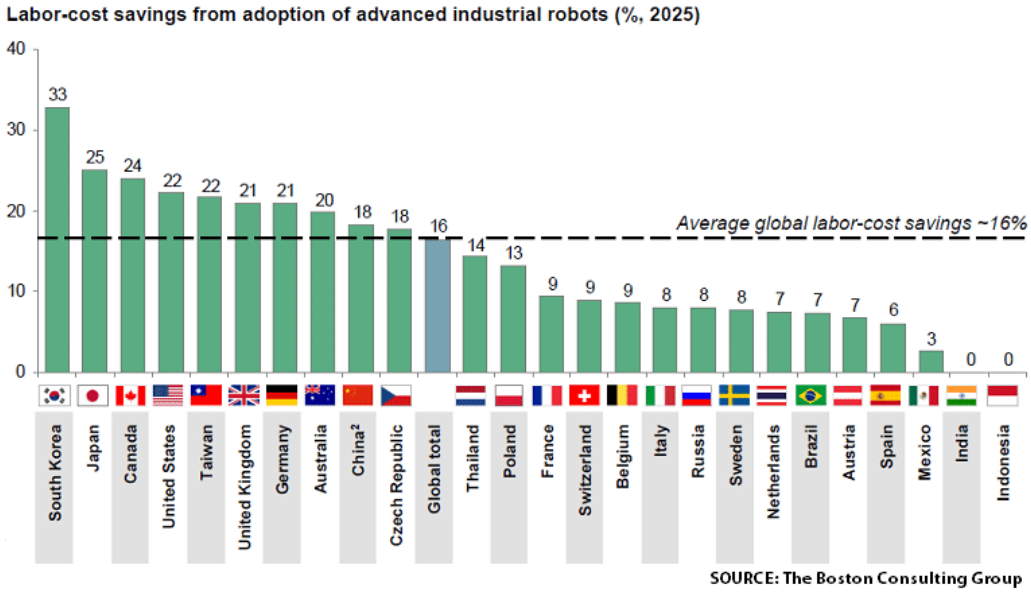

Figure 14. Labor-cost savings from adaptation of advanced industrial robots (The Boston Consulting Group, n. d.)

"A new report of Boston Consulting Group (BCG) estimates that by 2025 the average manufacturing employer will pay 16 percent less on labor by replacing human employees with robots. Industrial robots are costing less and are more dexterous as their predecessors, allowing them to be employed by smaller companies to do more complex repetitive tasks". (Young, 2015)

As it is stated in BCG report the costs of the average durable robot used in manufacture dropped for more than $ 50000 from 2005 to 2015 and it is going to continue to decrease during next decade more than 20 percent. (Young, 2015)

BCG says that in countries with advanced economy, such as South Korea and U.S., where labor costs are the highest. Already now industrial robots are replacing workers in fast-food line, who's salary is $7.25 hourly what is a minimum federal wage and robots pay prime cost. Some robots used in other areas require even less amount of money of that minimum and that gap is rising in the machines favor. (Young, 2015)

But it is expected that robotics labor costs will be below expenses for manual work even in countries with the lower economic indicator, such as Mexico or Thailand by 2025. (Young, 2015)

Figure 14 illustrates that robot and the adaptation depends on the country, currently South Korea, Japan, China, United States are the main customers, these countries are buying up to 80 percent of industrial robots.

Finland is not included into this graph, but considering that the economy of Finland is akin to Sweden, it is obvious that by 2025 in Finland will be around eight percent, while in some countries it will reach 20 and more.

5 POSSIBLE SOLUTIONS

At many enterprises robots are not a wonder anymore. These automated machines, due to the possibility of reprogramming or the use of several programmes simultaneously are applied for performing various production processes. Three main trends can be distinguished: the "compliment" of human with technologies: for example employees with portable devices; the replacement of people with machines as a cognitive virtual assistant, who works as a virtual employee of the customer support department, and also, the joint work of people and machines: mobile robot working together with a warehouse worker to carry cargo.

From all ways of replacing manual work with machines, the most cost saving and easy to release is replacing it with robots. There are several options can be considered as a solution of the problem posed in this thesis.

5.1 **Replacing people with machines: the case of a fully automated kitchen**

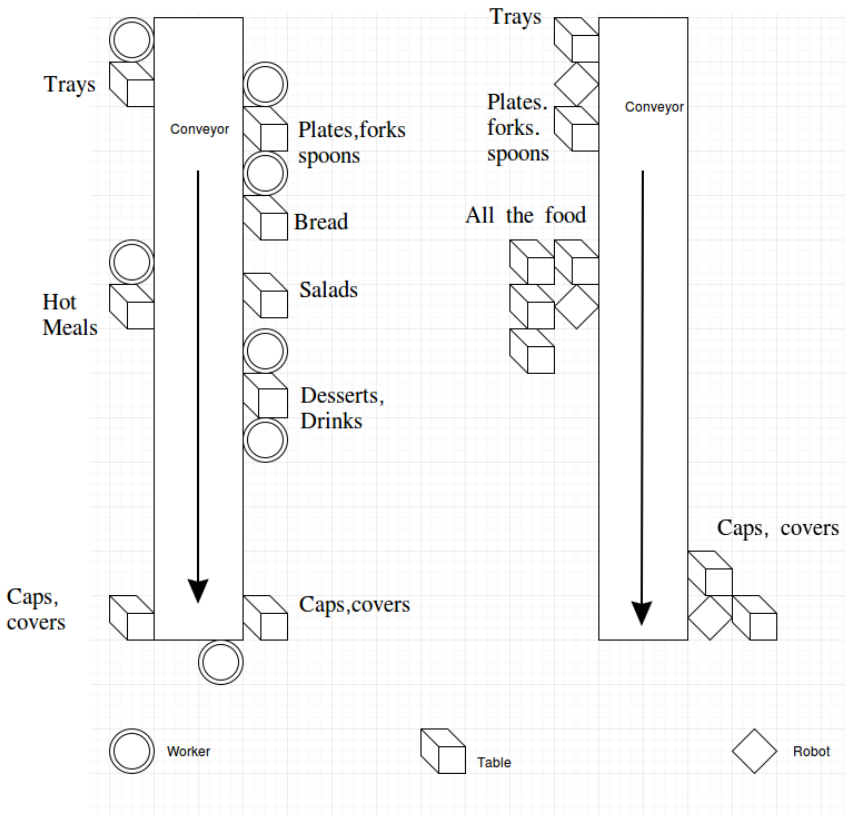

Figure 15. Layout of a fully automated kitchen

There are several areas where such a substitution of workers with machines arises, such as dangerous work or processes with simple routine and repetitive tasks, as in the company the commissioned in this thesis. In Figure 15 one possible solution to the problem is shown: all workers are replaced with robots.

5.1.1 Replacement of first two workers

As it is presented in the layout in Figure 15 first two workers can be easily replaced with one robot, there will not be need in printing out orders and cut them into orders, because robot will read the order straight from the system and make initial preparation of the tray like putting cutlery, utensils and tissues. For example, in one department of a small American company Vanguard Plastics Corp. among 30 ordinary employees there is also a very unusual worker. It is a prototype of a robot-worker Baxter (Figure 16), developed by Rethink Robotics company. It went on sale in October 2011 and it was the first inexpensive and simple multifunctional robot-worker. Baxter is a robot, which weighs about 75 kg, stands on a fixed base and has two hands to which various types of replaceable manipulators can be fastened, both: regular (sucker and two-fingered gripper) as well as the special one made for a certain task. Baxter is designed to perform

monotonous simple work, such as assembling plastic cups or bundling goods. It is unprofitable to create special robots for this kind of work and small entrepreneurs cannot afford multifunctional machines, as they require complex reconstruction of workshops and attracting highly qualified specialists. As a result, millions of people around the world are engaged in tedious low-paid work. Robot development Rethink Robotics can solve this problem.

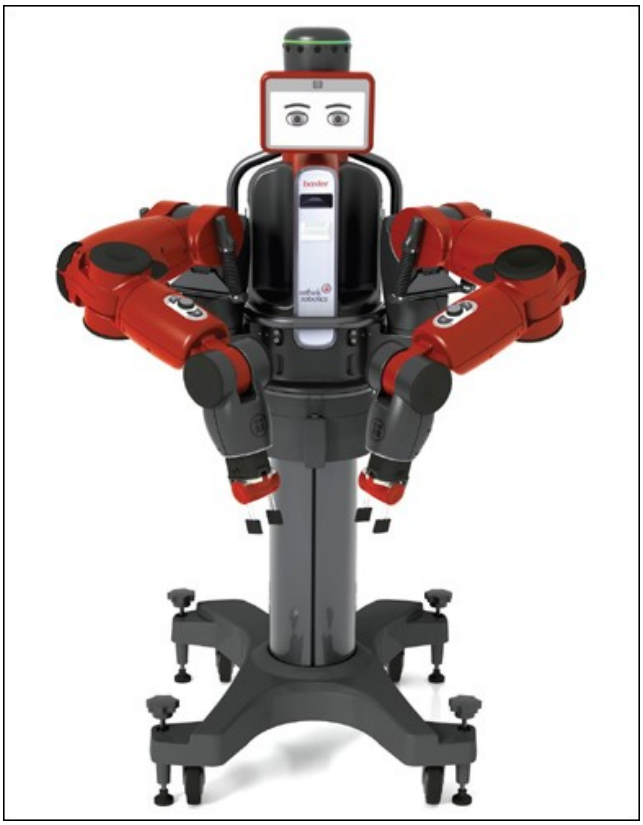

Figure 16. Robot Baxter

The main difference between Baxter and other industrial robots is in its unique consumer qualities. First of all, it costs only $22000 and around $38000 with all setup costs, what is considered as a very low price for industrial robots. To monitor the situation, Baxter uses 5 video cameras placed in different parts of its body. This allows to the robot to recognize the conveyor and the actual objects of its work, to detect unexpected obstacles. Moreover, the robot has an original working mechanism, it is so simple that Baxter can be taught to do a new job even by the child in ten minutes. To do this, robot should be taken by the hand and performed all the necessary actions. For example, after moving the hand to the box a special button has to be pressed to make the robot remember its image. After that, the hand is moved to another place and the corresponding button is pressed again, the robot will remember the commands and can immediately start doing a new job. In this process, reaction of the robot can be monitored. If he does not understand the command, he shakes his head, and the expression changes on the special display, depending on the understanding of the commands, from attentive to joyful or distressed.

5.1.2 Replacement of workers who work with food

A second robot could replace all the workers who work with food, this one would be the costliest robot, but with only one robot five people can be replaced. Already in 2010 at the international food machinery and technology exhibition which was held in Tokyo, Japan wide variety of machines designed to work with food were presented. There were quite a few interesting food technologies on display: from small and simple ones to truly complex multifunctional models. The robotic arm named the FlexPicker (Figure 17) presented by ABB company was able to detect the position of the item on the conveyor belt, its shape, color and it could also detect rejects and take them off the line. Because of the speed of this device it is far more efficient than any number of human assembly line workers. In addition, before food will be delivered to consumers, they should be taken from the conveyor belt and packed. When it is done by robots, hygienic conditions are improved as well as productivity. The ABB FlexPicker is specially created for helping people to manage with monotone tasks in food industries, as well as pharmaceutical and general FMCG industries. (Food Machinery and Technology Exhibition: Gyoza machine and robotic arms, 2010)

Figure 17. ABB FlexPicker

Considering that the exhibition took place in 2010, it is possible to assume that by now these robots would have been improved and become more complex. Based on this, it can be expected that one robot like this could

pick and sort food products instead of five people, what would be two or even three times more efficient.

5.1.3 Replacement of the last worker in the line

A third robot could replace the last person who stays at the end of conveyor and puts trays into trolleys. With YOBOT (Figure 18) the luggage-storing robot, installed in Yotel in New York in 2011 it is possible to make sure that the functions of the last person in the conveyor line also can be done by machines. The original robot, called ABB IRB 6640, ordinary designed to spot weld or transport materials in an industrial setting was adopted to work as a bell boy by Yotel hotel in cooperation with MFG Automation. The system provides necessary safety and security as well as an intuitive interface for customers who have never experienced such a system. For placing luggage into one of 150 boxes, the guest should put all required information on the touch screen, such as a full name, number and size of bags and a personal identification number, which was given with the room key and just watch how the robot makes its job, placing the luggage into the bin. After that, Yobot prints out the receipt with a bar code, which should be submitted, when the customer wants to get his bags back. Can be traced that algorithm of actions of this robot is similar to the work done by the last person in the line. Proceeding from the fact that this robot was installed in 2011, it is obvious that by now the functionality of the robot is much wider at a lower price.

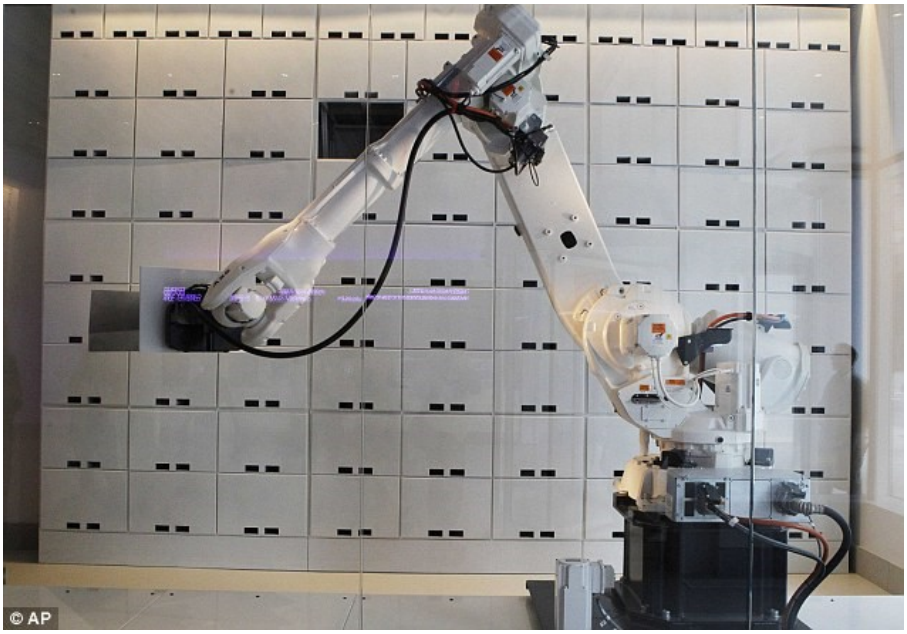

Figure 18. Yobot

So here we can see that full automation of the kitchen is possible and main advantages of this solution: improved productivity, enhancement of quality of work, which will not be change with time. Furthermore, robots can work 24 hours seven days per week, their work excludes mistakes

caused by human factors and work two to three times faster than manually.

The price of this solution will vary, because the cost of a new industrial robot with controllers and teach pendants is from USD 50000 to USD 80000 and after adding application-specific peripherals the whole system will come out approximately in USD 100000-USD 150000, but there is another option: purchasing used robots, what is a less expensive option. Typically, reconditioned robots cost half of the price of new ones, their price can range from USD 25000 to USD 40000 and with all installed applications it can be estimated between USD 50000 and USD 75000.

The average salary of a kitchen worker with Tekme is EUR 2750/month what is around USD 3100/month. Baselines can be calculated using following formula: Yearly Cost = Employee [Unit] * Shift [Unit] * Salary [USD], where number of employees on a shift [Unit], number of shifts per day [Unit], employee yearly salary [USD]. From here we get that Yearly Cost=8 (employee) * 3 (shifts) * USD 37200 (salary) = USD 892800. When the estimated price of robot system including all installed applications and calculating the most expensive option will be: USD 38000 (price for the first robot) + USD 150000 (price for the second robot) + USD 150000 (price for the third robot) = USD 338000, there should be added the operations and maintenance cost, which will be approximately USD 10000 per robot annually, so it is USD 30000 for three of them. By simple calculations it is visible that robot's installation and maintenance of it once per year will bring more profit in a long run than paying salaries to workers; it will be paid back within half a year.

5.2 **Automatization of the whole kitchen**

Furthermore, from 2018 it will be possible to replace not only workers in the production line, but to make the whole kitchen automated. At the beginning of 2017 a prototype of a new robot (Figure 19) created by Moley Robotics was presented at an exhibition in Germany and now they are looking for investments. Two robotic manipulators are suspended above the kitchen stove, oven, work surface and sink. By dexterity robotic arms are not inferior to human ones. The robot works as fast as a professional chef, controlled with smartphone. It is able to cook using recipes from internet.

The principle of kitchen work of a machine involves a chef cooking wearing a pair of sensor-lined gloves and the robot records him in action using motion capture technology. After that, these movements are converted into instructions for the chef robot, which can cook in a prepared kitchen without any input using these instructions. The user just places all ingredients in the right order, presses the button and in 20 minutes gets the dish. At the moment, it is only a prototype, but the founder of the company Mark Oleynik wants to start selling it commercially from 2018.

The estimated retail price for this technology miracle is USD 75000 It should be mentioned that the price includes not only the manipulators, but also a cooker, sink, work surface and cabinets.

Figure 19. Robot chef

5.3 The joint work of human and machines: kitchen with one worker left

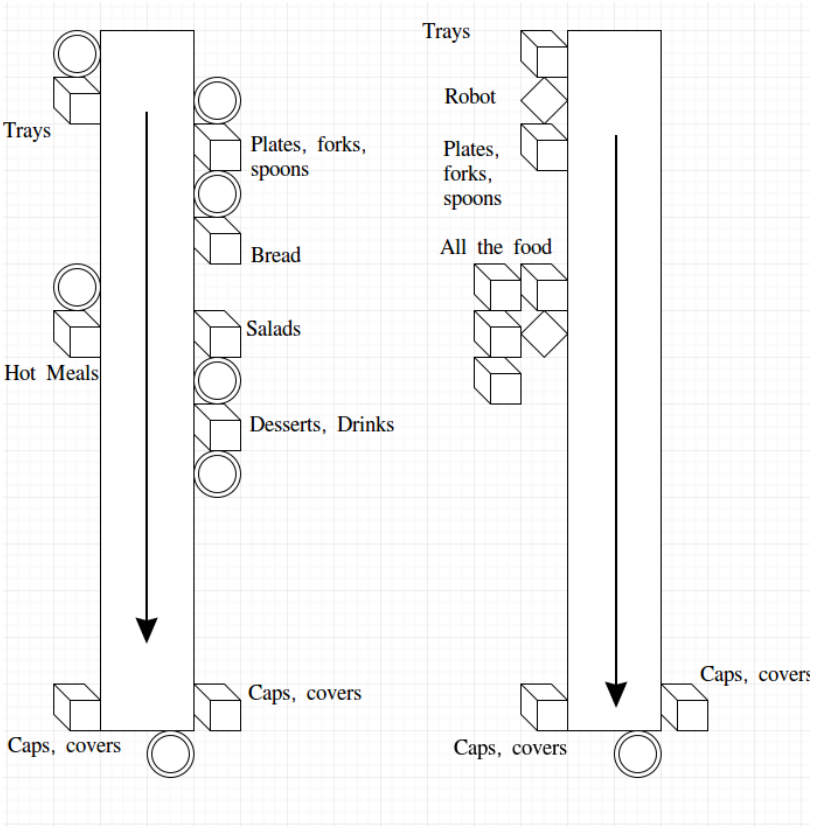

Figure 20. The layout of kitchen with one worker

The work of a human and a machine is not one of things that can be divided into black and white. Sometimes joint work is the best solution.

There is a new generation of robots being created, which are capable of working with people. The obvious advantage of such cooperation is the opportunity to take all the best from both worlds: the productivity and speed of a computer as well as the emotions, intelligence and ability to cope with unseen circumstances inherent in people. (Mashini vse luchshe ponimayut ludei, 2013)

The layout in Figure 20 presents a half-automated kitchen, where is one worker left. As it was mention before, at the end of conveyor there is a supervisor, who is responsible for controlling the meal fulfillment in accordance with the patients' orders and putting the tray into the trolley. In case of replacement other kitchen workers with machines, we can observe the joint work of human and robots, plus there is a possibility to teach the supervisor the basics of maintaining robots, which will lead to saving on specialist services.

This option seems to be the best solution, because the performance of quick and high-quality work by machines will be controlled by a human and for the current moment it is the most suitable combination, because in spite of the fact that the era of machines has already come, the best result is achieved only by an interaction of technology and a man.

5.4 **Compliment people with technologies: kitchen with only one robot installing**

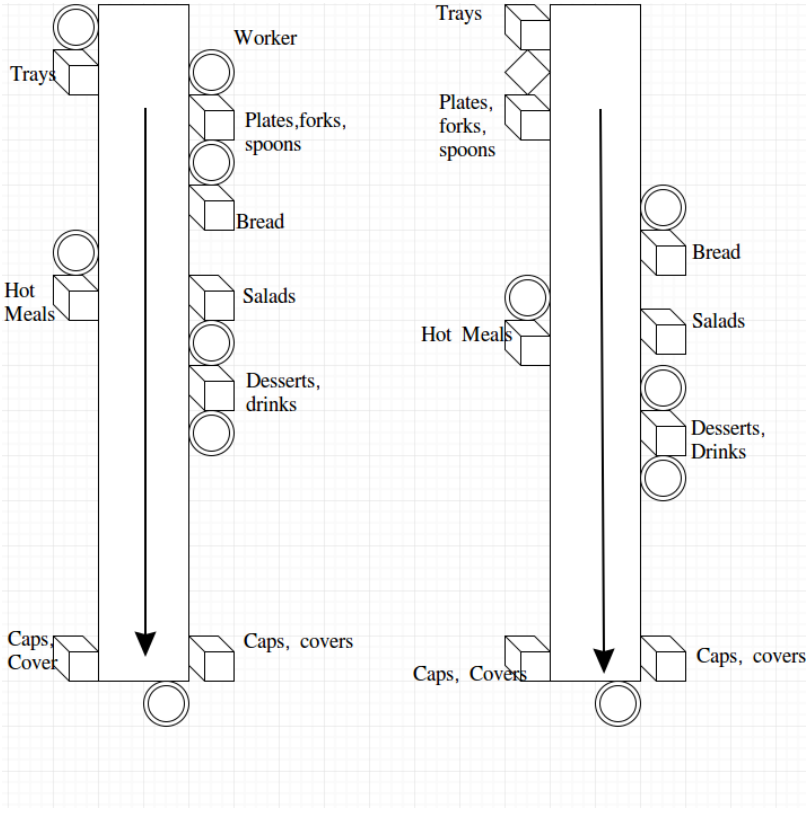

Figure 21. Layout of kitchen with one robot

Technology makes it possible to enhance human capability in the physical, emotional and cognitive fields. The main advantage of supplementing people with technology for business is to get "improved" employees. For example, if any employee had a portable computer with him that could give an answer to any question about the company's products or services or instantly provide any necessary data, it would obviously have a positive effect on business. The ability to increase productivity, to better sell or better serve a customer will increase repeatedly.

This scheme in Figure 21 shows another possible solution: the installation of only one robot instead of the first two workers. It can be the easiest, and most inexpensive option. Moreover, this solution could be a good start on the way of automatization of the whole working area. Motions of first two workers are monotonic and mechanical, so the replacing robot does not have to be stocked with artificial intelligence, it just should be programmed to perform a certain algorithm of actions. Even though this modification is insignificant, it will lead to substantial time and cost saving.

6 CONCLUSION

The main objective of this thesis project was to examine the Tekme department in Kanta-Hämen central hospital in Hämenlinna and by analysing the collected data and studying the theory find new ways of conduction the production line there and to come up with a more profitable solution both in economic and production terms.

The first part of this thesis mostly focused on the current situation in the kitchen of the hospital. The main research sources were personal communication with the development manager of this department, the website of the company and materials about the work process inside the company kindly provided by Niina Leino.

One of the most challenging parts was the detailed description of the current situation. Considering that Tekme OY is a company founded in Finland, all the materials I got were in the Finnish language. It would not be a problem, because nowadays technology allows one to translate even a high volume of text, just sometimes I needed an accurate translation in specification of some details, so I was forced to ask for help directly from Niina Leino who is not only a Finnish-speaking person, but also the one who knows the whole process in detail. However, in the end, all the necessary information was found.

The research process itself showed that a replacement of human workers with robots is not in the far future, it is already a reality. This switch will bring savings to manufacturers over long-term and enable finding and mastering of new specialities by people, because the application of robots

will not take on the job positions of people, it will raise people to another level of expertise.

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