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A STUDY ON HUMAN RESOURCE, TECHNOLOGY, PACKING AND COST OF THE PRODUCT CONCERNED WITH PROCESS DESIGN IN FOOD MANUFACTURING INDUSTRIES

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ABSTRACT
In this study, the research focuses on analyzing the impact of key parameters such as human resources, technology, product packaging, and production costs on the process design within food manufacturing industries. Human resources and technologies are the most valuable asset in an organization to maintain and improve safety of the food to achieve this proper training, and facility for working personals is very important. Tools and hand washing, protective clothing, avoiding of foreign particles left out on production line are the areas should be concentrated to increase hygiene of food production. Factors like job security, selective hiring, self-managed teams, and decentralization of decision making compensation policy, extensive training and information sharing are considered to be most dominant in human resource point of view. Latest technologies may reduce the labor requirement in a manufacturing unit, but individuals should have high technical skills. Technologies are needed for high storage to meet sudden demand, to reduce the production lead time and for quick packing of produced products. Due to consumer interest on consumption of fresh products, manufacturers must provide modern and safe packaging in terms of controlled quality and extended shelf life, these are the driving force for development of new and improved concepts of technology packaging. In food industries both direct and indirect costs need to be considered. Direct costs are resources, labor activities and ingredients that required for particular product and indirect costs include distribution, marketing, and after-sale.

Key words:
Ultrasound technology, Nano technology, Break-even point

I. Introduction
Food technology becomes more advanced year after year. Developments in food technology aimed towards more convenient, more efficient, low cost, high quality and safety of the processed food [15]. Demand for the food increased by 59% to 98% from 2005 to 2050 across the globe because population of the world projected to increase from 7.7 billion to 9.2 billion [3]. To achieve these demands, food industries should increase the production and new industries should be established. The competitiveness of food industries can be improved by innovations and adaptation of new food technologies. It provides so many benefits like food safety, increased shelf life and extension in nutritional and sensory quality [11].

Packing is one of the important process in food processing steps, because it will maintain the quality, transportation and endues of the food product. Food packing is designed in such a way that to contain and protect the food, to provide required information about the food, and to make food handling information from manufacturer to consumer table. The food industry consumes maximum packing materials among all industries in the glob, hence even small reduction in amount of packing material can leads to significant cost reduction and helps to solve solid waste problems [15]. Setting product cost in manufacturing is an hardest part, because if the price lower then chances of loss in revenue is more and if the price is higher then may be a chances of loosing valuable customers [23]. Charges of food industry for its service depend upon many factors like input costs, profits, and productivity [24].

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II.Human resource and technology

Human resources and technologies are interrelated to each other, the latest technologies and equipment's will reduce the need of labors, but labors retained in the production plant should have good skill. Popularity of new processing technologies increasing worldwide due to so many innovations related to sensory and nutritional quality, extension of self-life and food safety. However, consumers may be cautious of the food products produced by using these new processing technologies [11]. Constantly increasing demand from consumer for delicious and nutritious food product, the scientific community, food processors and food process engineers have challenges to develop new processing techniques and innovative ideas to ensure high nutritional value and fresh taste to the consumer [1]. Even through food heat processing technique inactivates the microorganisms, it causes undesirable changes in nutritional, sensory and physical properties of the food. Now a day's food processing involves technologies based on membrane like membrane distillation, nano-filtration, ultra-filtration, and microfiltration [2]. In present scenario food crop failure is increasing due to climate change, frequent natural disasters and rapid growth of population affecting food supply throughout the world. There for food waste need to be reduce by using latest technologies [3].

Table 1: Innovations in process technology and their impact [3]

Techniques	valorization of Food waste	Biodegradable packaging	Natural preservatives	nanotechnology and Smart packaging
Materials	• Brewer's Spent Grain (BSG) • Okara	Durian rinds	Flavonoid	Biosensors, gas and chemical
Challenges	• Up scaling feasibility • Cost of production	Cellulose purity	Up scaling feasibility	Thin film electronics performance
Future Prospective	Food waste reduction	Plastic waste reduction	Synthetic preservatives reduction	Increasing in food safety

With change in modern life pace and standardization of food demand for the ready to eat food is increasing, so industries need to accelerate the traditional food processing technologies. In ready to eat food process concentration should be given to quality and microbes because these may cause food safety hazard [4]. The environmental friendly ultrasound technology is used in food processes like tenderization, dehydration, curing, enzyme inactivation, sterilization, disinfection and fresh food cooking. Ultrasound technology will improve microbiological safety and destroys the microbial cells integrity leads to reduction in sensitization and protein confirmation. In addition, this is an auxiliary technology can reserve nutritional value and quality of the food with causing less damage to traditional processing technologies and also this is an green processing and efficient technology for the food produced as ready to eat, [4][9].

Balancing of energy sources usage and final product cost should also plays an important role in success of adaptation of new technologies [5]. Innovative technologies like Ohmic (OH). Microwave (MVH) and High pressure processing (HPP), energy performance has been measured and compared with conventional heat treatment, same pasteurizing effect achieved under commercial processing condition [12]. Electron spin resonance (ESR) is a very sensitive, nondestructive and powerful technique to find out free radicals in food system. ESR is used for direct identification of organic and inorganic paramagnetic species, highly reactive oxygen species and potential toxicity of the food. Its applications include investigation of oxidative stability of food and irradiated foods properties include cereal grains, oil seeds, spices, meats/fishes, fruits and vegetables [6]. Latest no thermal processing technologies includes pulsed electric field, ultrasound, cold plasma, irradiation, high pressure processing and pulsed light are used for allergenic proteins elimination in foods and their

processing. Compared to thermal based methods, non-thermal processing treatments can retain nutritional quality and sensorial of the food products adequately by altering allergen city. Much research needed on non-thermal processing techniques to ensure the quality food with affordable cost by using the available energy resources [7]. Process Analytical Technology (PAT) is used in food industry for the improvement of process efficiency and product quality by enhancing control over manufacturing process. NIRS is the best technology used in PAT, Near Infrared Spectrum (NIRS) has ability to analyses different phenomena of food processing and food fingerprinting simultaneously. Recent studies show that NIES potentials in food processes modeling and real time monitoring [8]. Ultraviolet radiation technology is used to mitigate the formation or removing of Hydroxy Methyl Furfural (5-HMF), which is a contaminant formed during heat processing, especially in acidic condition [10].

Figure - 1 shows that greenhouse gas emission of gas-fired and electrically driven technologies based on performance of energy. Technologies become innovative, means use of nonrenewable energy as primary energy source, hence it is efficient and more environmental friendly.

Hypothetical continuous OH process have best Green House Gas performance, followed by batch OH process and then followed by HPP system, MVH system and so on as shown in the figure.

From the vertical line (data of the year 2018) it's clear that nonrenewable energy sources efficient than the gas fired system. By 2027 HPP will become more energy resource efficient than the most efficient gas fired system.

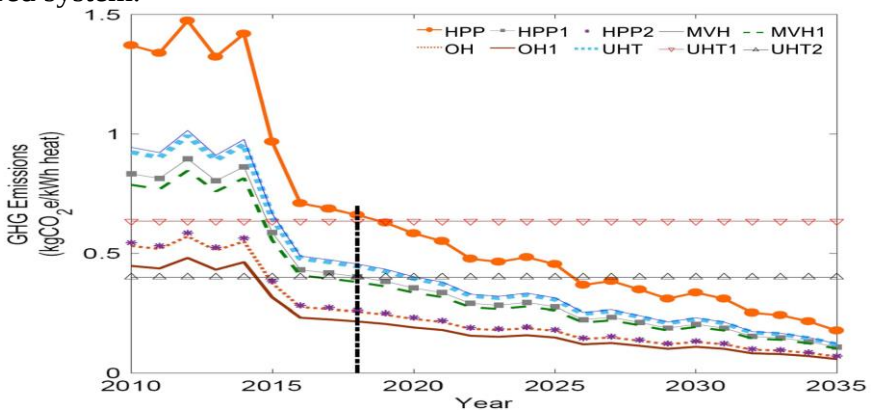

Figure 1: GHG emission comparisons among processes 2010 – 2035 [5]

III. Type of products and packing

While packing need to concentrate on its four basic functions like, containment, protection, convenience and communication. Containment will avoid product loss and food pollution. Protection will help to protect contents from the environmental influence like dust, gasses, vapors, water, microorganisms and forces like compressive forces, vibrations and shocks. Convenience will provide easy use (hold, open and pour) of packed food for example cook or reheating of the packed food in microwave oven without removing it from the pack. Communication indicates the information regarding product nutrition's, date of manufacture and expire, product code, serving instructions etc…,[21].According to product type, packing material and packing type is decided. In packed food extension of shelf life and preservation of food quality makes packing is most crucial part of food processing [13]. Among all type of process of food manufacturing packing is an integral operation since it will maintain food quality in processing, transportation, storage and distribution [14][15]. So packing is directly related to food industry economy because it has influence on quality of the food and health of the consumers [16]. Commonly used packing materials are metals, glass, paper and polymer. Sometimes combination of two or more above materials can used depending upon the expected property of package like transportation property, chemical property, optical property and mechanical property [17]. Types, function and properties of packing are shown in table 2.

Table 2: Types, function and properties of packing [22]

Types of packing			Function	Properties of packing			
Rigid packing	**Flexible packing**	**Semi Flexible packing**		**Thermal properties**	**Mechanical properties**	**Optical properties**	**Barrier properties**
• Bottle • Jar • Can • Tank	• Bag • Foam • Shrink, Cling, Bubble • Squeezable tube • Vacuum	• Cotton box • Tetra pack • Caps and Closure	• Protect from light, moisture, oxygen and temperature variation. • Physical protection from the damage • Biological protection from micro-organisms • Identification of product • Information about product	• Thermal conductivity • Heat capacity • Heat fusion • Glass transition • Melting point	• Bursting strength • Tear strength • Impact strength • Tensile strength	• Transparency • Opacity • Gloss • Haze	• Gas/moisture solubility • Gas/moisture diffusivity • Gas/moisture transmission rate • Permeability

Basically, plastic material is used in packing of the food to protect from degradation by the action of UV light, oxygen and microorganisms or to handle the fragile of food product. Especially the products in powder form and beverages function of package to avoid expanding and leaking into environment [12].

Plastic waste generation from the food packing more than 1/3rd of the world total packing market. Environmental concern rising because, annual growth of 12% being experienced by food processing industries, it may lead to greenhouse gas and carbon footprint [20].Modern lines of packing should be focus on grade category sorting instead of precise sorting to achieve the retail desires [19]. Now a day's biodegradable polymers becoming an alternative to polymers which are petroleum based because of easy decomposition nature [18].

IV.Cost of the product

While determining final product cost, all the expenditures from raw material procurement to packing should be consider. Most of the expenditure will fall into two categories one variable cost and fixed cost, again variable cost can be categorized into two groups like direct variable coast and indirect variable cost. In direct variable costs, the direct relationship between the number of units can be observed, similarly in indirect variable cost there is no direct relationship between the expense and number of units. Variable costs include expenditures that change with the number of units of production. Raw ingredients, Processing expenses, transportation, labor cost and marketing cost are comes under variable cost. Fixed costs includes that the costs which are not changed from time to time and number of units. This cost includes land, equipment, building and facility, insurance, utilities, and management salaries. Hence production cost can be determined by adding both variable cost and fixed

cost [23]. Among all the cost fixed cost account 21% after labor cost 38.5% of total cost of the product. Remaining costs are at the range of 2% to 4% expect packing, which accounts 8.5% of the total cost [24]. Breakeven point is the point where there is neither loss nor profit from the sales of the produced food product. Break-even point can be defined as the ratio of fixed cost per month to unit contribution margin. Where unit contribution margin is the difference between sale price and variable cost. Break even analysis gives exact picture on how many units of product should be sale and what will be the price of single unit to avoid the chances of loss and make profit [23].

V. Conclusion

Usage of emerging technologies like membrane-based technology, ultrasound, microwave, pulsed electric field etc., are increased nowadays. From these technologies industries can achieve shortening of residence and processing time, accelerated mass and heat transfer, Maillard reaction control, product quality improvement, functionality enhancement, extended preservation, protection from environmental stresses and deactivation of enzymes. Innovation in food packing process will helps to fulfill the market needs such as high quality and healthy food product, reduction of environmental impact on food. Latest technology in food packing provide innovative solutions and for long shelf life and improves the safety of the food product.

Environmental impact from packing material can be reduced by using bio degradable material, nanomaterial or plant extract. Pricing of processed food is an essential step in production, breakeven point concept can be used to fix the proper price for produced food and to achieve the maximum profit without losing the valuable customer.

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