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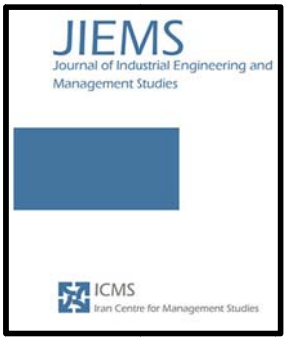

Designing Effective Strategies to Improve Performance Indicators of Bread Industry Using System Dynamics: A case study in Iran

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Abstract

Bread is the staple food in the Iranian food basket, so its quality is of high importance. Since traditional Iranian bread production methods are often unsanitary, in the last decades, different attempts were made to mechanize production of Iranian breads, but a few of them, due to a variety of factors, could succeed. The aim of this study is to examine various factors affecting the system of bread production in Iran and to provide effective solutions for the development of mechanized bakeries as the main strategy for improving the quality of bread production. Existence of different factors and the relation between them makes the system of bread production a complex system; therefore, this study uses system dynamics approach to analyze this system and to design solutions. Furthermore, the system of bread production is broken down to three subsystems: knowledge and technology subsystem, economic subsystem, and political and social subsystem.

Keywords: System analysis; system dynamics; mechanized bakeries; bread supply chain.

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1. Introduction

In many countries over the world, bread is the "staff of life" in people's diets. In Iran and the other Middle East countries, bread has always been considered as the staple food of choice (Malakootian and Dowlatshahi 2005). Bread is the main source of energy and protein for Iranian people (Payan 1995; Qazi, Wahab et al. 2003; Sabeghi 2004) therefore, the hygienic condition of its production is of high importance. Bread has been so vital to the Iranian lives that it has been an important economic, political and social issue over many years. While the quality of this food has a great impact on public health, its wastage can also be viewed as a major economic challenge.

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Around %90 of bread consumed by Iranian is produced in traditional bakeries whose production process is proven to be often unsanitary (Faridi, Finney et al. 1981; Malakootian and Dowlatshahi 2005). Furthermore, the huge amount of bread wastage in Iran, as an important economic challenge, is dependent on various factors the most important of which, is the quality of produced bread in traditional bakeries(Anderson 2011). Therefore, mechanizing Iranian bread production has been considered as the most important measure for improving the quality of bread.

During the last five decades, different attempts were made to mechanize production of Iranian breads, different supportive plans were designed and implemented, and a large number of establishment permits for mechanized bakeries were issued; but a few of them, due to a variety of factors, could succeed. Among all factors inhibited these plans from revolutionizing the Iranian bread industry, lack of holistic and systems approach in the design of supportive plans is the most fundamental and important factor. Achieving the desired goals in the bread industry relies on a variety of interrelated economic, political, social, and technological variables making a complex system. Therefore, in such a complex system, a scheme in which all of these variables and their dynamics are considered could be a reliable scheme. Also, a comprehensive scheme should take all players - from suppliers to final consumers - into consideration. This paper uses the system dynamics approach to study various factors involved in the Iranian bread industry. In this study, after identifying the variables using experts' opinions, a system dynamics model is developed for the bread industry. This system includes three main subsystems: 1- knowledge and technology subsystem, 2- economic subsystem, and 3- political and social subsystem.

Also, some solutions for the development of mechanized bakeries in Iran are proposed and their effectiveness is evaluated through tracing their effects in each subsystem. This approach in analyzing the system of Iranian bread industry is helpful in designing a comprehensive supportive plan in which all sectors of the bread supply chain are developed simultaneously, thus making a sustainable development in the bread industry achievable. The remaining of this paper is organized as following. In section 2, a brief review on system dynamics literature is presented. Section 3 gives an overview on the bread industry in Iran. The system dynamics model for the Iranian bread industry is developed in section 4 and some solutions for the development of the mechanized bakeries are proposed in section 5. In section 6, effectiveness of the proposed solutions is evaluated and finally, conclusions are drawn in section 7.

2. Literature review

The methodology of system dynamics was raised by J. W. Forrester for the first time. His first book entitled "Industrial Dynamics" which was published in 1961 still is known as an important reference book in this field. Since the publication of this book, the applications range of this methodology has greatly expanded and it currently covers the following areas (Forrester 1999):

Planning and designing the strategies and policies of departments of commerce -Management and policy-making of the public sector - Biological and medical modeling - Energy and environment - Theorizing in the natural and social sciences- Dynamic decision- Complex nonlinear system dynamics

This methodology could be considered as a problem-solving approach and also critical factors with their interactions can be identified by related tools in this methodology such as casual-loop and stock-flow diagrams (Wolstenholme 1986).

Many studies have been conducted about the applications of this methodology that are pointed out as following. Lyneis and Ford (2007) studied the applications of the system dynamics in the studies for project management. They classified infrastructures in these systems and studied the existing models and their applications in each class. This classification includes four structure- project features, duplication loop, controlling project and side effects (inhibitory and reinforcement). In another study, Anderson (2011) designed a dynamic model to examine the counterinsurgency policies. He analyzed various policies through analyzing sensitivity of the model parameters. Among important parameters in this system, we can point to time of stopping counterinsurgency and

sidestepping forces. Kiani et al. (2010) also studied the application of the system dynamics in analyzing and examining the resources of fossil fuel. In this research, diverse models associated with fuels such as natural gas, petroleum and coal have been classified. The models focuses have also been examined from various perspectives such as technology, demand, investment, pricing, production, exports and imports.

Jebaraj and Iniyan (2006) also studied on application of dynamic modeling at energy sector. These models have been described in the subsections of energy planning, energy supply and demand, forecasting, optimization, modern methods in the analysis of complex systems (neural and fuzzy methods) and waste reduction.

System dynamics scan be taken advantage in analyzing macroeconomic policies. Cavana and Clifford (2007) studied the relationship between collecting tobacco sales tax and amount of its consumption using dynamic modeling in New Zealand. This model answers the questions being useful in designing the tax and customs policies. For example, to what extent does the price factor affect tobacco consumption and its consequences? Key success factors in a business (production or service) have been widely investigated by many research projects. Sterman (2000) discussed the engine of corporate growth and stated that several positive feedback loops can be considered in this regards. Product awareness, unit development cost, price and production cost, network effects and complementary goods, product differentiation, new product development, workforce quality and loyalty, the cost of capital are examples of key factors acting as positive loops to promote corporates. Strategic planning is another area that has been much used in system dynamics. Paich et al. (2011) analyzed the dynamics in the pharmaceutical market and used the results for strategic planning. Competitive pressures among pharmaceutical companies cause to design their strategic programs more effective than before. These programs are sometimes product-based. In their study, they designed a model including patients' population, prescription and evaluation of the method of treatment and possible prescript alternatives to study the market behavior. Along this, Weil (2007) stated five major topics in determining corporate strategy with regard to systems dynamics. The first topic studies the tension between conflicting performance objectives and their effects. The second provides an organization of research and development that is responsible for managing changes, directing and guiding them. The third topic dedicates to the provision of goods and services to market. The fourth topic associates with the role of innovation in industry and studding its dynamics and finally, the latest model focuses on the market effectiveness by social factors such as trust, fashion, getting a product known and the effects of social networks.

Georgiadis, Vlachos et al. (2005) used system dynamics modeling to analyze a real multi-echelon food supply chain in Greece. What-if analysis is then applied to find the optimal value of inventory control parameters (S,s) as well as the sensitivity of the optimum fleet sizes with respect to them. Ghaffarzadegan and Tajrishi (2010) proposed a model for economic management in markets where there are policies for controlling the price. In this research, some suggestions have been provided for policy-making in Iran's cement industry. They set the price model for cement based on interview and existing models in the literature and calibrated it with economic conditions in Iran. Spengler and Schröter (2003) used system dynamics approach to study the role of information management in a closed-loop supply chain of electronic equipment. They represented an integrated production - recovery system for spare parts to evaluate possible strategies for meeting demands for in the end-of-life service period. Zaim, Bayyurt et al. (2013) modeled the dynamism of intangible assets in strategic management. They found out that several feedback loops affect the knowledge creation and promotion in the organizations. For instance,

- as the reliability of organization increases, customer satisfaction and organization performance would increase.
- higher safety leads to a higher satisfaction that causes growth in organization.
- higher satisfaction increase the profitability and consequently, the cost of poor quality will decreases.

They applied the methodology of system dynamics in a Turkish airline.
Snabe and Größler (2006) studied the ability of system dynamics approach to support strategy implementation in organizations. They conducted a real case study in a high-tech company and showed the improvements in both strategy refinement and transfer of insights and understanding underlying the strategy forming. Some other applications of dynamical modeling of complex systems are tourism decision modeling (Stewart and Stynes 1995; Honggang 2003), managerial interactions in multinational corporations(Singh and Doz 1983), forecasting agricultural gross domestic product (Fkirin and Al-Turki 1991), and industrial decision making (Coyle 1973; Riddalls* and Bennett 2003). As mentioned in this section, several feedback loops and their associated factors have been proposed to achieve success in a business in private and public sectors. Table 1 provides a comparative study between the present work and major ones from the literature.

Table 1: Summarized literature review in viewpoint of business growth factors

Authors	Case study	Main features	Main focus
Cavana and Clifford (2007)	Tobacco consumption in New Zealand	Analyzing tax effects on consumption	Tax and customs policies
Sterman (2000)	-	Business dynamism towards corporate growth	Price and production cost - Network effects Complementary goods- Product differentiation- Workforce quality and loyalty
Paich, Peck et al. (2011)	Pharmaceutical market	Strategic planning	Competitive pressures among companies
Weil (2007)	-	Systems dynamics in corporate strategy	Tension management between conflicting performance objectives- Organization of research and development - Provision of goods and services to market - Innovation in industry - Social factors such as trust, fashion, getting a product known
Spengler and Schröter (2003)	Electronic company	Integrated production - recovery system for spare parts	Information management
Zaim, Bayyurt et al. (2013)	Turkish airline	Dynamism of intangible assets in strategic management	Reliability of organization - Customer satisfaction - Safety - Reduced cost of poor quality
This study	Iranian baking industry	Supportive plans for mechanized units	Product variety and innovation - Taste adaptability - Level of Production technology - Labor productivity - Attractiveness of investment - Production scale – Unemployment - Political importance of the product

3. Iranian Baking industry

The average bread consumption per capita in Iran is about 300 g per day- about five times as high as that of Europe (Sabeghi 2004). So, bread is the most important nutrition source and the main source of calories, protein as well as mineral ingredients for Iranian people (Payan 1995; Sabeghi 2004; Cavana and Clifford 2007; Kiani, Mirzamohammadi et al. 2010) ; and its quality and hygienic condition are of high importance.

Four main types of Iranian traditional bread, i.e. Barbari, Taftoon, Sangak and Lavash constitute approximately %95 of the bread production. Different studies have been concentrated on the quality of the traditional Iranian bread production and almost of them have reached to this conclusion that traditional Iranian bread production methods are often unsanitary that will bring some serious health problems such as stomach trouble, malnutrition, increased blood pressure,

allergies, etc. (Faridi, Finney et al. 1981; Khan, Zaman et al. 1986; Rezakhah 2001; Eivaz Zadeh 2005; Takbiri 2005; Cavana and Clifford 2007). Direct oven flame and incomplete combustion of fuel would result in dangerous residues on bread. Air pollution as a result of the activities of a large number of small bakery units in various parts of the city, possible microbial contamination due to unhygienic delivery and the supply unwrapped bread are only the part of the problems. Mentioned problems have reached to the point that can only be solved by approaching to the establishment of modern bakery units (Payan 1995).

Throughout decades, different Iranian governments have tried to improve the quality of bread, and they have made repeated efforts to develop the baking industry. The first scheme was designed and implemented in 1980s whose main objectives was to increase the quality of bread, decrease the wastage, expand the total production capacity, and to promote investment in the baking industry. This plan couldn't achieve the predefined goals due to a variety of factors, the most important of which was the limited demand for the bread produced in mechanized bakeries. The latest effort for the development of the baking industry was launched in 2010 within the Subsidy Reform Law, which, aimed to gradually remove all subsidies over a five-year period and instead give families cash handouts as compensation. Before the implementation of this scheme, traditional breads were distributed at unreal prices and a large sum was paid by the government as bread subsidies. Despite these efforts and a huge amount of expenditures, Iranian baking industry still suffers different problems in all sectors including supply, production, and distribution, which necessitates a holistic approach in designing and analyzing effective approaches for the development of this industry.

4. Dynamics of the Iranian baking industry

In this section, the Iranian baking industry is modeled from the system dynamics approach. System dynamics approach consists of three main steps (Sterman 2000). The first step is to define the system, to identify different elements affecting the performance of the system, and to determine the system's boundaries (Senge 1994). In the second step, a dynamic hypothesis is defined, and finally in the third step, a causal model is developed.

a) The system of the Iranian baking industry

In this paper, the system of the Iranian baking industry is studied and its boundaries include political, economic, social and technological (PEST) aspects of the baking industry. The system of the Iranian baking industry is broken into three subsystems including knowledge and technology subsystem, economic subsystem, and, political and social subsystem. There are a number of affecting variables in each subsystem proposed by Arasti, Badri et al. (2012). Figure 1 illustrates system of the Iranian baking industry, its subsystems, and some of the most important variables in each subsystem.

Figure 1: The system of the Iranian baking industry

All variables are able to change over time and also will be affected by various factors. It should be noted that in this system, mechanized bakeries refer to production units that "all sectors of the production process will be involved by machinery and equipment and the minimal manpower intervention". Therefore, this definition includes modern workshop units and mass production factories.

b) **Dynamic hypothesis:** The dynamic hypothesis of this study is to move toward mechanized bread production by supporting establishment of mechanized bakeries in large, medium and small sizes and building a competitive market in the bread industry.

c) **Causal model:** After identifying dynamic variables, interactions of variables will be discussed. Along this, considering PEST framework, the identified variables are analyzed within three subsystems of knowledge and technology subsystem, economic subsystem, and political and social and subsystem.

4.1 Knowledge and technology subsystem

A very influential factor in the bread industry in Iran is the level of knowledge and technology of baking. Innovation in bread production and variety of products in Iran is not much favorable. However, Iranian people are accustomed to traditional breads and it could not be changed easily. The following diagram shows the interaction of variables related to innovation in bread industry.

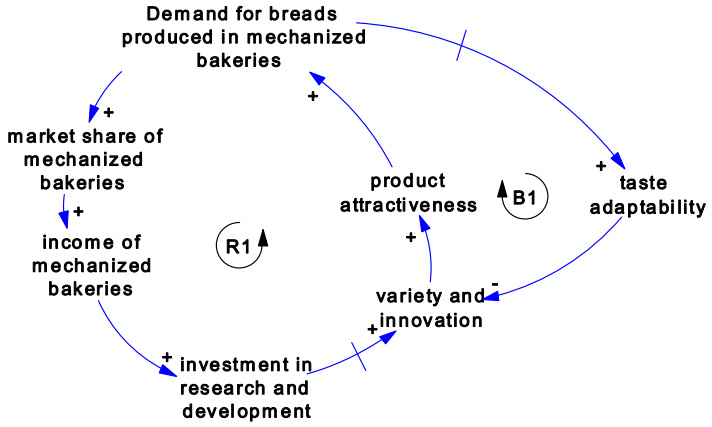

Figure 2 : the variety and innovation loop (R1) and taste adaptability (B1)

Investment in research and development causes increased innovation and diversity in products (Loop R1). On the other hand, the level of innovation has a direct relationship with the product attractiveness. Increase in the product attractiveness will increase demand and consequently, increase revenue in the industry. This increased income can support the cost of investment in various sectors particularly in research and development. This reinforcing loop increases revenue and improves the diversity and innovation in products. The less products fit the consumer taste, the more the need for greater innovation and diversity will be, so that by increasing the attractiveness of the product the demand for new products increases (Loop B1). Also, it is noteworthy that the increased demand for products over time increases the fitness to the taste of consumers. The next important issue in this section is the impact of the technology on the quality.

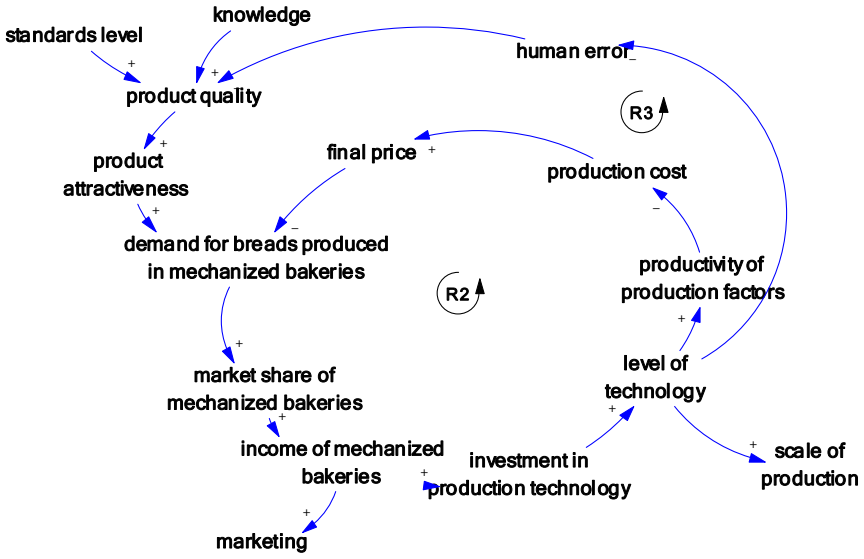

Figure 3 : Increasing the level of technology and its effects

Two increasing loops R2 and R3 are shown in Figure 3 which shows the positive effect of investment in the production technology on the quality and demand. On the other hand, it is clear that the level of knowledge and the standards will have a positive effect on this loop.

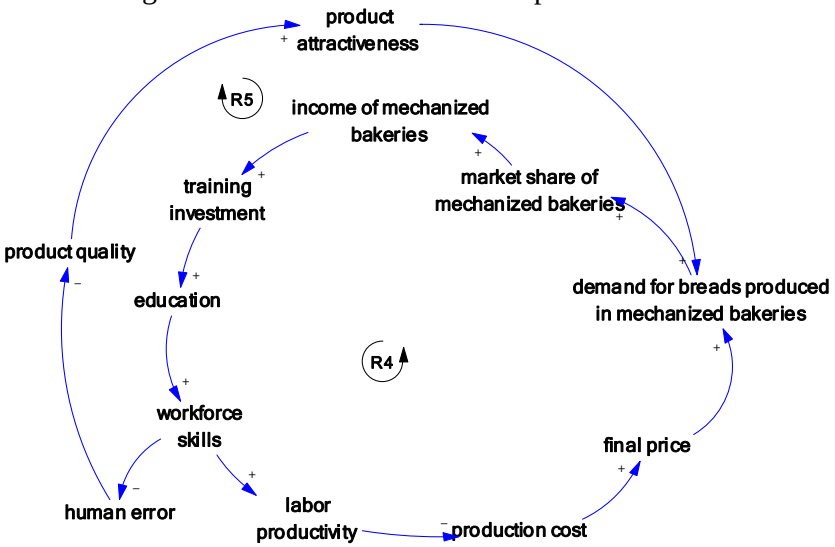

Figure 4 : improving skills of workers and their effect on the quality and demand.

In Figure 4, it is shown that both increasing loops R4 and R5, can act as a driving force in the bread industry and will result in quality and productivity.

As discussed, the level of technology, education and innovation can increasingly improve the quality of the bread industry. In Figure 4, the final model of this subsystem has been shown. As it is clear in this figure, reinforcing these three issues will cause the creation of increasing eight loops in the system that in case of improving, will lead to boom in industry and in case of weakening they will lead to a recession. Side loops R6 to R8 have been created due to interactions of variables in Figures 2 to 4. In loop R6, the effect of level of education on the quality and its income has been shown. Loop R7 represents the acquiring experiences of the industry and transferring them to research centers to develop baking knowledge and bread production that in turn leads to increased effective and efficient innovations. Loop R8 also shows the effect of increasing knowledge in the bread industry on the quality and income.

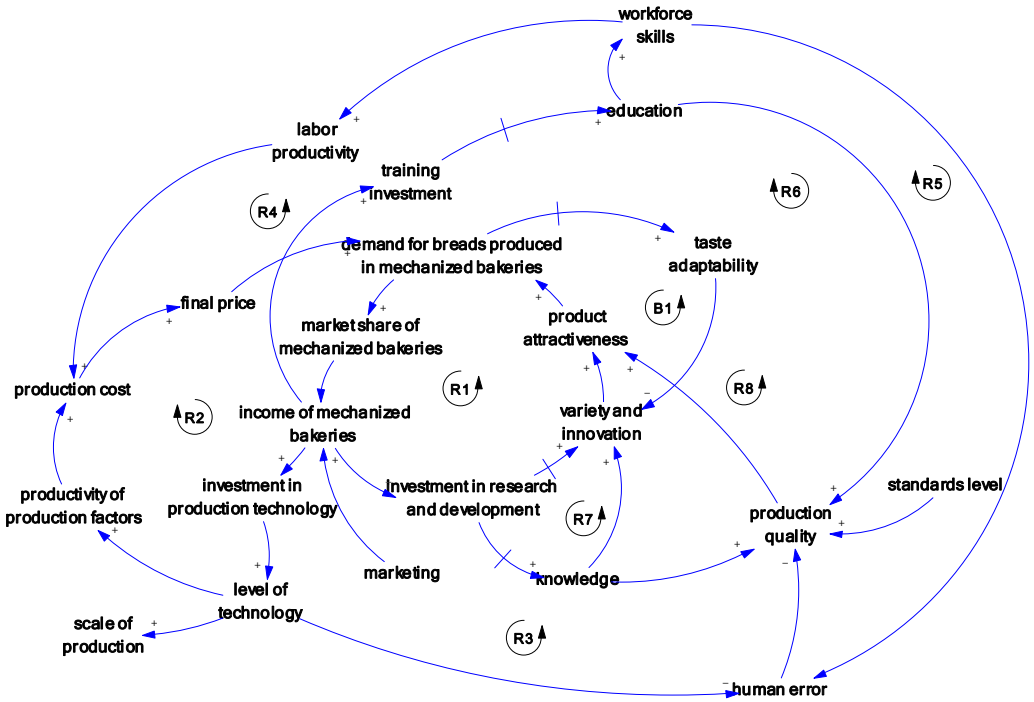

Figure 5 : knowledge and technology subsystem

4.2 Economic subsystem

Today, economic systems are considered as complex systems due to different variables and the mutual impact these variables have on each other. In examining bread production and distribution system in Iran, due to the significant role of bread in household spending, a systematic and comprehensive approach for the analysis of economic parameters appears to be necessary. On the other hand, sustainability of bread production firms necessitates ensuring the economic competitiveness in the bread market.

Figure 5 illustrates the role of economic variables in the bread industry. It is obvious that with the increased demand for the produced bread in mechanized bakeries, share of this sector in the market will increase. Increasing share of the mentioned sector in the market will increase its income. Clearly, one of the most important factors influencing the competitiveness of a sector is its income. Therefore, with income increasing in the sector of mechanized bakeries, the competitiveness of manufacturing units will also increase.

Increasing competitiveness in the sector of mechanized bakeries will enhance the attractiveness of investment in this sector. The more the attractiveness of investment in one sector, the misuse of facilities allocated to that sector will reduce. In other words, if there is confidence about the profitability of investment in this sector, facility applicants will have fewer incentives to apply for facilities to invest in other sectors. In this case, the indicator has been defined as the "productivity index of facility" which indicates the effectiveness of the facility is increasing production capacity. It is obvious that with reducing the amount of misuse of the facilities, its greater percentage will be designated to creating production capacity in this sector and therefore it will increase production capacity in this sector. Consequently, increasing the production capacity will increase supply in the market. Increasing supply in the market can increase excess of the supply that this in turn reduces the price. Reducing the bread price in the market also leads into increasing its demand. Therefore, R9 is a reinforcing loop.

In loop B2, it is also observed that the demand has a negative impact on excess supply i.e. with increasing the demand excess supply in the market will be reduced. As it was described above, with a reduction in excess supply, the ultimate price increases and thus with an increase in the final price in the market the demand for this product reduces. Hence, the B2 is a balancing loop.

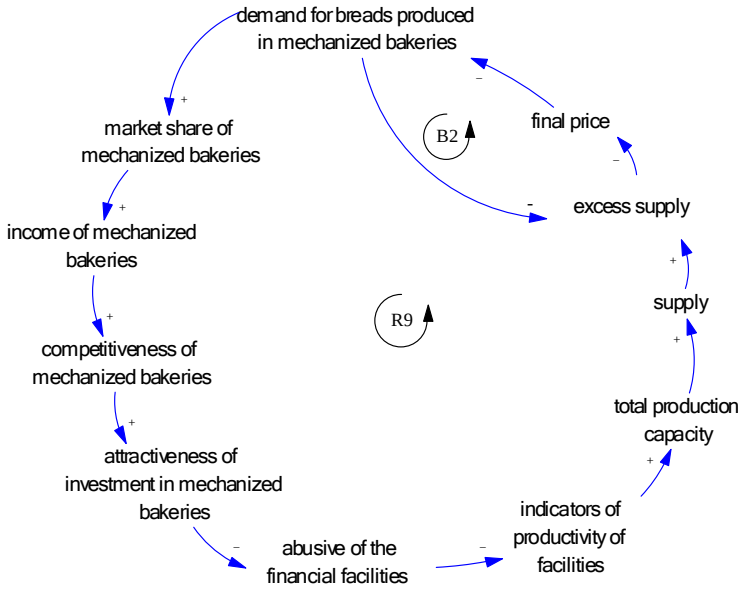

Figure 6 : the attractiveness of investment (R9) and excess supply (B2)

One of the effective ways for reducing production variable costs is through the economic scale. As in R10 which is a reinforcing loop, it is observed that with increasing demand and consequently, increasing the market share and income, competitiveness of manufacturing units increases and thereby the attractiveness of investment in this sector will be increased. Increasing the attractiveness of investment causes investors to be inclined toward the mass production and hence the production scale increases. Increasing the production scale leads to reducing production costs resulting in reduced cost for this product. Reducing the price of bread produced in mechanized bakeries at market will bring about increased demand for this product.

The level of production technology is also another factor affecting the production scale. In reinforcing loop R11, it is observed that increasing the incomes in the sector of mechanized bakeries which happen as a consequence of increased demand and increasing market share will cause investment in production technology. With increasing the investment in production technology, the level of technology also increases, thus increasing the production scale. As it was previously described, increasing the production scale leads to reduced production variable costs, thus reducing the price in the demand market for bread produced in mechanized bakeries. It should be noted about this loop that the increased level of production technology is achieved in a long-term horizon.

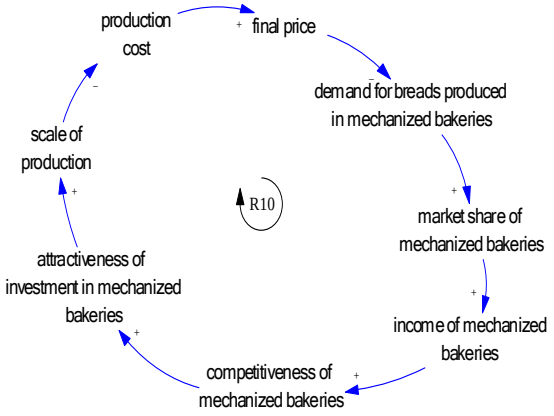

Figure 7 : the impact of production scale on the final price

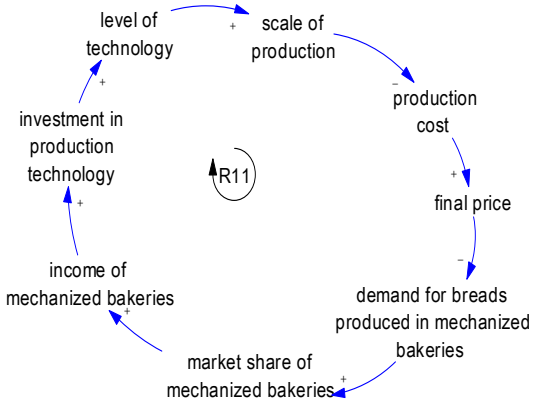

Figure 8 : The impact of the level of production technology on production

Today, one of the most important factors influencing the production variable cost is the efficiency of production factors. As it is observed in the reinforcing loop R12, with increasing the demand for

bread produced in mechanized bakeries, increasing market share and its incomes, investment in production technology increases, which this also will improve the level of production technology. Increasing the productivity directly affects the efficiency of production factors. By increasing the productivity of production factors, production costs reduce and also the final cost of this product reduces. Therefore, by reducing the final cost, demand for these products increases.

On the other hand, increasing the level of production technology will lead to increasing the costs of equipment. With the increasing cost of equipment, required initial investment increases. Thus, production costs are also increased. With increasing the production costs, the final price of the product increases, which reduces the demand for this product in the market.

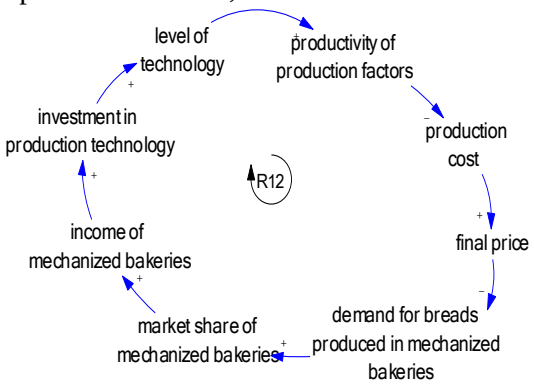

Figure 9 : the impact of the level of production technology on the productivity of production factors

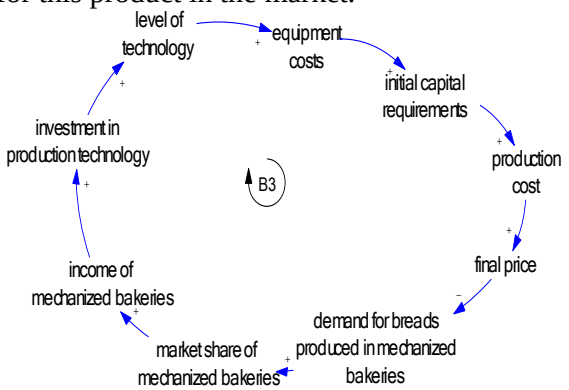

Figure 10 : the impact of the level of production technology on the cost of equipment.

Improving the level of the production technology can also reduce labor costs. As it is observed in loop B3, with increasing the level of production technology, labor costs in manufacturing firms is reduced. Since labor costs have a major share in production costs, reducing labor costs leads to reduced production costs. Reducing production costs and thereby reducing the final cost, demand for this product will increase.

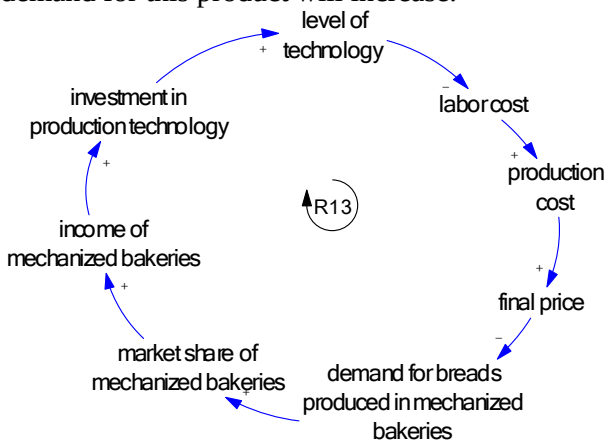

Figure 11 : Effect of the level of production technology on labor costs

Figure 12 illustrates the interaction of loops discussed above in the economic subsystem. In this subsystem which is composed of 27 variables, one can well see the way of the interactions of these variables.

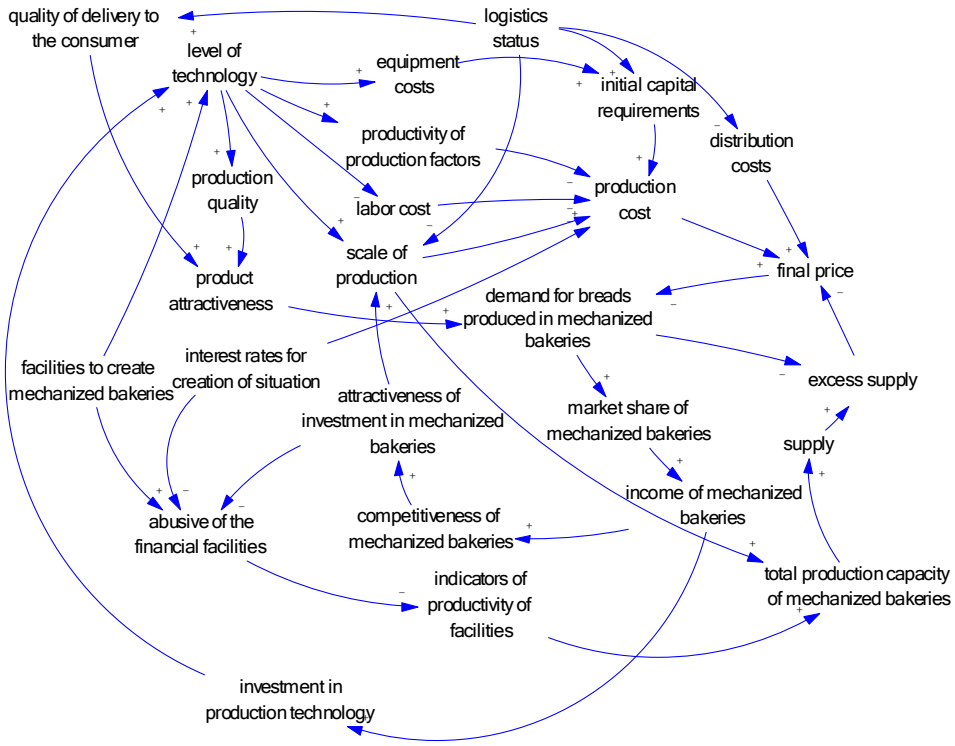

Figure 12: Economic subsystem

4.3 Political and social subsystem

Increasing the number of mechanized bakeries will affect the number of people employed. For example, by switching the traditional bread production units to distribution centers or accumulating their investment in running mechanized bread production units we can provide job security for workers in traditional bakeries and reduce the political pressures. By adapting such an approach, government support and subsidies to these units would no longer be needed and the price of the traditional bread will be determined according to its costs and by the market. Due to the low productivity of traditional bakeries, it is expected that the price of traditional breads will rise compared to products of the mechanized bakeries which this issue causes changing in demand from the traditional breads for its lower price to the breads produced in mechanized bakeries. Therefore the market share of mechanized bakeries and incentives for private sector to invest in this industry will increase.

As it is observed in loop B4 which is a balancing loop, increased political pressure on the government leads the subject of bread to be considered as a political issue, and to reduce discontent, the government will support the traditional bakeries. One of these supports can be allocating subsidies to the traditional bakeries that its impact will be on the price of traditional breads. So due to the allocated subsidies from the government, the relative price of traditional breads may reduce compared to products of mechanized bakeries. Considering the purchasing power of people, this leads to the tendency of people to buy traditional breads and therefore the demand for products of mechanized bakeries will decrease. This in turn will affect the incentives of the private sector to invest in traditional bakeries, so the number of traditional bakeries will increase.

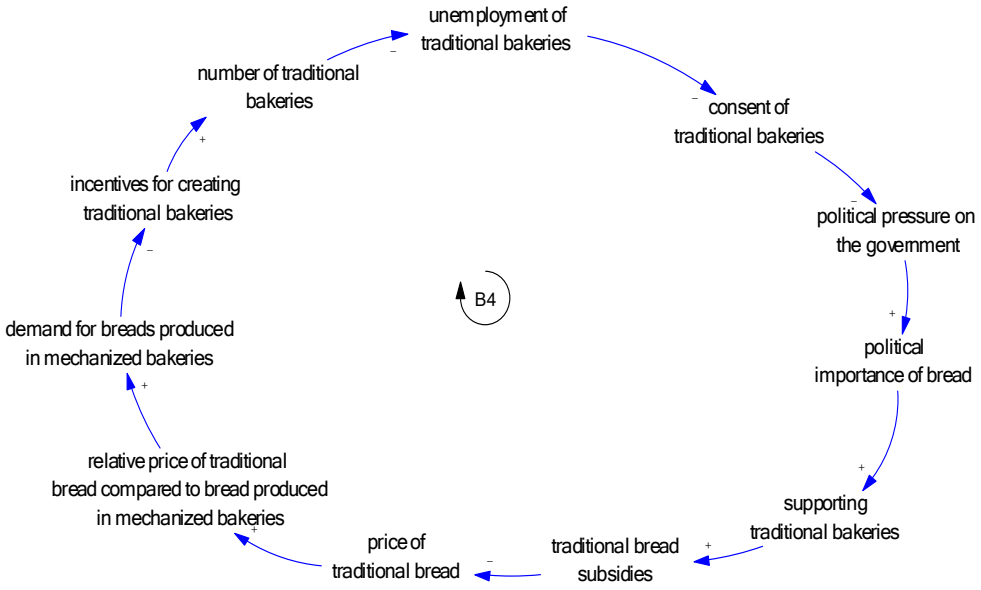

Figure 13 : Effect of unemployment of traditional bakers on the political importance of bread

Because the bread has a significant role in the food basket of the society, increasing its price can be an influencing factor on creating political pressure on the government and this leads to the political attitude to the bread. To reduce the grievances, the government will attempt to support the traditional bakeries. One of these supports can be allocating subsidies to traditional bakeries which have an impact on the prices of the traditional breads. This can well be observed in the balancing loop B5.

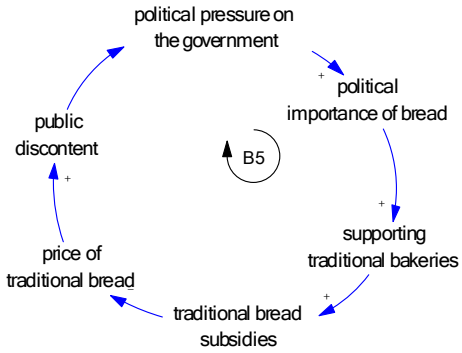

Figure 14 : Impact of the political importance of bread on supportive policies

The reinforcing loop R14 represents this fact that increasing the number of mechanized bakeries can increase the employment and reduces the political pressure on the government and this causes a balance in price in the market and booming in the high quality bread market that in turn in the course of time leads to increased motivation to create mechanized bakeries.

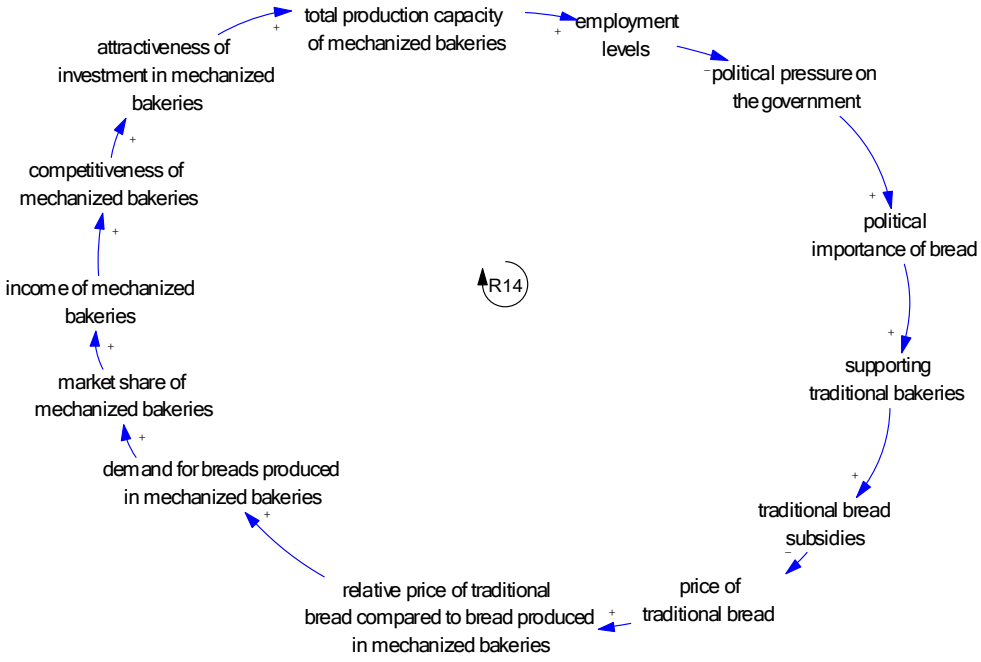

Figure 15 : The impact of the employment resulting from the creation of mechanized bakeries based on the political importance of bread

Figure 16 shows the social and political subsystem. In this subsystem, variables such as unemployment, public discontent, and awareness have been analyzed and their effects on the number of mechanized bakeries and interaction of these variables on each other has been shown.

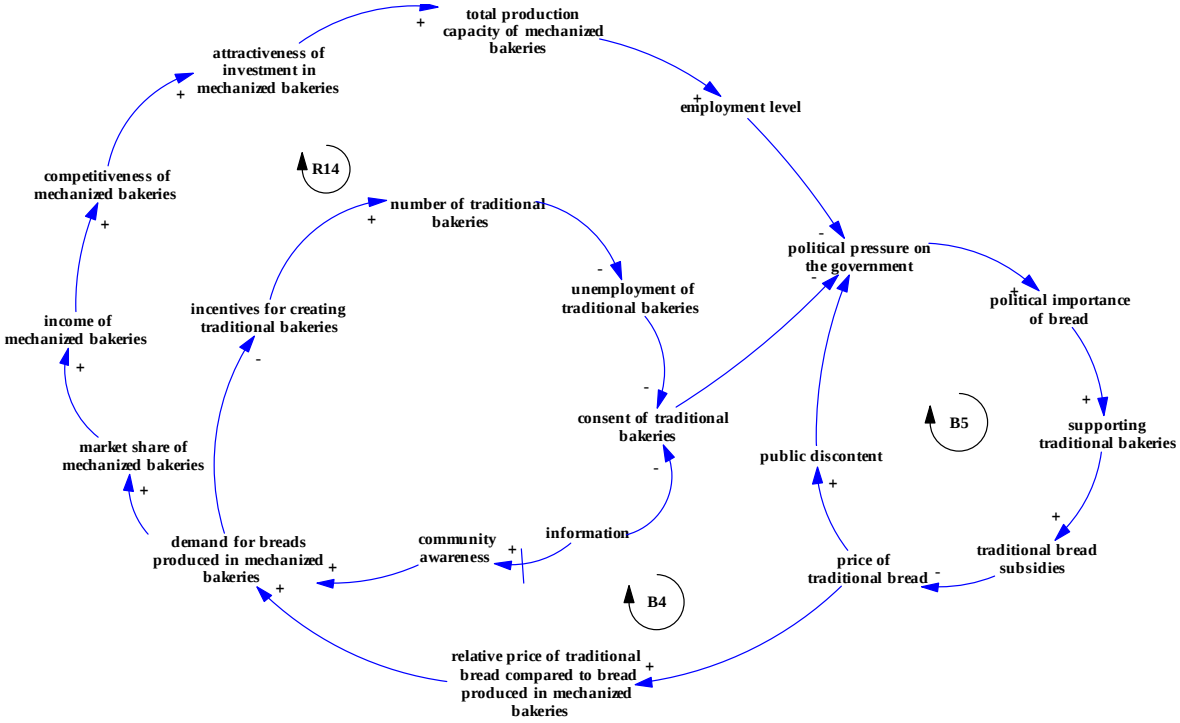

Figure 16 : Political and social subsystem

5. Solutions to develop mechanized bakeries

In this section, a list of solutions to eliminate obstacles to development of mechanized bakeries is proposed. The proposed solutions have been designed with a holistic approach and considering the interaction of factors in the system. Also, development of all components of

this industry such as supply, production and distribution in order to guarantee achieving a sustainable development is another feature of the proposed solutions.

The proposed policy is composed of 12 solutions as following:

Liberalization of prices; Full liberalization of energy prices for all production units; Targeted finance facilities; Customs exemptions for imports of manufacturing equipment; Supporting mechanized bakeries in the distribution of their products; Supporting complementary businesses; Establishing bread industry clusters in populated areas; Increasing the level of standards and requirements of the traditional bakeries; Giving priority to the owners of cooperatives constituted by traditional bakeries in performing activities associated with this industry.; Facilitating administrative processes; Directing the training and research activities in universities and higher education institutions towards the needs of the bread industry; Information about the characteristics of the high quality bread

5.1 Liberalization of prices

One of the major obstacles in creating a competitive environment and achieving the outlined perspective is determining the price of bread by the government. Hence, liberalization of prices is as an essential component in the competitive environment so that the price of bread will be determined by the market according to the type and quality. This action can help the bread market to be competitive based on quality, variety and price.

5.2 Full liberalization of energy prices for all production units

One of the important factors in determining the final price of products is the rate of energy cost. Hence, productivity in the production process is always a main concern of the producers. Energy subsidies are causing manufacturers to reduce the importance of energy efficiency in mind. By full liberalization of bread prices we can push bread production units towards the optimal use of energy. In such environment, only those producers who consider the consuming energy as an indicator in selecting equipment and designing the production process have the power to compete.

5.3 Targeted finance facilities

We should adopt a policy which ensures a good level of productivity regarding the finance facilities. In the other words, the designed policy should reduce the misuse of the finance facilities and lead to the development of production capacity proportional to the granted facilities.

Facilities for construction of mechanized bakeries: Two kinds of finance facilities and in two stages are granted to applicants: finance facilities with common interest rates in the banking system for constructing mechanized bakeries, and special finance facilities with low interest rates for advertising, marketing, research and development, training and developing distribution networks. Applicants of running mechanized bakeries could be benefited from finance facility with conventional conditions in the banking system in any production size. Maximum granted facilities in this case are determined according to the production capacity. After completion and commissioning of the project, applicants can apply for special facilities. Special facilities have low interest rates and they will be awarded to conduct advertising, marketing, research and development, training and distribution network. Obviously, the maximum level of these facilities is determined according to the production capacity.

Facilities for the development of traditional bakeries: To encourage owners of the traditional bakeries to develop their traditional bakery to the mechanized one, special facilities will be considered with lower interest rates. In this case, if the existing traditional bakeries have the capacity to become a mechanized bakery, special facilities are given for equipping and development. If these units do not have the potential to become a mechanized bakery, special facilities are awarded for changing to the sales and distribution centers.

5.4 Customs exemptions for imports of manufacturing equipment

Large part of the initial investment required to establish mechanized bakeries refers to the cost of manufacturing equipment. Since the current domestic production of machinery and equipment for bread industry are not so desirable, many bread producers are attempting to

import equipment from foreign countries. Hence customs exemption for importing bread production equipment can help reduce the volume of the initial investment and encourage private sector to invest in this sector.

5.5 Supporting mechanized bakeries in the distribution of bread products

Unlike many other products, the distribution in the bread industry plays an important role in the quality of the product. Therefore, effective policies regarding distribution network can have a dramatic effect on the development of this industry. One of the strategies and options in this area is providing optimum use of urban small stalls to distribute products. Small stalls which are constructed with low cost could be effective in reducing the costs imposed on producers and consumers. On the other hand, these stalls can be established anywhere in the cities, so this action can also lead to promote the quality of the delivery.

5.6 Supporting complementary businesses

Sustainable development requires formation of appropriate infrastructures. In the Iranian bread industry, the following complementary businesses require support:

Manufacturers of machinery and equipment; Bread Academia; Bread incubators; Distribution companies; Manufacturers of raw materials

To achieve a strong chain in all sectors, investment should be supported in all above fields.

5.7 Establishing bread industry clusters in populated areas

Bread industry clusters can be effective in the ease of supplying high quality raw materials, distributing and reducing costs associated with the supply and distribution. In these clusters, different manufacturers will work supplying their flour and other raw materials from the manufacturing companies based in the cluster. Bread producers can also jointly use distribution companies deployed in clusters to distribute their products in the market. This can form a lean supply, production and distribution chain.

5.8 Increasing the level of standards and requirements of the traditional bakeries

Alongside the development of mechanized bakeries, a policy must be adopted that the traditional bakeries also come with desirable quality. Therefore, the standards and requirements of these units must be promoted. Increasing the level of standards and requirements of these bakeries can be one of the effective strategies to encourage owners of these units to develop their unit into a mechanized bakery using allocated finance facilities.

5.9 Giving priority to the owners of cooperative constituted by traditional bakeries in performing activities associated with this industry.

Establishing cooperatives consisting owners of traditional bakeries can help to raise initial capital, knowledge and experience synergy and efficient management. These cooperatives can have activities on producing bread in a standard method, distribution of the products of the large corporations and other related activities.

5.10 Facilitating administrative processes

With signing agreements and memorandum between relevant organizations, we should try to do the administrative processes of permit for the creation of new units and developing units or changing the application of the existing traditional bakeries in the shortest possible time and with minimal cost. This can encourage the owners of existing traditional bakeries to expand or change the application of their units; also it can be effective in encouraging private sector to invest in this sector.

5.11 Directing the training and research activities in universities and higher education institutions towards the needs of bread industry.

If appropriate level of training is made in the bread industry, the capacity of universities and higher education institutions could be paid special attention to as one of the richest sources of knowledge in the bread industry, so that a clear path for those who want to upgrade their skills and knowledge be provided. Discontinuities and inconsistencies between the needs, opportunities and resources will be identified and the relationship between science and industry

will be stronger by identifying research needs of bread industry, supporting academic dissertations and creating effective and continuous links between universities and industry. To achieve high quality and desirable bread we should pay particular attention to manufacturing factors of raw material and training professionals in this field so that those who are planning to bake bread, pass bakery courses in professional education centers.

5.12 Information about the characteristics of high quality bread

One of the most important factors behind the low demand for bread produced by mechanized bakeries is the lack of community awareness about characteristics and indicators of high quality bread. Awareness should be done in such a way that covers all segments of the society. Therefore, a variety of audio, video, text media, etc. should be used. This requires the allocation of advertising budget by the government. This action among all the solutions listed in the proposed policy, is a priority.

6. Systematic analysis of the proposed policy

The results of implementing the proposed policy can be examined and analyzed using systematic sub-models of bread industry.

6.1 Main impacts of the proposed policies on the economic subsystem

In the economic subsystem as it is shown in Figure 17, by providing facilities for creating mechanized bakeries with a common interest rate in the banking system, in practice there will be no incentive to misuse the facilities. Reducing the misuse of the facilities, the productivity index of the facilities increases, which this increases the production capacity. But on the other hand, this interest rate may lead to increased production costs that by creating customs exemptions and facilitating the importation of manufacturing equipment, production costs will be reduced. Also, in mechanized bakeries, by increasing energy efficiency and reducing labor costs, production costs will be reduced.

By allocating finance facilities with special rates for distribution network, and allocating stalls for selling bread, distribution costs will be reduced. Reduction in the cost of distribution leads to lower final price that it also increase the demand for bread produced in mechanized bakeries. On the other hand, the quality of the delivery to the customer will also improve that this increases the attractiveness of the product resulting in increased demand for it.

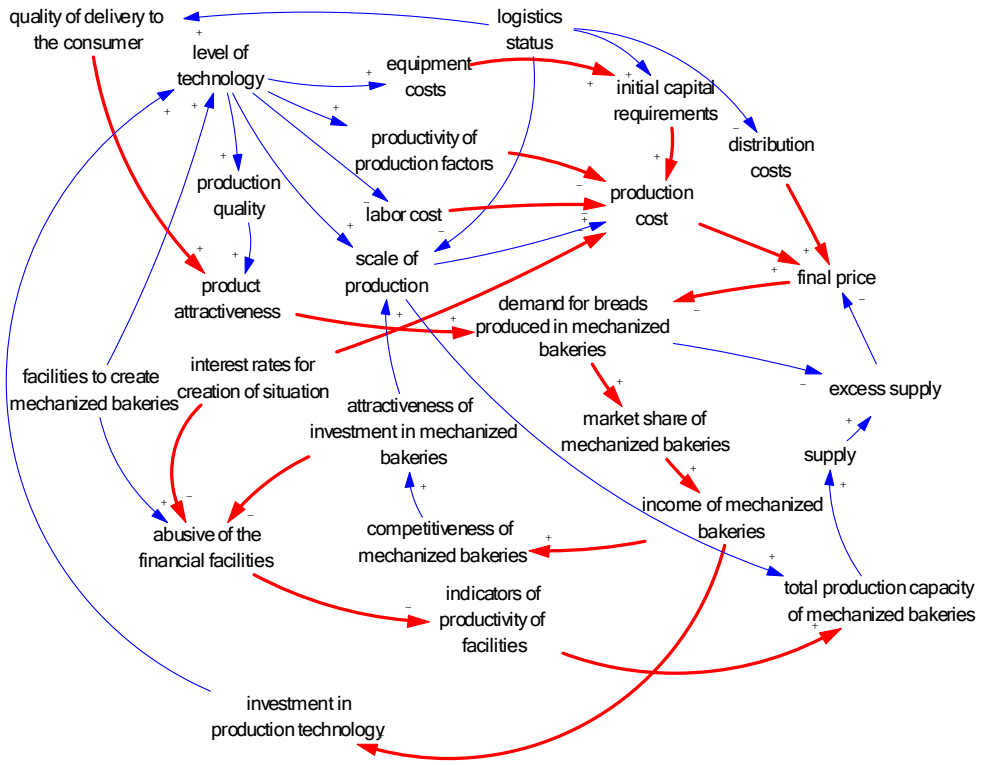

Figure 17 : Impacts of the proposed policies on the economic subsystem

Since now domestically produced machinery and equipment are not satisfactory, many of these machines can be purchased from foreign manufacturers. Therefore, customs exemption can be effective in reducing the cost of equipment. Reducing equipment costs also reduces the amount of initial capital, resulting in lower manufacturing costs.

Supporting mechanized bakeries in the distribution and creating the possibility of establishing stalls on one hand help to reduce distribution costs, and on the other hand is effective in increasing the quality of delivery to the customer. Reduction in distribution costs and reduction in the final price and increasing the quality of delivery to the customers will be effective in the attractiveness of the product and thus increase the demand for it.

In case of effective support of complementary businesses, reduction in equipment costs, costs of raw materials and distribution costs will be inevitable in the long term. If domestic investors with considerable support can produce equipment and machinery and raw materials, at a specified time horizon, a bread industry with all features of development can be achieved. Also, forming bread industry clusters is effective in the ease of supplying raw materials and distributing the products. By activating manufacturing companies with high quality raw materials in the bread industry cluster, the cost of raw materials and thus production costs will be reduced. By establishing distribution companies within the cluster, bread companies can send their products to their own markets with lower costs. By reducing the distribution costs, the final price of the product reduces and thus increases the demand for bread produced in mechanized bakeries. In most above-mentioned cases, by implementing the proposed policy the demand for bread produced in mechanized bakeries will increase that this will increase the market share of mechanized bakeries. With the increase in market share of mechanized bakeries, the income of these units also increases and thus the power of competitiveness can be more in the market. On the other hand, by increasing the income of units, investment in production technology increases which will promote the level of production technology.

6.2 Main impacts of the proposed policies on the science and technology subsystem

With the liberalization of prices and creating a competitive environment, variety and innovation becomes a key factor in competitiveness. With increasing competitiveness, attractiveness of the product increases and results in increased demand for bread produced in mechanized bakeries.

Allocation of special facilities for training causes increase in skilled labor that will result in increased labor productivity. Increasing the labor productivity results in reduced production costs and thus by reducing the cost of bread produced, the demand for bread produced in mechanized bakeries increases. On the other hand, upgrading the labor skills through reducing the human error leads to improving the final quality of the product. Promoting the quality of the product increases the attractiveness of the product and thus increases the demand for bread produced in mechanized bakeries. Supporting supplementary businesses such as bread incubators will be effective in reducing costs of research and development. Reducing the cost of research will bring knowledge development in this industry. With promoting the level of knowledge, on one hand the variety and innovation in the product increases that this leads to increase the attractiveness of the product and the demand for it. On the other hand, the quality of the product increases. With this development, and increasing the attractiveness of the product, the demand for bread produced in mechanized bakeries increases.

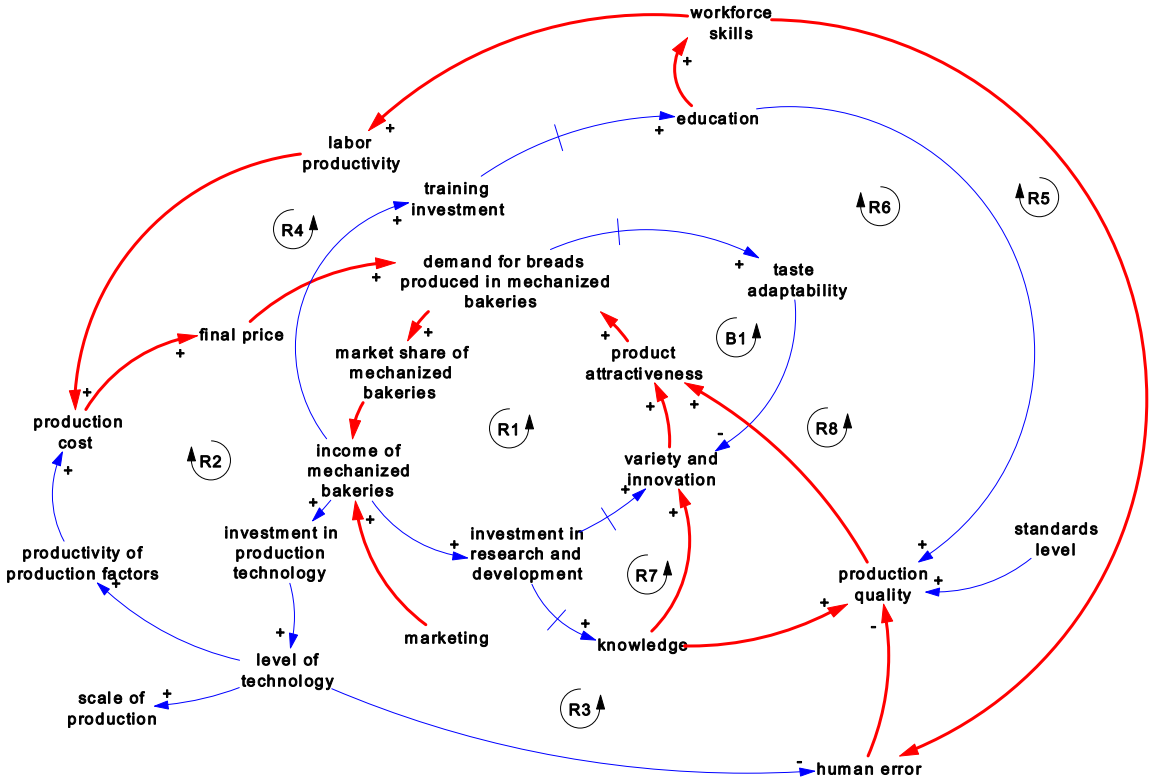

Figure 18 : Impacts of the proposed policy on science and technology subsystem

6.3 Major impacts of the proposed policy on the social and political subsystem

In this subsystem as it is observed in Figure 19, political pressure on the government is one of the crucial factors is the bread industry. By creating employment through the creation of new units on one hand, and on the other hand by creating the possibility for traditional bakers to play a role in the development of bread industry through the development of their units or converting them to sales and distribution centers, political pressure on governments will be reduced.

With increasing awareness programs in such a purposeful way, one can hope to increase consumers' awareness, which this increases the demand for bread produced in mechanized bakeries. It should be noted that increasing the demand for bread produced in mechanized bakeries will reduce motives to create new traditional bakeries. On the other hand, the increase in

this demand leads to increase the income of mechanized bakeries; resulting in increased market share of mechanized bakeries.

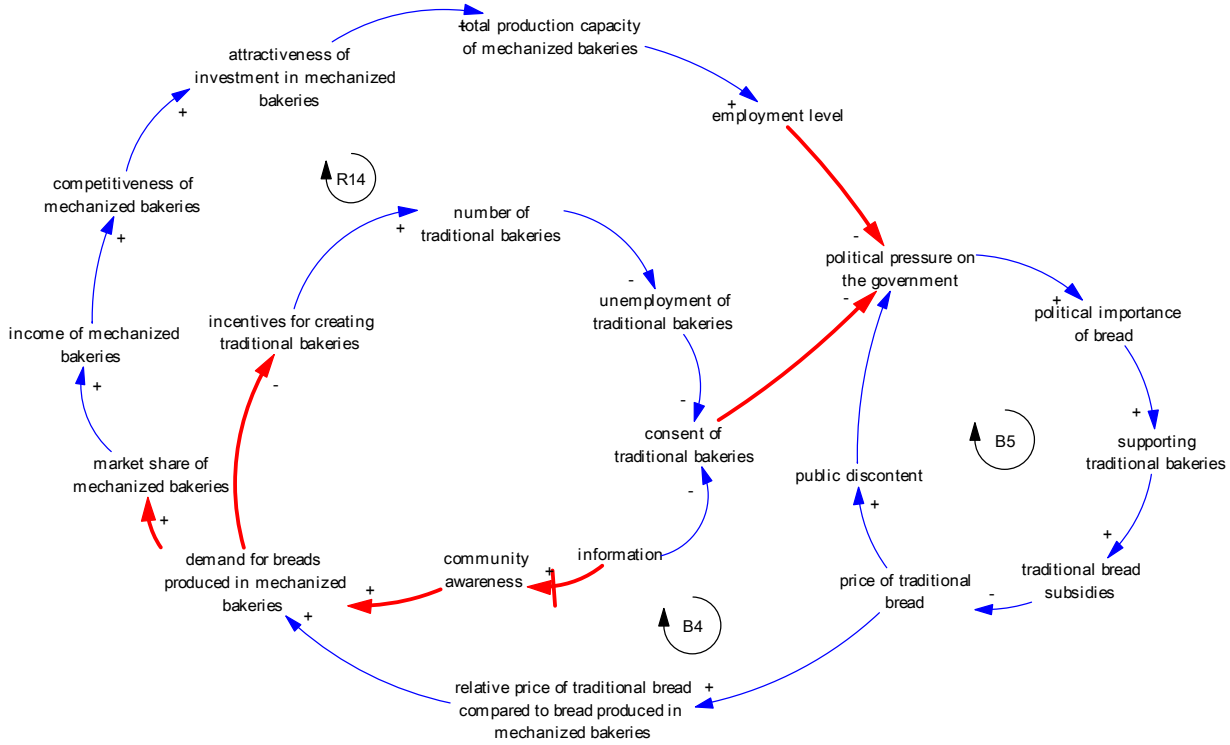

Figure 19 : Impacts of the proposed policies on the political and social subsystem

7. Summary and conclusions

Because of the crucial role of bread in the households' food basket, bread industry in Iran is of extreme importance.

In this study, a system approach was adopted to study the Iranian baking industry and to provide appropriate solutions for the development of mechanized bakeries as the main strategy for improving performance indicators of this industry. Based on the adopted approach, the system of the Iranian baking industry was broken to three main subsystems including knowledge and technology subsystem, economic subsystem, and political and social subsystem. By the use of causal loops, each subsystem was analyzed to recognize the effects each of these variables has on the system. Considering the behavior of these variables in the system, a number of solutions were designed for the promotion of the mechanized bakeries in the Iranian baking industry the most important of which are the liberalization of prices, full liberalization of energy prices for all production units, supporting mechanized bakeries in the distribution of their products, supporting complementary businesses, and customs exemptions for imports of manufacturing equipment. Also, the effects of the proposed solution in each subsystem were analyzed using the designed causal loops. Based on the results of the analysis conducted in this research, a sustainable development of the bread industry requires development of all sectors such as procurement, production, and distribution, concurrently. Also, it is essential to take political, social, economic, and technological issues associated with the baking industry into consideration.

The main contribution of this research in the baking industry is the modeling of the Iranian baking industry using system dynamics approach which has been applied for the first time in the analysis of factors affecting this industry. Using the developed model, we could adopt a holistic approach in designing a number of solutions for the development of the Iranian baking industry. In the context of system dynamics, applying this method in the baking industry with highly interrelated variables (political, social, economic, and technological variables) could be considered as another contribution

of this research. . Also, considering the development of all segments of the baking industry (procurement, production, and distribution) is another characteristic of this study.

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