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Measuring the Efficiency of Iran's Red Meat Value Chain (BSC-AHP Model Approach)

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Abstract

Inefficiencies in Iran's red meat value chain have led to skyrocketing prices, the exclusion from the food basket of vulnerable groups, and systemic bottlenecks in production and distribution. To address this issue, this study measures the efficiency of the red meat value chain in Iran. For this purpose, value chain performance indicators were first identified using the Delphi technique by a panel of 23 experts (selected through snowball sampling) familiar with Iran's national red meat supply chain. Subsequently, these indicators were weighted by applying the Analytic Hierarchy Process (AHP) within the four perspectives of the Balanced Scorecard (BSC) framework. This study contributes by providing a comprehensive, nation-level efficiency measurement using an integrated BSC-AHP-Delphi framework, which has not been previously applied to Iran's red meat value chain. The results showed that the criteria for measuring the efficiency of Iran's red meat value chain include 79 secondary sub-indicators, 15 sub-indicators and 3 main indicators. Also, among the BSC dimensions, executive processes, growth dimension, financial dimension and consumer dimension are important, respectively. Furthermore, the value chain efficiency in "planning processes" and "enabling processes" was evaluated as low, and in "executive processes" as medium. In addition, the main sub-indices of "design and planning of the entire chain" and "distribution and sales process" had the lowest and highest efficiency, respectively, and efficiency of entire Iran's red meat value chain was evaluated as low. Finally, in order to increase the value chain efficiency of the examined product, it was suggested to form a "policy council for Iran's red meat value chain".

Keywords: Efficiency measurement, Delphi technique, Integrated BSC-AHP model, Red meat industry, Value chain.

JEL Classification: L11, Q13, Q18.

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1. Introduction

In the field of economics, the chain means paying attention to the two categories of supply and value, so that the supply chain includes all actors and links between them from farm to fork. The supply chain consists of activities that lead to production and supply of the final product or service, and its main focus is on reducing costs and increasing efficiency while the value chain shows the value flow. Supply and value chains are complementary to each other and show a structure of integrated businesses that depicts the flow of products and services on the one hand and value through demand and cash flow on the other hand (Valdés, 2024). According to statistics from the Food and Agriculture Organization of the United Nations (FAO), Iran ranks 20th in the world and second in the Middle East after Turkey, with an annual production of about 850,000 tons of red meat. This is while per capita consumption of red meat in Iran (10.4 kg) is higher than the global average (8.1 kg), but less than half of the per capita consumption in developed countries such as Australia (26 kg). The gap between domestic production and consumption, on the one hand, and the increase in livestock input costs, on the other hand, have doubled the importance of paying attention to the efficiency of the value chain of this product. In agriculture, the development of a value chain and supply chain is an approach related to the development of planning with the aim of stimulating economic growth and increasing competitiveness, and they provide an opportunity to reduce production costs and reduce income risk. Therefore, in order to increase competitiveness in the production of some major products, it is necessary to consider the value chain and supply (Acharjee et al., 2023). In this regard, the animal husbandry industry has a special place in the national economy due to the provision of protein needed by society; So that 25.3% of gross domestic product, 83.7% of fixed capital formation, 21.4% of export and 4.7% of import of agriculture sector are allocated to animal husbandry sector. Also, this sector accounts for 1.3 million job opportunities and about 50% of protein consumption of Iranian households (Cham Cham et al., 2023). Animal husbandry, as one of the important subsectors of Iran's agricultural sector, besides being the main supplier of protein products in the country, has the highest share in the added value of the agricultural sector after the subsectors of agriculture and horticulture. Also, because of dealing with living organisms, production in this area has differences with other production and commercial fields, and in order to ensure food security and enjoy sustainable economic growth in the agricultural sector of the country, it is of particular importance. Based on this, the livestock sector plays a vital role in the agricultural economy of Iran, because about 70% of the population working in the village, 90% of the nomadic population and 10% of the

urban population are directly involved in activities related to livestock affairs (Alizadeh et al., 2024).

Also, the added value in this sector will lead to growth of other economic sectors of the society, especially the two sectors of industry and services. However, with the increase in population in recent years, the effectiveness of traditional methods of obtaining food, including agriculture and animal husbandry, has been lost, and it is not responsive to the government's policies based on the need for self-sufficiency. Meanwhile, unbridled increase in price of meat has always been one of the main challenges of the Iranian market, which has led to the imbalance of the market and caused a decrease in the well-being of consumers and damage to producers (Kakai et al., 2022). This is while the value chain as the main component, or in other words, the most golden key to success in the knowledge-based economy, can facilitate the production and supply process and make the final product competitive in terms of price. Experts believe that changing the structure of the red meat production industry can improve the efficiency of value chains to a significant extent and reduce undesirable and additional costs to an effective extent. In addition, with the correct management of the value chain in order to coordinate the different parts of the chain and achieve the common goal of producing high-quality meat at the lowest cost, it is possible to make optimal use of the existing conditions and, as a result, increased the technical and economic performance of farms and animal husbandry (Houshyar et al., 2024). Therefore, this study measures the efficiency of Iran's red meat value chain. To this end, the paper is organized as follows: Section 2 reviews the state of Iran's red meat value chain and background literature. Section 3 describes the research methodology employed. Section 4 presents and discusses the results. Finally, Section 5 provides the conclusions and policy recommendations.

1.1. Status of red meat production, consumption and market in Iran

The Iran's livestock population by livestock type is presented in Table 1:

Table 1. Iran's Livestock population trend (1000 livestock).

Year	Camel	Buffalo	Cattle	Goats	Sheep
2011	157	197	7612	21221	46679
2012	158	199	7800	21009	46212
2013	160	202	7936	20591	45430
2014	162	204	8118	20408	48778`
2015	172	205	8189	19968	47931
2016	178	211	8151	18719	47639
2017	184	215	8153	18501	46601
2018	190	219	8089	18112	45622
2019	195	222	8057	17732	44664
2020	201	224	7986	17732	44664
2021	212	226	6983	17538	44182
2022	234	252	7049	17300	51160
Growth rate	3.73	2.30	-0.61	-1.83	0.97

Source: MAJ (2024).

According to above findings, during 2011-2022, Iran's light livestock population (sheep and goats) has slightly positive annual growth rate (0.15%) and heavy livestock population (cattle, buffaloes and camel) has had small negative annual growth rate (-0.43 percent). In addition, per capita consumption of sheep, cattle and poultry meat in Iran compared to other world's countries in 2023 presented in Figure 1.

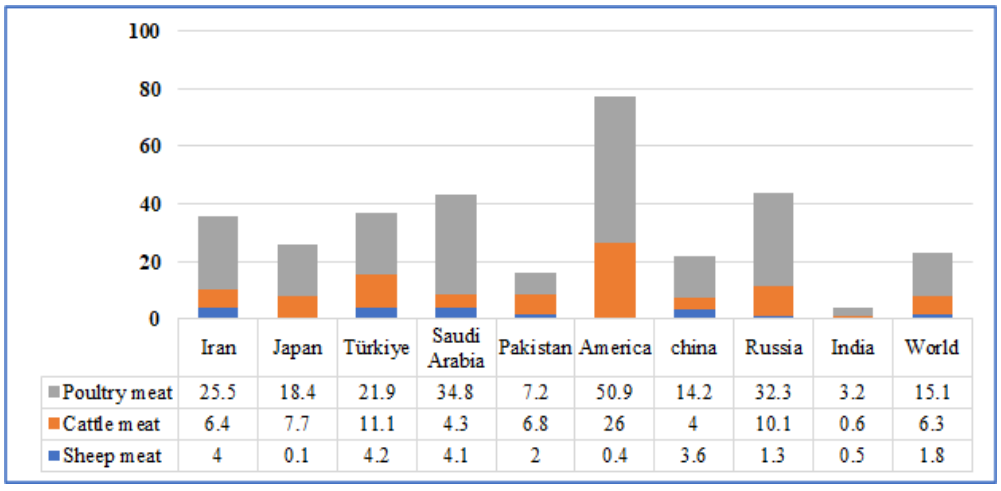

Figure 1. Per capita meat consumption in Iran and other world countries (kg)- Source: OECD database (2024).

The above findings show that the annual per capita consumption of red meat (sheep and cattle) in Iran is equal to 10.4 kg, which is more than the world average (8.1 kg) (https://data.oecd.org/agroutput/meat-consumption.htm.2024). In addition, in recent years, especially due to removing subsidized foreign currency from imported livestock inputs, the price of red meat has experienced an unbridled increase. Figure 2 shows the monthly price of red meat:

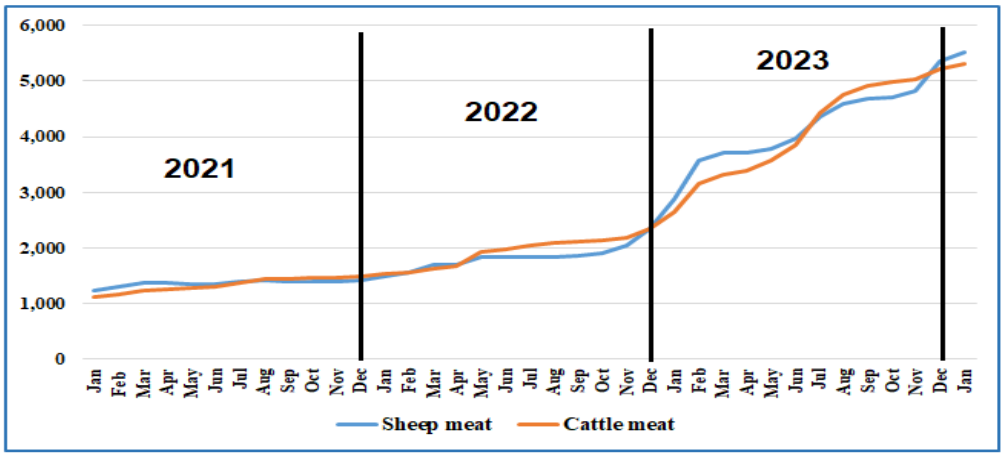

Figure 2. Monthly price of red meat in Iran (1000 Rials) - Source: SCI (2024).

Above findings show that the average price of sheep meat increased from 1,229,153 Rials to 5,516,090 Rials (348.77 percent) and the average price of cattle meat increased from 1,114,697 rials to 5,315,427 Rials (376.85 percent) from Jan 2021 to Jan 2024. Furthermore, Table 2 indicates the share of different costs in total price of Iran's red meat in 2023:

Table 2. Share of different costs of red meat in Iran (percentage).

Row	Cost description	Share of cattle meat	Share of sheep meat
1	Buying calves/lambs	54.60	46.50
2	animal feed	39.90	17.30
3	personnel	2.48	28.00
4	Electricity, telephone, fuel and water	0.05	0.20
5	Vaccination, medicine and treatment	0.03	1.00
6	Livestock transportation	0.02	1.00
7	Depreciation	0.26	1.00
8	Current investment interest expense	0.66	3.00
9	Mortality	0.50	0.50
10	Unforeseen expenses	1.50	1.50
	Total	100	100

Source: Research calculations based on statistics of MAJ (2024).

Above findings show that with exception of initial cost of buying livestock at the beginning of fattening period, livestock feed has high share in total cost of livestock at the end of fattening period and as a result red meat in Iran.

1.2. Iran's red meat value chain

In fact, more than 25% of Iranian household food expenses are made up of types of meat. Based on this, today red meat is considered one of the most expensive foods in Iran, but its supply and demand is mainly done in a traditional way. In rural areas, livestock slaughter is often done traditionally and meat is offered fresh. Meat distribution in cities is done outside the supply chain and butchers have direct relationship with small owner producer (Houshyar et al., 2024). Small local slaughterhouses are responsible for the slaughter of butchers. In these areas, livestock markets and slaughterhouses are connected and close to each other. Local authorities

are responsible for monitoring the health and safety of meat. In industrial areas and big cities, the process of supplying livestock by butchers to slaughterhouses is decreasing, and this is done by an intermediate link and chain. After slaughtering animals in slaughterhouses, this intermediary sells carcasses to butchers or packs meat. According to the dominant preferences of consumers, fresh meat is still often sold in traditional markets (Alizadeh et al., 2024). Furthermore, in recent years, supply of meat in form of packaging has started in stores and supermarkets, but the share of these types of markets in the whole meat market of the country is very limited. Surveys show that in Iran's industrial livestock breeding sector, few institutions and companies are among the big industrial livestock breeders. But the structure of these producers is mostly quasi-governmental and lacks complete production chain links and lacks an institutional structure to supply meat to the market (ChamCham et al., 2023). In addition, in recent years, with the establishment of some chain stores in big cities, the supply of red meat with a variety of added flavors and ready-to-cook with the brand of respective store has been offered, and these types of markets are also popular with consumers. But the share of these types of stores in the Iran's red meat supply is very limited, and according to the traditional structure of the country's meat market, most of the meat is still sold through butchers. In addition, the process of meat production and consumption in livestock sector is more traditional, and part of the production is for self-consumption, and part of it is sold and consumed in the form of live animals on various occasions, such as Eid al-Adha, mourning ceremonies, etc. Also, in the current distribution method of red meat and its products, its supply is mainly done in an unsanitary and unfair manner, and in this activity, the poor quality of this product is mostly distributed to the vulnerable sections of the society. Therefore, planning and policy-making to increase production and establish the necessary infrastructure for processing, maintaining and supplying these products and formulating related laws to change the current method of distribution in line with the use of new, healthy and hygienic methods of distribution, seems necessary (APERDRI, 2022). Figure 3 summarizes the Iran’s red meat value chain:

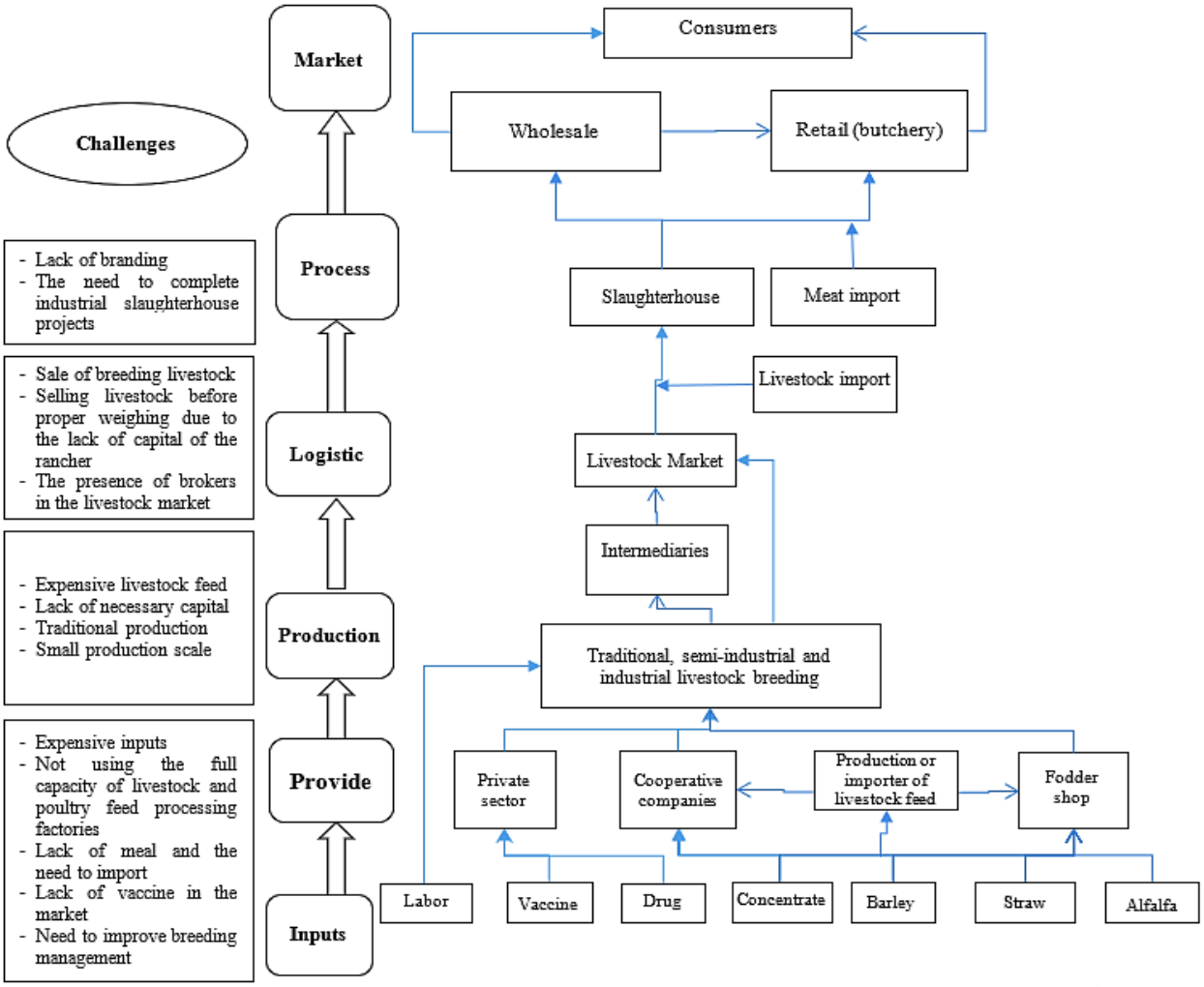

Figure 3. Iran's red meat value chain - Source: researcher's findings.

This chain is a high-level overview of the general structure of the red meat value chain in Iran and does not include minor differences related to the type of livestock (light (e.g., sheep and goats) or heavy (e.g., cattle)) and different regions. Despite the differences in some actors and channels, the overall structure of the chain, including the supply chains of inputs, fattening, slaughter, processing and retail, is the same in both. Therefore, drawing a single value chain to show the overall situation of the country's red meat is justifiable, and this approach has been used in this study to avoid unnecessary complications.

Also, various studies have investigated the value chain of agricultural products which summarized in Table 3.

Table 3. Most important studies related to meat value chain.

Year	Researcher(s)	Product - Country	Main finding
2019	Bardhan et al.	Buffalo meat value chain in India	Chain's actors include ranchers, dairies on the outskirts and in the city, aggregators, traders, retailers, restaurants and roadside stalls, and export-oriented slaughterhouses.
2020	Palouj and Lavaei	Chicken chain in Mazandaran province	The Livestock Affairs Support Company has caused the most damage to the chains by adopting ineffective policies.
2021	Cham Cham *et al.*	Sheep meat value chain in Lorestan province	Social problems 24.21%, management problems 41.21%, financial problems 8.67% and technical problems 6.67% explain the challenges of sheep meat value chain.
2021	Zalite *et al.*	Meat supply chains in Latvia during COVID-19	The main internal and external risks are associated with greater uncertainty and instability in EU markets.
2022	Vasko *et al.*	Beef supply chain in Ghana	The livestock trade was southward, where traders were able to bargain for higher prices.
2022	Kakai *et al.*	Meat supply chain in Tehran	Supply chain management has a positive role on prices, product quality and reliability, delivery speed, delivery reliability and product flexibility.
2023	Acharjee *et al.*	Fish supply chain in Bangladesh	The retail price leads to the wholesale and farm prices, and in most cases, the coefficient of variation decreases with the delivery of fish from the farm to the retail levels.
2023	Hashemnia *et al.*	Red meat supply chain in Zagros area	Traditional livestock farmers were in a very critical situation economically (27.8%) and socially (35.5%).
2024	Alizadeh *et al.*	Value chain of veal meat in Mashhad	The population of productive livestock has experienced a downward trend, which will continue if appropriate measures are not taken in the supply chain of this product

Despite the critical role of the red meat sector in Iran's economy and food security, its value chain suffers from profound systemic inefficiencies. These manifest as skyrocketing consumer prices, exclusion of vulnerable groups from the market, bottlenecks in input supply and distribution, and a lack of coordination between traditional and industrial production systems. While existing literature has addressed specific segments or challenges-such as regional studies on sheep meat or analyses of poultry supply chains-a significant research gap persists. There is a lack of a comprehensive, nation-level efficiency assessment for Iran's entire red meat value chain that employs an integrated performance measurement framework. Previous studies have not simultaneously combined the multi-perspective view of the Balanced Scorecard (BSC) with the rigorous weighting capabilities of the Analytical Hierarchy Process (AHP) based on expert consensus (Delphi) to diagnose inefficiencies across the chain's planning, execution, and enabling processes.

This study aims to bridge this gap. Its primary novelty lies in developing and applying an integrated BSC-AHP-Delphi model for the holistic efficiency measurement of Iran's red meat value chain at the national level. This approach allows for: (1) identifying a comprehensive set of efficiency indicators spanning the entire chain from input supply to final consumption, (2) weighting these indicators based on the relative importance of financial, consumer, internal process, and learning/growth perspectives, and (3) providing a quantitative diagnosis of efficiency levels for different chain processes. Consequently, the main goals of

this research are threefold: first, to identify and prioritize key performance indicators for Iran's red meat value chain using the integrated Delphi-AHP method within the BSC framework; second, to quantitatively measure the current efficiency status of the chain and its main sub-processes; and third, to identify the most critical inefficient nodes requiring policy intervention. The findings of this research offer distinct scientific and managerial applications. Scientifically, it contributes to the literature on agricultural value chain analysis by demonstrating the application of a robust, multi-criteria decision-making framework (BSC-AHP) in a complex, real-world context. The developed methodology can serve as a template for efficiency assessment in other agri-food value chains. Managerially and from a policy perspective, the results provide actionable insights. For policymakers, the identified low-efficiency areas (e.g., Design and planning of the entire chain) offer clear targets for strategic investment and regulatory reform. For chain actors and managers, the breakdown of efficiency across BSC dimensions highlights whether their deficiencies are primarily in internal processes, financial management, customer orientation, or innovation capacity, guiding focused improvements. Ultimately, the study's conclusion to form a "Red Meat Value Chain Policy Council" emerges directly from the diagnosed need for enhanced coordination and strategic planning—a key managerial implication for governing the chain.

2. Research Method

The statistical population of this research includes experts who are aware about the Iran’s red meat supply chain. Also, using the snowball sampling the sample size was determined equal to 23 persons. Furthermore, the required data were collected through distributed questionnaires related to the Delphi, AHP and BSC methods among the panelists (group of experts).

In this study, efficiency is defined as the degree to which the current performance of the red meat value chain and its sub-processes aligns with the optimal performance expectations derived from the expert panel. After weighting the indicators via AHP, the efficiency score for each indicator was calculated by asking experts to rate the current status of each secondary sub-indicator on a Five-point Likert scale. These scores were normalized to a 0-1 scale, aggregated using their AHP-derived weights, and averaged across respondents. The final efficiency score for any main or sub-indicator is thus a weighted composite index reflecting the expert consensus on its performance level.

In addition, a brief explanation of the statistical models used in the present research is given below:

This study adopts a positivist research paradigm, employing a descriptive-analytical and applied quantitative method. The statistical framework is based on consensus-building (Delphi), multi-criteria decision-making (AHP), and performance measurement (BSC). Validity was ensured through the iterative expert review in the Delphi rounds and the consistency ratio (CR<0.1) in AHP pair wise comparisons. Reliability was assessed by calculating Cronbach's Alpha for the expert evaluation questionnaires in the final Delphi round, which yielded a value of (0.85), indicating acceptable internal consistency.

The target population consisted of national-level experts with comprehensive knowledge of Iran's red meat supply chain. A purposive snowball sampling technique was used to identify and recruit 23 such experts from key stakeholder groups in 2024, including policy-makers from the Ministry of Agricultural Jihad, senior researchers from agricultural research institutes, representatives of national livestock unions, and managers of major distribution companies. This composition ensured a macro-level, holistic perspective on the entire chain rather than a micro-level view of individual producers. The sample size was determined based on the saturation principle in qualitative-quantitative expert-based studies, where additional participants no longer provide new insights.

2.1. Delphi technique

In this study, Delphi technique is used to identify the indicators needed to measure the Iran's red meat value chain (Figure 4). The purpose of Delphi technique is to reach the most reliable group agreement of experts on a specific issue. The implementation steps of Delphi are as follows: first, the experts present their opinions in form of low, medium and high, then the average of experts' opinion and amount of disagreement of each expert is calculated from the total average. Then this information is sent to experts to get new opinions. In the next step, each expert based on information from the previous step presents a new opinion or revises his previous opinion. This process continues until the average number becomes stable enough (Loo, 2002).

The criteria for joining the panel included: at least 10 years of relevant experience, a master's degree or higher, and employment in one of the value chains links.

The research steps were implemented as follows: (1) Expert Selection: A preliminary list of 15 key national experts was identified based on their publications and organizational roles. Using snowball sampling, each was asked to recommend other qualified individuals, leading to a final panel of 23. (2) Delphi Execution: In the first round, an open-ended questionnaire about

potential efficiency indicators was sent. Responses were synthesized into a structured list (79 sub-indicators) for the second round, where experts rated importance on a Likert scale. In the third round, they received a summary of group ratings and were asked to reconsider their scores, leading to final consensus. (3) AHP-BSC Integration: A pairwise comparison questionnaire based on the finalized indicators within the four BSC perspectives was distributed. Experts' judgments were collected, aggregated using the geometric mean, and checked for consistency (CR<0.1). The resulting weights were applied in the final efficiency calculation.

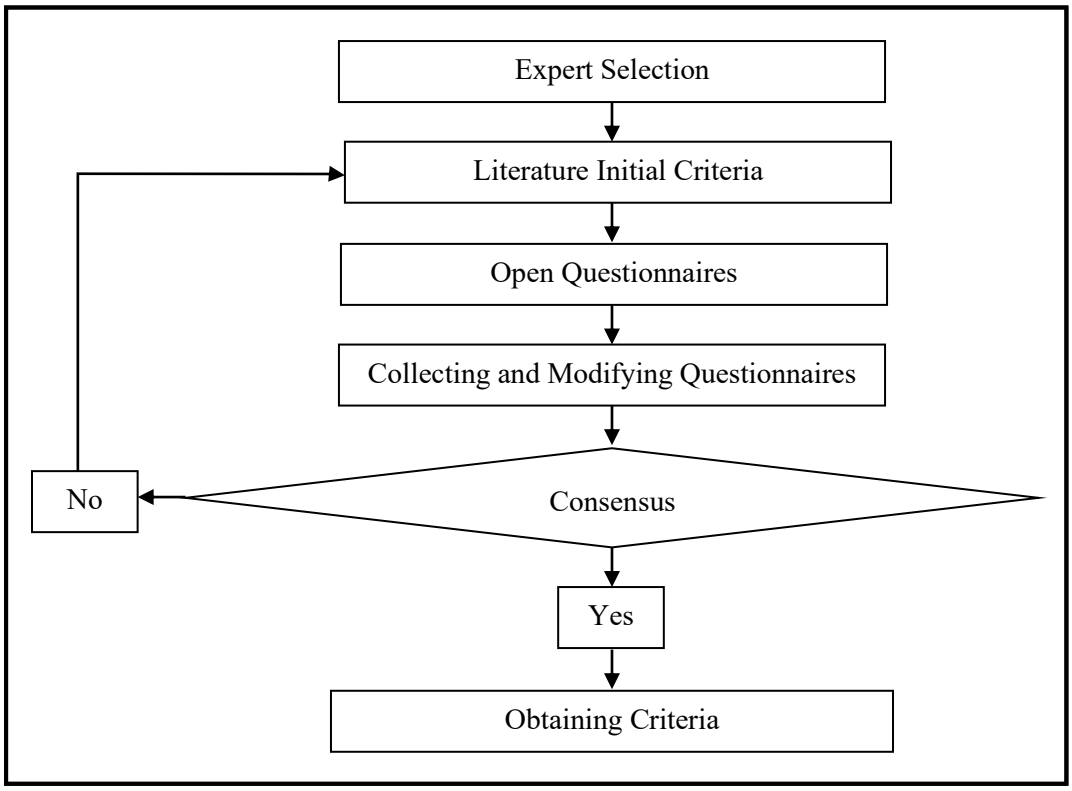

Figure 4. Delphi technique process.

2.2. Analysis Hierarchy Process (AHP)

In this study, AHP is used in order to weight and prioritize the performance indicators of red meat value chain. This method requires five major steps: 1. modeling, 2. priority judgment, 3. calculation of relative weights, 4. integration of relative weights and 5. consistency in judgments. Also, the compatibility of the comparisons is ensured using the compatibility rate. So that if inconsistency rate is less than 0.1, the compatibility of the comparisons is acceptable. The steps for calculating inconsistency rate are: Step 1. Calculation of the weighted sum vector: the matrix of pairwise comparisons is multiplied by the "relative weight" column vector and

the resulting vector is called the weighted sum vector. Step 2. Computation of the compatibility vector: the elements of the weighted sum vector are divided by the relative priority vector and the resulting vector is called the compatibility vector. Step 3. Obtaining □max, which is: the average of compatibility vector elements. Step 4. Calculation of compatibility index which is defined as follows (Saaty, 1994):

$$CI = \frac{\lambda_{max}}{n-1} \quad (1)$$

So that *n* is the number of options in the problem. Step 5. Calculation of the compatibility ratio, which is obtained by dividing the compatibility index by the random index as follows:

$$CR = \frac{CI}{RI} \quad (2)$$

2.3. Balanced Score Card (BSC)

Supply chain performance evaluation is the process of measuring the efficiency of different links in the chain in achieving the set goals. There are various methods for this evaluation, the most important of which are cost-based models (such as activity-based costing), productivity-based models (such as data envelopment analysis), quality models (such as quality performance extension), and hybrid models.

In this study, the weighting and prioritization of indicators for measuring the efficiency of red meat value chain is based on the dimensions of BSC perspective (financial perspective, consumer perspective, internal processes perspective, and growth perspective). The BSC method was proposed in the early 1990s by Kaplan and Norton (1996). Also, for the first time Brewer and Speh (2000) linked the concept of scorecard to the primary goals of SCM. Using this method allows managers to transform strategic goals into a series of interdependent performance measurement criteria by having a comprehensive framework. This means that successful companies do not rely only on financial metrics to evaluate their performance, but also evaluate their performance from three other perspectives, i.e., consumers, internal processes, and growth. The dimensions of BSC can be shown as Figure 5:

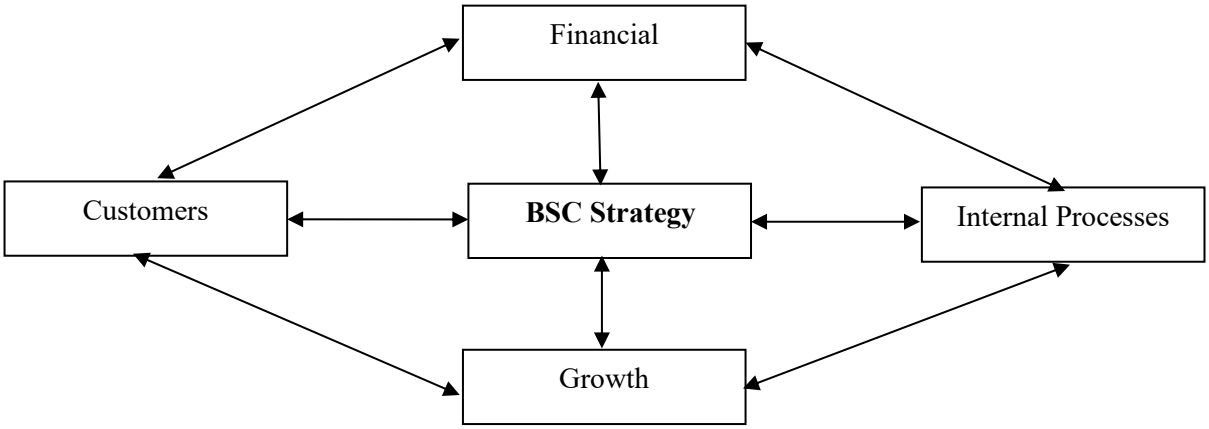

Figure 5. BSC approach - Source: Brewer and Speh (2000).

3. Results and Discussions

The extracted indicators are categorized into three levels: main, sub- and secondary sub-indicators. Planning processes (C1) are a set of actions that are performed before the implementation of production and distribution operations and include designing the structure, allocating resources, and determining macro-chain strategies. Implementation processes (C2) refer to operational activities along the chain from the supply of the institution to the sale of the final product. Enabling processes (C3) also refer to the monitoring, coordination, and support functions that provide the basis for the efficient implementation of the other two categories. The 15 sub-criteria each represent a set of related activities in one of these three areas.

The results of three-step Delphi technique in order to identify the efficiency measurement indicators of Iran's red meat value chain presented in Table 4.

362 **Table 4.** Indicators of measuring efficiency of Iran's red meat value chain.

Main indicators	Sub-indicators	Secondary sub-indicators
Planning processes (C1)	Design and planning of entire chain (C11)	C111: Designing the entire chain structure C112: Allocating resources to processes C113: Locating production factories and livestock feed warehouses C114: Designing how to transport inputs and products in the chain C115: Determining macro chain strategies C116: Designing an integrated tracking system and database for entire chain
	Supply chain design and planning (C12)	C121: Planning the preparation and production of seeds for livestock fodder C122: Planning for the production of livestock inputs in the country C123: Determining the share of provinces in production of livestock inputs C124: Integrated planning of transportation of livestock inputs C125: Planning the import of livestock inputs C126: Planning maintenance and storage of livestock inputs
	Production design and planning (C13)	C131: Livestock production planning by type C132: Livestock production planning according to traditional and industrial methods C133: Livestock feeding planning C134: Planning to increase the conversion rate of livestock feed C135: Health principles supervision planning
	Design and planning of distribution and sending (C14)	C141: Planning the amount of annual livestock slaughter C142: Annual meat distribution and sales planning C143: Planning the amount of meat storage C144: Planning the amount of meat import C145: Integrated planning of meat transportation in the country C146: Planning the amount of subsidy allocation to producers or consumers C147: Designing and planning returns (wastes)
Executive processes (C2)	Process of preparing and producing required inputs (C21)	C211: Preparation and supply of industrial livestock feed and fodder C212: Storage of industrial livestock feed for distribution to livestock farms
	Livestock production process (C22)	C221: Vaccination of livestock C222: Creating suitable conditions for raising livestock C223: Registration of livestock
	Processing and packaging process (C23)	C231: Compliance with the principles of packaging and maintaining quality C232: Compliance with health principles C233: Compliance with product marketability considerations
	Import process (C24)	C241: Importing fodder and livestock feed C242: Import of live animals C243: meat import
	Transportation Process (C25)	C251: Livestock fodder and livestock feed transportation C252: Transportation of live livestock C253: Meat transportation
	Storage and warehousing Process (C26)	C261: Storing fodder and livestock feed C262: Meat storage C263: Storage of meat products
	Distribution and sales process (C27)	C271: Distribution of meat from slaughterhouse to factories producing meat products C272: Distribution of meat from slaughterhouse to stores C273: Distribution of meat from the slaughterhouse to butchers C274: Distribution of meat from stores to consumers C275: Distribution of meat from butchers to consumers C276: Distribution of meat to government organizations and departments
Empowering processes (C3)	Management of entire chain (C31)	C311: Establishing appropriate rules and guidelines for the entire chain C312: Evaluation of chain performance C313: Management of the entire supply chain C314: Integration and coordination of all components of the chain C315: Integrated management of statistics and information C316: Pursuing chain strategies C317: Facilitating required credits and their optimal allocation C318: Management of communication between components
	Supply management (C32)	C321: Establishing appropriate laws in the field of providing fodder and livestock feed C322: Performance evaluation of input suppliers C323: Collecting, updating and managing information on livestock inputs at the level of provinces C324: Management of the requirements of producers of livestock inputs C325: Supplier network management C326: Management of capital assets C327: Managing the import of livestock inputs
	Production management (C33)	C331: Establishing appropriate laws in the field of animal husbandry C332: Performance evaluation of traditional and industrial livestock farms C333: Collecting, updating and managing livestock production and fattening information at provincial level C334: Managing the needs of traditional and industrial livestock farms C335: Manufacturer network management C336: Livestock import management
	Distribution and shipping management (C34)	C341: Establishing appropriate laws in the field of slaughterhouses and meat distribution C342: Performance evaluation of distributors C343: Collecting and updating information on distribution and sending of meat at provincial level C344: Management of distribution and shipping requirements C345: Distributor network management C346: Measuring customer satisfaction C347: Red meat import management C348: Market management C349: Inventory management C3410: Management of capital assets C3411: Return management (waste)

363 Source: Research findings.

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365 Findings showed that the indicators for measuring efficiency of Iran's red meat value chain
366 include 79 secondary sub-indicators, 15 sub-indicators and 3 main indicators. Also, the

conceptual model of indicators for measuring efficiency of Iran's red meat value chain can be drawn as Figure 6.

The conceptual model of the efficiency measurement framework for Iran's red meat value chain is presented in Figure 7. This model illustrates the hierarchical structure of the identified indicators (3 main indicators, 15 sub-indicators, and 79 secondary sub-indicators) that collectively form the tool for assessing the chain's performance. It is important to note that this figure represents the analytical construct for measurement, not the physical flow of the value chain itself (which is depicted in Figure 6).

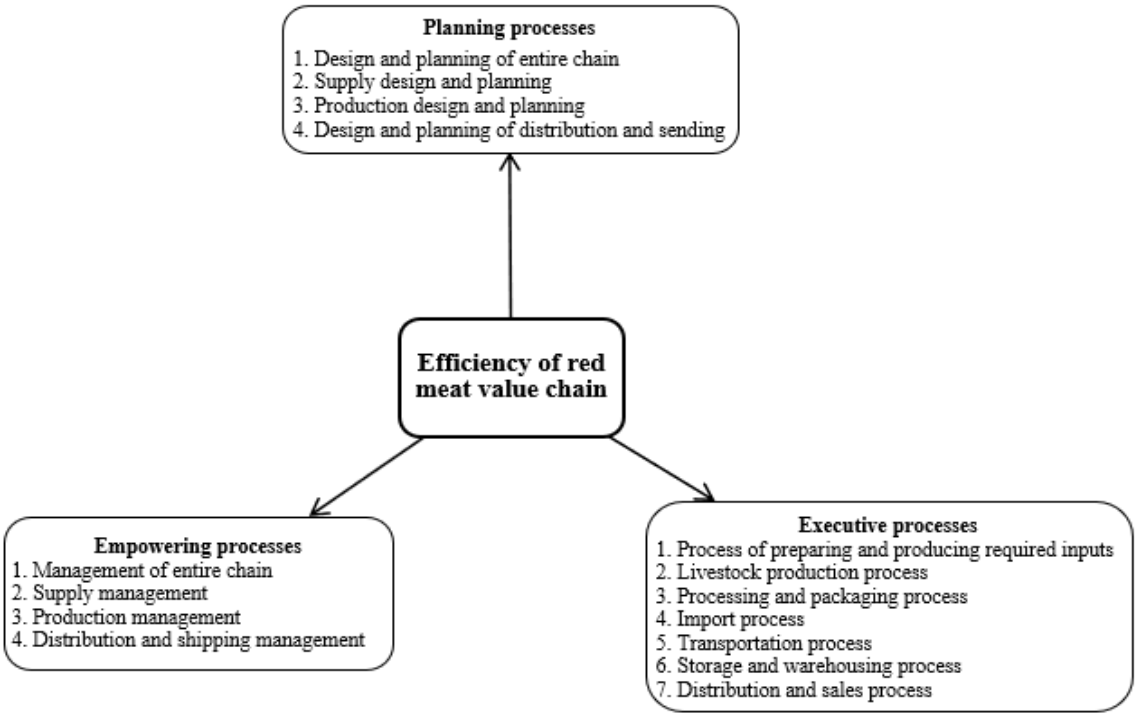

Figure 6. Hierarchical structure of the efficiency measurement framework of Iran's red meat value chain.

For determining the importance coefficient of identified indicators based on BSC approach, AHP technique was used. Although in the red meat value chain, some criteria can potentially be interdependent, in this study, the relative independence of the criteria was assumed at the level of prioritizing the BSC dimensions, because the main goal was to weight the four dimensions of the balanced scorecard at the macro level and within each of the three processes (planning, execution, and enabling), at which point, no significant dependence was found according to the experts. Therefore, the hierarchical structure of measuring efficiency of Iran's red meat value chain with BSC can be drawn as Figure 7.

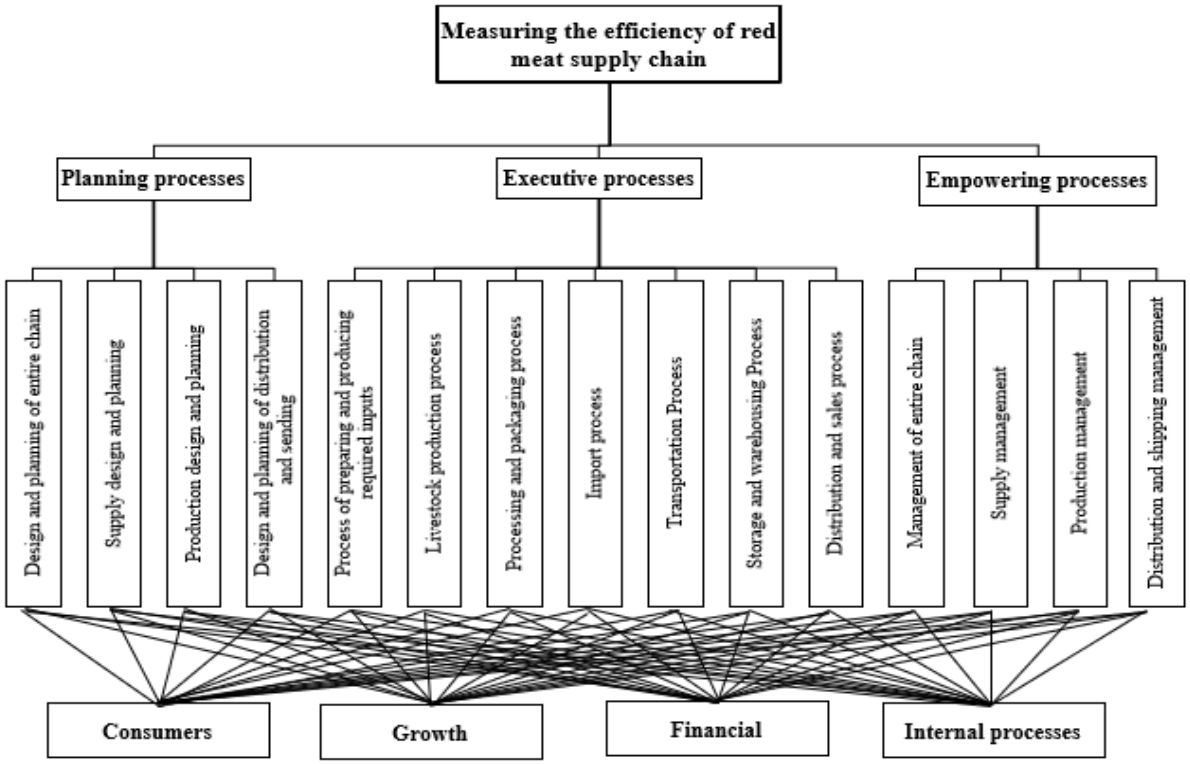

Figure 7. Indicators of measuring efficiency of Iran's red meat value chain using BSC.

Although, due to space limitations, all 79 sub-indices cannot be displayed in Figure 7 and are only plotted up to the level of 15 sub-indices, all of these sub-indices have been included in the weighting process and efficiency calculation.

The weight of each dimension of BSC in sub-indicators of planning processes, executive processes and empowering processes of Iran's red meat value chain based on AHP results presented in Table 5. Due to the limitation of the number of pages in the article, separate tables for the 79 sub-indices were not provided.

412 **Table 5.** Weight of BSC dimensions in sub-indicators of red meat value chain.

Weight of BSC dimensions in sub-indicators of planning processes (C1)					
	C11	C12	C13	C14	Final weight
Internal processes	0.310	0.308	0.333	0.310	0.315
Financial	0.241	0.231	0.259	0.207	0.235
Growth	0.276	0.269	0.259	0.276	0.270
Consumers	0.172	0.192	0.148	0.207	0.180

Weight of BSC dimensions sub-indicators of executive processes (C2)								
	C21	C22	C23	C24	C25	C26	C27	Final weight
Internal processes	0.375	0.381	0.333	0.261	0.318	0.348	0.333	0.336
Financial	0.292	0.333	0.286	0.348	0.273	0.261	0.259	0.293
Growth	0.208	0.190	0.190	0.217	0.227	0.217	0.222	0.211
Consumers	0.125	0.095	0.190	0.174	0.182	0.174	0.185	0.161

Weight of BSC dimensions in sub-indicators of empowering processes (C3)					
	C31	C32	C33	C34	Final weight
Internal processes	0.308	0.308	0.296	0.308	0.305
Financial	0.231	0.231	0.259	0.192	0.228
Growth	0.269	0.308	0.296	0.269	0.286
Consumers	0.192	0.154	0.148	0.231	0.181

413 Source: Research findings.

414 Finally, the weight of each dimension of BSC in main indicators for measuring efficiency of
415 Iran's red meat value chain based on AHP results presented in Table 6.

416 **Table 6.** Weight of BSC dimensions in main indicators of measuring efficiency of red meat
417 value chain.

Weight of BSC dimensions in red meat value chain performance	C1	C2	C3	Final weight
Internal processes	0.315	0.336	0.305	0.319
Financial	0.235	0.293	0.228	0.252
Growth	0.270	0.211	0.286	0.256
Consumers	0.180	0.161	0.181	0.174
Inconsistency rate	0.036	0.027	0.038	0.049

418 Source: Research findings.

419 Above findings show that the inconsistency rates are less than 0.1, therefore, the experts'
420 responses to evaluations and pair wise comparisons are acceptable. Also, according to the
421 importance coefficients (final weight), among the main indicators for measuring efficiency of
422 Iran's red meat value chain, respectively, executive process, growth, financial and consumer
423 dimensions are important.

424 It is important to acknowledge a key limitation regarding the generalizability of findings. Iran's
425 vast geography and the heterogeneous nature of its red meat production systems-encompassing
426 large-scale industrial, semi-industrial, traditional, and nomadic units-present a significant
427 complexity. While the expert panel provided a national, macro-level perspective on the chain's
428 overarching structure and key processes, the results primarily reflect this high-level diagnostic
429 view. Therefore, the efficiency scores should be interpreted as indicative of the systemic
430 performance of the national value chain framework rather than a precise assessment of every
431 individual producer or regional condition.

After identifying and determining the importance coefficient of indicators for measuring efficiency of Iran's red meat value chain based on BSC, the efficiency of current status of Iran's red meat value chain was calculated according to experts' opinions. The results presented in Table 7:

Table 7. The efficiency of Iran's red meat value chain.

Sub indicators	Efficiency score	Performance Status*	Efficiency ranking	Main indicators	Performance score/status	Efficiency of Iran red meat value chain 0.331 Low
C11	0.290	Low	15	C1	0.313 Low	
C12	0.310	Low	12			
C13	0.324	Low	9			
C14	0.330	Low	8			
C21	0.332	Low	6	C2	0.361 Medium	
C22	0.334	Medium	5			
C23	0.385	Medium	3			
C24	0.296	Low	14			
C25	0.401	Medium	2			
C26	0.377	Medium	4			
C27	0.406	Medium	1			
C31	0.309	Low	13	C3	0.319 Low	
C32	0.331	Low	7			
C33	0.314	Low	11			
C34	0.322	Low	10			

* Score of 0 to 0.333 indicates low efficiency, score of 0.333 to 0.667 indicates medium efficiency and score of 0.667 to 1.0 indicates high efficiency. Source: Research findings.

The composite efficiency score is calculated as a weighted average of expert ratings on secondary sub-indicators, normalized to a 0-1 scale.

The composite efficiency scores for each indicator, calculated as described in Section research method, range theoretically from 0 (completely inefficient) to 1 (fully efficient). For interpretive clarity, a three-level categorization was adopted, following common practice in performance measurement studies: scores from 0 to 0.333 are classified as low efficiency, indicating a critical need for improvement; scores from 0.334 to 0.667 as medium efficiency, indicating a moderate level with room for enhancement; and scores from 0.668 to 1.0 as high efficiency, indicating satisfactory or optimal performance. This equal-interval scale provides a clear and objective benchmark for diagnosing the chain's status.

The findings show that:

- Among the 3 main indicators, the efficiency of red meat value chain is low in "Planning processes" and "Empowering processes" and medium in "Executive processes".
- Among the 15 main indicators, the efficiency of Iran's red meat value chain in "Design and planning of entire chain", "Supply design and planning", "Production design and planning", "Design and planning of distribution and sending", "Process of preparing and producing required inputs", "Import process", "Management of entire chain",

"Supply management", "Production management" and "Distribution and shipping management" is low.

- Efficiency of Iran's red meat value chain in "Livestock production process", "Processing and packaging process", "Transportation process", "Storage and warehousing process" and "Distribution and sales process", is medium.
- Value chain of Iran's red meat has the least and the most efficiency in the "Design and planning of the entire chain" and "Distribution and sales process", sub-indicators respectively.
- Efficiency of the entire Iran's red meat value chain was evaluated as low based on 3 main indicators, 15 sub-indicators and 79 secondary sub-indicators.

This study measures perceived efficiency based on expert evaluations, rather than calculating a purely objective productivity ratio (e.g., output/input). This approach is justified for several reasons. First, given the complexity and fragmented data availability in Iran's multi-layered red meat value chain, constructing a singular, objective productivity metric for the entire system is exceptionally challenging. Second, the research goal was to conduct a diagnostic evaluation of the chain's performance across a wide range of managerial, financial, and process-oriented indicators -many of which (e.g., quality of planning, level of integration) are inherently qualitative and best assessed by informed stakeholders. Therefore, the study adopts a recognized expert-based methodology (Delphi-AHP-BSC) to synthesize professional judgments into a systematic and weighted assessment. While this yields a robust composite index of perceived efficiency, it is acknowledged that future research could complement these findings by integrating hard, objective data (e.g., actual cost ratios, physical yields, time-to-market) where available.

4. Conclusions

This study provided a diagnostic efficiency measurement of Iran's red meat value chain using an integrated BSC-AHP model. It confirms that inefficiency stems primarily from strategic and coordinative failures rather than from core execution.

The lack of timely access to inputs needed by livestock, the high cost of inputs and their heavy dependence on imported products, live livestock smuggling abroad, etc. are among the most important problems of the Iran's red meat value chain which can be solved under coherent value chain management. Therefore, in this study, the effectiveness of Iran's red meat value chain was investigated. For this purpose, in the first step, the indicators for measuring

efficiency of red meat value chain were identified using Delphi technique. Then, identified indicators were weighted and prioritized using AHP technique in each of BSC dimensions. Finally, efficiency of Iran's red meat value chain was measured. The most important research findings are:

Our finding that internal processes hold the highest weight (0.319, Table 5) aligns with Porter's (1985) emphasis on operational effectiveness as a source of competitive advantage. The low efficiency in planning processes (C1) and empowering processes (C3), particularly in Design and planning of the entire chain (C11, Table 6), suggests a systemic lack of strategic coordination, which is a known bottleneck in agri-food chains in developing economies (Valdés, 2024).

The medium efficiency in executive processes (C2), especially in Distribution and sales (C27), contrasts with the severe inefficiencies reported by Hashemnia et al. (2023) for the Zagros region. This may indicate that core operational activities function at a basic level, but the strategic and supportive layers (planning and empowerment) are failing. The root cause of low overall efficiency (0.331) can be traced to this disconnect: operational units (producers, distributors) function in isolation due to poor top-level design (C11) and weak enabling management (C3).

Contrary to generalized approaches, our indicator-specific results allow for targeted recommendations. For instance, the lowest-ranked sub-indicator (C11) demands interventions in integrated chain modeling and data system design, not just better planning.

Finally, research findings confirm that there is no high efficiency in pre-production (planning) and elementary levels (providing fodder and livestock feed) of Iran's red meat value chain; So that the livestock feed production is done without planning and without considering demand of next levels of chain (livestock production). In intermediate levels of chain (livestock production), there is no integrated planning to supply chain regarding livestock production. In such a way that traditional, industrial and nomadic animal husbandries operate in an island manner and produce without considering demand and initial stock. At the end levels (livestock slaughter and meat distribution) there are many problems, especially lack of inventory and high price of red meat for final consumers. The problems at the end levels are rooted in lack of proper planning at the beginning and middle levels of chain. Furthermore, examining meat industry in successful countries indicates that a joint institution is responsible for chain integration. Hence, creating trustee consisting of different members of chain with a single window view in entire Iran's red meat value chain is of undeniable importance. This institution

or policy-making council should consist of representatives of various public and private sectors and be responsible for basic matters such as planning and empowering Iran's red meat value chain.

To directly address the measured inefficiencies, we propose:

For Low-Efficiency Planning Processes (C1): Establish a national digital platform for the red meat chain to integrate data on input supply, livestock inventory, and demand forecasts (addressing C111, C116).

For Low-Efficiency Empowering Processes (C3): Form the suggested Policy Council with a mandate to formulate specific regulations on contract farming, quality standards, and inter-provincial logistics (addressing C311, C341).

For Medium-Efficiency Executive Processes (C2): Promote cluster-based development by linking traditional producers to industrial slaughterhouses and modern retailers through incentive schemes (improving C27, C22).

As noted in Section 4.4, this study relies on expert perception. Future research should validate these efficiency scores with objective data (e.g., actual cost ratios, yield gaps) and conduct regional case studies to tailor these national-level findings to local conditions.

This study faces some limitations: first, the possibility of bias in expert opinions despite compliance with selection criteria; second, the focus on the AHP method and the lack of consideration of interdependence of indicators, which can be resolved in future research with ANP; third, the limitation of the generalizability of the findings due to the sample size of 23 people; fourth, the lack of separation of light and heavy livestock chains, which is suggested to be considered in future studies.

Another limitation of this research is its focus solely on the economic and managerial dimensions of value chain efficiency and its neglect of environmental sustainability indicators such as water footprint, greenhouse gas emissions, waste management, and animal welfare. Therefore, for future studies, it is recommended to investigate and evaluate the efficiency of the red meat value chain with a three-dimensional sustainability approach (economic, social, and environmental) with an emphasis on indicators such as water consumption intensity, carbon emissions, and slaughterhouse waste management.

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اندازه‌گیری کارایی زنجیره ارزش گوشت قرمز ایران (رویکرد مدل BSC-AHP)

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چکیده

ناکارآمدی در زنجیره ارزش گوشت قرمز ایران منجر به افزایش سرسام‌آور قیمت‌ها، حذف از سبد غذایی گروه‌های آسیب‌پذیر و تنگناهای سیستماتیک در تولید و توزیع شده است. برای پرداختن به این موضوع، این مطالعه به سنجش کارایی زنجیره ارزش گوشت قرمز در ایران می‌پردازد. برای این منظور، ابتدا شاخص‌های عملکرد زنجیره ارزش با استفاده از تکنیک دلفی توسط گروهی متشکل از 23 متخصص (که از طریق نمونه‌گیری گلوله برفی انتخاب شده‌اند) آشنا با زنجیره تامین ملی گوشت قرمز ایران شناسایی شدند. متعاقباً، این شاخص‌ها با استفاده از فرآیند تحلیل سلسله مراتبی (AHP) در چهار منظر چارچوب کارت امتیازی متوازن (BSC) وزن‌دهی شدند. این مطالعه با ارائه یک اندازه‌گیری جامع کارایی در سطح ملی با استفاده از یک چارچوب یکپارچه BSC-AHP-Delphi که قبلاً در زنجیره ارزش گوشت قرمز ایران اعمال نشده است، به این امر کمک می‌کند. نتایج نشان داد که معیارهای سنجش کارایی زنجیره ارزش گوشت قرمز ایران شامل 79 زیرشاخص فرعی، 15 زیرشاخص و 3 شاخص اصلی است. همچنین، در بین ابعاد کارت امتیازی متوازن، به ترتیب فرآیندهای اجرایی، بعد رشد، بعد مالی و بعد مصرف‌کننده دارای اهمیت هستند. همچنین، کارایی زنجیره ارزش در «فرآیندهای برنامه‌ریزی» و «فرآیندهای توانمندساز» کم و در «فرآیندهای اجرایی» متوسط ارزیابی شد. علاوه بر این، زیرشاخص‌های اصلی «طراحی و برنامه‌ریزی کل زنجیره» و «فرآیند توزیع و فروش» به ترتیب کمترین و بیشترین کارایی را داشتند و کارایی کل زنجیره ارزش گوشت قرمز ایران کم ارزیابی شد. در نهایت، به منظور افزایش کارایی زنجیره ارزش محصول مورد بررسی، پیشنهاد شد که «شورای سیاست‌گذاری زنجیره ارزش گوشت قرمز ایران» تشکیل شود.