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Technological Capability Assessment of Iranian Confectionery and Chocolate Manufacturers: An Approach Based on the AFRICP Model

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Abstract

The Iranian confectionery and chocolate industry has considerable potential for industrial upgrading, employment generation, and regional export development. Nevertheless, the accumulation of production capabilities has not translated proportionately into stable access to international markets and stronger inter-firm and institutional linkages. This study assesses the technological capabilities of leading Iranian confectionery and chocolate manufacturers and identifies the principal capability gaps and upgrading constraints. Drawing on an evolutionary perspective on technological learning and a capability-based framework adapted from the AFRICP approach, the study examines five dimensions: function, product, production process, end market, and linkages. An exploratory mixed-method design was employed, combining semi-structured interviews and structured capability scoring among ten leading firms with export experience and established domestic brands. To improve methodological transparency, dimension-specific scoring rules and an explicit aggregation procedure were applied. Because the end-market indicator showed no quantitative variation across the ten firms, its numerical score was treated as a descriptive indicator rather than as a discriminating component of the composite capability index; the distinction between domestic market strength and international market capability was subsequently examined through qualitative evidence. The findings indicate relatively strong capabilities in production processes and products, while substantial heterogeneity remains in functional capabilities and linkages. In particular, institutional and inter-firm linkages are weak, and international market relationships are often temporary and vulnerable to sanctions, currency-transfer constraints, and exchange-rate volatility. The results suggest that technological capability accumulation in the industry has been stronger than its conversion into sustained international market access and systemic upgrading. Accordingly, policy interventions should simultaneously address firm-level capability deepening, inter-firm and institutional coordination, export-market diversification, workforce development, and the institutional conditions required for learning and innovation.

Keywords: Technological Capabilities; Confectionery and Chocolate Industry; AFRICP Framework

چکیده

صنعت شیرینی و شکلات ایران از پتانسیل بالایی در ارتقای صنعتی، اشتغال‌زایی و توسعه صادرات منطقه‌ای برخوردار است. با این حال، انباشت قابلیت‌های تولیدی در این بخش به‌طور متناسب به نفوذ پایدار در بازارهای جهانی و شکل‌گیری پیوندهای مستحکم بین‌بنگاهی و نهادی منجر نشده است. این مطالعه با اتکا به رویکرد تکاملی یادگیری فناورانه و چارچوب قابلیت‌محورِ برگرفته از مدل AFRICP، توانمندی‌های فناورانه شرکت‌های پیشرو را در پنج بعد «کارکرد»، «محصول»، «فرآیند تولید»، «بازار نهایی» و «پیوندها» ارزیابی می‌کند. پژوهش با روش آمیخته اکتشافی و از طریق مصاحبه‌های نیمه‌ساختاریافته و امتیازدهی ساختاریافته به ۱۰ بنگاه پیشتاز و صادرات‌محور انجام پذیرفته است. یافته‌ها مبین استحکام قابلیت‌ها در ابعاد فرآیند تولید و تنوع محصول است؛ اما ناهمگونی شدیدی در قابلیت‌های کارکردی و ضعف مفرط در پیوندهای نهادی و بین‌بنگاهی به چشم می‌خورد. افزون بر این، حضور در بازارهای بین‌المللی عمدتاً شکننده، کوتاه‌مدت و متأثر از تکانه‌های ارزی، تحریم و چالش‌های نقل‌وانتقال مالی است. نتایج نشان می‌دهد انباشت قابلیت‌های فناورانه بر ظرفیت تبدیل آن‌ها به نفوذ پایدار تجاری و ارتقای سیستمی پیشی گرفته است. بنابراین، مداخله سیاست‌گذار باید هم‌زمان بر عمق‌بخشی به قابلیت‌های درون‌بنگاهی، توسعه هماهنگی‌های نهادی و شبکه‌ای، تنوع‌بخشی به مقاصد صادراتی، ارتقای سرمایه انسانی و بهبود زیرساخت‌های نهادی یادگیری و نوآوری متمرکز گردد.

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1. Introduction

Industrial development in emerging economies has always been intertwined with the issue of "learning" and "accumulation of technological capabilities" (Amsden, 2001; Lall, 1992). Unlike neoclassical approaches that view technology as a public good readily transferable, the evolutionary economics approach emphasizes that technology comprises tacit knowledge and firm-specific routines that can only be acquired through experience, trial and error, and learning by doing (Nelson & Winter, 1982). From this perspective, industrial competitiveness depends not merely on production costs or cheap labor, but on the extent and depth of technological capabilities accumulated within firms (Khan, 2009; Lall, 1992).

The Iranian confectionery and chocolate industry represents a significant segment of the country's food-processing sector and has developed a substantial domestic production base and export presence. Available official statistics indicate significant production and trade activity in the sector; however, because monetary values and revenue changes in Iran are strongly affected by inflation and exchange-rate movements, nominal market-value and revenue-growth figures should be interpreted cautiously. Accordingly, this study does not use nominal revenue growth as evidence of real industrial expansion and focuses instead on firm-level technological capabilities, production performance, market relationships, and upgrading constraints (Statistical Center of Iran, 2020; Islamic Republic of Iran Customs Administration, 2023). Nevertheless, despite qualitative achievements (such that the quality of products from some factories is comparable to European samples), this industry has not been able to gain a worthy position in global markets, and its export share remains negligible.

The main research question is why, despite the efforts of confectionery and chocolate manufacturers over the past years, this industry has failed to achieve desired competitiveness. Answering this question requires going beyond macroeconomic analyses and entering the firm level, studying technological capabilities; because as Bell and Pavitt (1995) argue, technological capabilities are "intangible and non-transferable capital" that underpin the structural transformation of the national economy and diversification into new products and industries.

Accordingly, the main objective of this research is to assess the technological capabilities of leading firms in the Iranian confectionery and chocolate industry using a capability-based framework adapted from the AFRICP approach and the broader technological-capability literature. The framework used in this study focuses on five analytically distinct dimensions: function, product, production process, end market, and linkages. The first four dimensions capture firms' ability to undertake increasingly sophisticated value-adding activities and participate in domestic and international markets, while the linkage dimension captures the relational and institutional capabilities required for learning, knowledge exchange, and upgrading (Lall, 1992; Morrison et al., 2008).

The use of this framework in the confectionery and chocolate industry requires an explicit adaptation because the underlying capability literature has been applied across

different industrial contexts. The present study therefore does not assume that an industry-specific framework developed for another sector can be transferred mechanically to food manufacturing. Instead, the dimensions and indicators were contextualized to the technological, production, market, and inter-organizational characteristics of confectionery and chocolate manufacturing. In particular, product complexity and variety, production quality and reliability, market relationships, andinter-firm and institutional linkages were operationalized according to the characteristics of theIranian confectionery and chocolate value chain. This adaptation is consistent with the capability literature, which emphasizes that technological capabilities are context-dependent and embedded in firm-specific learning processes (Lall, 1992; Morrison et al., 2008).

The significance of this study is therefore not the application of AFRICP as a universal industrytemplate, but its contextual adaptation as an analytical device for examining technologicalcapability accumulation and upgrading constraints in an Iranian food-processing industry.

2. Theoretical Framework and Literature Review

2-1. The Concept of Technological Capabilities: From Evolutionary Economics to the Firm-Level Approach

The theoretical roots of the concept of "technological capabilities" go back to evolutionary economics and the foundational works of Nelson and Winter (1982). In this theoretical tradition, the firm is conceptualized as "a set of routines" that are formed over time through learning, trial and error, adaptation, and imitation. These routines include not only codified knowledge but also tacit dimensions embedded in individual skills, organizational structures, and patterns of social interaction (Bell & Pavitt, 1995). Hence, technology transfer is not possible merely by purchasing machinery or obtaining technical documents; it requires "learning by doing" and "problem- solving" in the specific contexts of each firm (Lall, 1993).

Lall (1992, 1996), systematizing these concepts, divides technological capabilities into three general categories: (1) **"Investment capabilities"** – skills needed to identify, evaluate, design, construct, equip, and commission new facilities; (2) **"Production capabilities"** – skills necessary for the efficient operation of a production unit and its continuous improvement through quality control, maintenance, inventory management, and innovation in processes and products; and (3) **"Linkage capabilities"** – communication skills and relationship management with suppliers, buyers, consultants, research institutions, and government agencies. Each of these categories can also be distinguished at three levels of complexity (basic, intermediate, advanced) (Biggs et al., 1995).

A key concept in the technological capabilities literature is the distinction between "static efficiency" and "learning dynamics." Firms may achieve a certain level of productivity using existing technology, but to maintain competitiveness in the long run they need continuous

investment in "technological efforts" including training, R&D, acquisition and adaptation of new technologies, and organizational improvement (Lall, 1993; Khan, 2013). These efforts always involve risk and uncertainty, because the learning path and the time to achieve competitive productivity cannot be predicted in advance.

2-2. The AFRICP Model: A Matrix for Assessing Technological Capabilities

The AFRICP model, conceptually formulated by Lall (1992) and operationalized by UNIDO for various industries, provides a matrix framework for assessing technological capabilities at the firm level (Morrison et al., 2008). In this model, technological capabilities are classified into four main dimensions: "Product" (complexity and variety of manufactured products), **"Production process"** (quality, reliability, productivity, and compliance with standards), **"End market"** (number and stability of relationships with buyers and distribution channels), and **"Linkages"** (relationships with other firms, suppliers, government and educational institutions). To these four dimensions, a fifth dimension, **"Function"**, is added, which specifies the firm's position in the value chain from simple assembly for others (OEM) to custom design (ODM) and finally own-brand manufacturing (OBM) and turnkey (Gereffi, 1999).

The extended matrix in the present study (Table 1) integrates Lall's approach with global value chain literature. The vertical axis of this matrix corresponds to **"functional upgrading,"** meaning that moving toward higher functions in the value chain (from mere production to design, branding, logistics, and distribution) requires more complex and advanced capabilities (Humphrey & Schmitz, 2002). The horizontal axis details the five capability dimensions at three levels of complexity (basic, intermediate, advanced). This matrix enables analysis of both **"horizontal upgrading"** (deepening capabilities within a given function) and **"vertical upgrading"** (moving to higher functions).

Table 1: Technological Capability Assessment Matrix Adapted to the Iranian Confectionery and Chocolate Industry

Capability dimension	Basic	Intermediate	Advanced
Function	Turnkey production based mainly on established routines	Turnkey production with strong branding and market coordination	Strong own-brand capabilities combined with advanced design, marketing and value-chain functions
Product	Simple and standardized products with limited variety	Moderate variety and complexity	High variety, product differentiation and technically complex products
Production process	Basic quality control and limited process standardization	Formal quality-management systems and process improvement	Advanced quality systems, multiple international standards, high reliability and continuous process innovation

Capability dimension	Basic	Intermediate	Advanced
End market	Concentration on a limited number of domestic buyers/ channels	Multiple domestic channels and relatively stable buyer relationships	Diversified domestic and international markets with stable export relationships
Linkages	Limited relationships with suppliers and other firms	Formal supplier relationships and emerging industry collaboration	Extensive vertical and horizontal linkages, institutional collaboration and joint learning/R&D

Table 1 presents the operational capability dimensions used in the empirical analysis. Investment capability and logistics/supply-chain finance are not treated as independent measured dimensions in the present study because the interview instrument did not generate sufficiently systematic indicators for their quantitative assessment. They are therefore considered contextual factors that may influence capability accumulation rather than direct components of the empirical capability index. This distinction is important for maintaining consistency between the conceptual framework, measurement instrument, and empirical analysis.

2-3. Linking Technological Capabilities to Upgrading in Global Value Chains

In the last two decades, the global value chains (GVC) literature has provided a powerful framework for analyzing industrial dynamics and upgrading paths of firms in the global economy (Gereffi et al., 2005; Coe & Yeung, 2015). Upgrading in this literature refers to the process by which firms improve their position in the hierarchy of value-added activities (Bair & Gereffi, 2003). Humphrey and Schmitz (2001, 2002) distinguish four types of upgrading: (1) process upgrading (increasing production efficiency), (2) product upgrading (moving to higher quality and more complex products), (3) functional upgrading (changing the mix of activities toward design, branding, and marketing), and (4) end-market upgrading (diversifying export markets). Later studies have added supply chain upgrading (creating backward linkages) and inter-chain upgrading (entering related industries) (Frederick & Staritz, 2011).

The intersection of technological capabilities and GVC literature lies in the fact that **"technological capabilities underpin the realization of all types of upgrading"**. In other words, without accumulating necessary capabilities in product, process, market, and linkages, no upgrading is possible (Morrison et al., 2008; Pietrobelli & Rabellotti, 2006). However, one should not assume that upgrading is always a linear and upward process. Empirical research has shown that firms may pursue multiple strategies simultaneously: some maintain simple, low- value production, others enter regional markets while simultaneously building own brands for the domestic market (Tokatli, 2013; Pickles et al., 2006). Also, functional upgrading (especially moving to design and branding) is often more successful in domestic and regional markets than in global markets, because global lead firms tend to keep these high-value-added activities within their core competencies (Kaplinsky & Morris, 2001; Navas-Aleman, 2011).

Drawing on the above theoretical framework, this research assesses the technological capabilities of Iranian confectionery and chocolate firms and attempts to identify potential upgrading paths considering the country's specific conditions (sanctions, exchange rate fluctuations, import restrictions).

3. Research Methodology

3-1. Research Approach

The present study employs an "exploratory-explanatory mixed methods" approach. Mixed methods were chosen because assessing technological capabilities requires a combination of quantitative data (scores, percentages, counts) and qualitative data (understanding learning processes, analyzing relationships and linkages, institutional contexts) (Creswell & Clark, 2017). The qualitative part was conducted through semi-structured in-depth interviews, and the quantitative part through a questionnaire derived from the AFRICP model and the scoring guide table.

3-2. Population and Sampling

The research population includes "leading firms in the Iranian confectionery and chocolate industry". Criteria for being leading were: (1) having export experience in the last 5 years (as an indicator of competitive ability in foreign markets) and (2) having a recognized domestic brand (as an indicator of marketing capability and brand investment). After consulting experts and managers of the Iranian Confectionery and Chocolate Industry Association, an initial list of 15 firms was prepared. Of these, after repeated follow-ups and sending formal requests to the association, interviews with stakeholders from "10 firms" were possible (response rate 67%). Each interview lasted between 2 to 8 hours, and in some cases, the interview was conducted in two multi-hour sessions. Interviewees included CEOs, production managers, quality managers, and export managers of the firms.

3-3. Data Collection Instrument and Scoring Procedure

The main research instrument was a "semi-structured questionnaire" derived from the AFRICP model, validated in previous studies (e.g., Biggs et al., 1995; Morrison et al., 2008). This questionnaire comprised five main sections:

1. **"Function":** Questions about the type of firm activities in the value chain (OEM, ODM, OBM, turnkey).
2. **"Product":** Questions about complexity and variety of manufactured products, number of main products, average unit price.
3. **"Production Process":** Questions about on-time delivery rate, internal reject rate (waste and rework), standard certifications (ISO, BSCI, WRAP, ISO 14001), quality control systems.

4. **"End Markets":** Questions about number of main buyers and sales channels, stability of buyer relationships, history of losing buyers.
5. **"Linkages":** Questions about collaboration with other firms (horizontal), relationships with input and service suppliers (vertical), relations with government institutions and industry associations, participation in joint projects.

The main research instrument was a semi-structured questionnaire derived from the capability dimensions identified in the theoretical framework. The instrument contained five capability dimensions: function, product, production process, end market, and linkages. Each indicator was scored on a three-point ordinal scale, where higher values represented greater technological capability. The scoring criteria were defined prior to the assessment and were applied consistently across all ten firms.

Function was assessed on a four-point maximum scale because the observed firms were predominantly operating at the turnkey level, with the distinction between standard turnkey production and turnkey production supported by strong own-brand capabilities. Product capability was assessed through two indicators, product complexity and product variety, with a maximum score of six. Production-process capability was assessed through three indicators, delivery reliability, internal rejection/rework, and certification/quality-management systems, with a maximum score of nine. End-market capability was initially assessed through buyer/ channel breadth and relationship stability, with a maximum score of six. Linkage capability was assessed through horizontal inter-firm relations, vertical supplier relations, and relations with government and industry institutions, with a maximum score of nine.

For each dimension, the score was obtained by summing the scores of its constituent indicators. The following thresholds were used for dimension-level interpretation:

Table 2: Scoring Procedure

Dimension	Maximum score	Low	Medium	High
Function	4	2	3	4
Product	6	2–3	4–5	6
Production process	9	3–5	6–7	8–9
End market	6	2–3	4–5	6
Linkages	9	3–5	6–7	8–9

The overall capability status was not determined by simply summing raw scores across dimensions because the dimensions have different numbers of indicators and therefore different maximum scores. Instead, scores for the four quantitatively discriminating

dimensions, function, product, production process, and linkages, were normalized by dividing each dimension score by its maximum possible score and multiplying by 100. The overall capability index was then calculated as the arithmetic mean of the four normalized dimension scores, thereby assigning equal analytical weight to each dimension.

The following thresholds were used for the overall capability index: below 50 = low; 50–59.99 = lower-medium; 60–69.99 = medium; 70–79.99 = upper-medium; and 80 or above = high. No separate "very high" category was introduced because such a category had not been theoretically or empirically defined in the original scoring framework.

The end-market dimension requires special treatment. Because all ten firms received the maximum numerical score of six, the indicator had zero variance and therefore could not discriminate between firms in the quantitative aggregation. Accordingly, the end-market score is reported descriptively but excluded from the composite index. Its substantive meaning, particularly the distinction between domestic market strength and international market access, is examined using the qualitative interview evidence.

3.4 Data Analysis Method

Qualitative interview data were analyzed using thematic analysis. MAXQDA was used to organize, code, retrieve, and compare interview segments across firms. The analysis followed a systematic thematic-analysis procedure consisting of six stages: familiarization with the data, generation of initial codes, searching for candidate themes, reviewing themes, defining and naming themes, and producing the final analytical narrative (Braun & Clarke, 2006).

The coding process was both deductive and inductive. The five capability dimensions provided an initial analytical structure, while additional codes and subthemes were generated from the interview data when participants identified issues not adequately captured by the predefined framework. Particular attention was given to differences between domestic and international market relationships, inter-firm collaboration, institutional relationships, workforce capabilities, technology acquisition, and external constraints such as sanctions, exchange-rate volatility, and import restrictions.

To enhance the credibility of the qualitative findings, three complementary procedures were employed. First, data triangulation was achieved by interviewing managers occupying different organizational positions, including CEOs, production managers, quality managers, and export managers. Second, member checking was used to clarify the interpretation of key statements with selected interviewees. Third, peer review was used to examine the coherence between codes, themes, and the final interpretation (Lincoln & Guba, 1985).

The qualitative findings were subsequently integrated with the quantitative capability scores. Quantitative scores were used to identify capability profiles and differences across firms, while qualitative evidence was used to explain the mechanisms underlying these differences and to interpret dimensions that could not adequately discriminate between firms quantitatively.

Table 3. Main Themes and Subthemes Identified from the Qualitative Interviews

Main theme	Subthemes	Illustrative analytical meaning
Production capability	Quality control; certification; machinery; delivery reliability	Strong accumulated production routines but persistent external disruptions
Product capability	Product variety; complexity; product differentiation	Moderate product complexity with relatively high variety
Functional capability	Own-brand development; branding; design; market coordination	Stronger downstream functions among established firms
Domestic market capability	Chain stores; domestic channels; brand recognition	Expansion of domestic market presence
International market capability	Export continuity; buyer stability; market diversification	Weak and unstable international relationships
Inter-firm linkages	Supplier relations; joint purchasing; joint R&D	Limited horizontal cooperation
Institutional linkages	Government relations; industry associations; customs	Weak institutional coordination
Learning and upgrading constraints	Sanctions; exchange-rate volatility; training; R&D	External constraints limit capability conversion into upgrading

4. Findings

4.1 General Characteristics of the Studied Firms

Table (4) summarizes the key characteristics of the 10 studied firms. All firms were established between 1956 and 1995 (Iranian calendar years 1335 to 1374) and all have export experience (though often intermittent and unstable). The dominant function of all firms is "turnkey"; meaning they are responsible for input supply, design, production, branding, and distribution. Annual production capacity of firms ranges from 10,000 to 50,000 tons, and number of employees ranges from 277 to 1,500. Most firms have dedicated retail networks, online channel, and direct sales. Interestingly, all firms in the last 5 years (despite the Covid crisis and reduced purchasing power) have experienced growth in capacity and workforce, which according to interviewees is mainly due to reduced presence of foreign brands due to exchange rate jumps and import bans.

Table 4: General Characteristics of Studied Confectionery and Chocolate Manufacturing Firms

Firm	Year Est.	Function	Main Products	Capacity (tons)	Employees	No. of Brands	Export Experience
A	1974	Turnkey	Chocolate, cake, biscuit, gum, snack	46,700	756	10	Yes
B	1956	Turnkey	Biscuit, cake, chocolate, wafer	50,000	972	7	Yes
C	1959	Turnkey	cheese puff, biscuit, gum, chocolate	30,000	1,242	8	Yes
D	1962	Turnkey	Chocolate, gaz, dragee, gum	15,000	560	8	Yes
E	1959	Turnkey	Biscuit, pofak, toffee	40,000	349	5	Yes
F	1961	Turnkey	Biscuit, wafer, cake, cereal	10,000	277	3	Yes
G	1979	Turnkey	Chocolate, cotton candy, jelly, wafer	10,000	600	2	Yes
H	1995	Turnkey	Chocolate, toffee, biscuit, cake mix	30,000	1,500	2	Yes
I	1965	Turnkey	Cake, chocolate, biscuit, wafer	50,000	1,100	22	Yes
J	1988	Turnkey	Chocolate, dragee, licorice, jelly	25,000	500	5	Yes

Source: Research findings.

4-2. Assessment of Firms' Technological Capabilities

Table (5) shows the disaggregated scores of each firm across the five technological capability dimensions. Analysis of findings indicates:

"End-market capability": The end-market dimension requires a cautious interpretation. All ten firms received the maximum quantitative score of six. Although this indicates that the firms have relatively broad and established market access within the measurement criteria used in the questionnaire, the absence of variation means that the indicator cannot distinguish firms statistically or contribute meaningfully to the ranking of their overall technological capabilities.

More importantly, the qualitative interviews reveal a substantial distinction between domestic market strength and international market capability. The firms generally reported strong domestic brand recognition, access to multiple domestic sales channels, and growing relationships with modern retail and chain-store networks. However, international buyer relationships were considerably less stable. Managers reported temporary export relationships, difficulties in transferring export proceeds, sanctions-related constraints, exchange-rate volatility, and instability in input prices as factors that interrupt or weaken international commercial relationships.

Accordingly, the high numerical end-market score should not be interpreted as evidence of strong global market capability. Rather, it reflects the strength of domestic market access within the original measurement structure. The qualitative evidence suggests that international market diversification, buyer stability, and continuity of export relationships remain important upgrading gaps.

"Medium dimensions": "Product" capability in 8 firms was upper-medium (score 5 out of 6) and in 2 firms (F and I) medium (score 4 out of 6). Product complexity level was assessed as "medium" in all firms, while product variety was mostly "high" (11 products or more). Although this high variety indicates flexibility from a technological capability perspective, someinterviewees warned that "excessive variety with limited scale" can lead to lower productivity through lack of focus on flagship products. "Production process" capability also had a relatively balanced distribution: three firms (A, G, H) scored high (8-9), six firms medium (6-7), and one firm (F) low (4). Notable is that despite advanced quality control systems and multiplecertifications (8 firms had more than 6 standard certificates), "on-time delivery" remains aserious challenge. Six firms acknowledged "sometimes" (2-4% of orders) and one firm "often" (more than 5%) face delivery delays. Interviewees cited factors outside the firm's control (power cuts, input shortages, customs and currency problems) as the main causes of delays.

"Weak dimensions": "Linkages" capability in 4 firms was medium (score 6-7 out of 9), in 4 firms high (8-9), and in 2 firms (F and I) low (5). But what remains hidden behind the average scores is "severe inequality within the components of linkages". In most firms, "linkages with local suppliers" (especially after the exchange rate jump and import restrictions) have strengthened, but "relations with government institutions" were assessed as weak in all firms.One CEO stated: "Unfortunately, the government has no understanding of the industry'sproblems… no financial support, no customs facilitation, no technical advice. Our onlyinteraction with the government is through paying taxes and duties." Also, "linkages with other confectionery and chocolate firms" are at a low level. Although the industry association hasbecome more active in recent years, effective and continuous inter-firm collaborations (especially in joint R&D, collective marketing, or group purchasing of inputs) have not materialized.

"Overall score": Based on the combination of the five scores, the status of firms' technological capabilities is as follows: 2 firms "high" (A, G), 4 firms "upper-medium" (B, C, E, J), 2 firms "medium" (D, I), 1 firm "lower-medium" (F), and 1 firm "very high" (H). The dispersion of scores indicates that technological capability in the Iranian confectionery and chocolate industry is not homogeneous, and a significant gap exists between leading firms (e.g., H with continuous export experience and collaboration with international brands) and firms with averageperformance.

Table 5: Technological Capability Scores of Confectionery and Chocolate Manufacturers Based on the AFRICP Model

Firm	Function	Product	Production Process	End Market*	Linkages	Overall capability
A	4 (High)	5 (Medium)	9 (High)	6 (High)	9 (High)	High
B	3 (Medium)	5 (Medium)	7 (Medium)	6 (High)	7 (Medium)	Upper-medium
C	3 (Medium)	5 (Medium)	7 (Medium)	6 (High)	9 (High)	High
D	3 (Medium)	5 (Medium)	7 (Medium)	6 (High)	6 (Medium)	Upper-medium
E	3 (Medium)	5 (Medium)	7 (Medium)	6 (High)	8 (High)	High
F	3 (Medium)	4 (Medium)	4 (Low)	6 (High)	5 (Low)	Medium
G	3 (Medium)	5 (Medium)	9 (High)	6 (High)	9 (High)	High
H	3 (Medium)	5 (Medium)	9 (High)	6 (High)	9 (High)	High
I	3 (Medium)	4 (Medium)	6 (Medium)	6 (High)	5 (Low)	Medium
J	3 (Medium)	5 (Medium)	7 (Medium)	6 (High)	7 (Medium)	Upper-medium

* End-market score is reported descriptively and is not included in the composite overall capability index because all firms received the same score.

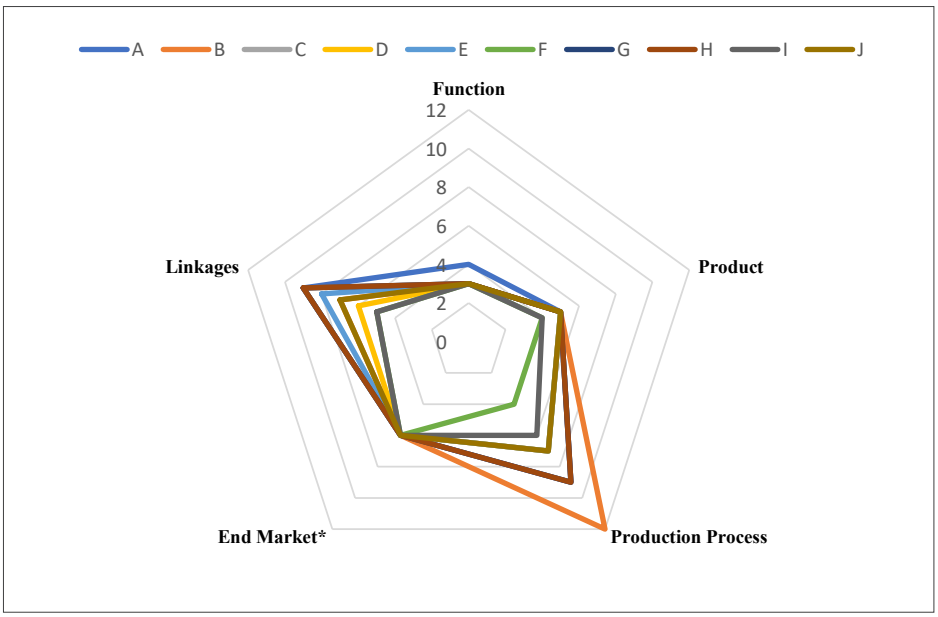

Figure 1. Technological Capability Profiles across the Studied Firms

The revised aggregation procedure produces a more internally consistent classification of the ten firms. Firm A remains in the high-capability category because of its strong performance in production processes and linkages, combined with a relatively advanced functional position. Firms C, E, G, and H also fall into the high-capability category. Firms B, D, and J are classified as upper-medium, while firms F and I are classified as medium. Importantly, firms G and H receive exactly the same classification because their observed dimension scores are identical. No "very high" category is used because such a category was not defined in the original measurement framework.

The results therefore indicate that technological capability is heterogeneous across the sample, but the distribution differs from the original classification. The strongest capabilities are concentrated in production processes and, for some firms, inter-organizational linkages. By contrast, functional depth and especially the ability to convert accumulated production capabilities into stable international market relationships remain important areas for upgrading.

4-3. Structural and Environmental Analysis of the Industry

The qualitative evidence was further interpreted through the complementary lenses of PESTEL and Porter's Diamond. These frameworks were not used as independent quantitative measurement models; rather, they were employed to organize the external factors reported by interviewees and to explain why firm-level technological capabilities have not always translated into sustained competitiveness.

From a PESTEL perspective, political and institutional factors, including international sanctions, restrictions on financial transfers, import regulations, and changes in trade policy, were repeatedly identified as constraints on international transactions and technology acquisition. Economic factors, particularly exchange-rate volatility, inflationary pressures, and fluctuations in input prices, affect both production planning and the continuity of export relationships. Technological factors show a mixed pattern: leading firms have invested in modern machinery, quality-control systems, and certifications, but investment in formal R&D remains limited. Social and human-capital factors are characterized by the coexistence of experienced technical personnel and gaps in advanced managerial, digital, and specialized skills (The evidence does not support a general conclusion that the industry suffers from a uniformly low-skilled workforce. Rather, the interviews indicate an uneven distribution of skills. The industry benefits from experienced engineers, technicians, and production personnel, particularly in established firms, while gaps remain in advanced technical skills, digital capabilities, specialized R&D competencies, international marketing, and managerial capabilities required for global market development. Thus, the principal issue is better characterized as a gap in the depth and breadth of advanced capabilities rather than a general lack of workforce skills.). Legal and regulatory uncertainty, particularly in customs and foreign-exchange procedures, further increases transaction costs.

Porter's Diamond provides a complementary interpretation. Factor conditions are supported by an established industrial base, experienced firms, and accumulated production knowledge, but weaknesses remain in advanced skills, R&D intensity, and access to specialized technological inputs. Demand conditions are relatively favorable in the domestic market because of strong brand recognition and the expansion of modern retail channels, but domestic demand alone is insufficient to generate sustained international competitiveness. Related and supporting industries remain fragmented, particularly with regard to inter-firm collaboration, joint R&D, collective purchasing, and institutional coordination. Finally, firm strategy, structure, and rivalry have encouraged investment in production and branding capabilities, but external constraints have limited the ability of firms to translate these capabilities into diversified international market positions.

Taken together, the two frameworks indicate that the principal competitiveness challenge is not the absence of production capability per se, but the weak conversion of firm-level capabilities into sustained learning, coordination, innovation, and international market access.

5. Discussion and Conclusion

5-1. Interpretation of Findings in Light of the Literature

The findings provide a more differentiated picture of technological capability in the Iranian confectionery and chocolate industry than a simple high-versus-low classification would suggest. The firms have accumulated relatively strong capabilities in production processes and product variety, reflecting learning through repeated production, investment in quality-management systems, acquisition and adaptation of machinery, and exposure to demanding domestic and export markets. This pattern is consistent with the technological-capability literature, which emphasizes that firms in developing economies often accumulate production capabilities before achieving more advanced functional, market, and innovation capabilities (Lall, 1992; Morrison et al., 2008).

However, the findings also demonstrate that production capability does not automatically translate into international upgrading. The firms examined in this study have relatively strong domestic market access, but the qualitative evidence indicates that international buyer relationships remain unstable. This distinction is important because market access and technological capability are mutually reinforcing only when market relationships generate sustained learning, information exchange, and opportunities for upgrading. In the Iranian context, sanctions, exchange-rate volatility, restrictions on financial transfers, and trade-policy uncertainty interrupt these learning mechanisms.

The findings concerning linkages are particularly important. While some firms have developed stronger relationships with local suppliers, horizontal collaboration among manufacturers and institutional relations with government agencies remain weak. This

supports the broader literature emphasizing the role of inter-firm and institutional linkages in knowledge diffusion and technological upgrading (Morrison et al., 2008). The problem is therefore not simply a shortage of technological resources within individual firms; it is also a coordination problem involving firms, suppliers, industry associations, knowledge institutions, and public agencies.

The findings are also consistent with the global value chain literature, which distinguishes process, product, functional, and market upgrading (Humphrey & Schmitz, 2002; Gereffi et al., 2005). The Iranian firms appear to have made greater progress in process and product capabilities than in international market and linkage capabilities. Consequently, the central upgrading challenge is to convert accumulated production knowledge into more diversified markets, stronger relational capabilities, and sustained learning.

5-2. Upgrading Paths: Opportunities and Constraints

According to the findings, the Iranian confectionery and chocolate industry appears to be at an **"important turning point"**. On one hand, significant technological capabilities (especially in production processes, quality control systems, and product variety) have been accumulated in recent years. On the other hand, constraints in accessing global markets (due to sanctions and structural barriers) and weak institutional linkages prevent full exploitation of these capabilities. In such circumstances, three upgrading paths are conceivable:

"Path One: Deepening in regional and neighboring markets". Instead of focusing on distant European and American markets (which require stringent standards and stable business processe), Iranian firms can target regional markets such as Iraq, Afghanistan, Pakistan, Persian Gulf states, and the Eurasian market. These markets are culturally and taste-wise closer to Iran, with lower entry barriers. The experience of some studied firms (e.g., C and H) shows that continuous exports to Iraq and Afghanistan have been possible despite sanctions. Supportive policies such as customs process facilitation, creation of dedicated export lines, and participation in regional fairs can strengthen this path.

"Path Two: Developing own brands and chain stores in the domestic market". Given the reduced presence of foreign brands (due to exchange rate jumps and import restrictions), a historic opportunity has arisen for domestic brands to increase their market share and consolidate brand identity. This path is profitable in the short term, but in the long term cannot substitute for presence in global markets. Therefore, it should be considered as a temporary and complementary strategy.

Path Three: Collaborating with multinational companies through contractual models (OEM/ODM)". Although sanctions are the main barrier to this path, some interviewees indicated that companies of Russian, Chinese, and Indian nationality are willing to collaborate with Iranian firms (due to low final cost and acceptable quality). Perhaps through the formation of export consortia or specialized trading companies, these negotiations could be facilitated.

Ultimately, this research shows that upgrading the Iranian confectionery and chocolate industry is a "multilevel" issue requiring coordinated interventions at the macro level (exchange rate and trade policy), the sectoral level (supply chain development, standards, R&D), and the firm level (marketing capabilities, branding, linkages). Table 6 summarizes the most important proposed policies based on the research findings.

Table 6: Summary of Proposed Policies at Macro, Sectoral, and Firm Levels

Level	Capability problem	Recommended intervention	Expected upgrading outcome
Macro	Financial and trade uncertainty	Facilitate export-proceeds transfer and reduce foreign-exchange uncertainty	Greater continuity of international transactions
Macro	Sanctions and transaction barriers	Develop alternative financial and trade mechanisms within the applicable regulatory framework	Lower transaction costs
Industry	Weak inter-firm linkages	Establish export consortia, joint purchasing and joint R&D platforms	Stronger collective capabilities
Industry	Limited advanced skills	Industry-specific technical and managerial training	Deeper human capabilities
Industry	Weak international market intelligence	Shared export-market intelligence and buyer databases	Market diversification
Industry	Limited R&D	Establish competitive industry R&D programs involving firms and research institutions	Product and process upgrading
Firm	Strong production but weaker market upgrading	Invest in international marketing, branding and customer relationship capabilities	Functional and market upgrading
Firm	Product variety without sufficient focus	Develop high-value-added and differentiated product portfolios	Product upgrading
Firm	Weak institutional relationships	Strengthen engagement with industry associations and relevant public agencies	Institutional upgrading

5-3. Limitations and Directions for Future Research

Several limitations should be considered when interpreting the findings. First, the empirical sample consists of ten leading firms and therefore does not represent the full population of Iranian confectionery and chocolate manufacturers, particularly small and medium-sized firms without export experience. Second, capability scores were partly based on managerial assessments rather than direct observation of production processes, independent audits, or access to firm-level financial records. Although interviews with managers occupying

different organizational positions and member checking were used to reduce interpretive bias, self-reported assessment remains a potential source of measurement error.

Third, the end-market indicator displayed zero variance across the ten firms. This limitation reduces its usefulness as a quantitative discriminator and indicates the need for a more refined measurement model that separately captures domestic market capability, export-market diversification, buyer stability, and international customer relationships. Future studies should therefore develop and validate a multidimensional market-capability scale rather than relying on a single aggregate indicator.

Fourth, the research captures a specific period characterized by considerable exchange-rate, trade-policy, and sanctions-related uncertainty. Longitudinal research would therefore be valuable for examining how technological capabilities evolve in response to changes in the external environment.

Future research should extend the present study by including a larger and more representative sample, developing a validated measurement scale for technological capabilities in food-processing industries, comparing Iranian firms with regional competitors, and examining the longitudinal relationship between technological learning, market access, and upgrading.

5-4. Final Conclusion

This study examined the technological capabilities of ten leading Iranian confectionery and chocolate manufacturers using a capability-based framework adapted to the characteristics of the industry. The results indicate that the industry has accumulated meaningful capabilities in production processes and product development. These capabilities are reflected in quality-management systems, production technologies, certifications, product variety, and accumulated operational experience.

At the same time, the analysis shows that capability accumulation remains uneven. The principal weaknesses are not necessarily located in basic production capabilities but in the mechanisms through which firms transform these capabilities into sustained upgrading. Inter-firm collaboration, institutional linkages, advanced R&D capabilities, and stable international market relationships remain insufficiently developed.

An important methodological finding is that the original end-market indicator did not discriminate among the firms because all ten received the maximum score. The result should therefore not be interpreted as evidence that firms possess equally strong global market capabilities. Instead, the qualitative evidence indicates a clear distinction between relatively strong domestic market access and more fragile international market relationships. This distinction highlights the importance of separating domestic market strength from export-market capability in future measurement instruments.

Overall, the evidence suggests that the industry's strategic challenge is best described as a transition from production capability accumulation toward capability conversion

and systemic upgrading. At the firm level, this requires deeper investment in product differentiation, R&D, international marketing, and organizational learning. At the industry level, stronger supplier networks, joint R&D, export consortia, and collective market intelligence are required. At the policy level, predictable trade and foreign-exchange arrangements, facilitation of financial transactions, support for international certification, workforce development, and mechanisms for inter-organizational learning are necessary.

The central implication is therefore that Iranian confectionery and chocolate manufacturers largely possess the ability to produce competitively, but their capacity to learn collectively, sustain international relationships, and convert production capabilities into diversified global-market positions remains comparatively limited. Industrial policy should consequently shift from narrowly supporting production toward facilitating capability accumulation, coordination, learning, and international market upgrading.

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