

Evaluation System for the Overseas Competitiveness of Chinese Automobile Products

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Abstract

In the new stage of deep integration between global competition and localized operations, building a scientific, systematic, and operable "automotive overseas product capability evaluation system" is of key significance for promoting the sustainable international development of Chinese automobile enterprises with product value as the core. Based on the international competitive practices of Chinese automotive products, this study proposes a dual evaluation dimension of "intrinsic quality" and "appealing quality" to construct an automotive product evaluation system that meets the requirements of overseas markets.

Keywords

Automotive Overseas Product Capability Evaluation System; Intrinsic Quality; Appealing Quality.

1. Classification and Grading of Overseas Automotive Products

In order to ensure that the evaluation system accurately reflects the core competitive dimensions of each market, it is necessary to systematically classify overseas automotive products based on key environmental variables. The significant differences in policies and regulations, market access standards, natural environments, infrastructure, and consumer habits in various overseas markets collectively determine the definition of exported automotive products (including product categories, powertrain types, etc.), technical configurations, and performance priorities. These differences will directly influence the competitiveness model of products in each market.

Therefore, it is essential first to conduct primary classification of overseas automotive products according to their export markets, secondary classification based on product type, and tertiary classification based on power performance. Then, corresponding product evaluation models should be defined for products at different classification levels.

1.1. Evaluation Target

The evaluation target for overseas automotive product capabilities is passenger vehicles of the M1 category intended for sale outside China.

1.2. Classification and Grading of Evaluation Targets

1.2.1. Primary Classification: According to Overseas Market Regions

Due to significant differences in market access requirements, natural environments, and consumer preferences across different automotive export regions, these factors directly impact product definition and design. Therefore, based on the typical characteristics of each market, overseas automotive products are classified according to key export market regions, including

the European Union, the United Kingdom, North America, Southeast Asia, the Middle East, Latin America, Central Asia, and the Eurasian Economic Union, among others.

1.2.2. Secondary Classification: According to Product Powertrain

Based on the type of powertrain, products are classified into internal combustion engine vehicles and new energy vehicles. New energy vehicles are further divided into battery electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles.

2. Construction of the Evaluation Index System

When Chinese automobile brands expand into overseas markets, they generally face three core challenges: regulatory compliance, product consistency, and environmental adaptability. These three collectively constitute the key sources of indicators for evaluating overseas automotive products. Regulatory compliance and product consistency are the basic thresholds and market requirements for Chinese automotive products to enter overseas markets, while environmental adaptability concerns the actual performance of products in specific usage scenarios, directly determining user experience and market acceptance.

Therefore, Chinese automotive products are evaluated along two dimensions: "intrinsic quality" and "attractive quality." "Intrinsic quality" must cover the basic requirements of regulatory compliance and product consistency, including safety, environmental, cybersecurity, and other requirements for market entry and oversight, as well as basic usability requirements. This represents the fundamental demands for the product and the baseline for market access. "Attractive quality" covers environmental adaptability, intelligent driving, and innovative product design, which exceed user expectations and are key to brand competitiveness[1].

This evaluation selects the European Union region as the primary market for constructing the product evaluation system.

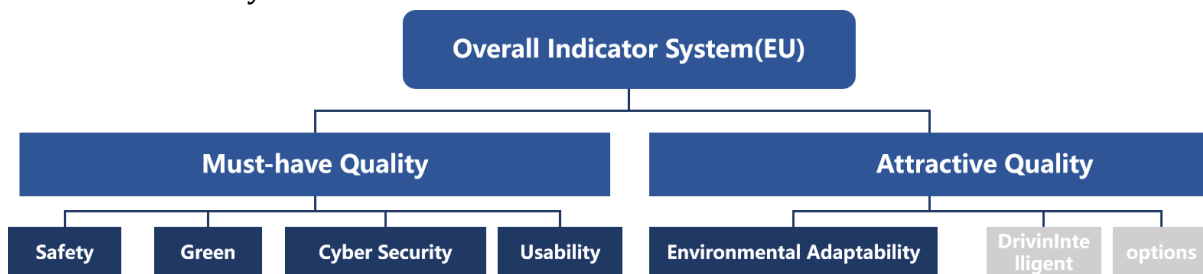


Figure 1. Overall Indicator System (EU)

2.1. Natural Quality Indicator Construction

2.1.1. EU Regulatory Compliance Requirements

The EU's technical regulatory system for automotive product market access management is mainly based on the two major technical framework regulations (EU) 2018/858 and (EU) 2019/2144. It implements access management for complete vehicles and parts of M, N, and O categories, covering regulatory areas such as safety, environmental protection, intelligent driving, and cybersecurity. Safety is the core focus of EU access regulations, covering passive safety, active safety, and special safety aspects, such as collision, braking, and electromagnetic compatibility[2]. The EU's automotive environmental emission requirements are the strictest in the world, mainly including exhaust emissions, noise, and related aspects. With advances in automotive technology, the EU has also incorporated new technical regulatory requirements, such as intelligent driving functions and cybersecurity, into access requirements. All the above fall within the scope of EU regulatory compliance requirements. However, for the evaluation system, the focus will be on incorporating projects that are difficult for automotive products to pass and prone to issues into the scope of natural quality evaluation.

In addition, EU market access also covers regulatory requirements for Level 2 and above functions. However, since this feature is currently an optional function of automotive products, which is a key marketing feature for companies, this part will be included in the scope of attractiveness quality evaluation.

2.1.2. EU Regulatory Consistency Requirements

Table 1. List of EU Market Supervision Sampling Projects

Environmental performance and emissions		
1	Sound level	Regulation (EU) No 540/2014
2	Tailpipe emissions of vehicle in lab	Regulation (EC) No 715/2007
3	Determination of specific CO2 emissions and fuel consumption of vehicle and device for monitoring on board the vehicle the consumption of fuel and/or electric energy	Regulation (EC) No 715/2007
4	Tailpipe emissions on the road	Regulation (EC) No 715/2007
5	Evaporative emissions	Regulation (EC) No 715/2007
6	Low-temperature tailpipe emissions in lab	Regulation (EC) No 715/2007
7	On-board diagnostics	Regulation (EC) No 715/2007
8	Air-conditioning systems	Directive 2006/40/EC
Restraint systems, crash tests, fuel system integrity and high-voltage electrical safety		
9	Safety-belts and restraint systems	UN Regulation No 16
10	112-based eCall in-vehicles systems	Regulation (EU) 2015/758
On-board instruments, electrical systems, vehicle lighting and cyber attacks		
11	Radio interference (electromagnetic compatibility)	UN Regulation No 10
12	Protection of vehicle against cyberattacks	UN Regulation No 155
13	Intelligent speed assistance	(EU) 2021/1958 (9)
14	Installation of light signalling, road illumination and retro-reflective devices	UN Regulation No 48
Vehicle Information Acquisition and OBD		
15	Access to vehicle OBD information and vehicle repair and maintenance information	Regulation (EU) 2018/858, Articles 61 to 66 and Annex X.
16	Software update	UN Regulation No 156
Driver and system behavior		
17	Alcohol interlock installation facilitation	Regulation (EU) 2021/1243
18	Driver drowsiness and attention warning	Regulation (EU) 2021/1341
19	Advanced driver distraction warning	Regulation (EU) 2023/2590
20	Driver availability monitoring system (in case of automated vehicles)	UN Regulation No 157
26	Braking	UN Regulation No 13
27	Advanced emergency braking on light-duty vehicles	UN Regulation No 152
Vulnerable road users, field of vision and visibility		
28	Advanced emergency braking for pedestrians and cyclists ahead	UN Regulation No 152
29	Pedestrian and cyclist collision warning	UN Regulation No 159
30	Blind spot information system	UN Regulation No 151
31	Reversing detection	UN Regulation No 158

The core purpose of EU market supervision is to ensure that products placed on the market continuously comply with the technical requirements of access regulations and to prevent risks to health, safety, the environment, and other public interests. In recent years, the EU has continually strengthened market supervision, significantly expanding and deepening its intensity and scope. The legal basis for market supervision is mainly the EU type-approval

regulation (EU) 2018/858[3], which comprehensively covers both fuel vehicles and new energy vehicles. Regarding regulatory priorities, research shows that the check items of Germany's KBA are still focused on traditional areas such as emissions and safety, while attention to emerging areas such as intelligent driving and information security is increasing. The specific list of spot check items highly overlaps with the EU technical regulatory requirements for market access, as shown below[4].

2.1.3. Usability Requirements

The compatibility of automotive products with local infrastructure, meaning the degree to which vehicles match the public support systems in the target market, including charging networks, fuel, and communication networks, directly affects whether the cars can be used locally. Therefore, infrastructure compatibility, as an important part of environmental adaptability, constitutes a portion of inherent quality.

For example, charging system compatibility pertains to new energy vehicles and focuses on verifying their interoperability with diverse overseas charging facilities. The evaluation should cover the mechanical fit of hardware interfaces, the consistency of communication protocols, the electrical safety and functional stability during the charging process, ensuring that vehicles can access the mainstream charging networks in the target market efficiently and safely. It also involves assessing the coverage and convenience of accessing different operators' networks, the charging efficiency and stability in real-world environments, and the time required to charge from low to full[5].

Communication and network compatibility ensures that in-vehicle intelligent systems (such as smart cockpits and connected car functions) can effectively access local communication networks (such as 4G/5G bands) and reliably receive FM/DAB broadcast signals, ensuring the normal usability of intelligent functions.

2.1.4. Inherent Quality Indicator Setting

Based on the above key points, including EU regulatory compliance requirements, EU conformity requirements, and usability requirements, and fully considering the performance of Chinese automotive products in these key areas, the testing difficulties and easily retestable items are extracted. The inherent quality evaluation indicators are set at three levels: first, second, and third grade.

2.2. Construction of Attractive Quality Indicators

2.2.1. Extreme Climate Tolerance

Due to significant differences between overseas automotive climates and domestic environments, the performance stability and durability of vehicles under special natural climate conditions such as high and low temperatures, humidity, heat, and corrosion present a major challenge. For example, in high-temperature environments, prolonged exposure to high heat, thermal immersion, and high-temperature driving tests are conducted, focusing on assessing air conditioning cooling performance, thermal management systems, and material heat resistance. In extremely cold environments, tests include extremely low-temperature cold starts (including cold immersion), driving on icy and snowy roads, and defrosting/defogging performance, examining low-temperature starts, battery performance, and material brittleness resistance. In high humidity/wet heat areas, anti-mold, anti-corrosion, and electrical insulation performance are verified. In high-altitude regions, power degradation and adaptability of thermal management systems at high altitudes are evaluated. This also includes protective capabilities, driving stability, and safety under extreme weather conditions[6].

Table 2. Quality Rating Indicators

Level 1 Indicators	Level 2 Indicators	Level 3 Indicators
Safety	Passive Safety	Frontal Crash Test
		Offset Crash Test
		Side Crash Test
		Pole Crash Test
	Active Safety	Lane Keeping Assistance (LKA) Performance
		Driver Warning and Monitoring
		Emergency Braking
		Intelligent Steering
		Intelligent Speed Assistance (ISA)
Euro NCAP Rating	Reference Evaluation System and Results	
Green	Health	Electromagnetic Compatibility (EMC)
		Noise
	Low Carbon	Tailpipe Emissions
	Energy Consumption	Driving Range
		Energy Consumption
Green NCAP Rating	Reference Evaluation System and Results	
Cybersecurity	Cybersecurity	Cybersecurity
	Data Security	Data Security
Availability	Charging Compatibility	Charging Operator Coverage Rate
		Charging Efficiency
		Charging Time
Availability	Intelligent Cockpit	Network Performance
		DAB Signal Reception Sensitivity
		FM Signal Reception Sensitivity
		Voice Interaction
		Classical Chinese Translation
		Black Screen & System Crash

2.2.2. Adaptability to Complex Road Conditions

There is a significant difference between overseas and domestic road conditions, making vehicle adaptability to local road conditions (such as pavement quality, slope, and congestion) and long-term reliability a major challenge. For example, assessment is conducted on maneuverability, ride comfort, steering precision, and braking performance for typical road conditions in the target market (such as highways, urban roads) and poor roads (such as unpaved roads and damaged roads). Special tests on braking performance, thermal management, and drivability are conducted for region-specific road conditions (such as continuous slopes and congested roads). These validations comprehensively identify product design defects and localization adaptation issues, ensuring compliance with local regulations and market requirements, providing technical assurance for successful entry into overseas

markets. Validation for region-specific road conditions includes checking continuous braking performance and power system thermal management on long uphill and downhill sections (such as mountain roads); frequent start-stop reliability and energy recovery efficiency under congested conditions (for new energy vehicles); drivability and maneuverability in specific traffic environments (such as roundabouts and narrow roads).

2.2.3. Setting Attractive Quality Indicators

Therefore, based on the above dimensions including infrastructure compatibility, extreme climate tolerance, and adaptability to complex road conditions, along with intelligent driving functions that are non-mandatory in the EU, an attractive quality indicator system is formed. Specific indicators are shown in the table below. Since there are currently no industry standards or unified specifications for environmental adaptability indicators, annotations are provided for the assessment content of specific indicators.

Table 3. Charm Quality Evaluation Indicators

Level 1 Indicators	Level 2 Indicators	Level 3 Indicators	Annotation on Index Selection
Extreme Adaptability	High-temperature air conditioning refrigeration	Air conditioning refrigeration efficiency	For high-temperature markets such as the Middle East and Southeast Asia, the cooling speed and stability directly affect driving safety and comfort.
	High-temperature battery temperature control	Battery temperature control (during fast charging)	When fast charging in a high-temperature environment, the battery is prone to overheating. It is necessary to verify whether the thermal management system can effectively control the temperature to ensure charging safety and battery life.
	Extreme cold start	Drag time and start attempts	The vehicle's starting ability in extremely low temperatures is a basic survival indicator. Failure to start will result in the vehicle being unusable.
	Extreme cold range	Actual range attenuation rate	The range of electric vehicles significantly decreases in low temperatures. It is necessary to quantify the extent of the attenuation to provide users with expected management and promote technological optimization.
	Extreme cold charging	Extreme cold charging performance	Low temperatures may cause a sharp decline in charging speed or even prevent charging altogether. This indicator is crucial for the practicality of electric vehicles in cold regions.
	Idle air conditioning test	8-hour fuel consumption, temperature stability	To verify the system stability and energy consumption rationality in scenarios where users in Southeast Asia, the Middle East, and other regions tend to idle the vehicle with the air conditioning on for long periods.
Bonus Items	Intelligent Driving - L2 + Functions		This project combines the design of enterprise product functions, allowing users to freely choose whether to evaluate, which is an added bonus.
	Corporate Selling Points	Can be Designed According to Enterprise Product Selling Points	Incorporating the company's advantageous projects, the enterprise can choose to evaluate or test them on its own, which will be regarded as an additional bonus.

3. Overall Evaluation System and Its Limit Value Settings

3.1. Overall Evaluation System

The following is an indicator system constructed for the EU market, integrating both natural quality and charm quality.

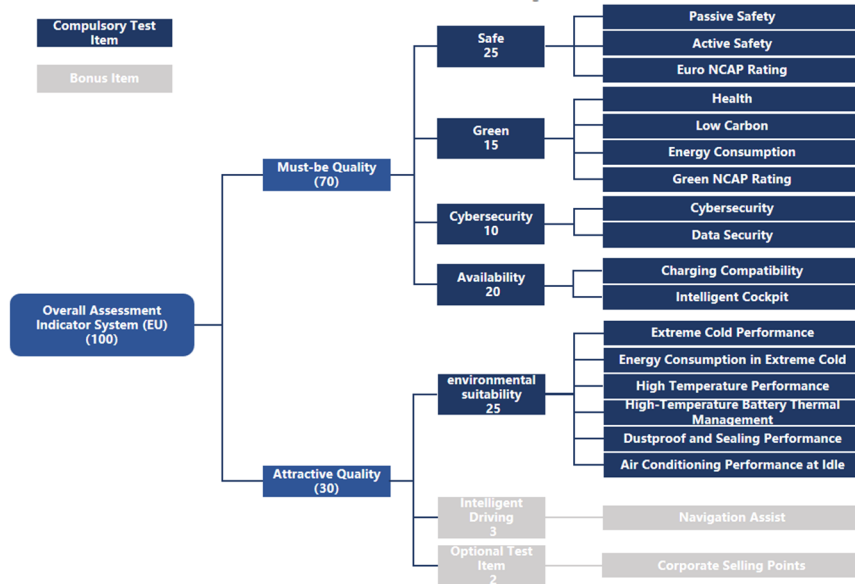


Figure 2. Indicator System Limit Settings

3.2. Evaluation System Assessment Limit Requirements

Table 4. Evaluation system assessment limit requirements

Level 1 Indicators	Level 2 Indicators	Level 3 Indicators	limiting value
Safety	Passive Safety	Frontal Crash Test	R94
		Offset Crash Test	R95
		Side Crash Test	R135
		Pole Crash Test	R137
	Active Safety	Lane Keeping Assistance (LKA) Performance	(EU)2021/646
		Driver Warning and Monitoring	(EU)2021/1341
		Emergency Braking	R152
		Intelligent Steering	R79
		Intelligent Speed Assistance (ISA)	(EU)2021/1958
Euro NCAP Rating	Reference Evaluation System and Results	Euro NCAP evaluation criteria thresholds	
Green	Health	Electromagnetic Compatibility (EMC)	R10
		Noise	R51
	Low Carbon	Tailpipe Emissions	(EC)715/2007
	Energy Consumption	Driving Range	R101

		Energy Consumption	R101	
	Green NCAP Rating	Reference Evaluation System and Results	Green NCAP evaluation criteria thresholds	
Cybersecurity	Cybersecurity	Cybersecurity	R155	
	Data Security	Data Security	R156	
Availability	Charging Compatibility	Charging Operator Coverage Rate	The share of fast-charging operation brands exceeds 95%.	
		Charging Efficiency	The slow charging rate of communication is over 90%, and the fast charging rate of communication is over 92%.	
		Charging Time	When using fast charging, the SOC (State of Charge) goes from 20% to 80%, and the charging time is no more than 30 minutes.	
	Intelligent Cockpit	Network Performance	<ol style="list-style-type: none"> To activate the network connection, both strong coverage and weak coverage functions need to be met. After the flight, the search function requires both strong coverage and weak coverage capabilities to be enabled. It is necessary to meet the inter-frequency redirection function within the system. 	
		DAB Signal Reception Sensitivity	<ol style="list-style-type: none"> Gaussian sensitivity of components: ≤ 97.7 dBm Resonance sensitivity of components: ≤ 92.2 dBm Average gain of the vehicle-mounted DAB antenna: Across all frequency bands, it between 5 ± 3 dBd. 	
		FM Signal Reception Sensitivity	<ol style="list-style-type: none"> Noise limit sensitivity of components (S/N: 30 dB): ≤ 10 dBuV Signal-to-noise ratio of components: ≥ 55 dB Average gain of FM antenna for the entire vehicle: Between -5 dBd and -10 dBd across the full frequency band 	
		Voice Interaction	<p>The interaction success rate is $\geq 85\%$ (in noise-free environment)</p> <p>The interaction success rate is $\geq 80\%$ (at 60 km/h)</p> <p>The interaction success rate is $\geq 75\%$ (at 120 km/h)</p>	
		Classical Chinese Translation	The number of black screen occurrences ≤ 3 (tested continuously for 3*24 hours)	
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Bonus Items	Intelligent Driving - L2+ Functions		
	Corporate Selling Points	Can be Designed According to Enterprise Product Selling Points	

4. Conclusion

This study takes the EU market as a pilot to establish a dual-dimensional evaluation system for the overseas product competitiveness of Chinese automobiles, namely, inherent quality and charm quality. It clearly defines core indicators such as safety, greenness, cyber security, usability, environmental adaptability, and intelligent driving, as well as the regulatory limits of the EU. The system takes into account both the market access bottom line and the localized competitive advantages, providing standardized support for automakers in product optimization, overseas layout, and risk management. In the future, it can be extended to more overseas regional markets, facilitating the high-quality international development of China's automotive industry.

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