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#635

UX EVALUATION

In-car HMI UX Evaluations

In-Car HMI UX Evaluation & Benchmarking

Xpeng P5

First impressions of the Xpeng P5 (China market car) are very positive: a minimalistic, high quality and clutter-free cockpit dominated by a 12.3-inch instrument cluster and a 15.6-inch portrait-configuration central display occupying the entire centre stack. The only immediately obvious physical controls are on the steering wheel, but even these are minimalistic and thoughtfully designed.

In use, the system doesn't disappoint with a high level of responsiveness, functionality and stability, leading to the highest HMI UX score achieved in recent times. There is of course always room for improvement.

| COVERAGE				FREQUENCY			PUBLICATION FORMAT				PAGES
GLOBAL	NA	CHINA	EUROPE	ANNUALLY	QUARTERLY	6 CARS PER YEAR	PDF	POWERPOINT	EXCEL	ONLINE	150+

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Scoring

> **Features and functionality:** evaluating whether the solutions provide features that customers expect, need and solve problems (or provide a wow factor).

> **Usability:** evaluating whether the features available are easy to learn and use. This considers areas such as ergonomics, legibility, usability characteristics and how the system implements the various features.

> **Reliability/stability:** evaluating the repeated usability and whether the users can have a similar (positive) experience each time.

> **Perceived quality:** evaluating the potential perception in quality of the HMI components and how this contributes to the overall customer experience.
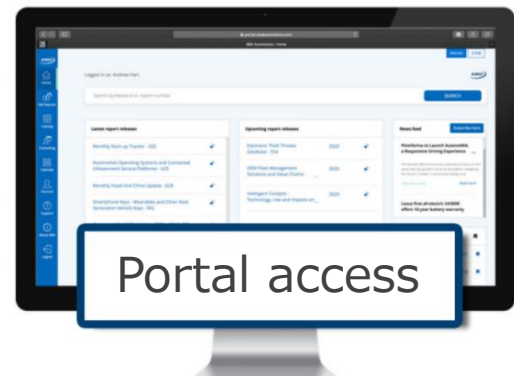
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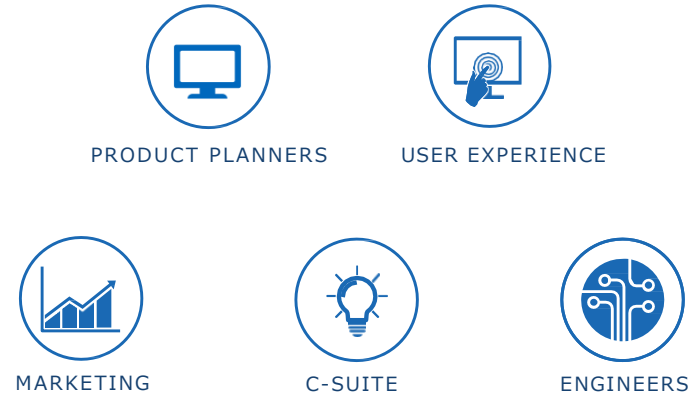
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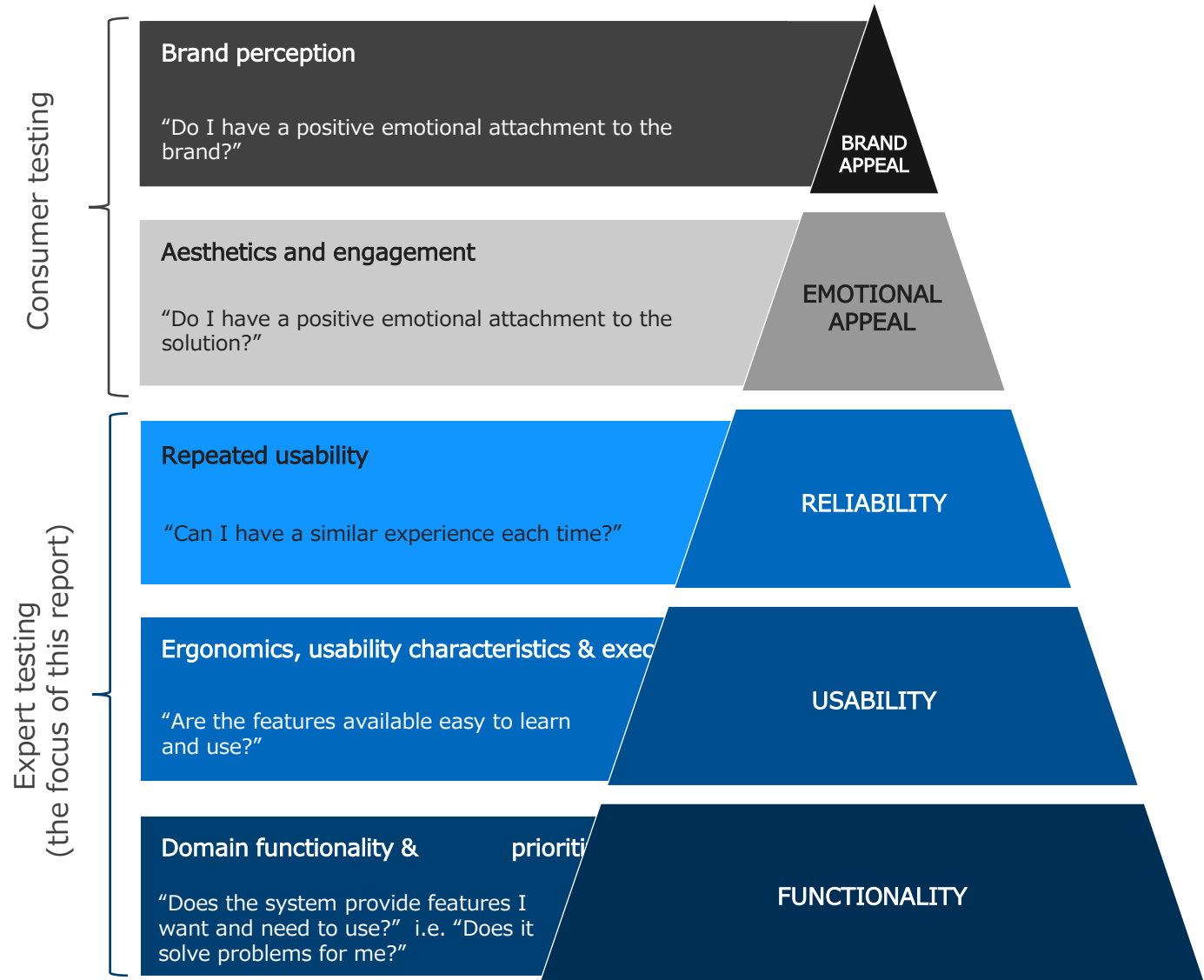Introduction

Aim of this report

Welcome to the 2022 HMI benchmarking report series. This report has been created to provide a fair, unbiased and objective view of the latest in-vehicle HMI solutions in the European, US and Japanese markets. Evaluations are carried out by SBD usability experts with a deep understanding of CASE domains such as the Connected Car and ADAS & autonomy domains.

One of the core goals of these studies is to provide a true indication of what the final customer experience of each solution could be. To do this evaluations are focused on providing scoring and analysis in the following areas:

- **Features and functionality:** evaluating whether the solutions provide features that customers expect & need, and solve problems (or provide a wow factor)

- **Usability:** evaluating whether the features available are easy to learn and use. This considers areas such as ergonomics, legibility, usability characteristics and how the system implements the various features

- **Reliability/stability:** evaluating the repeated usability and whether the users can have a similar (positive) experience each time

- **Perceived quality:** evaluating the potential perception in quality of the HMI components and how this contributes to the overall customer experience

SBD supports clients throughout the development of new HMI and products from a relatively simple companion app to a more complex multi-domain infotainment solution. The methodologies used in these reports take into account many years of experience with consumer testing and custom client projects to provide a fair and, as much as possible, objective methodology.

All viewpoints and analysis within the report are aimed defining areas of concern through a data driven approach. This report aims to benchmark and score solutions whilst also being able to provide actionable recommendations to design and development teams.

Consumer testing

Brand perception

"Do I have a positive emotional attachment to the brand?"

BRAND APPEAL

Aesthetics and engagement

"Do I have a positive emotional attachment to the solution?"

EMOTIONAL APPEAL

Expert testing (the focus of this report)

Repeated usability

"Can I have a similar experience each time?"

RELIABILITY

Ergonomics, usability characteristics & exec

"Are the features available easy to learn and use?"

USABILITY

Domain functionality & prioriti

"Does the system provide features I want and need to use?" i.e. "Does it solve problems for me?"

FUNCTIONALITY

SBD's view on the hierarchy of needs for CX benchmarking

Scope of report: focus on in-car HMI evaluations

The scope of evaluations in this report are constrained to the in-car HMI experience, in both static and dynamic conditions. One notable element is driver distraction which SBD covers at only a high level in this study as carrying out a full driver distraction evaluation requires biometrics test equipment to ensure the collected data is unbiased and objective.

Pre-purchase — Purchase — Activation — In-car HMI — Driver distraction — IoT

A full evaluation of the end-to-end customer experience is not within scope of this report, but it is something which SBD has may years experience in from both a consumer and expert perspective. Other areas such as the companion app, online portal and in-home smart devices are not in scope as they are defined as "out of car" experiences.

Within the vehicle, any HMI element the user interacts with is evaluated including steering wheel controls, touch screen displays, voice control, HUDs and digital keys. The features and services on offer have been broadly grouped into the following domains (or test areas):

- ADAS domain

- Infotainment domain

- Navigation domain

- Voice recognition domain

- Connected services domain

- Convenience domain

2022 vehicle list

SBD has chosen six cars to evaluate in 2022, based on two selection categories. New/interesting UX focuses on systems with to never-seen-before features or functionality, or the implementation of a solution that has previously been a challenge or pain-point for end-users. New mass-market UX includes vehicles in segments that are sold in high numbers and are entering a new generation of UI for that vehicle. While we make best efforts to adhere to the chosen cars and schedule, the last year has seen release dates slipping significantly, so it may be necessary to make substitutions.

| Cars tested				Awaiting test	
Lucid Air	**Rivian R1T**	**Renault Megane E-Tech**	**Xpeng P5**	**GMC Hummer EV**	**Lexus NX**
• Potential disruptor • Multiple displays • US market test	• New disruptor • Appears to have an innovative approach to HMI • US market test	• LG's new Android Automotive IVI • French market test	• High level of ADAS • Advanced voice recognition • Configurable avatar • China market test	• GM's new Android OS system • Unreal Engine graphics • US market test	• New Lexus system • Cloud-based navi • New voice recognition • German market car, UK test

SBD experience through years of testing in-car solutions

Over the last nine years SBD has evaluated 96 solutions from a Connected Car or ADAS perspective for our public report series (many more for private client evaluations). This current report series is an evolution of both test methodologies to provide a holistic view of in-car HMI. Furthermore, custom evaluations methodologies used across the globe for SBD clients have been included where applicable to enhance to overall approach.
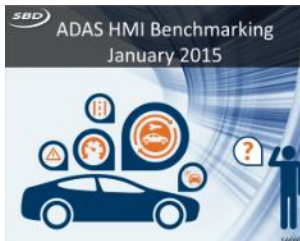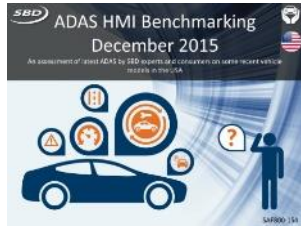
One page methodology overview

One of SBD's core goals of this report is to be as objective, fair and as transparent as possible. To achieve this, various methodologies are used throughout the testing to evaluate different areas of the solution in various conditions.

These methodologies are a mix of different types of tests:

- **Objective tests:** where the value provided is not influenced by a tester's viewpoint e.g. response time

- **Subjective tests:** the test score is based on the expert testers' viewpoints e.g. task ease of use

- **Task-based:** evaluations carried out based on a predefined task list e.g. navigate to a pizza restaurant near location X

- **Freeform:** random free testing by the tester with no clear pre-defined task list. This allows the testers flexibility to dig deeper into various parts of a solution when needed

- **Scoring range:** ranges and definitions of how to score a test element e.g. poor depth and accuracy score = the results provided are not in line with what is reasonably expected by the user

- **Static:** tests are carried out when the vehicle is not moving

- **Dynamic:** tests are carried out when the vehicle is moving in various road conditions and locations e.g. motorways/highways, cities, villages, country roads etc.

- **Misuse/failures:** carried out to evaluate the stability of the solution in unusual conditions e.g. repeatedly pressing the voice command button

This document does not provide a detailed description of the methodology and this page serves to provide an overview of the approach.

For a detailed discussion and presentation of SBD's methodology please contact us.

Test area	Type of tests							
	Objective	Subjective	Task based	Freeform	Scoring range	Static	Dynamic	Misuse/ failures
First impressions		✓		✓		✓	✓	
Static tasks	✓	✓	✓		✓	✓		
Dynamic tasks	✓	✓	✓		✓		✓	
Random free	✓	✓		✓		✓	✓	✓
Navigation specific tests	✓	✓	✓		✓		✓	✓
Voice recognition	✓	✓	✓	✓	✓	✓	✓	✓
Performance & response	✓		✓			✓	✓	✓
System Usability Scale (SUS)		✓			✓			
Final SBD UX score	✓	✓			✓			
ADAS	✓	✓	✓		✓	✓	✓	✓
UX heuristics	✓		✓			✓	✓	
Execution		✓			✓			
Ergonomics	✓	✓	✓			✓	✓	
Legibility & readability	✓		✓			✓	✓	
Perceived Quality (PQ)	✓	✓	✓	✓	✓	✓	✓	

Example slides from the full 150+ page report

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Xpeng P5

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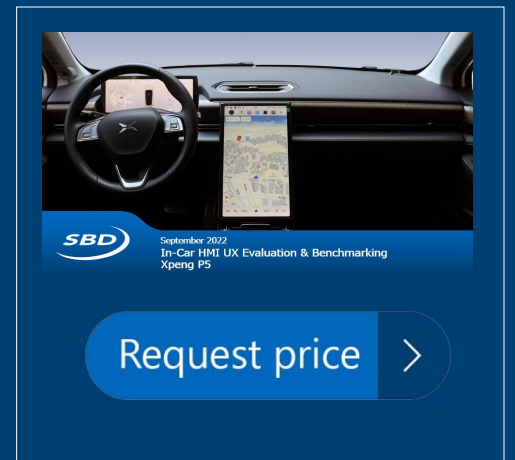
Many delight features, performance features mostly well implemented

Delight feature considerations:

- The P5 has many delight features, among which the ability to connect to a voice-controlled drone is one that stands out.

- Smart recommendation is a less common feature to find in the market. The P5 can push suggestions to the head unit based on location and other conditions.

- In-car games are also notable. Several are provided that do not require touchscreen interaction and can be played with voice only.

Connected drone

The head unit can be connected to a DJI Mavic 2 Pro drone using a USB cable. The drone does not come with the car and has to be purchased separately. The app for the connected drone however, is a native app that comes with the system. Once connected, the drone can be controlled by the P5 voice assistant. Controllable movements include take off, return and several flying modes.

Performance feature considerations:

- No major issues were found in performance features. Most of the features are well implemented.

- Two large, high-definition displays with fast response lead to a smooth and pleasant user experience.

- The handwriting input area is located very low down due to the portrait design, which makes it more difficult to access than it should be.


In-car KTV

Catering to Chinese people's tastes, in-car KTV is not uncommon in connected cars in the Chinese market. However, most OEMs only provide one app, either Changba, WeSing or Thunderstone KTV. Xpeng provides two KTV Apps (Changba and WeSing) for users to choose from. A microphone can be bought in the Xpeng online shop with Bluetooth connection supported.

Issue with parking sensors

3. ADAS

On one occasion, the error message 'Parking sensors unavailable' showed on the instrument cluster in white text, followed by 'Check parking sensors' in yellow. This remained for a few minutes, then was not seen again.
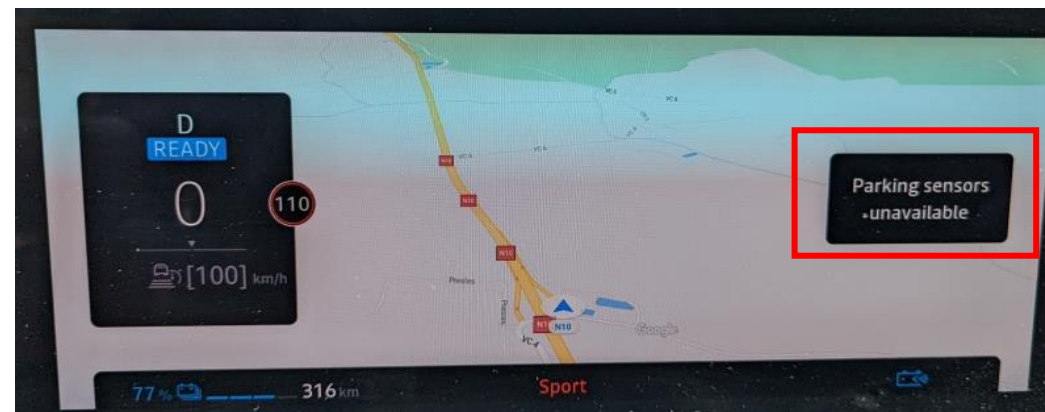
Frequency	Low	Medium	High
Severity	Minor	Major	Critical

Failed to trigger VPA when leaning towards the center console

2. Voice recognition

The Xpeng P5 has positional detection feature. Under most conditions, it is very convenient to use, however, the downside is that the wake-up rate is significantly lower when trying to wake up the VPA near the centre console.

Frequency	Low	Medium	High
Severity	Minor	Major	Critical

Key lowlights

Portrait display leads to bigger glance-down angle

Glancing down posing driving risks

Users must glance down to operate the central display

The central display (15.6-inch) is reasonably wide for a landscape orientation and occupies the entire centre stack.

While this works well for the visual appeal, it unfortunately presented reach issues in operation for SBD's testers. When sitting in the driver's seat, interacting with the central display requires the tester to look down to the screen. Also, since the screen is very large, locating desired information may be time-consuming. This can cause potential risks if the driver is not focusing on the road for a long time.

Perceived Quality: Tactile

Level 1	Tactile
SBD viewpoint	**Stiffness & looseness:** No wobble experienced during testing, everything feels secure and high quality. **Force feedback:** Most of the feedback experienced matches the user's expectations, including feedback from steering wheel buttons and stalks. However, there is no haptic feedback for the display and the response time is good. **Material quality:** The feel of all buttons/stalks/displays provides an impression of good quality. **Material harmony:** Tactile quality is consistent throughout the vehicle. **Geometric & Positioning:** The overall shape of the hard buttons and shifters conveys good quality and fits the brand identity.

Good response time for the central display touch screen

All physical controls give impression of high quality

Level 2 scoring				
Stiffness & looseness	Force feedback	Material quality	Material harmony	Geometric & positioning
Good	Good	Good	Good	Good

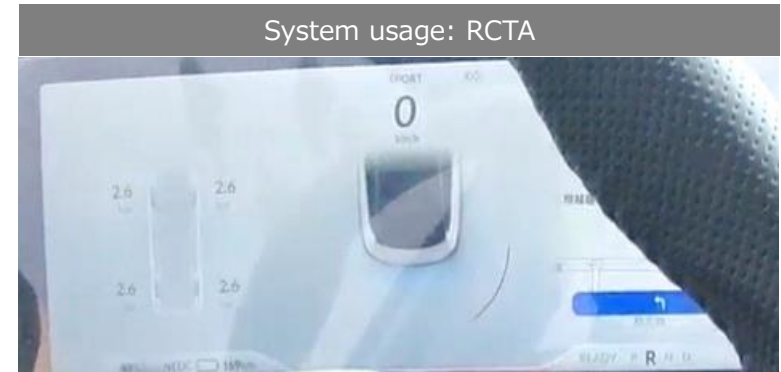# SAE Level 0 ADAS: System usage

System usage: LDW/LKA
Visual warning after lane deviation

System usage: BSM
Warning icon in mirror

System usage: RCTA
Warning in cluster is very subtle

System usage: LKA
Solid line in cluster   Broken line on road
Poor reflection of lane lines

Smart recommendations and reminders

Category	Infotainment
Description	Contextual recommendations/reminders add value
SBD viewpoint	When carrying out static testing, it was observed that the system can either recommend activities that might be suitable to interact with, or give reminders if something happens. • If the vehicle has been started and has remained motionless for a period of time, the system may recommend entertainment activities such as video watching. • If the smart fridge door is left open, it will remind the passengers to close it promptly. This is a pleasing feature that is unexpected and adds an element of 'wow' to the user experience of the system.

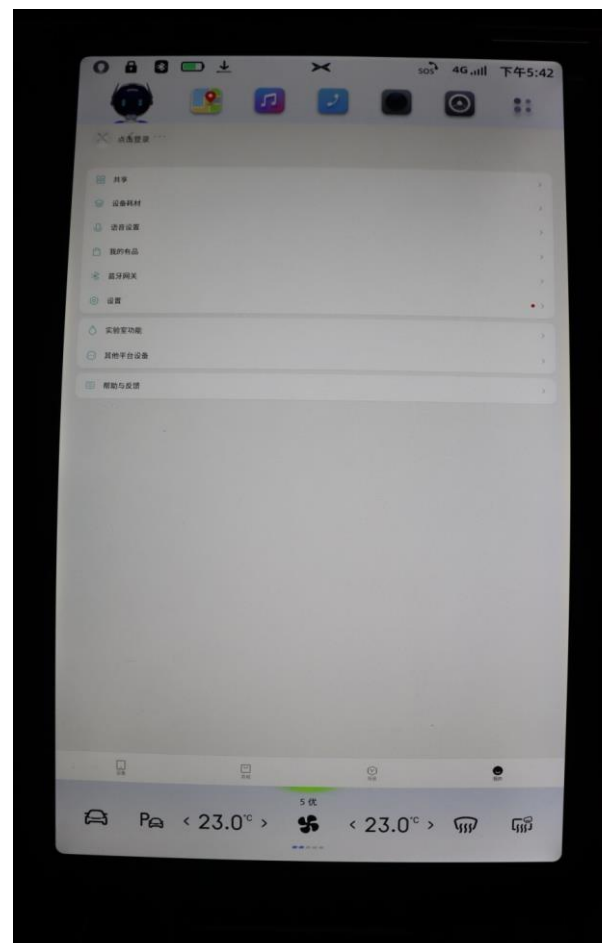| UX impact	Major negative	Minor negative	No impact	Minor positive	Major positive
					Major positive

Shall we watch movies together?

Smart fridge door is open

Pop-up recommendation and reminder shown on screen

Some apps and mini-programs are not well integrated

Category	Infotainment
Description	Third-party apps and mini-programs poorly integrated
SBD viewpoint	Although the system features many third-party apps and mini-programs, not all of them are well integrated. • In some cases, the text shown on the central display is extremely small and cannot be easily read. • Some content is not optimized to fit the full screen and large spaces are left unused. • For mini-programs, the takeout-ordering platform (Eleme) malfunctioned during testing, with pages failing to load normally. The above issues drive down the user experience, and should be prioritized for future OTA improvements.

UX impact	Major negative	Minor negative	No impact	Minor positive	Major positive

Small text size
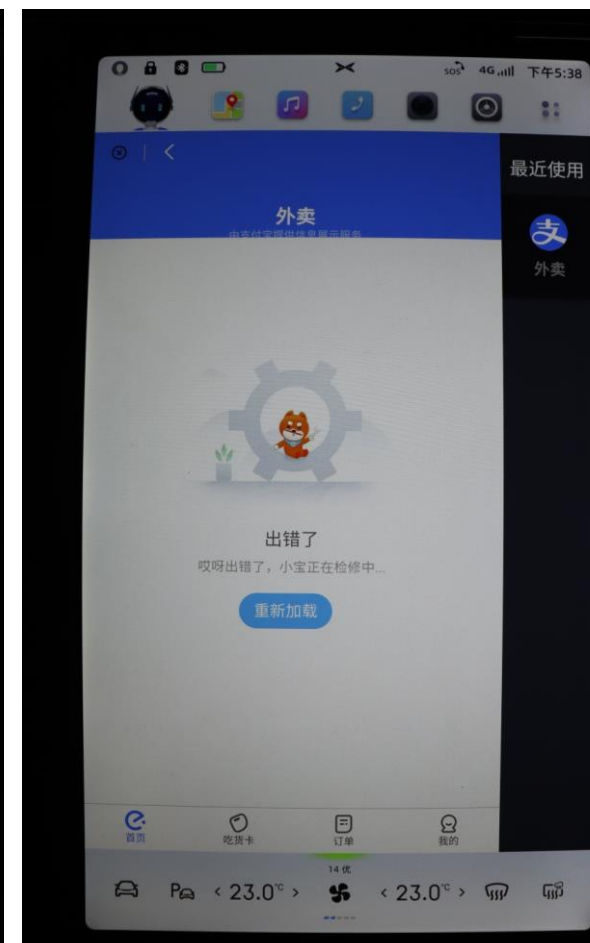
Mini-program bug

USB music playback lacks simplicity

Category	Infotainment
Description	USB music playback requires specific folder structure and file naming
SBD viewpoint	During media source testing, a USB drive containing songs was connected to the system. On connection, a message was shown saying users must create an "Xpeng music folder" in the root of the USB drive, and the songs are recommended to be renamed with a "Singer, Song name" structure. • This process of playing USB tracks is far more complex than it needs to be. • USB media playback is considered a hygiene feature, and should be an effortless process without any requirement for specific folder structures or naming conventions. • To be able to play files, users will have to create a folder on the USB drive using a computer and then move all files into it before potentially renaming each one individually. The system should be able to read any standard music files copied to the USB, irrelevant of naming convention or folder structure. Although USB music is a less frequently used medium nowadays, the current approach is likely to be viewed as a significant and unnecessary inconvenience.

UX impact	Major negative	Minor negative	No impact	Minor positive	Major positive

Cannot find USB music

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Xpeng P5

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Contact SBD Automotive

Do you have any questions?

If you have any questions or feedback about this research report or SBD Automotive's consulting services, you can email us at info@sbdautomotive.com or discuss with your local account manager below.

✉ info@sbdautomotive.com

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USA | UK | Germany | India | China | Japan

Garren Carr
North America
garrencarr@sbdautomotive.com
+1 734 619 7969

Luigi Bisbiglia
UK, South & West Europe
luigibisbiglia@sbdautomotive.com
+44 1908 305102

SBD China Sales Team
China
salesChina@sbdautomotive.com
+86 18516653761

Andrea Sroczynski
Germany, North & East Europe
andreasroczynski@sbdautomotive.com
+49 211 9753153-1

SBD Japan Sales Team
Japan, South Korea & Australia
postbox@sbdautomotive.com
+81 52 253 6201