



In-car HMI UX Evaluations

#635

# In-Car HMI UX Evaluation & Benchmarking

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## End of Year Summary

Welcome to the End-of-Year Summary edition of our 2024 HMI benchmarking reports series.

In this edition, our experts conclude the 2024 series with a broader analysis and comparison between the nine vehicles tested throughout the year. While mapping out their HMI commonalities, and their performance in domains such as navigation and voice recognition, the report also assesses the functionality of each model against 13 UX laws. A concise car-by-car summary similarly offers a mix of deep analysis and top-level takeaways.

In 2024, the series covered the BMW X1, Mercedes-Benz E-Class, Xiaomi SU7, Lincoln Nautilus, Kona Electric, Acura ZDX, Audi Q6 e-tron, Avatr 12, and Mini Electric Countryman.

### COVERAGE



GLOBAL



NA



CHINA



EUROPE

### FREQUENCY



ANNUALLY



QUARTERLY



6 CARS PER YEAR

### PUBLICATION FORMAT



PDF



POWERPOINT



EXCEL



ONLINE

### PAGES



70+

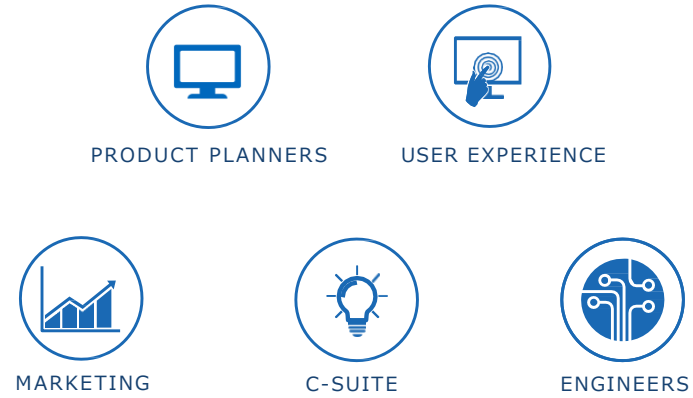
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# Scoring

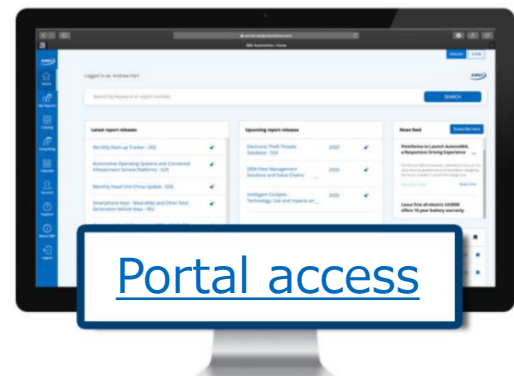
- > **Features and functionality:** evaluating whether the solutions provide features that customers expect, need and solve problems (or provide a wow factor).
- > **Reliability/stability:** evaluating the repeated usability and whether the users can have a similar (positive) experience each time.
- > **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.
- > **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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2024  
**In-Car HMI UX Evaluation & Benchmarking**  
End of Year Summary

635-24(24j)

## 635 - In-Car HMI UX Evaluation & Benchmarking – End of Year Summary

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## Introduction

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# Aim of this report

Welcome to the 2023 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 US, European, 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.

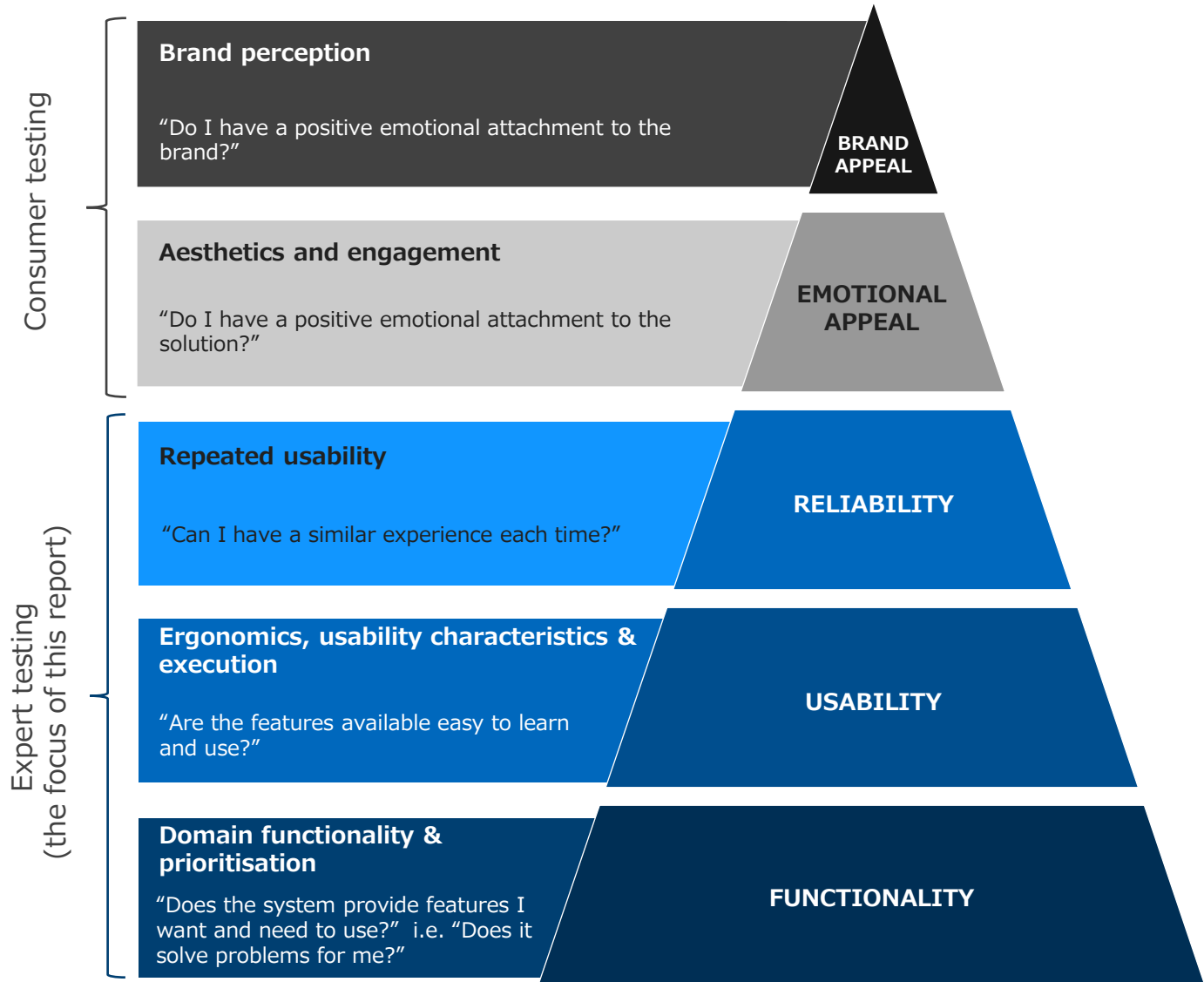
One of the core goals of these studies is to provide a true indication of what the final customer experience of each solution could be. To do this evaluations are focused on providing scoring and analysis in the following areas:

- **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.

Please note that due to the ever-evolving automotive technology market, SBD updates it's methodology each year, but does not update scores from the previous years. Therefore, please assume a slight drop in scores for both user experience (UX) and functionality from the previous year.



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.



A full evaluation of the end-to-end customer experience is not within scope of this report, but it is something which SBD has many 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
- Convenience domain





# 2024 vehicle list

The nine vehicles evaluated in 2024. Selections based on 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 SBD makes best efforts to adhere to the chosen cars and schedule originally planned at the beginning of each year, the last two years have seen release dates slip significantly, so it may be necessary to make substitutions throughout the year.

## Group A

### Cars tested & Report published



**BMW X1**

- First BMW to be released with iDrive9
- Android based system
- US market test



**Mercedes-Benz E-Class**

- All-new MBUX Superscreen
- Unique features, apps and games
- German market test



**Lincoln Nautilus**

- BlueCruise hands free
- Digital Experience
- All-new infotainment system
- US market test



**Hyundai KONA Electric**

- 12.3-inch cluster and central display
- New Bluelink+ services
- US market test



**MINI Electric Countryman**

- MINI Operating System 9
- MINI Navigation AR
- Circular OLED display
- UK market test

## Group B

### Cars tested & Report published



**Xiaomi SU7**

- Xiaomi's first vehicle offering
- New vehicle from CE company
- Xiaomi Pilot MAX
- Chinese market test



**Acura ZDX**

- Google Built-in
- AcuraWatch 360+ with hands free cruise
- US market test



**AVATR 12**

- Harmony 4.0 OS
- Huawei ADS 2.0 (ADAS)
- Innovative displays
- Chinese market test



**Audi Q6 e-tron**

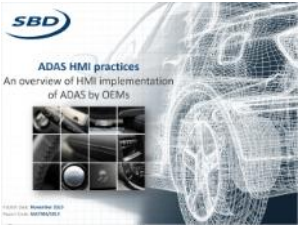
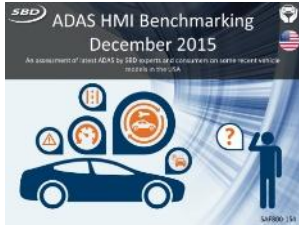
- All-new "Digital Stage" infotainment system
- AR HUD integration
- UK market test





# SBD experience through years of testing in-car solutions

Over the last ten years SBD has evaluated over 100 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.

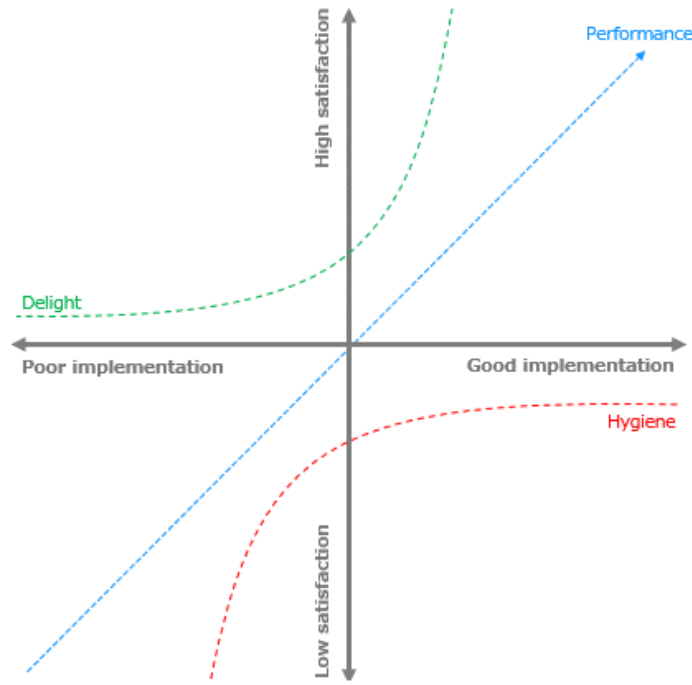
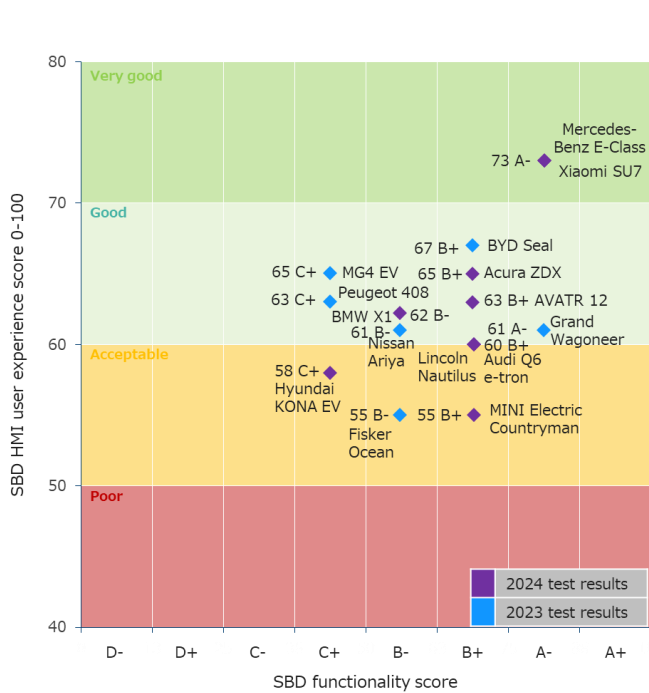
For a detailed discussion and presentation of SBD's methodology please [contact us](#).

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)	✓	✓	✓	✓	✓	✓	✓	

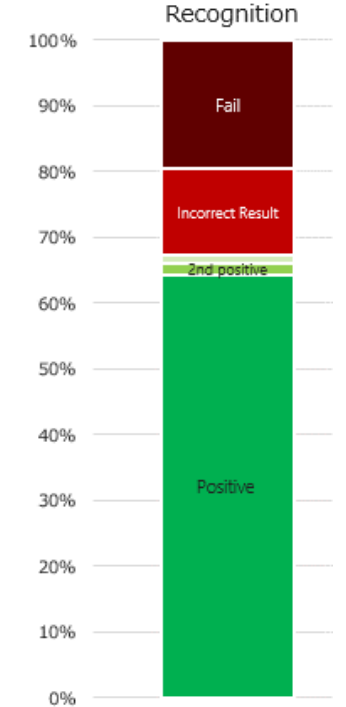


# Report structure and how to interpret certain data sets

Throughout the testing and evaluation process SBD uses multiple methodologies to align to the situation and test area. Outputs from these evaluations can be broadly grouped into the following three types of report outputs - SBD's goal with these options is to ensure understanding of the results are as clear and fair as possible.



UX heuristic	Score
Cockpit clutter	Good
GUI clutter	OK
Display quality/size	Good
Map aesthetics	Very good
Map layout	OK
Navigation routing	OK
Instrument cluster	Good
General system HMI	OK



## UX & functionality score

Final usability scored based on a 100-point scale with solutions scoring less than 40 defined as "not fit for purpose" with major user complaints expected and score above 80 defined as "exceptional".

Functionality score based on eight core feature set areas: delight features, performance features, hygiene features, navigation feature, ADAS, IoT integration, music, entertainment and info features.

## Modified Kano feature analysis

Features plotted against three lines based on their implementation and satisfaction levels:

- **Delight** features: "wow" features likely to provide high satisfaction even with poor implementation
- **Performance** features: as the level of implementation increases so does the customer satisfaction
- **Hygiene** features: poor implementation provides low satisfaction, but good implementation may not provide positive satisfaction as it can be considered as expected functionality

## Subjective & objective scores

Scoring across multiple areas through subjective scoring with pre-defined ranges, definitions, and comparison to past results.

Objective scoring generally based on a pass/fail criteria or time-based considerations. SBD attempts to minimize subjectivity as much as possible with results aimed at being fair and reasonable with a minimal level of bias.

# Example slides from the report



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# Google Built-in UX similarities across OEMs

## Google's control over many aspects of the overall UX

- Now that more systems with Google Built-in have been released into the market and evaluated, some similarities, both good and bad, across OEMs have surfaced.
- Similarities include:
  - Positives:
    - Ability to expand features and functionality with the Google Play Store
    - Good search logic for Google Maps
    - Very familiar UX to CE world for most users
    - Level of depth for POIs in Google Maps, to offer contextual notifications
  - Negatives
    - Frequent stability/bug issues experience with Google Assistant
    - Minimal POI categories offered by Google Maps
    - Google Assistant doesn't always recognize other input methods
    - Google Maps saved/favorited destinations categories is implemented poorly and confusing/unintuitive
- As more systems with Google Built-in are released and evaluated, and these similarities continue, it shows and confirms how much power Google holds in the overall user experience of the vehicles system. Therefore, the important thing for OEMs with Google Built-in in their vehicles to do is find ways outside of the Google features to stand out, like ADAS, radio and phone implementation.



Google Play Store with familiar UX as the CE world and ability to expand system content



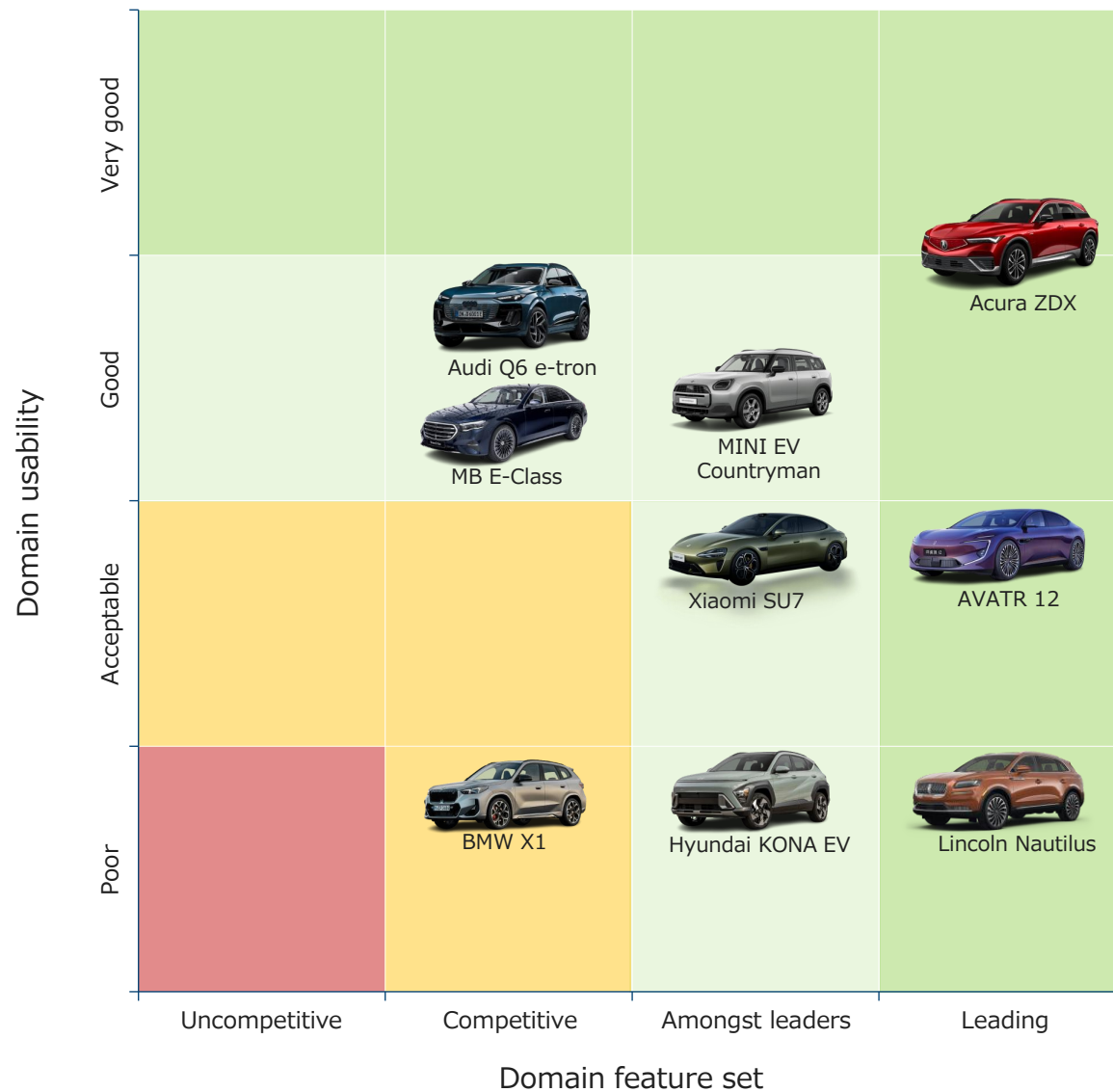
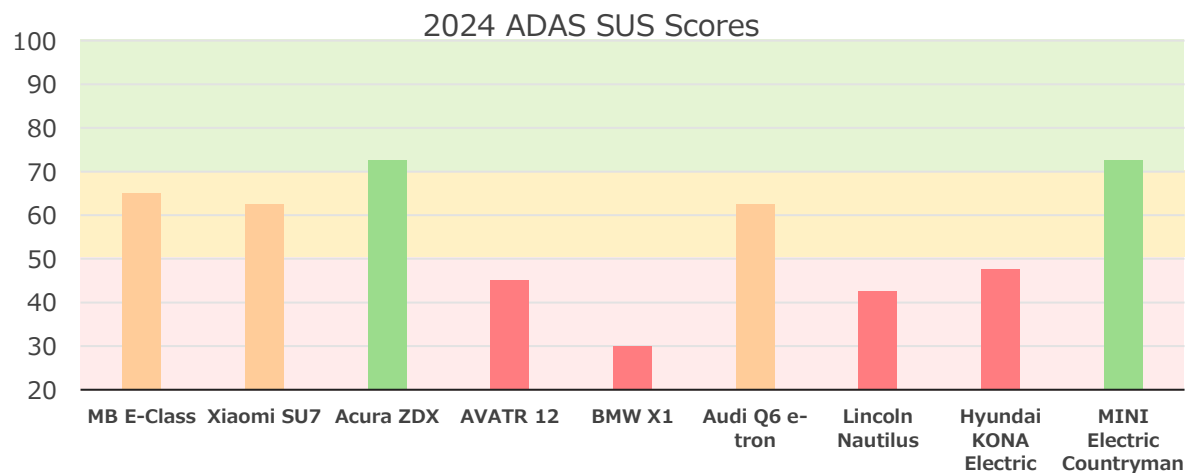
Limited POI categories offered without the ability to customize



# ADAS

This section summarizes the usability and feature offering of ADAS features across the 2024 series showing if there have been any success stories or trade-offs between features and user experience. The section considers the activation, deactivation and in-use feedback of assistance systems, and is not a feature performance rating.

**Acura ZDX, AVATR 12** and **Lincoln Nautilus** are all leading in their featuring offering for ADAS, but as it shows the way in which the features are implemented makes a big difference in the usability score of the feature, especially since these are safety related features.





# Major delight features and impressive voice recognition ability



## Significant delight features offered

Several significant delight features are offered within the vehicle, having a positive impact on user enjoyment as well as creating lasting talking points and positive impression of the brand. These features include a passenger display, ambient lighting that can react to music, digital headlights with animations, Superscreen integration, 3D cluster, games, built-in selfie camera and 4D sound.



## 'Zero-layer' shallow menu structure

When setting up a user profile, the user can choose the 'Zero-layer' theme. This brings frequently used features and information to the home screen using the 'Zero-layer' dock along the bottom of the central display. Suggested feature shortcuts change depending on user habits. This helps to create a shallow menu structure overall and more intuitive experience for the user.



## Capable voice recognition system

The voice recognition system is very capable in the number of tasks and use cases it can complete successfully. Even for those tasks that it cannot complete with a specific utterance, the system offers a good degree of flexibility and works with various other utterances. Due to how successful the system is in returning correct responses, it is often the preferred input method.



# Flying high, but attention required for some hygiene elements

The SU7 offers a rich variety of features and functionality with music listening options and entertainment & information features being particularly impressive and contributing to the high score. IoT integration is also significant with a high level of integration with smart home devices. However, a number of hygiene features are missing and have a negative impact on the overall score. No permanent display of headway, no ability to save radio favorites, the inability to search radio stations by number, limited input method types and the lack of adequate ADAS labelling.

The voice recognition system demonstrates a high level of capability and utilizes a Large Language Model (LLM) to support a high rate of successful responses. The system can be interacted with in a human-like way.

It's clear that Xiaomi have used their expertise in consumer electronic products and applied it to an automotive product. The HMI follows much of the same operating logic. However, Xiaomi may want to take note of traditional OEMs and ensure basic hygiene features are not missed or overlooked.



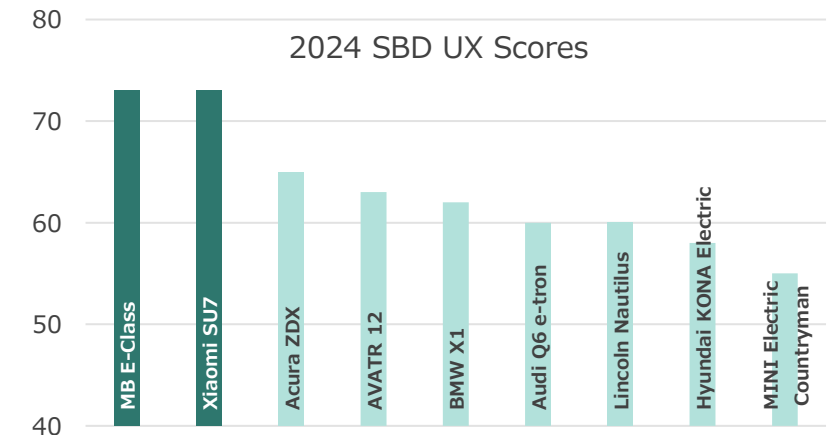
### What the system **does** well

- High features and functionality offering especially for IoT and delight features.
- A large language model (LLM) is used to support the voice recognition system enabling a more human-like interaction and greater understanding and recognition by the system.
- High level of stability offered enabling confidence and trust in the system.
- Seamless Xiaomi phone to car integration, which enables phone mirroring and a broader feature set offering.

### What the system **doesn't** do well

- Lack of important hygiene features offered, including missing input methods, no ability to save radio favorites, the inability to search radio stations by number, and the lack of adequate ADAS labelling.
- Poor implementation of POIs, including inconsistencies throughout and lacking support for searching like subcategories.
- Phone brands supported by the system is limited, with no support offered for Huawei and HONOR phones.

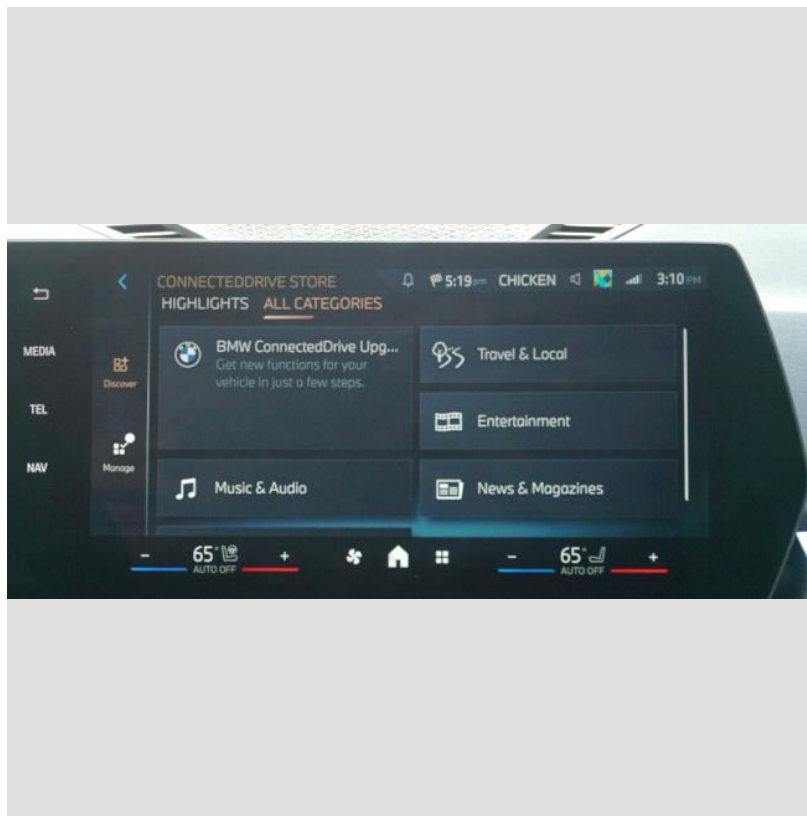
SUS Score by Domain	
Infotainment	72.5
Navigation	67.5
Voice recognition	85
ADAS	62.5
HVAC	77.5





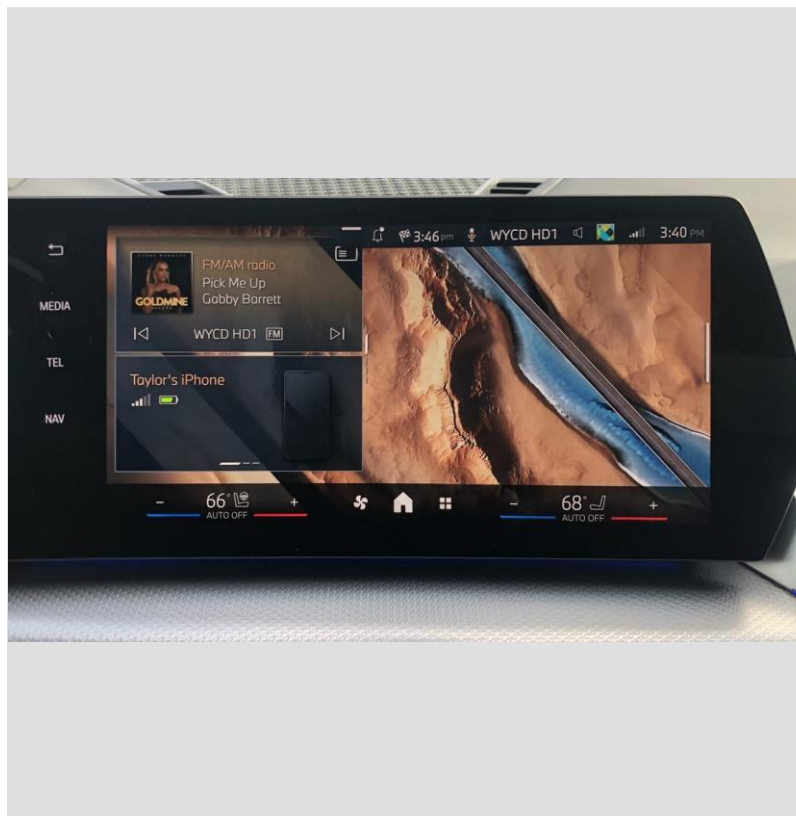


# Significant ability to customize and configure



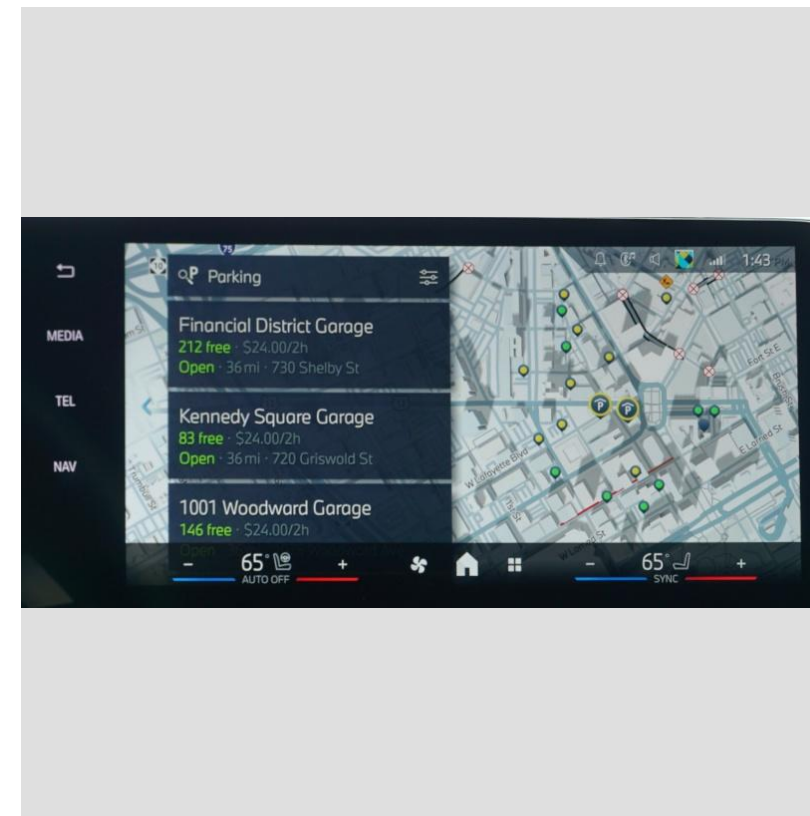
## In-vehicle app store

The inclusion of the BMW ConnectedDrive store, accessible via the head unit, allows users to expand the feature offering within their vehicle by downloading games and other entertainment & information features direct to the vehicle. The app store is easy to navigate and will be familiar to users of other consumer electronic devices in the way it operates. An app store and the expansion of feature sets it provides is likely to contribute towards longer consumer engagement and satisfaction with the vehicle.



## Significant personalization

A significant level of personalization is possible allowing the user to customize the system to meet their own preferences. 'My Modes' gives access to curated themes changing the interior lighting, sounds and other elements. User habits are learned over time allowing the vehicle to make proactive suggestions unique to the user profile. ADAS settings can be tied to user profiles allowing users to adjust and save their own personal settings.



## Integration of live data

Live data is integrated successfully throughout the navigation system. During route guidance, the user is alerted to various hazards including construction, obstructions and developing traffic situations ahead utilizing cloud sourced data. Other data integration includes on-street parking locations and POI review data provided by Yelp.



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