



In-car HMI UX Evaluations

#635

# In-Car HMI UX Evaluation & Benchmarking

## TABLE OF CONTENTS

Executive Summary

Introduction to this Report

Features and Functionality

Execution

Perceived Quality

ADAS Domain

Infotainment Domain

Navigation Domain

Voice Recognition Domain

Connected Features Domain

Convenience Domain

## BMW X1

In this edition of the In-Car HMI UX Evaluation and Benchmarking series, the UX team is testing the BMW X1. Evaluations are carried out by SBD usability experts with a deep understanding of CASE domains such as the Connected Car and ADAS & autonomy domains.

The 2024 BMW X1 is the first BMW model launched with the new iDrive 9 operating system (OS). The new iDrive 9 system is based on Android OS, which is the same for BMW's previous models with the iDrive 8.5 system. However, SBD found some surprising issues during the evaluation that weren't major issues with previous BMW's models in the past.

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### 619 – UX Benchmarking Series

A precursor to the new **In-Car HMI UX Evaluation & Benchmarking Series**, SBD Automotive's UX Team evaluates the infotainment user experience of over 40 vehicles.

### 806 – ADAS HMI Evaluations

A precursor to the new **In-Car HMI UX Evaluation & Benchmarking Series**, SBD Automotive's Autonomous Car Team evaluates the ADAS performance and usability of over 20 vehicles.

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GLOBAL



NA



CHINA



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ANNUALLY



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CARS PER YEAR

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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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# In-Car HMI UX Evaluation & Benchmarking BMW X1

## 635 - In-Car HMI UX Evaluation & Benchmarking – BMW X1

### **Introduction»**

5

- Report introduction

### **Bird's-eye view»**

7

- UX principles
- What's new in vehicle UX?
- Comparison of past vehicles
- 645 Hands-free driving
- OTA, FaaS + SW-defined features guide
- The cockpit guide
- Health and wellbeing in automotive
- Digital cockpit & infotainment forecast

### **Executive summary»**

16

- Key takeaway 1
- Key takeaway 2
- Key takeaway 3
- Ranking
- Scoring

### **The basics»**

22

- Aim of report
- Scope of report
- 2024 vehicles
- SBD experience
- Methodology
- Report structure

### **Analysis»**

29

- SUS scores by domain
- Kano analysis
- Positive and negative implementations
- CX recommendations
- Potential improvements

### **Features and functionality»**

36

- Overview
- Delight and performance features
- Hygiene and navigation
- ADAS feature set
- IoT integration, music, entertainment and information

### **Execution»**

42

- Overview
- System scoring
- UX laws
- System performance
- Stability
- Ergonomics
- Legibility and readability

## 635 - In-Car HMI UX Evaluation & Benchmarking – BMW X1

### [Perceived quality»](#)

72

- Introduction
- Definitions
- Evaluation results
- Highlights

### [ADAS domain»](#)

80

- Summary
- UX Heuristics
- SAE L0
- SAE L1&2

### [Infotainment domain»](#)

98

- Summary
- UX heuristics
- Key positive and negative

### [Navigation domain»](#)

120

- Summary
- UX heuristics
- Navigation specific scoring
- Key positive and negatives

### [Voice recognition domain»](#)

142

- Summary
- Functionality
- Recognition
- SUS score
- SBD UX principles
- Command structure
- Localization
- Level of integration

### [Convenience domain»](#)

154

- UX heuristics
- HVAC summary
- HUD summary

### [Future outlook»](#)

160

- Introduction
- UX principle groups

### [Next steps»](#)

165

### [Contact us»](#)

174





## Introduction

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# Report Introduction

Welcome to the 2024 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 Chinese 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.

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.



**Intuitive**



**Supportive**



**Flexibility**



**Consistency**



**Brevity**



**Depth**



**Presentation**

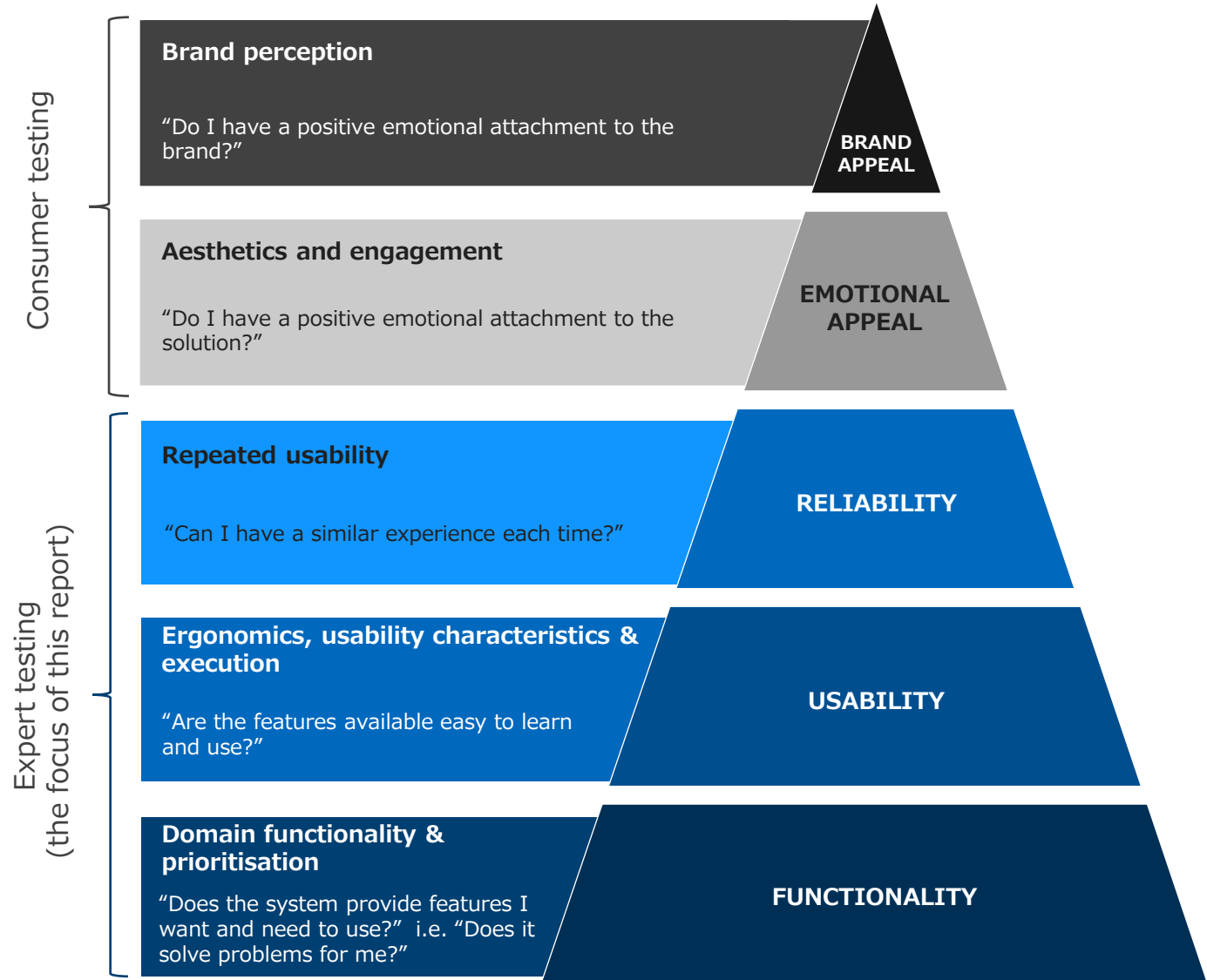
Section	Content
<b>Birds Eye View</b>	An overview of the key findings from SBD's various CX related and adjacent reports.
<b>Executive Summary</b>	Presents key highlights and conclusions from the report.
<b>The Basics</b>	What do you need to know about SBD's CX evaluation methodology?
<b>Analysis</b>	Analysis of report findings by SBD experts.
<b>Features and functionality</b>	Overview of key features and functionality by domain.
<b>Execution</b>	Assess success of implementation and overall execution of various system elements.
<b>Perceived quality</b>	Scoring and analysis of interior perceived quality levels.
<b>ADAS domain</b>	Highlight and analysis of key positive and negative points within the ADAS domain.
<b>Infotainment domain</b>	Highlight and analysis of key positive and negative points within the infotainment domain.
<b>Navigation domain</b>	Highlight and analysis of key positive and negative points within the navigation domain.
<b>Voice recognition domain</b>	Summary and scoring of various aspects of the voice recognition system.
<b>Convenience domain</b>	Summary of various convenience focussed features.
<b>Future Outlook</b>	Seven UX principles are considered against drivers and barriers into the future of this reports test vehicle.
<b>Next Steps</b>	Can SBD help you with any unanswered questions?



# Aim of this report

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'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

SBD has chosen nine cars to evaluate in 2024, 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 two years have seen release dates slipping significantly, so it may be necessary to make substitutions.

## Group A

### Cars tested



BMW X1

### Priority target vehicles for 2024



Mercedes-Benz E-Class



Hyundai Kona/Kona Electric



Volvo EX90



Ford F-150 Lightning

## Group B

### Other vehicles being considered for 2024



Li Auto MEGA



Audi Q6 e-tron



Acura ZDX

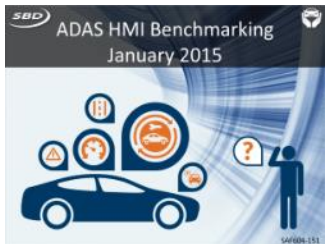
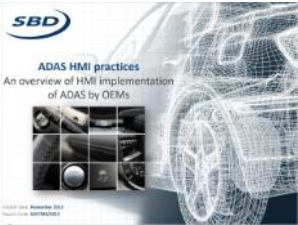
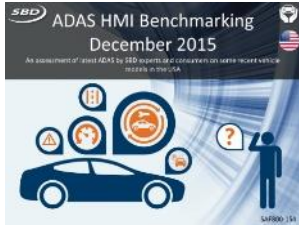


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# SBD experience through years of testing in-car solutions

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.

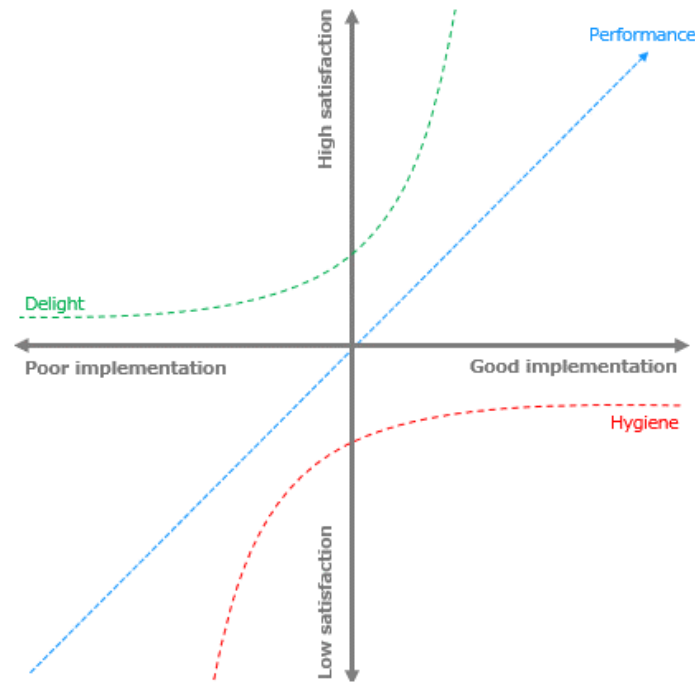
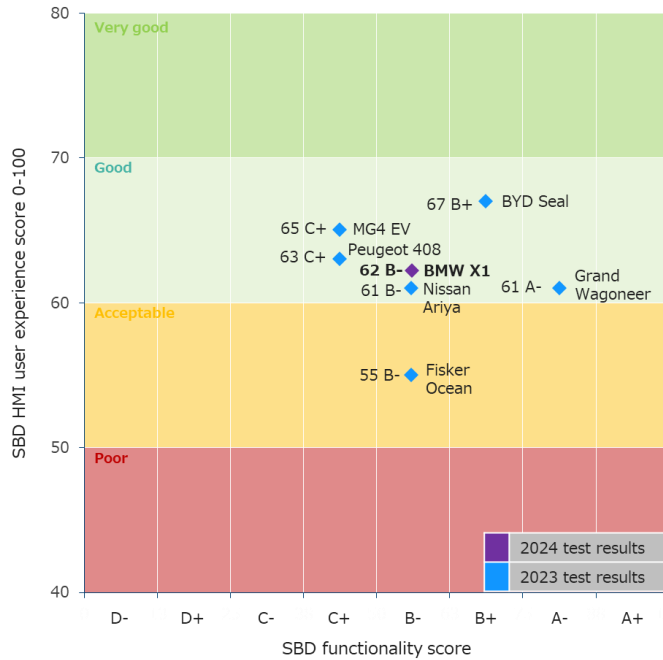
For a detailed discussion and presentation of SBD's methodology please [contact us](#).

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.

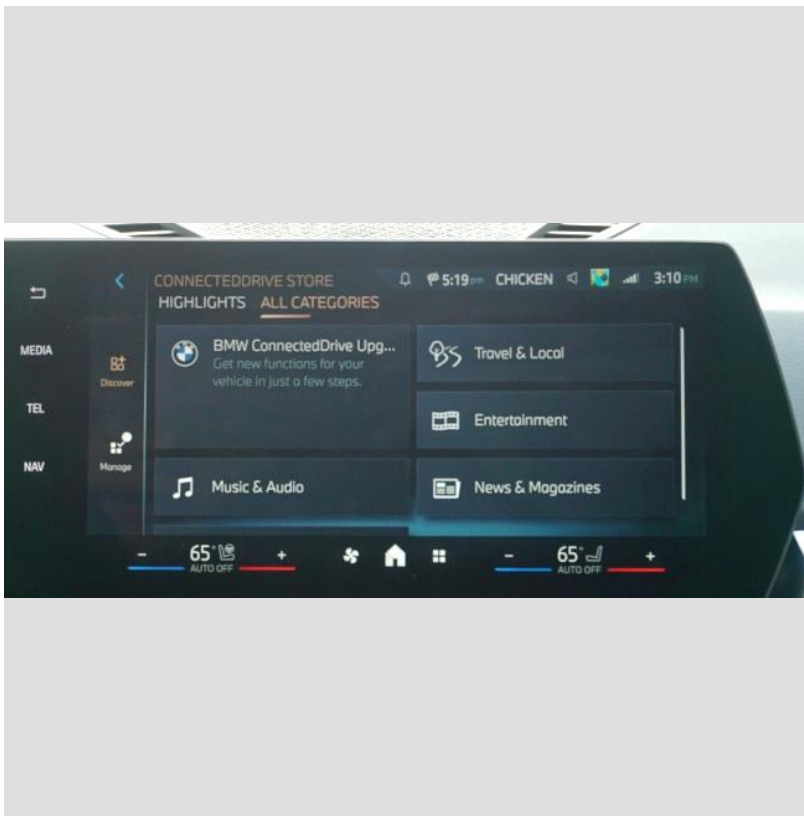


# Example slides from the report

This is an example slide from a report, enclosed in a white border. The top portion of the slide features a photograph of a car's interior, showing the steering wheel, dashboard, and center console. Below the image, there is a dark blue banner containing the SBD logo on the left and the text 'In-Car HMI UX Evaluation &amp; Benchmarking BMW X1' on the right. At the bottom of the slide, there is a prominent blue button with the text 'Request price' and a white right-pointing chevron symbol (&gt;).

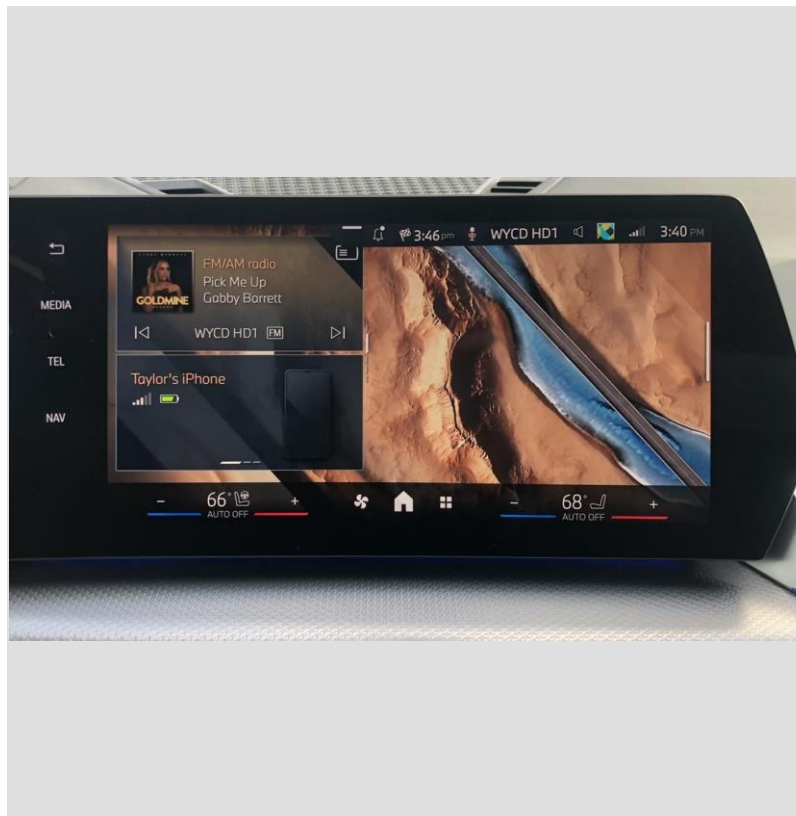


# Significant ability to customize and configure



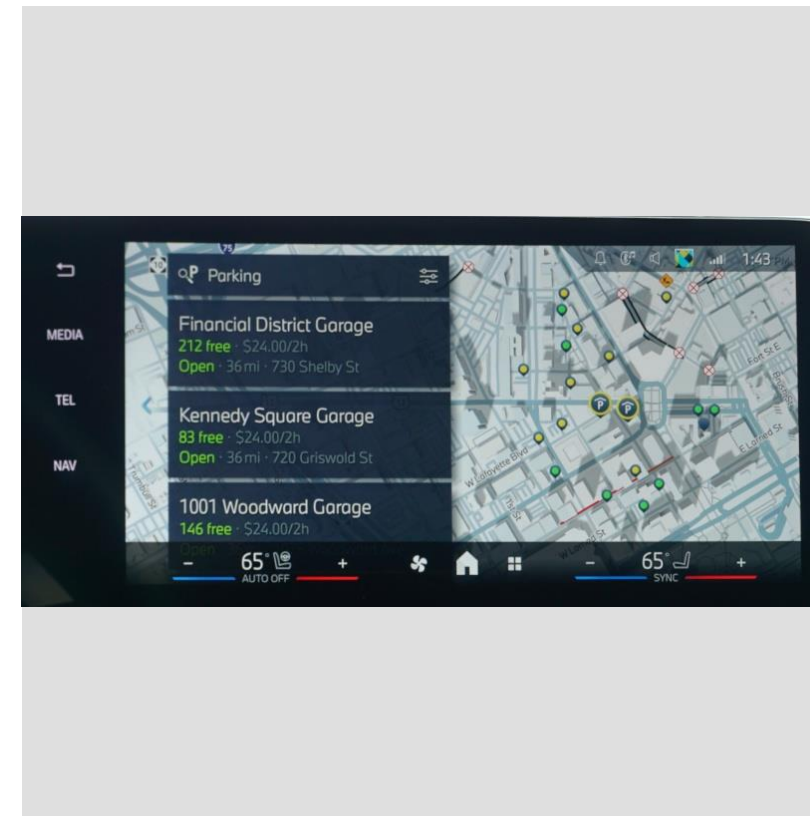
## In-vehicle app store

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

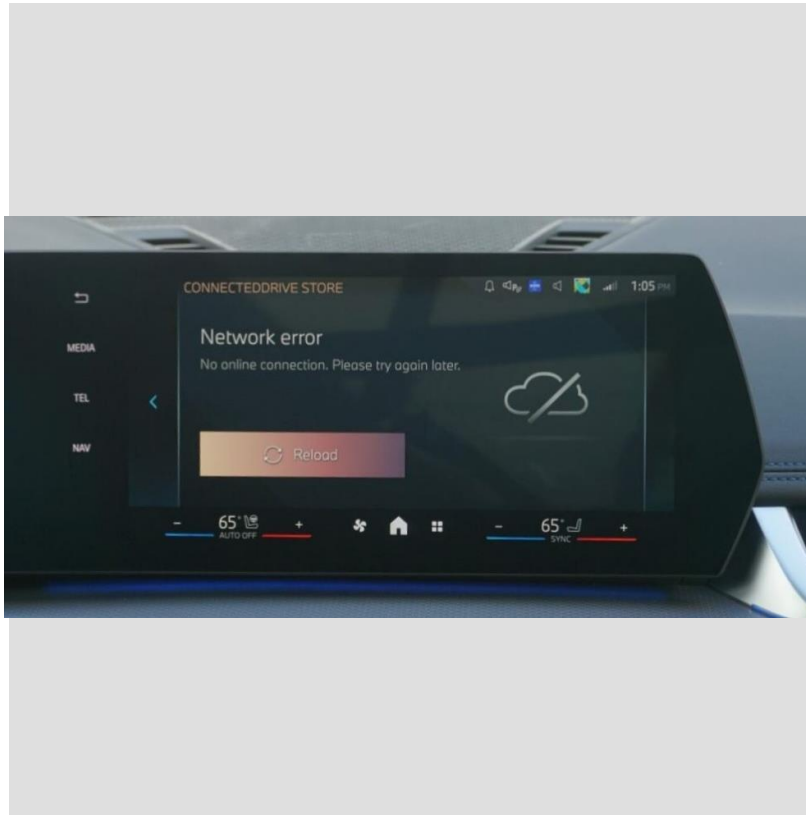
A significant level of personalization is possible allowing the user to customize the system to meet their own preferences. 'My Modes' gives access to curated themes changing the interior lighting, sounds and other elements. User habits are learned over time allowing the vehicle to make proactive suggestions 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

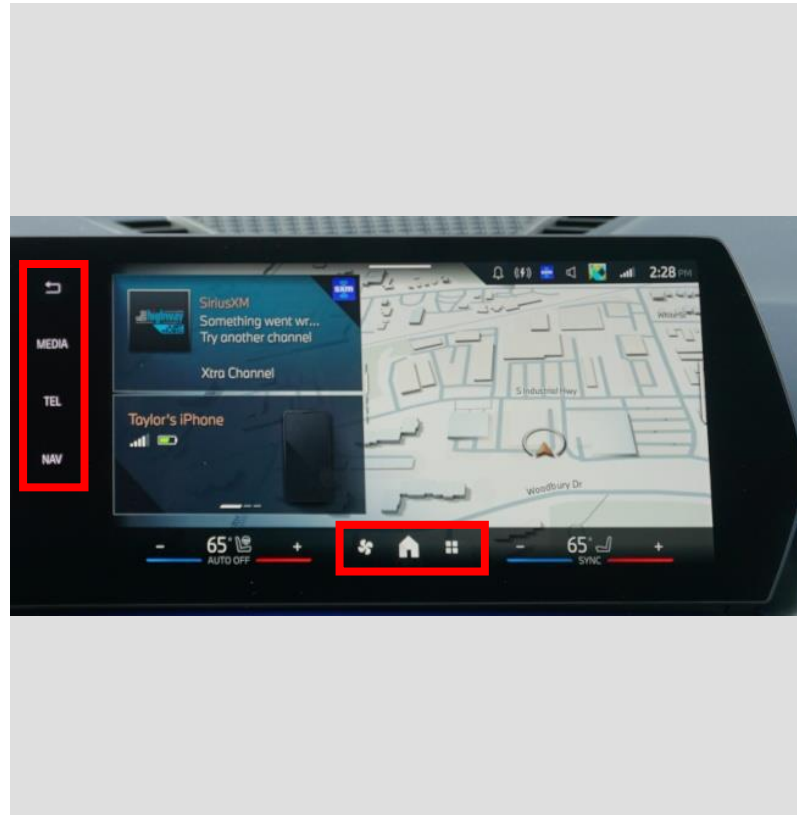
Live data is integrated successfully throughout the navigation system. During route guidance, the user is alerted to various hazards including construction, obstructions and developing traffic situations ahead utilizing cloud sourced data. Other data integration includes on-street parking locations and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

# System stability issues and lacking expected intuitiveness



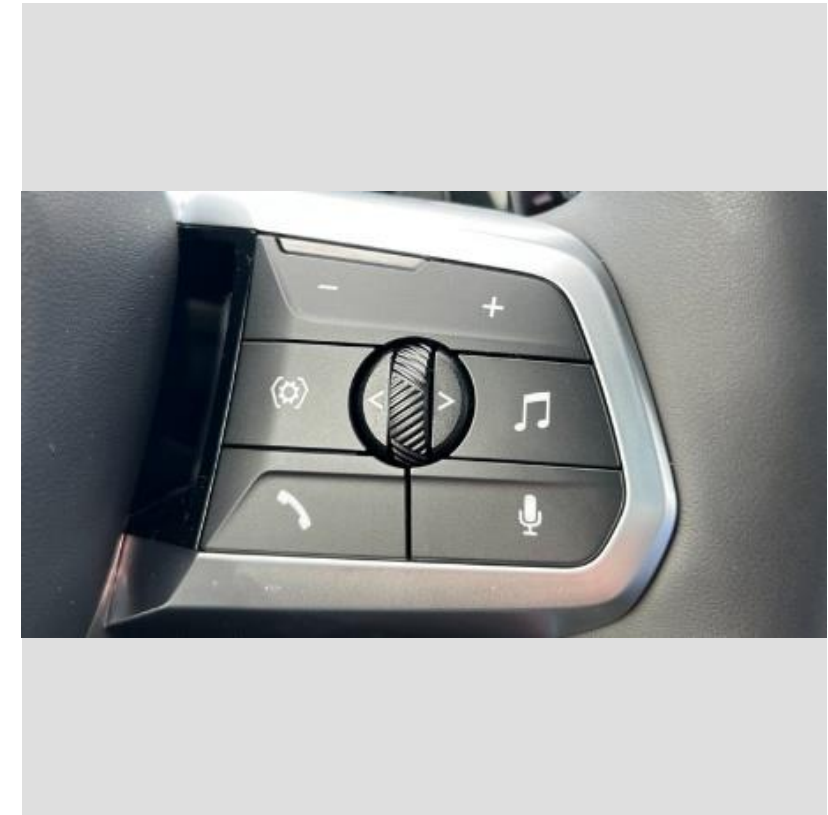
## Poor level of stability

Throughout one week of testing, the observed level of system stability is generally poor. A total of 13 bugs are identified ranging from minor, less frequent occurrences to critical issues. A system struggling with stability has a negative impact on the overall user experience and perception of quality. One issue of stability required a soft reset, something that many users will not expect to have to perform.



## Complicated system architecture

A disjointed information architecture is partly caused by main menu buttons located in different areas. Just off the left-hand side of the display are permanent buttons for Media, Telephone, Navigation and a back button are displayed using words. However, along the bottom of the display built into the HVAC bar are buttons for HVAC, Homepage and App screen. These buttons use icons instead of words. This disjointed appearance is visually jarring and can cause difficulty in navigating the system.



## Complex steering wheel controls

The integration of steering wheel controls to control the HUD and/or cluster has the potential to confuse and frustrate users. With the HUD off, the right-hand side steering wheel controls interact with the cluster. With the HUD turned on, they interact with the HUD. Dual use for buttons always holds the potential to confuse users and this is no exception. It takes longer than expected to understand this implementation.





# UX Laws (1/4)

Law name	Law definition	What to check	Score	SBD comments & reasoning
<b>Fitt's law</b>	The time to acquire a target is a function of the distance to and size of the target	Are there any small buttons which hinder their usability?	Concerns	On the central display, the temperature (+/-) controls, the HVAC fan touch button, the apps button and the media/radio sources button are all small and the touch target isn't always clearly defined, making it difficult to use, especially while driving.
<b>Hick's law</b>	The time it takes to make a decision increases with the number and complexity of choices	Are there any instances where the HMI in the vehicle offers too much choice, and makes it difficult to make a decision?	Concerns	The apps screen can be overwhelming at times, making it difficult to find what the user needs. The layout of the radio screen with the long list of radio stations makes it difficult to make a decision. Navigating through ADAS settings is complex as well, making it hard to find the setting the user is looking for.
<b>Jakob's law</b>	Users will transfer expectations they have built around one familiar product to another that appears similar	Are there any instances where the HMI in the vehicle uses an operating principle that is unlike similar products available today? If so, does this lack of familiarity make the HMI difficult to use?	Concerns	In the navigation screen, the location of the search bar is at the bottom of the screen, which is unfamiliar to navigation apps on a phone and other navigation systems in other vehicles, which is cause for mistouches and frustration by the user. There is also no direct tune input on the radio screen in the central display.
<b>Miller's law</b>	The average person can only keep 7 (plus or minus 2) items in their working memory	Throughout user journeys, are users required to remember a large number of things to complete that journey? An easy example of this is in menu architectures which are deep and require the user to memorize the location of a particular setting or feature.	Acceptable	Some ADAS settings, like distance control / gap distance, require a larger number of steps to remember, but overall, most tasks can be completed with a reasonable number of steps.
<b>Occam's Razor</b>	Complexity: The path along the user journey should be simplified to the point where no additional choices or steps in that journey can be removed	Has the complexity of a user journey had all unnecessary steps removed? Or are there a number of unnecessary inputs required before the task is complete?	Concerns	There are a few instances where there are unnecessary steps required to complete a task. There is no button on the steering wheel controls that offers just one touch to toggle between presets / favorites for radio / media. Some steering wheel buttons control a menu on the HUD or instrument cluster requiring the driver to look at the display and take multiple steps to complete the task. Some ADAS settings, like distance control / gap distance, require unnecessary steps. Some HVAC and radio tasks also require some unnecessary steps.



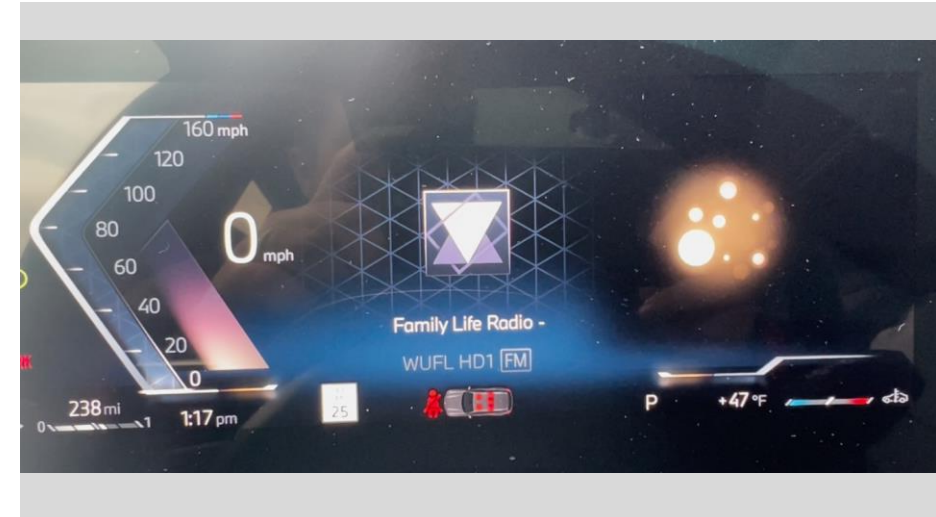
# System does not give the driver a chance to speak

## 5. Voice Recognition

On multiple occasions, the system fails to give the driver chance to speak.

When pressing the voice button on the steering wheel or saying 'Hey BMW', the voice recognition system instantly opens with "Please try again" or "Try it once more". The user can speak over the top of this message but isn't always recognized by the system.

Frequency	Low	Medium	High
Severity	Minor	Major	Critical





# Perceived Quality: Visual

Level 1

## Visual

**Harmony/alignment:** The cluster and the central display are integrated into one surface, elevating the visual of the cockpit. Other components such as surfaces, trim, and controls are consistent with entry level luxury vehicles.

**Geometric:** Some steering wheel buttons are too small and have unclear icons/text. On the central display, some buttons lacked easily identifiable touch targets. Some visual shapes for the screen on the central display, such as buttons, were inconsistent (i.e. size, shape, location).

**Spatial harmony:** The app menu within the central display appears cluttered and can be overwhelming. However, the hard buttons throughout the cabin are well spaced and do not appear to be cramped.

**Branding:** "M" badge for the vehicle model tested is branded on the bottom of the steering wheel. Overall HMI is sharp and dynamic, aligning with the ethos of the BMW brand.

**Output HMI:** Key output HMI factors include lightbars on the steering wheel to show relevant ADAS status/warnings and voice assistant animations that appear on the HUD, cluster, and central display.

**Interior lighting:** Ambient lighting with many color choices is built into the vehicle trim with a thin illuminating bar that wraps around the cockpit. Other buttons are illuminated well in low light instances.

SBD viewpoint



### Level 2 scoring

Harmony/alignment	Geometric	Spatial harmony	Branding	Output HMI	Interior lighting
Good	Fair	Fair	Good	Good	Good



# Key positive and negative points - ACC

## System usage:

- Headway can only be adjusted via the settings menu in the central display.

Major

## System turn ON:

- System turn ON controls located conveniently on steering wheel.

## System usage:

- New upcoming (higher/lower) speed limit is suggested by the system.

Negative

## System turn ON:

- Icon and text on 'mode' button and ON button does not match that found in the cluster or relate to the system well.
- One button is shared between multiple systems (ACC, PD, Speed Limiter).

## System usage:

- Detail lost from ACC display when alternative content is chosen in cluster.
- Headway is only shown with assistance display chosen.

## System turn OFF:

- Only minimal reaction when the system is turned OFF.
- Press and hold action to turn OFF the system is not intuitive.

Positive

## System turn ON:

- Activation is automatic when turned ON if conditions are met.
- Reaction when turned ON is acceptable (text label provided when switching from PD or speed limiter to ACC)

## System usage:

- ADAS display in cluster differentiates between cars and trucks.
- Good graphics shown in cluster and HUD when assistance display is chosen. Vehicle ahead, set speed and headway are shown.
- When activated, ACC set speed and icon turn green.

## System cancellation/turn OFF:

- When cancelled using the brake pedal or button, correct color logic is used.

Minor

# Good integration of Android Auto and Apple CarPlay

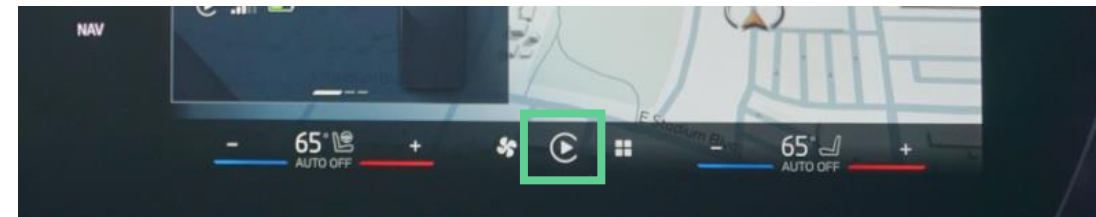
Wireless Android Auto and Apple CarPlay are available in the BMW X1.

- With a mobile device paired, a toggle setting in the phone screen can be used to enable/disable Android Auto and Apple CarPlay. Buttons for Bluetooth media and Android Auto/Apple CarPlay in the phone screen can also be used to swap between the brought-in and native infotainment systems.
- When Apple CarPlay or Android Auto are active, telephone functions and media playback are only available through those systems, not the native system.
- When enabled, the home menu button becomes a toggle switch between the native infotainment system and Android Auto/Apple CarPlay.
- The climate controls are still present at the bottom of the central display when Android Auto and Apple CarPlay are in use.

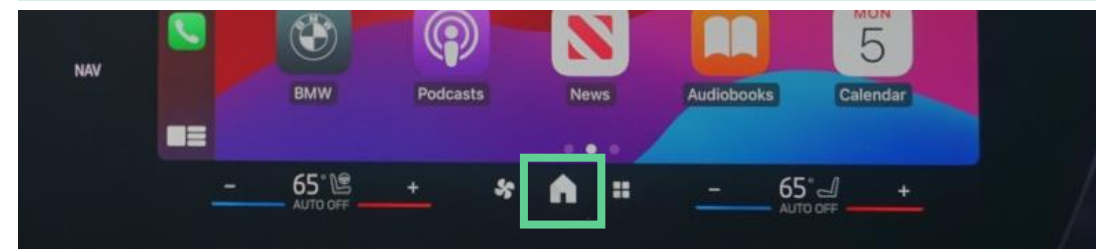
Owners can easily swap between the systems with one button press, leading to a seamless integration of these services which enhances the overall user experience.

SBD  
viewpoint

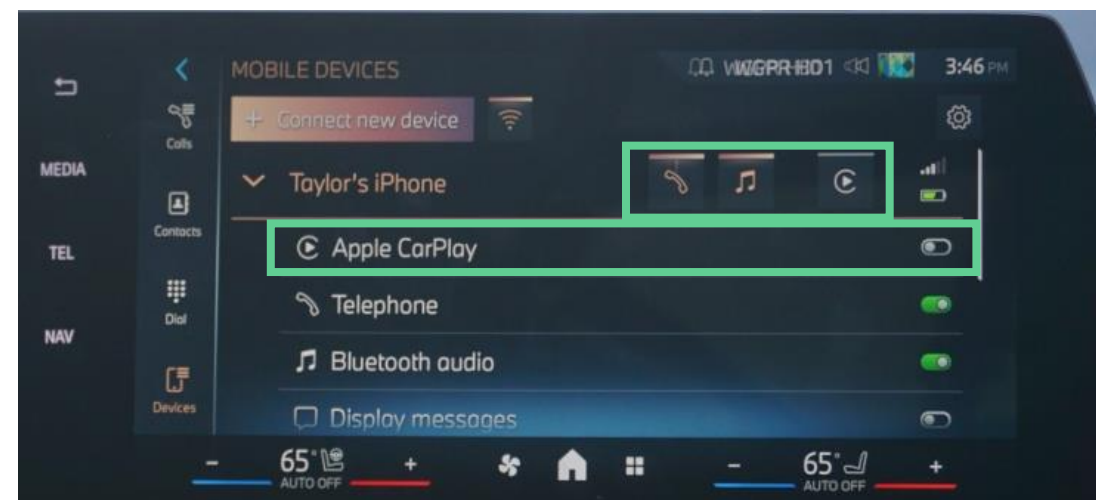
UX impact	Major negative	Minor negative	Minor positive	Major positive
-----------	----------------	----------------	----------------	----------------



Apple Carplay button in native system toggles to Apple CarPlay




Home button in Apple CarPlay toggles to native system



Toggle setting and buttons to enable/disable Apple CarPlay (or Android Auto if set up)



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the full report



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The complex block is a white-bordered rectangle containing a thumbnail image of a car's interior dashboard and steering wheel. Below the image is a blue banner with the SBD logo and the text 'In-Car HMI UX Evaluation & Benchmarking BMW X1'. At the bottom of the block is a blue button with the text 'Request price' and a white right-pointing chevron symbol.



# 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](mailto:info@sbdautomotive.com) or discuss with your local account manager below.



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