



## TABLE OF CONTENTS



Executive Summary

Features and Functionality

HMI Execution

Perceived Quality

ADAS

Infotainment

Navigation

Voice Recognition

Connected Features

Convenience

## RELATED SBD REPORTS



## 619 – UX Benchmarking Series

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In-car HMI UX  
Evaluations

#635

# In-Car HMI UX Evaluation & Benchmarking

## BMW iX

In this edition, the UX Team is testing the BMW iX. The new electric SUV adopts the eighth generation of the iDrive infotainment system – providing users with new software features and a range of options for personalization.

iDrive 8 is hosted on the EV's 14.9-inch central touchscreen, which sits with the 12.3-inch digital instrument cluster within a single display spanning the dashboard. While this display is curved towards the driver for easier use, the system can also be operated by a rotary dial found on the center console. iDrive 8 also introduces BMW ID, a new feature that utilizes machine-learning AI, and data from the cloud, to recommend UX options based on the user's recent activity. The iX supports integrations with Apple CarPlay and Android Auto, and leverages 5G to deliver over-the-air updates.

## COVERAGE



GLOBAL



NA



CHINA



EUROPE

## FREQUENCY



ANNUALLY



QUARTERLY



CARS PER YEAR

## PUBLICATION FORMAT



PDF



POWERPOINT



EXCEL



ONLINE

## PAGES



170

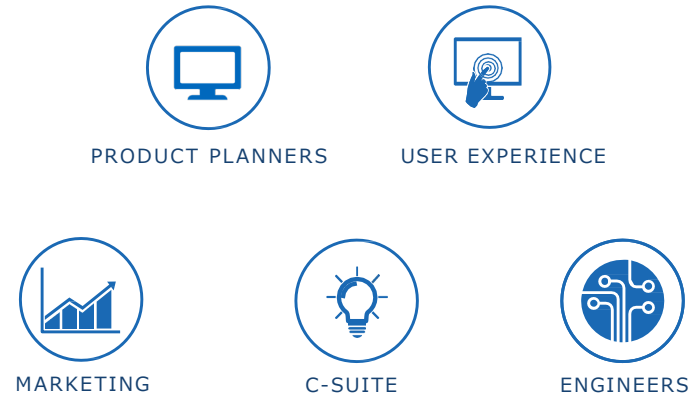
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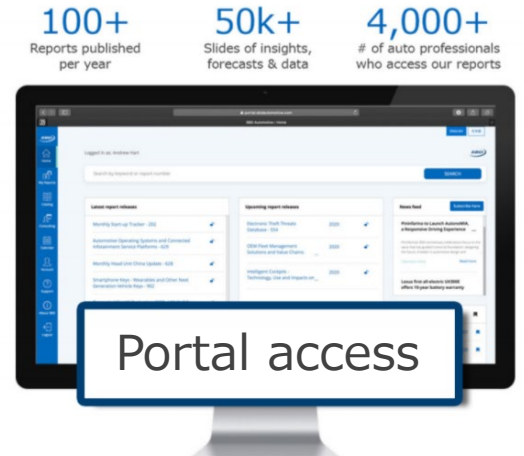
# Scoring

- > **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.

## This research is useful for



## Do I have access?



## Request a quote for

In-Car HMI UX Evaluation & Benchmarking Series  
BMW iX

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December 2021

CON635-21(21g)

In-Car HMI UX Evaluation & Benchmarking  
BMW iX



|  |     |   |     |
|--|-----|---|-----|
| <a href="#"><u>Executive summary »</u></a>           | 4   | <a href="#"><u>Convenience domain »</u></a> | 155 |
| <a href="#"><u>Introduction to this report »</u></a> | 13  | <a href="#"><u>Support areas »</u></a>      | 163 |
| <a href="#"><u>Features and functionality »</u></a>  | 20  | <a href="#"><u>Contact us »</u></a>         | 170 |
| <a href="#"><u>Execution »</u></a>                   | 26  |   |     |
| <a href="#"><u>Perceived quality »</u></a>           | 55  |   |     |
| <a href="#"><u>ADAS domain »</u></a>                 | 63  |   |     |
| <a href="#"><u>Infotainment domain »</u></a>         | 88  |   |     |
| <a href="#"><u>Navigation domain »</u></a>           | 115 |   |     |
| <a href="#"><u>Voice recognition domain »</u></a>    | 136 |   |     |
| <a href="#"><u>Connected features domain »</u></a>   | 148 |   |     |



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## Introduction

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# Aim of this report

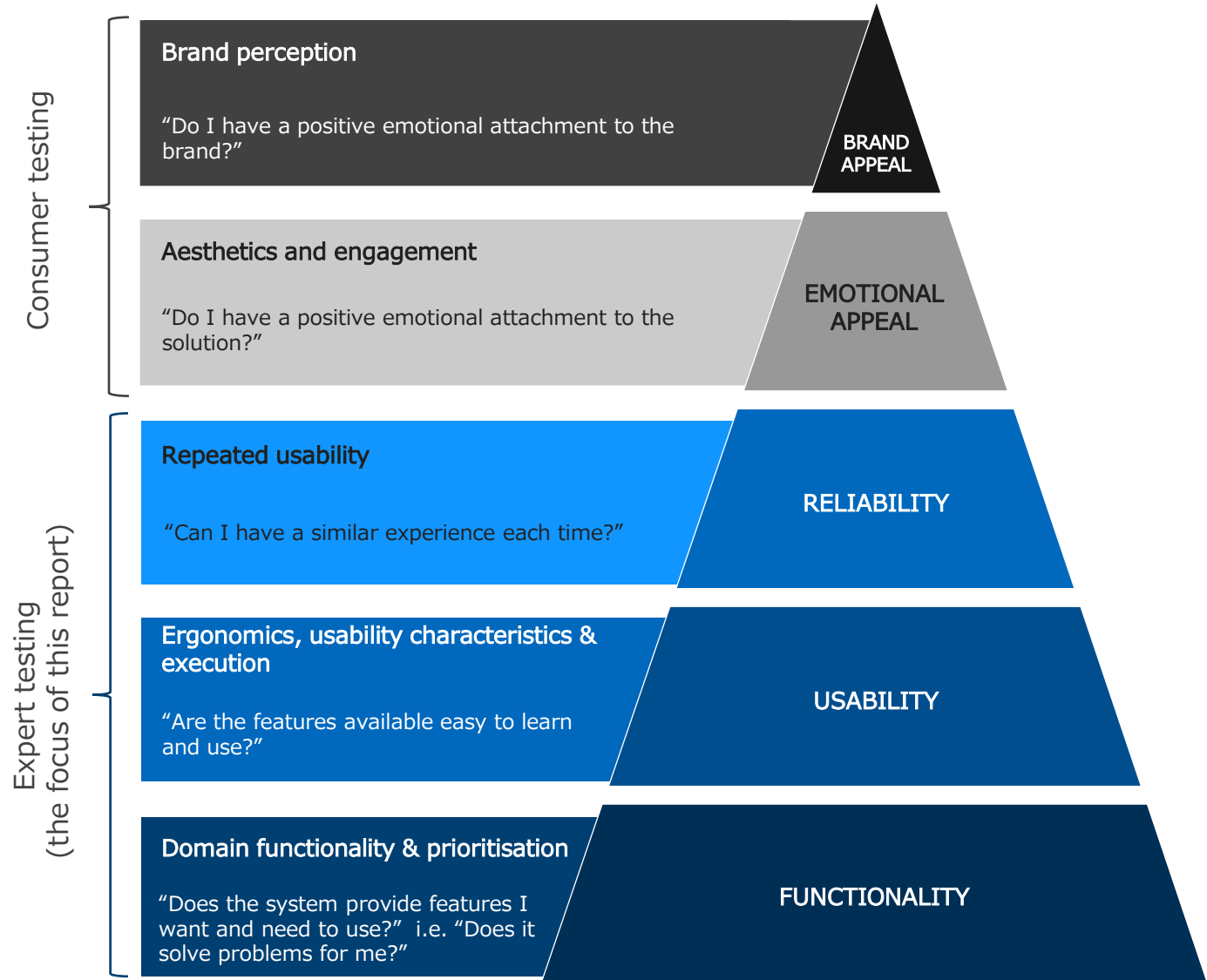
Welcome to the 2021 HMI benchmarking report series. This report has been created to provide a fair, unbiased and objective view of the latest in-vehicle HMI solutions in the European, US and Japanese markets. Evaluations are carried out by SBD usability experts with a deep understanding of CASE domains 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.



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
- Connected services domain
- Convenience domain





# Vehicle list

SBD has chosen eight cars to evaluate in 2021, based on two selection categories. New/interesting UX focuses on systems with 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 best efforts have been made to adhere to the chosen cars and schedule, slippages in release dates have continued and been exacerbated by the chip shortage, so it has been necessary to make some substitutions.

## Cars tested so far in 2021



Mercedes-Benz  
S-Class



CUPRA  
Formentor



Tesla  
Model S



Hyundai  
IONIQ 5



Lexus  
LS



Cadillac  
Escalade



BMW  
iX

## Testing completed, report due January 2022



NIO  
ES8

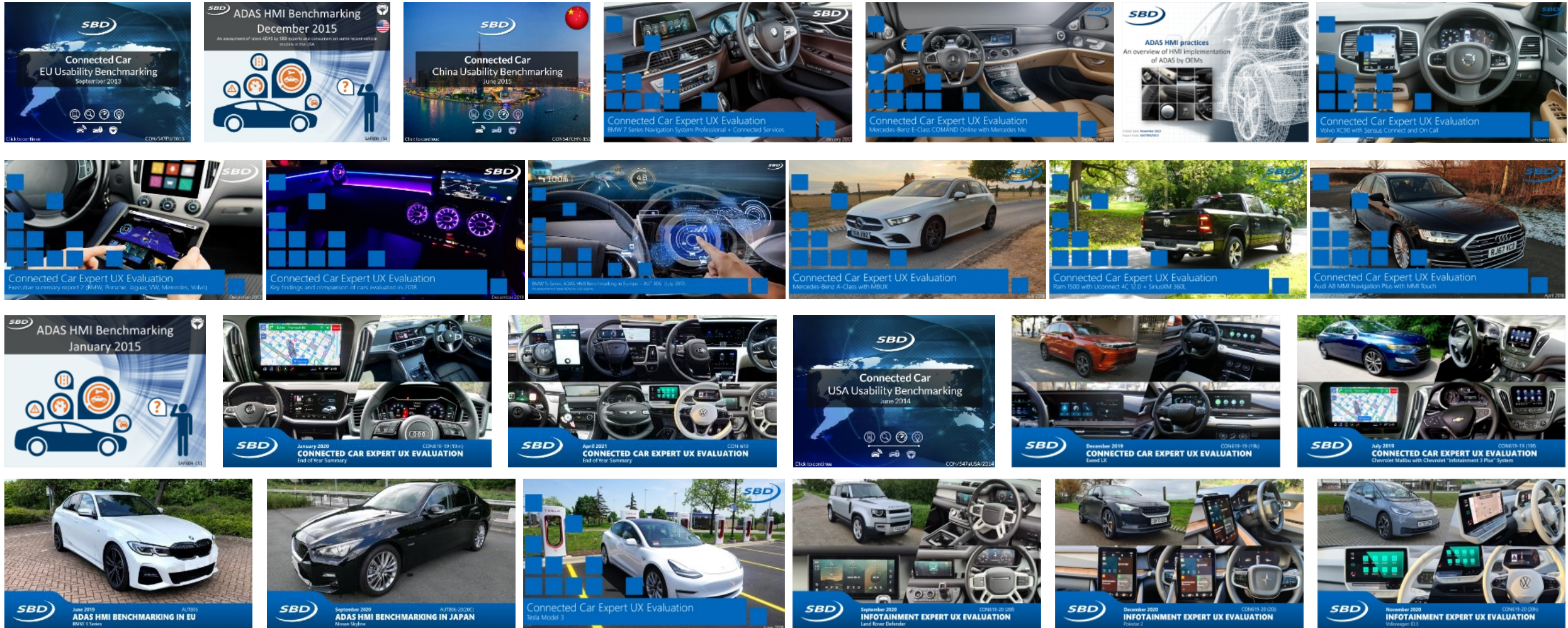
- Latest OS3 software
- Fully updated GUI
- European market car





# SBD experience through years of testing in-car solutions

Over the last eight years SBD has evaluated 86 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.

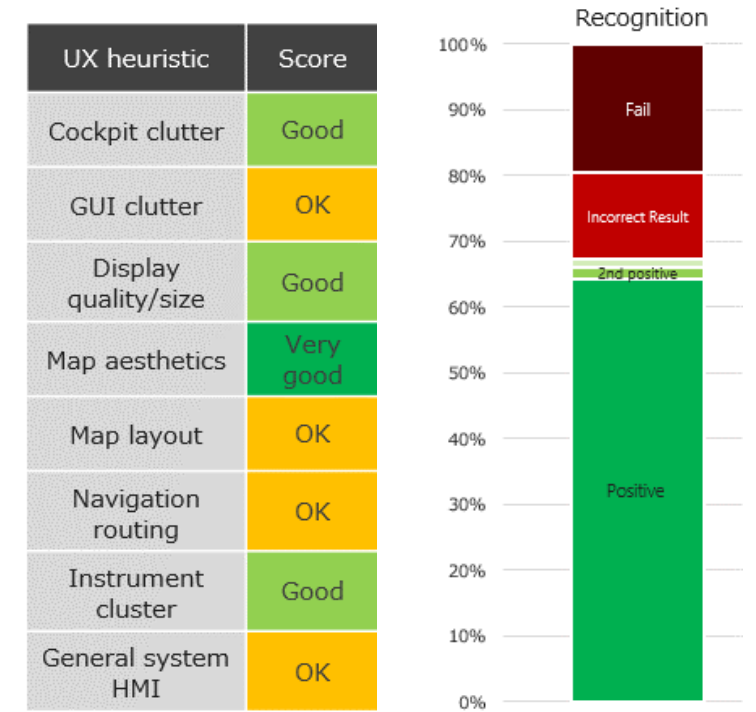
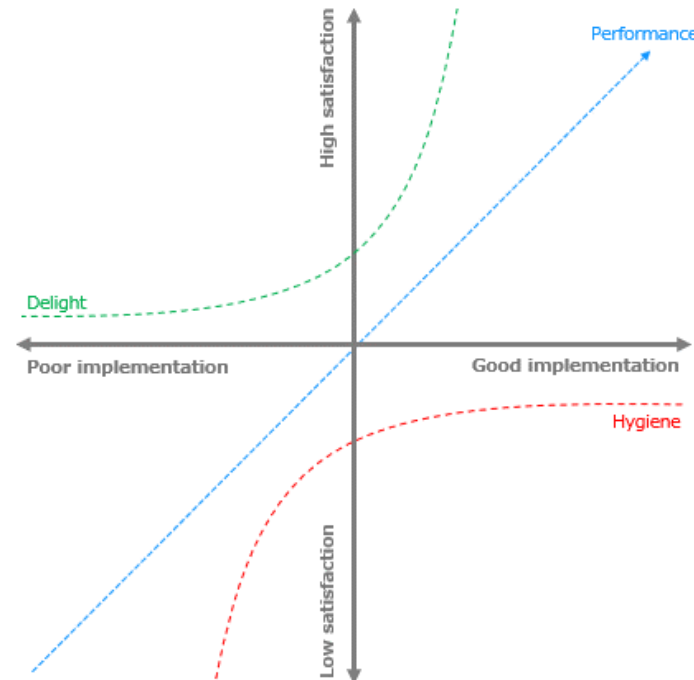
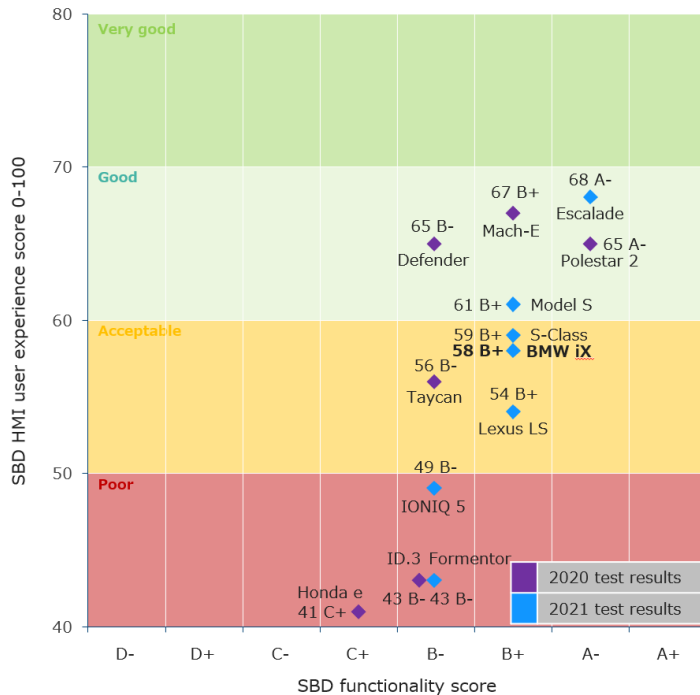
| Test area                    | Type of tests |            |            |          |               |        |         |                 |
|------------------------------|---------------|------------|------------|----------|---------------|--------|---------|-----------------|
|                              | 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 & 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:

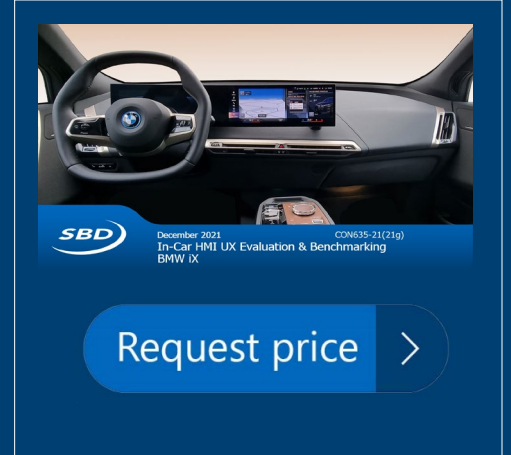
- **Delight** features: “wow” features likely to provide high satisfaction even with poor implementation
- **Performance** features: as the level of implementation increases so does the customer satisfaction
- **Hygiene** features: poor implementation provides low satisfaction, but good implementation 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 minimise subjectivity as much as possible with results aimed at being fair and reasonable with a minimal level of bias.

# Example slides from the full 170 page report







# Hygiene meets, and navigation mostly meets, expectations: A+ & B+

- Hygiene features are those that are expected in a system. The best implementations may offer a minor uplift, however, will largely often go unnoticed and are unlikely to provide a high level of satisfaction. Poor implementations or a lacking feature, however, will still provide low satisfaction.
- In the iX, the score of A+ reflects the presence of all expected hygiene features in the system, despite some of them currently being affected by software issues. These should be regarded as priority items to be addressed in imminent OTA updates.



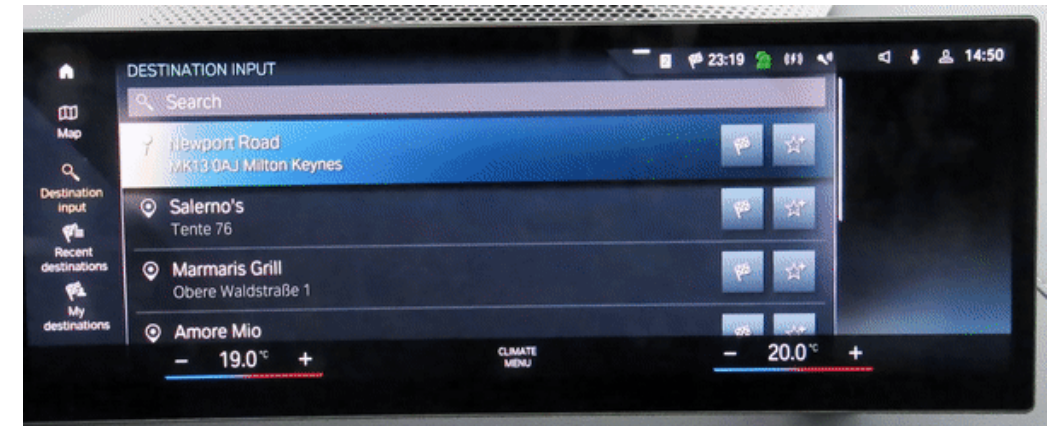
Central input panel

As a primary input for many years on BMWs, the iDrive controller functions extremely well and is likely to be the input of choice for many users.

Haptic feedback on the controller itself gives a sensation of quality and increases confidence during input. The location of the controller is optimised for easy reach.

The provision of a rotary input control in this case is seen as a benefit to users, providing additional input choice and catering for those loyal to the BMW brand who are used to this form of input.

- Much of the core navigation functionality is well implemented and is likely to provide a system that users will choose in preference to another solution via smartphone mirroring.
- Maps mostly have a high level of clarity and routing provides a good level of accuracy. Search functionality works effectively with good error correction and relevant results that are logically ordered by distance and relevance.
- Implementation of range estimates within BMW's range map leaves room for improvement in terms of visualisation. Only a rudimentary visualisation is shown that does not include external factors such as topography.



Calculating charging stops is slow

Calculating charging stops is an important feature in electric vehicles as it offers a noticeable impact on user experience when a trip requires one or more charge stops.

The above GIF shows the iX calculating charge stops for a long trip, however the time it took for the route calculation was far longer than expected.

This kind of functionality is important for navigation solutions in electric vehicles especially if the user has prior experience of a solution which offers it seamlessly and effectively, such as Tesla. A system that is sluggish is still better than one without this functionality, but improving this process will further improve user experience.



# HVAC lost functionality of most features

## 1. HVAC system

On several occasions during testing, the HVAC lost all heating functionality i.e. warm air, heated seats, heated steering wheel, heated arm rests and panel heaters. The ventilation feature still worked but blew cold air. On one occasion (see right) all functionality was lost. A cold boot cycle/leaving the system overnight was needed to rectify these issues but due to time constraints, the lack of heating was usually tolerated for the remainder of the day.

|           |       |        |          |
|-----------|-------|--------|----------|
| Frequency | Low   | Medium | High     |
| Severity  | Minor | Major  | Critical |



# Some issues with access and usage of touchscreen



The user needs to lean forward to control the outer part of the touch display

## Central display issues

### Scrolling, reach, lack of support and slight obscuration issues

- Touchscreen list scrolling was noted to be extremely slow. Specifically, even with a large swipe, the screen only scrolled a few lines, this was not a performance issue. This meant that repetitive scrolling was required when it shouldn't have been, potentially increasing fatigue.
- In order to reach the far side of the touchscreen, the driver needs to lean forward enough that their back leaves the seat.
- No support is offered for the hand while the touchscreen is being used. This is considered a minor negative only, due to the fact that neither tester experienced any fatigue while using the touchscreen.
- In some seating positions, the steering wheel can obscure the bottom left of the central display. This was only considered a minor issue as it was not noticed in general usage and only a small amount of the screen was obscured.





# Perceived Quality: Tactile

## Level 1

## Tactile

**Stiffness & looseness:** The control buttons reach the expected impression of quality and are pleasing to use. A minor concern is some freeplay in the seat adjustment buttons and in the right steering wheel control scroller.

**Force feedback:** Button feedback is generally good and meets the expected level of quality. Minor issues are perceived with the haptic feedback of buttons on the wood effect panel: on some occasions the feedback has a slight delay.

**Material quality:** The crystal effect buttons feel quite plasticky, otherwise the car gives an impression of high quality, particularly the large dual screens. Although slightly out of scope, when entering the vehicle, its 'Carbon Cage' is visible around the door openings, including along the sill trim. The finish of this falls well below expected standards for visual carbon fibre elements with rough joins and irregular hexagon/diamond patterning.

**Material harmony:** The interior has some striking design elements that harmonise well with each other. The impression of luxury and quality runs consistently throughout the vehicle. The 'wooden' control panel is a clear contrast but serves more as a focal point than a distraction. The bright blue seatbelts are supposed to convey a feeling of sportiness, but look out of place and stand in clear contrast to the rest of the vehicle.

**Geometric & Positioning:** The diamond/hexagon shape of most interfaces gives the impression that much consideration has been invested and that they have been developed specifically for this vehicle. Controls are easy to reach, with a good choice of input methods.

## Level 2 scoring

Stiffness &amp; looseness

Force feedback

Material quality

Material harmony

Geometric &amp; positioning

Good

Good

Good

Good

Excellent



Seat adjustment buttons have excessive freeplay

Golden elements can be found outside and inside the vehicle

Holistic design approach with diamond/hexagon motif in several elements of the vehicle such as the seats, steering wheel and the side view mirrors





# SAE Level 0 ADAS: System usage

System usage: LKA



Visual warning after lane deviation

System usage: BSM



Good level of warning in mirror

System usage: RCTA



Good visual warning in the side mirror

System usage: LKA



Poor icon colouring during warning

System usage: BSM



No status icon or minimum speed indication

System usage: RCTA



No status indication shown for RCTA

# Poorly structured and cluttered HVAC controls

|               |  |                |           |                |                |
|---------------|--|----------------|-----------|----------------|----------------|
| Category      | HVAC   |                |           |                |                |
| Description   | HVAC interface is cluttered, unclear and confusing   |                |           |                |                |
| SBD viewpoint | <p>The HVAC interface is a confusing implementation especially for novice users.</p> <ul style="list-style-type: none"> <li>The interface does not entirely fit within one screen and requires scrolling to access all the controls. This is explained by the nine dots at the bottom of the screen (incorrectly suggesting nine screens) rather than a scroll bar.</li> <li>The left hand panel is used as an integral part of the interface (rather than switching between subsections), which is inconsistent with the rest of the system. It also has a high character count and little distinction between the buttons, adding to the clutter.</li> <li>The main part of the interface comprises nine very similar buttons for different functionality which was found to cause decision paralysis and potential for distraction, particularly during initial interaction.</li> <li>The panel heater icons are difficult to understand and have no text explanation.</li> </ul> <p>Overall, due to the cramped layout, poorly discernible icons, general usage of the HVAC section is frustrating and unintuitive especially for novice users. Further detailed information can be found in the <a href="#">convenience domain section</a>.</p> |                |           |                |                |
| UX impact     | Major negative   | Minor negative | No impact | Minor positive | Major positive |



# Poor icon implementation adds unnecessary clutter

|               |   |                |           |                |                |
|---------------|---|----------------|-----------|----------------|----------------|
| Category      | General systems   |                |           |                |                |
| Description   | Icons at top right of central display add clutter   |                |           |                |                |
| SBD viewpoint | <p>An icon bar is visible at the top right of the central display. Due to the number of icons shown, this lends a cluttered appearance to the screen while in most cases adding minimal benefit.</p> <ul style="list-style-type: none"> <li>In the example to the right, 11 elements are shown in the top bar. The icons are small and close to each other, many are not immediately recognisable and the sheer quantity may well overwhelm users and divert their attention elsewhere.</li> <li>Several icons are unlikely to be expected in this location by users, including the current radio station and navigation arrival time. Additionally, showing two different times could well cause confusion as the finish flag icon may not be interpreted as being linked to the arrival time.</li> </ul> <p>Overall, it is expected most icons will see little or no use. SBD recommends simplifying the bar to display a maximum of five icons. These should be the ones that see the most usage and/or are the most important, including current time and data connection signal strength. They could also change dynamically according to system usage (e.g. if wireless charging started to be used, this icon could replace a currently inactive one).</p> |                |           |                |                |
| UX impact     | Major negative  | Minor negative | No impact | Minor positive | Major positive |





# iDrive controller is intuitive in central display inputs

|               |  |                |           |                |                |
|---------------|--|----------------|-----------|----------------|----------------|
| Category      | General systems  |                |           |                |                |
| Description   | iDrive controller functions effectively and may be input of choice   |                |           |                |                |
| SBD viewpoint | <p>As a primary controller for many years in BMWs, the iDrive controller functions extremely well and may be the input of choice for many users. In some cases, new buyers will not have a choice.*</p> <ul style="list-style-type: none"> <li>The controller provides the ability to easily scroll through, select, and configure central display options.</li> <li>The latest iteration has a degree of 'wow-factor' with its light ring and see-through construction that retains handwriting input.</li> <li>Haptic feedback on the controller itself gives a sensation of quality and increases confidence during input.</li> <li>The location of the controller is optimised for easy reach.</li> <li>One minor drawback to note is that misoperation was experienced on several occasions when clicking the controller: instead of registering a central click, a directional click was instead recognised.</li> </ul> <p>The provision of a rotary input control in this case is seen as a benefit to users, providing additional input choice and catering for those loyal to the BMW brand who are used to this form of input.</p> <p>*It was announced in November 2021 in the US that due to the semiconductor shortage, many BMW models would have touchscreen input deleted.</p> |                |           |                |                |
| UX impact     | Major negative   | Minor negative | No impact | Minor positive | Major positive |



Rotary controller has a degree of 'wow-factor'

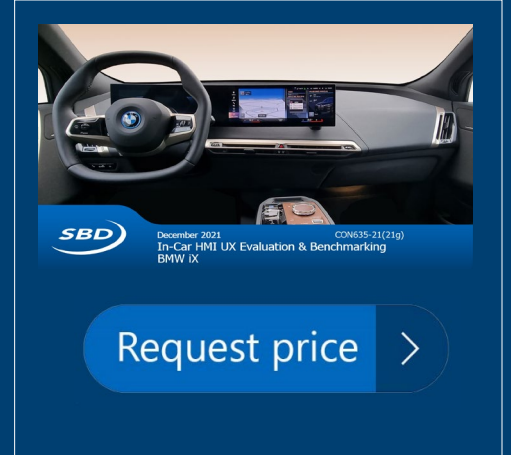


Video showing rotary input configurations





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the full 170 page report



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**Garren Carr**  
**North America**  
[garrencarr@sbdautomotive.com](mailto:garrencarr@sbdautomotive.com)  
+1 734 619 7969

**Luigi Bisbiglia**  
**UK, South & West Europe**  
[luigibisbiglia@sbdautomotive.com](mailto:luigibisbiglia@sbdautomotive.com)  
+44 1908 305102

**SBD China Sales Team**  
**China**  
[salesChina@sbdautomotive.com](mailto:salesChina@sbdautomotive.com)  
+86 18516653761

**Andrea Sroczynski**  
**Germany, North & East Europe**  
[andreasroczynski@sbdautomotive.com](mailto:andreasroczynski@sbdautomotive.com)  
+49 211 9753153-1

**SBD Japan Sales Team**  
**Japan, South Korea & Australia**  
[postbox@sbdautomotive.com](mailto:postbox@sbdautomotive.com)  
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