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UX EVALUATION

In-car HMI UX Evaluations

#635

In-Car HMI UX Evaluation & Benchmarking

Hyundai IONIQ 5

In this edition of SBD Automotive's HMI UX Evaluation report series, the UX Team tests the new Hyundai IONIQ 5. Inside, a reasonably attractive GUI features on its two 12.3-inch displays, one focusing on infotainment and the other functioning as the instrument cluster, which features three 'paper' themes which animate when transitioning from one to another.

The IONIQ 5's HMI approach has several basic UX principle violations, such as a lack of intuitiveness, brevity and consistency in some cases and several examples of complexity. Many of these, however, would be relatively simple to resolve with software modifications.

COVERAGE	FREQUENCY	PUBLICATION FORMAT	PAGES
GLOBAL, NA, CHINA, EUROPE	ANNUALLY, QUARTERLY, 8 CARS PER YEAR	PDF, POWERPOINT, EXCEL, ONLINE	140+

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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.

This research is useful for

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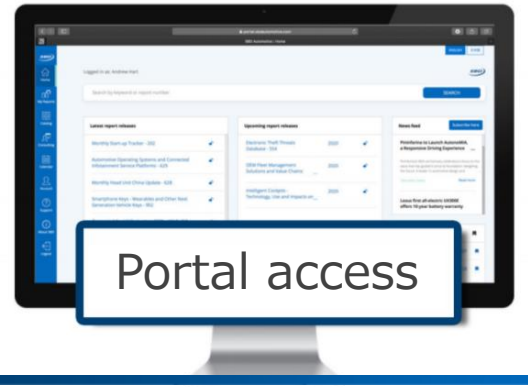

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Hyundai IONIQ 5

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SBD

September 2021

635-21(21d)

IN-CAR HMI UX EVALUATION & BENCHMARKING

Hyundai IONIQ 5

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Introduction

Aim of this report

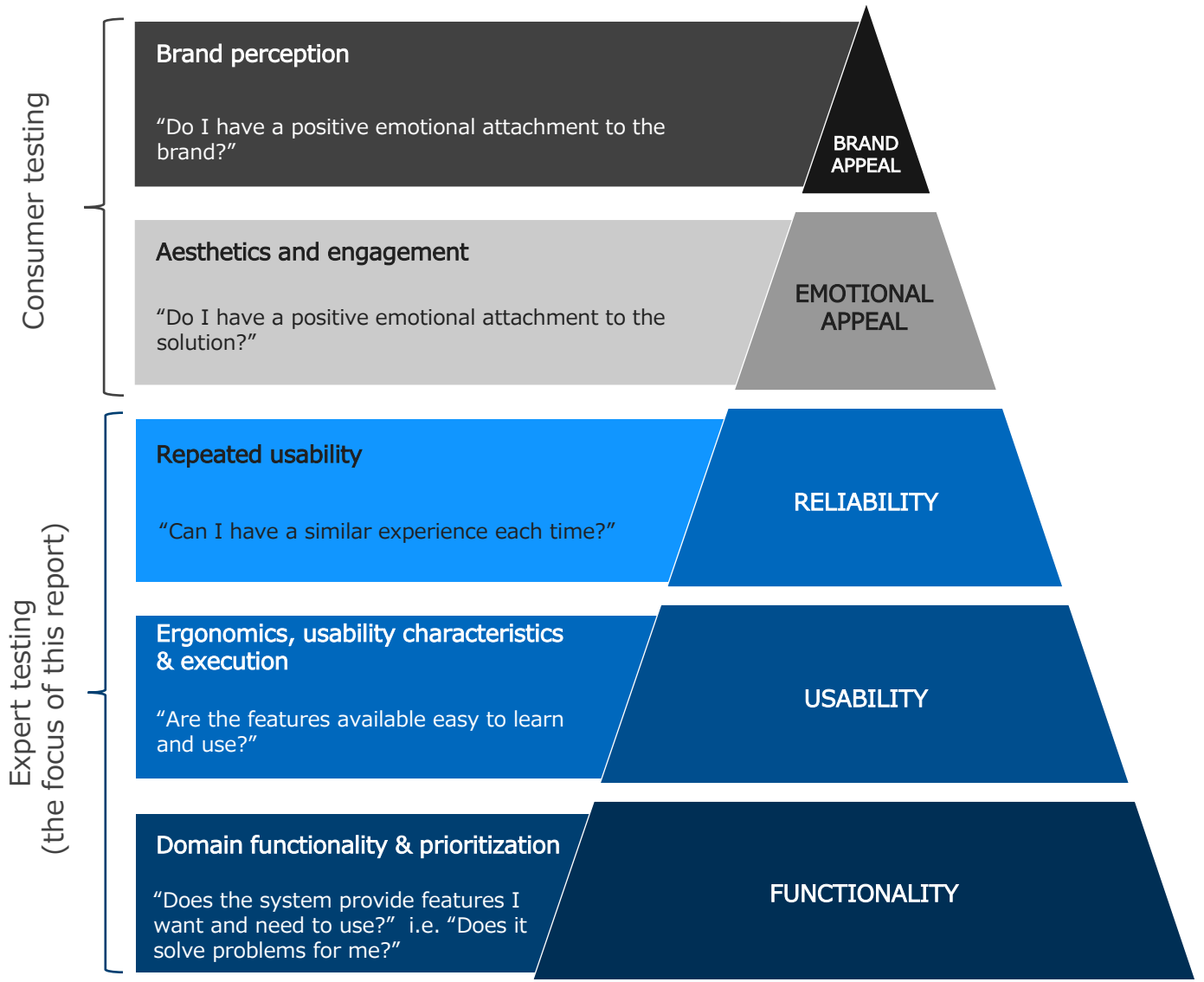
Welcome to the 2021 HMI benchmarking report series. This report has been created to provide a fair, unbiased and objective view of the latest in-vehicle HMI solutions in the European and US markets. Evaluations are carried out by SBD usability experts with a deep understanding of CASE domains such as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

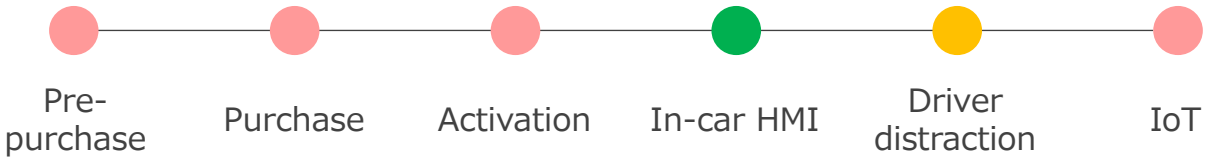
All viewpoints and analysis within the report are aimed defining areas of concern through a data driven approach. This report aims to benchmark and score solutions whilst also being able to provide actionable recommendations to design and development teams.



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 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

Vehicle list

SBD has chosen eight cars to evaluate in 2021, 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 or delay testing slightly.

Confirmed cars for 2021

Mercedes-Benz S-Class

- Advanced HUD with augmented reality
- Biometrics
- Multiple wow-features

CUPRA Formentor

- Volume brand offering
- CarPlay and Android Auto analysis
- Departure from VW group UI
- First CUPRA HMI test

Tesla Model S

- Updated Tesla UI
- New steering wheel approach
- High performance graphics
- US market test

Hyundai IONIQ 5

- AR head up display
- Highway Driving Assist 2 ADAS

Lexus LS

- Advanced ADAS feature set
- Japan market test

BMW iX

- New generation of iDrive
- Expanded BMW VPA
- Most advanced BMW ADAS
- Digital Key Release 3.0

Remaining cars due for testing in 2021

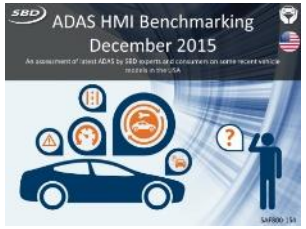
Cadillac Escalade

Final car TBA

- Due to supply issues, it is likely the Rivian R1 and Lucid Air will be tested in early 2022 as part of the 2022 report series

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

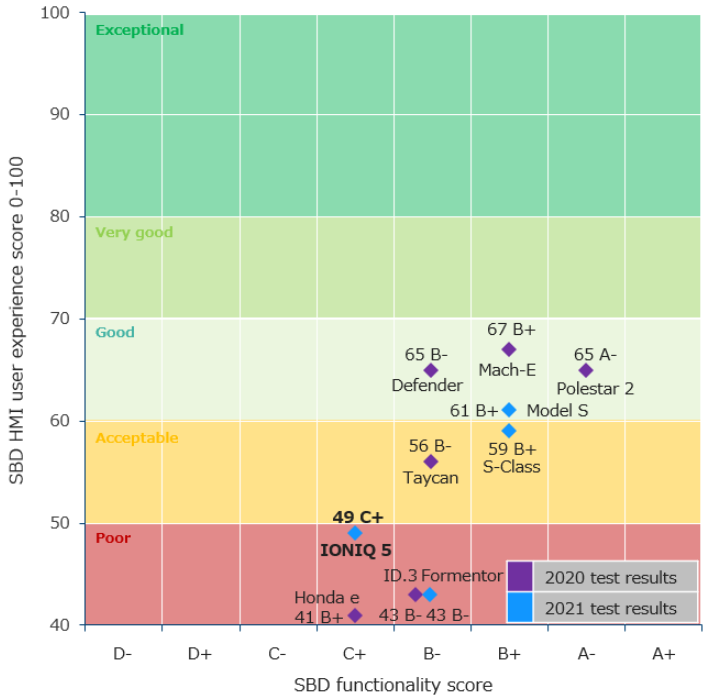
This document does not provide a detailed description of the methodology and this page serves to provide an overview of the approach.

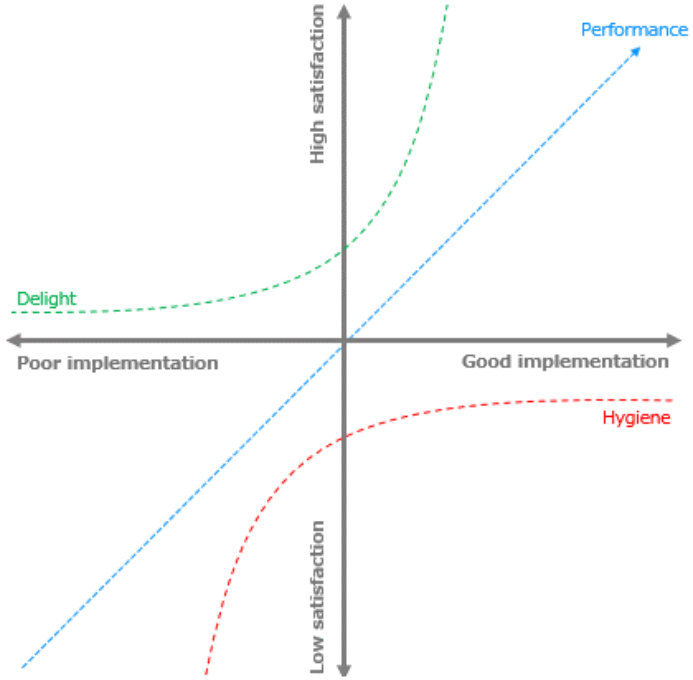
For a detailed discussion and presentation of SBD's methodology please contact us.

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)	✓	✓	✓	✓	✓	✓	✓	

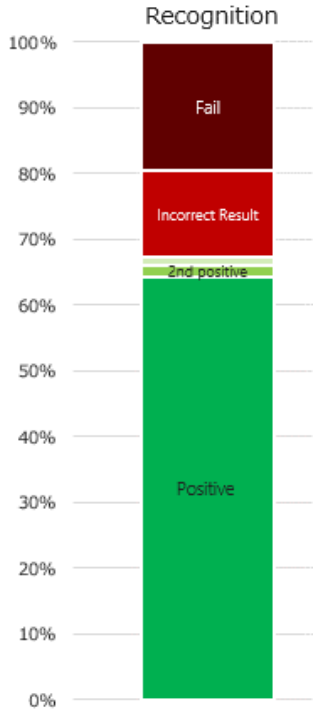
Report structure and how to interpret certain data sets

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 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.

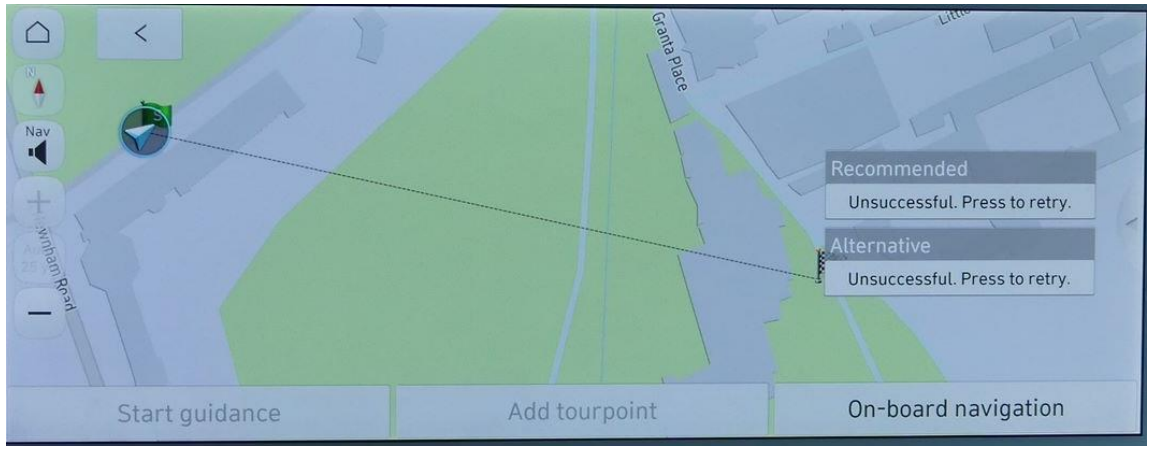
Objective scoring generally based on a pass/fail criteria or time-based considerations. SBD attempts to minimize subjectivity as much as possible with results aimed at being fair and reasonable with a minimal level of bias.

Example slides from the full 140 page report

Request price

Basic feature expectations not met, navigation leaves room to improve

- It's likely users will be left disappointed by either the lack of, or bad implementation of some basic essential features.
- A feature such as navigation lane guidance is good when offered, but on a number of occasions where it was deemed necessary, it wasn't provided.
- Although the system provides a connected charging station feature, this search isn't fully integrated into the destination input process like it is in the Tesla solution. The Hyundai system simply calculates if the destination exceeds the vehicle's remaining range, and provides the user with a method of searching for charging stations. In Tesla, the location of charging stops and charge duration are automatically plotted.



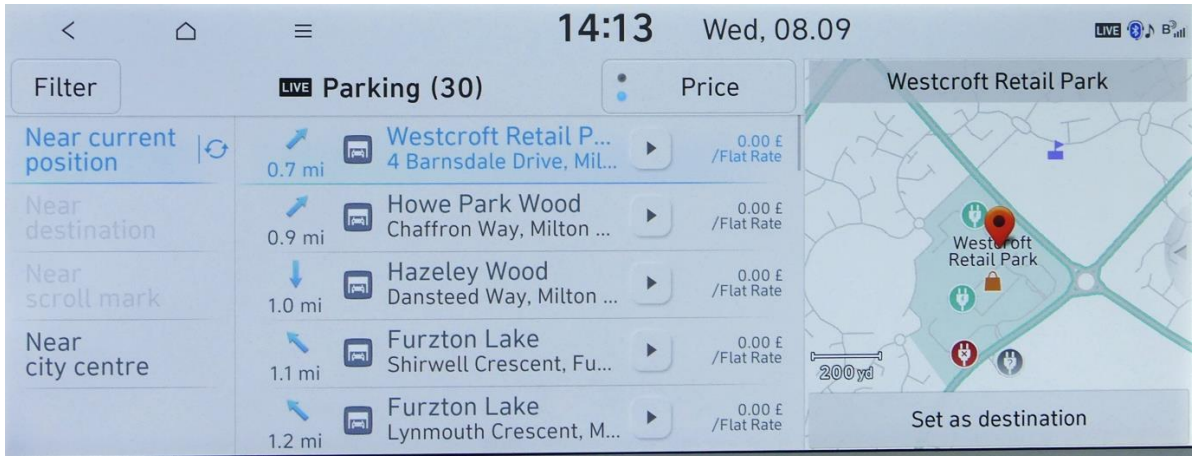
Data connectivity issues

Data connectivity throughout the evaluation suffered instances of no functionality which had a severe impact on navigation and voice recognition.

When connectivity was not functional, it would behave as if the system had no cellular reception, although while this happened the reception indicator in the top right of the display indicated that a signal was being received.

This meant that for a number of voice recognition interactions, the system would respond with "No network response. Use the screen to search for your destination". For connected routing, an error message would be shown on the screen saying "Unsuccessful. Press to retry."

- In terms of connected navigation features, the system offers connected traffic, routing, charging stations and parking.
- The exact benefit of the connected routing was not observed, and in fact on a few occasions the recommended route was not the best route that could have been taken. Sometimes, a prompt appears with an alternative "Bluelink Recommended" route, but vital information for how this route is better than the current route is not shown.



Connected parking

Of the limited connected functionality that the IONIQ 5's navigation system offers, connected parking offers a means of finding supplementary information for parking POIs to users.

Data offered includes address, opening hours, cost, height restrictions and contact details. This is what was displayed for the local POIs when checked, but further information such as number of spaces may also be offered for other locations.

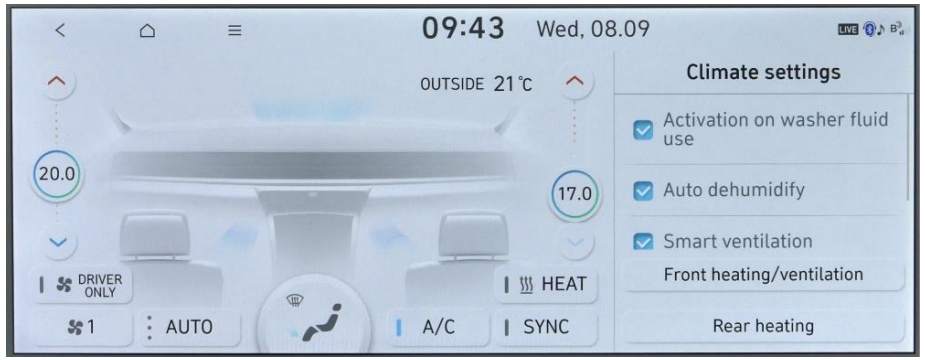
If the solution were to offer this level of supplementary information for other POI groups such as restaurants or coffee shops.

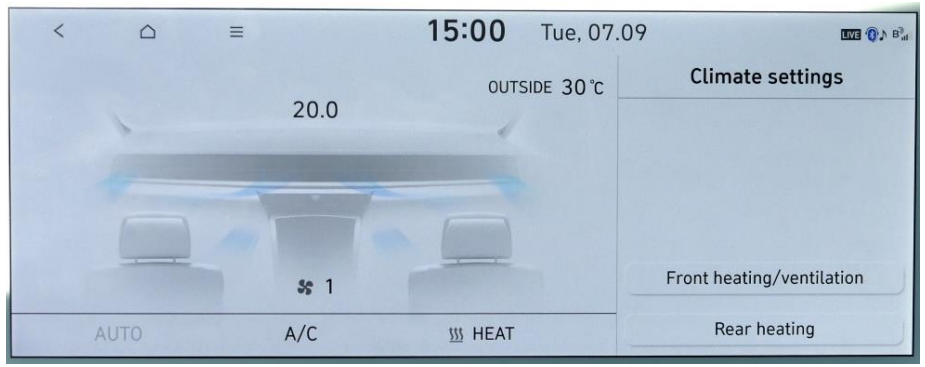
Some on-screen HVAC controls sometimes disappeared

2. HVAC

HVAC behaved erratically, with critical controls sometimes disappearing. The first image shows the HVAC ‘Front climate’ page as it normally displays. Two different unexpected behaviours were experienced: most of the controls within the 'Front climate' section disappeared at one point and changes to distribution showed as blue arrows coming from the vents (second image) rather than the expected circular tri-mode interface. On another occasion, the controls again disappeared, and when using the physical button panel, changes showed in the right hand side panel (third image).

Frequency	Low	Medium	High
Severity	Minor	Major	Critical





Key lowlights

Placement of the central display presents reach issues

Central display

Out of reach for even 95th percentile users

Placement of the central display in this vehicle is very good in terms of visibility, however it is in a location that puts it out of reach for the vast majority of users – even those with long arms.

To reach the display, the user needs to lean forward out of their seat by approximately 100mm. Although not a critical issue, it is something that could be avoided or mitigated.

This concern is expected to affect most (if not all) users on a high frequency basis.

Perceived Quality: Tactile

Level 1	Tactile
SBD viewpoint	**Stiffness & looseness:** Stiffness of HMI when in use is very good and only a small but acceptable degree of movement tolerance is experienced. This is most noticeable in the steering wheel rocker switches. **Force feedback:** The button feedback feels well-rounded and satisfying in use and manages to avoid feeling cheap. **Material quality:** The majority of tactile HMI surfaces in the IONIQ 5 have a very plastic look and feel. Although the silver colour of switches and stalks is meant to convey an aluminium-like aesthetic, it does not manage this and clearly looks and feels like silver-coloured plastic. **Material harmony:** The choice of materials are a fairly broad mix of plastics that offer the expected tactile sensations. Plastics in the lower areas of the cockpit appear of lower quality than those higher up, such as USB ports and their surrounding trims. **Geometric & Positioning:** Some components feel surprisingly effective in use such as the steering wheel controls, while others feel abnormally cumbersome such as the stalks around the steering wheel. This imbalance between small and precise vs. large and cumbersome may result in a negative perception of quality towards those larger controls.

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

SAE Level 0 ADAS: System usage

System usage: LDW/LKA

Visual warning after lane deviation

System usage: BSM/BSI

Warning in cluster

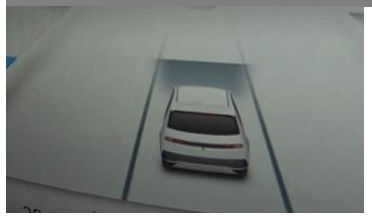
Warning in mirror

Good visual warning in cluster and mirror

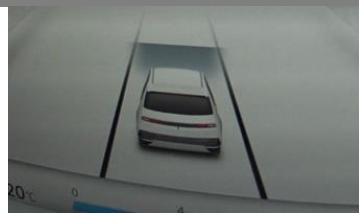
System usage: RCTA with braking

Good audio and visual warning in cluster, corresponding side mirror and infotainment screen

System usage: LDW/LKA



Not Tracking



Tracking

Lane tracking status colors are very subtle

System usage: BSM/BSI

Lack of BSM icon or status in cluster

Information architecture issues add complexity to operation

Category	General system
Description	Information architecture issues hinder frictionless interaction
SBD viewpoint	The infotainment system in the IONIQ 5 suffers from a range of information architecture issues, some highlighted in the previous Kia Sorento UX report and persisting in this implementation. • The home screen was one element that received criticism in the Sorento report due to its mostly blank appearance. The IONIQ 5's system now shows content, but it is more aesthetic than functional, and it is expected that few users would make frequent use of this screen. Three dots at the bottom show that it's one of three screens, however these fade out after a few seconds, and are easy to miss. New users may become stuck on this screen and fail to understand how it is integrated. This is a further example of the point raised in the Kia report of the system appearing to have been coded for proximity sensing but not having the hardware implemented. This point remains relevant to the IONIQ 5's navigation interface. • The two subsequent 'all apps' pages demonstrate absolutely no logical ordering: it would be expected that Map/Nav, Media and Phone at least would be prioritised. It is possible to customise the order, however the process does not behave as expected and the conventionally accepted behaviours when dragging one tile in a list are not adhered to, leaving gaps in the list and demonstrating a strange phenomenon where an icon jumps between pages.

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

IONIQ 5 system shows similarities to previously evaluated Kia system

Connected routing: Positives not found, some negatives experienced

Category	Navigation
Description	Bugs: Voice turn-by-turn guidance unexpectedly stopped for over 30 minutes
SBD viewpoint	At one point during navigation testing, the Hyundai solution did not provide any audible guidance for the driver for a duration of just over 30 minutes. This meant that in a busy inner city driving scenario where the driver's concentration levels are highly focused on the current road condition, they had to frequently check the display for the next turn instruction. Although it did not result in any wrong turns being taken, this issue certainly had a negative impact on the experience and is likely to have been mitigated by the driver having some experience of the route. Had the route been completely unfamiliar, it's expected that this issue could have resulted in turns being missed.

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

During this route, voice guidance was not given by the system for over 30 minutes

Clear voice turn-by-turn instructions

Category	Navigation
Description	Verbal commands are clear and timely
SBD viewpoint	During the evaluation it was found that the Hyundai solution had particularly clear and timely spoken guidance when compared with the other solutions tested in the UK. • Both the Mercedes-Benz S-Class and CUPRA Formentor displayed instances of confusing voice guidance, such as “take the first lane on the right” for keeping right in a highway scenario, or the CUPRA solution’s confusing roundabout instructions. Although when working as expected accurate turn-by-turn instructions are normally taken for granted, a comparison to other solutions which perform below expectation highlights the benefit of accurate spoken guidance and how it reduces the need to look at the visual guidance on the displays.

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

Multiple instances of visual guidance can be overwhelming or confusing, good voice guidance reduces reliance on visual guidance and reduces the risk of distraction

Request the price for the full 140 page report

Request price

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USA | UK | Germany | India | China | Japan

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

Alessio Ballatore
West Europe
aballatore@sbdautomotive.com
+44 74 71 03 86 22

Luigi Bisbiglia
South Europe & RoW
luigibisbiglia@sbdautomotive.com
+44 1908 305102

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

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

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