



#635



In-car HMI UX Evaluations

In-Car HMI UX Evaluation & Benchmarking

Hyundai KONA Electric

In this edition, HMI UX report sees our experts test the EV variant of the 2024 Hyundai Kona. Inside, it offers a next-generation infotainment system with dual 12.3-inch panoramic display screens that are integrated into the audio-video navigation system for a widescreen digital experience.

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COVERAGE



FREQUENCY



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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

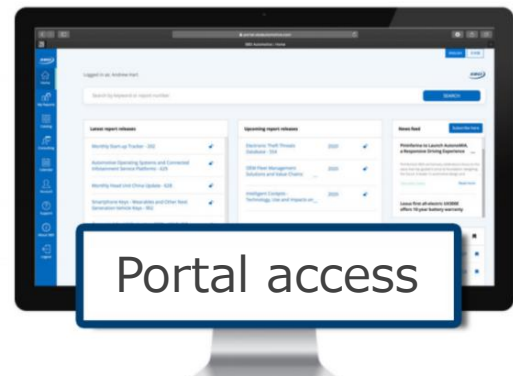


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Introduction



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 while 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

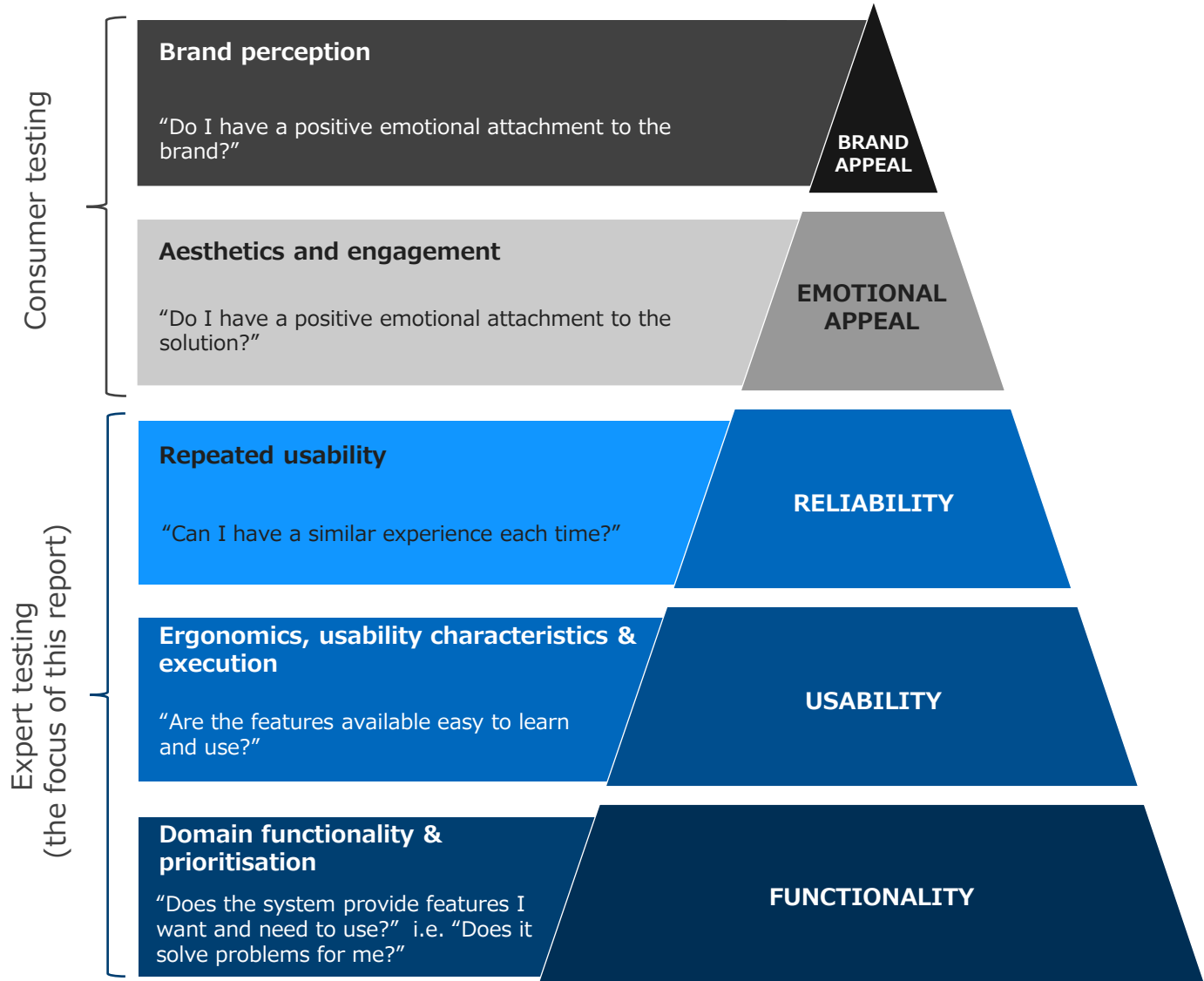
Section	Content
Birds Eye View	An overview of the key findings from SBD's various CX related and adjacent reports.
Executive Summary	Presents key highlights and conclusions from the report.
The Basics	What do you need to know about SBD's CX evaluation methodology?
Analysis	Analysis of report findings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

- 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

Priority target vehicles



Volvo EX90

- Volvo Pilot Assist
- 14.5-inch central display
- EU or US market test

Group B

Cars tested



Xiaomi SU7

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

Other vehicles being considered for 2024



Audi Q6 e-tron

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



Acura ZDX

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



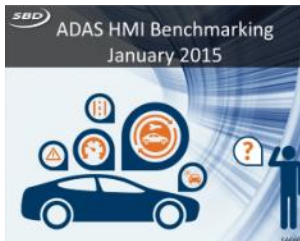
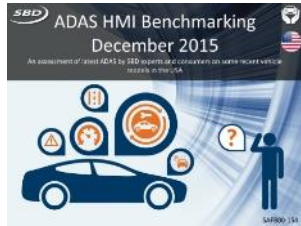
Avatr 12

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



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.

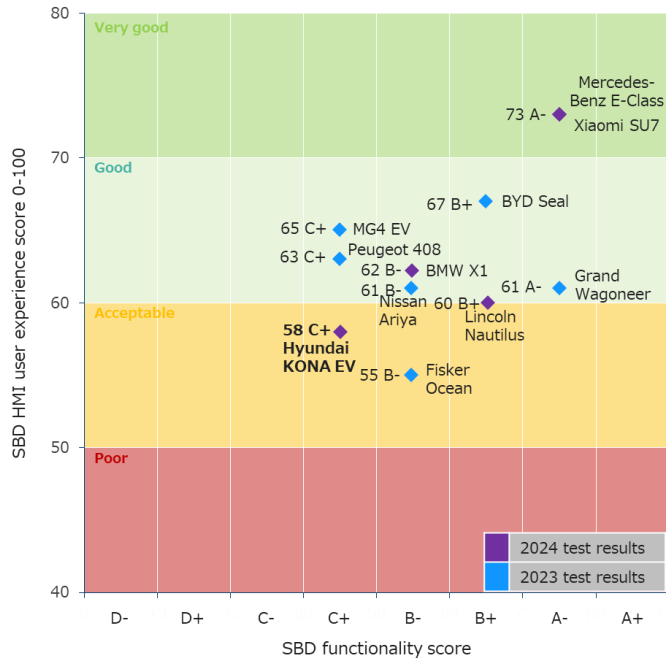
For a detailed discussion and presentation of SBD's methodology please [contact us](#).

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

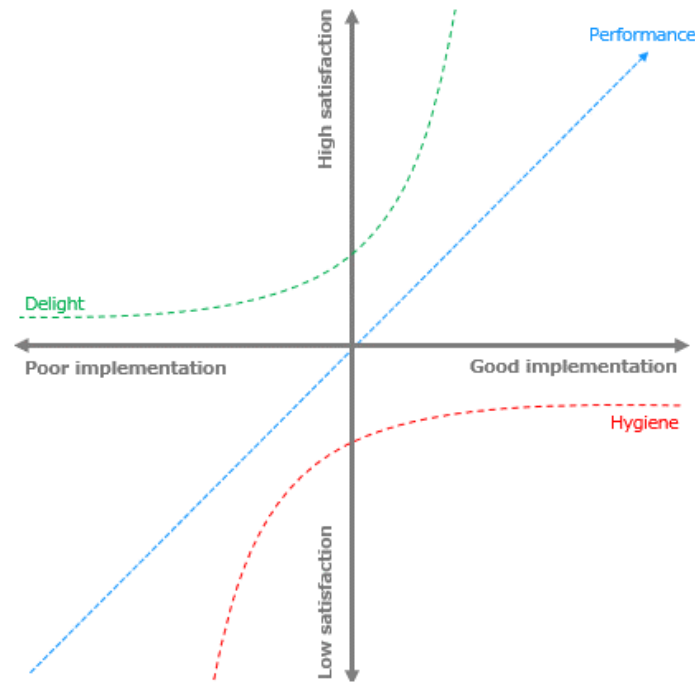
Throughout the testing and evaluation process SBD uses multiple methodologies to align to the situation and test area. Outputs from these evaluations can be broadly grouped into the following three types of report outputs - SBD's goal with these options is to ensure understanding of the results are as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



UX & 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.

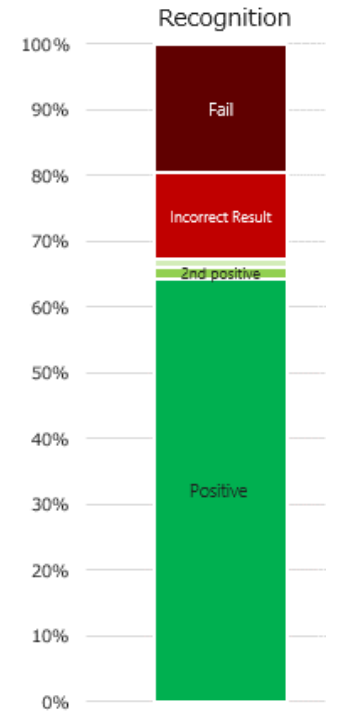


Modified Kano feature analysis

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

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



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

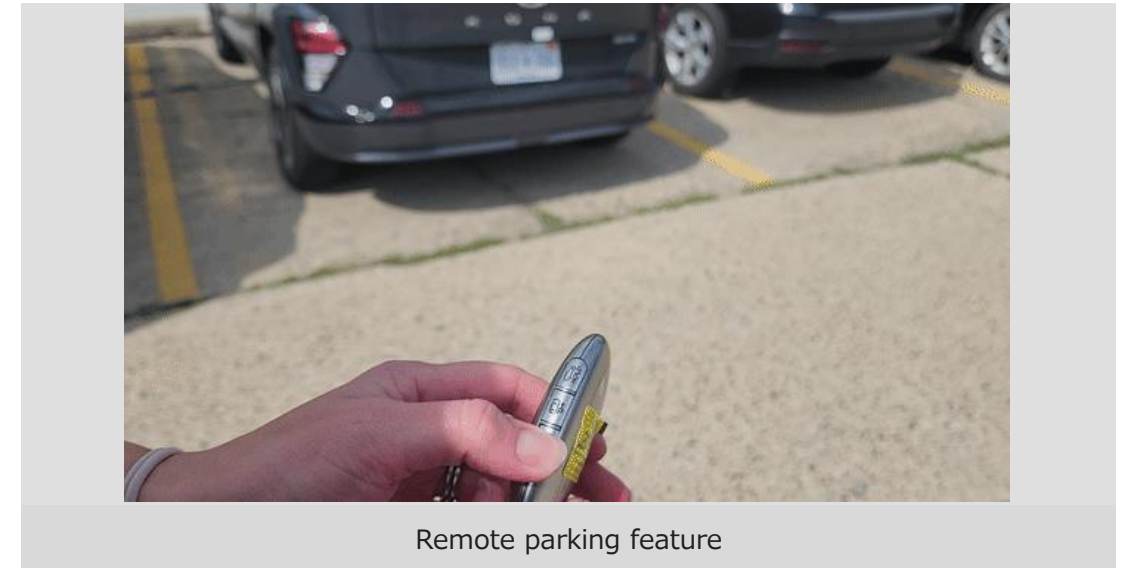
This is an example slide from the report, enclosed in a white border. The top portion of the slide features a photograph of a car's interior, showing the steering wheel, dashboard, and center console. Below the image is a dark blue banner containing the SBD logo on the left, the text 'August 2024' and '635-24(24e)' on the right, and the title 'In-Car HMI UX Evaluation & Benchmarking Hyundai KONA Electric' in the center. At the bottom of the slide is a prominent blue button with the text 'Request price' and a white right-pointing chevron symbol.



Surprising delight features offered

Unique and convenient features for volume brand vehicle

- The KONA Electric offers the ability for owners to pay through the infotainment system for EV charging and parking at participating suppliers. The user can find participating suppliers in the navigation search or directly in the Hyundai Pay app and pricing information is also included in the app.
- Convenient remote parking is offered in the KONA Electric, which is a unique feature for both volume and premium brand vehicles. Remote parking can be performed by using the dedicated buttons on the key fob and can be done outside or inside the vehicle. This feature is helpful for tight parking spots to help prevent door dings or help create more room for a parent to be able to fully open a door to put their child in a car seat for example. Interestingly the KONA EV tested did not have a semi or fully automatic parking solution instead or in combination with the remote parking feature.
- The Hyundai Pay feature is convenient but has some minor room for improvement to help make it more convenient for the user by offering plug and charge for the EV charging. The current implementation requires the user to initiate payment through the infotainment screen, but if the user could just drive up to the charger and plug in their vehicle for it to start immediately charging, that'd add more positive to the overall user experience.



Remote parking feature

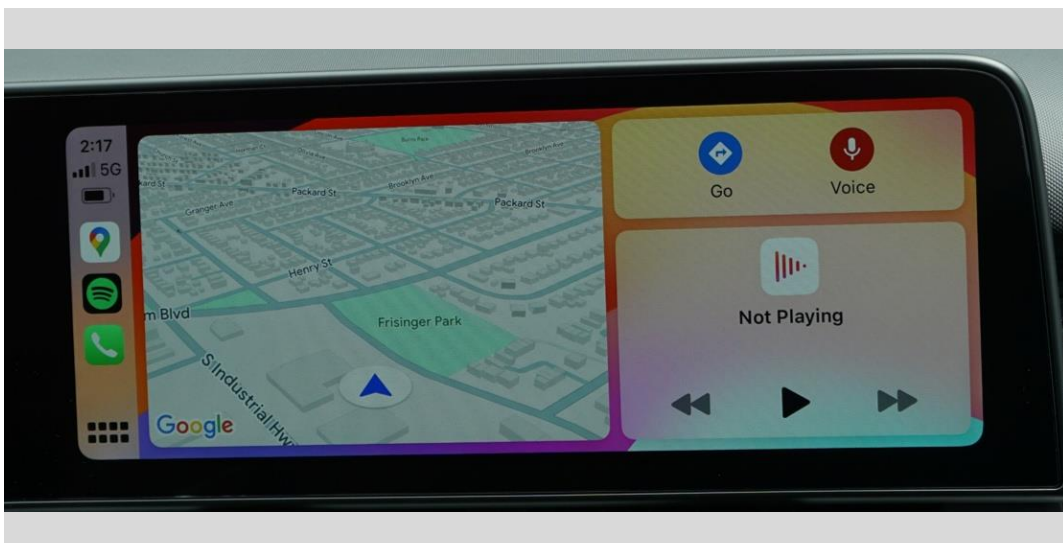


Hyundai Pay has some room for improvement



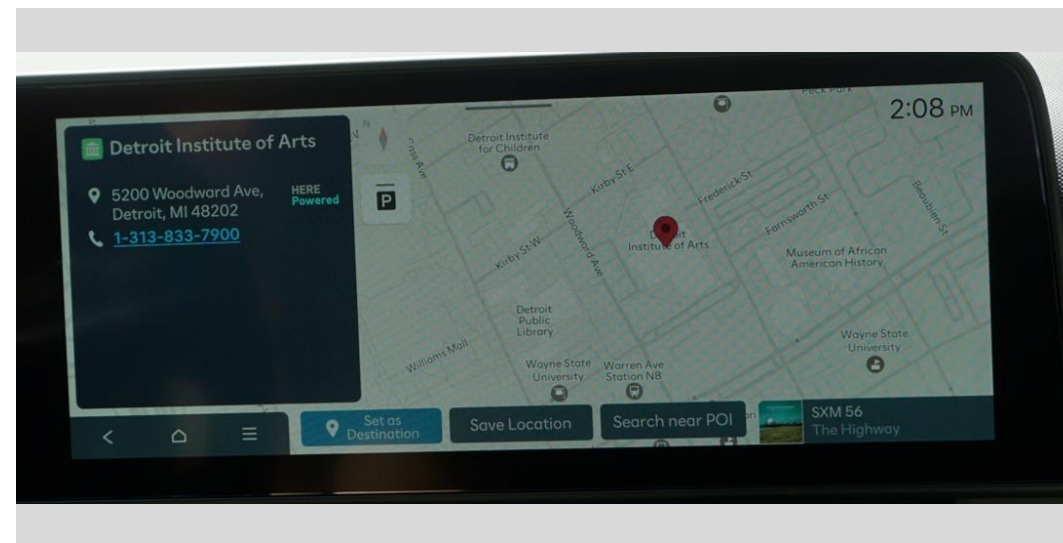
Majority of hygiene features included, but poorly integrated

- Most hygiene features are included in the KONA EV, but some minor features missing, include no HVAC control offering through the display in combination with the hard button controls on the center console.
- There's no text search offered for search phone contacts, also when Android Auto/Apple CarPlay is the current source, there's no ability to change the source to something else through the central display.



Android Auto/Apple CarPlay preventing source selection

- Navigation has a low feature set with not much details offered for POIs, lacking rating information or operating hour information in order to provide a level of contextualization.
- The minimal connected information for navigation is included with participating suppliers for Hyundai Pay, for example, those EV chargers show charger availability and pricing information.



Minimal connected information



Home button does not lead to the first home page screen

2. General

When the user selects the home button on the central display, the system returns back to the second of three home screens, not the first as would be expected by most users.

Frequency	Low	Medium	High
Severity	Minor	Major	Critical





Perceived Quality: Kano model

Level 1 Kano model

SBD viewpoint

Delight features: Hyundai Pay is offered to be able to pay for EV charging and parking for participating POIs. Remote parking feature is available to offer a level of convenience.

Performance features: There are a decent amount of issues with the implementation of a variety of performance features, especially navigation related ones, that negatively impacts the quality.

Basic / Hygiene features: Some minor issues with implementation of some hygiene features, but no obvious misses that negatively impact quality.

Level 2 scoring

Delight features

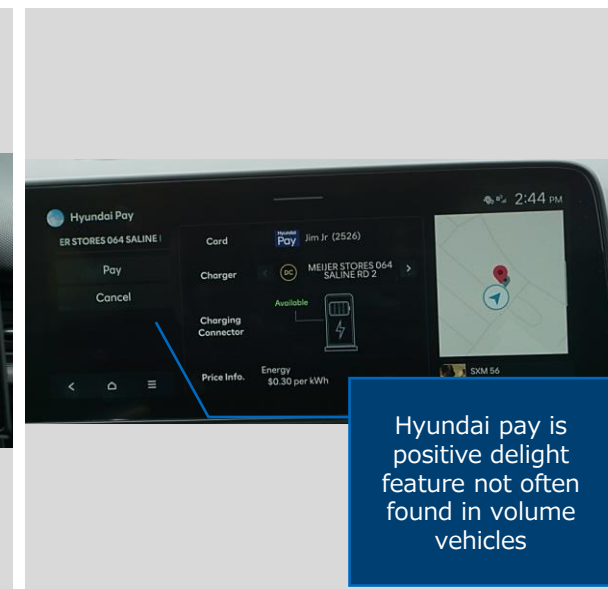
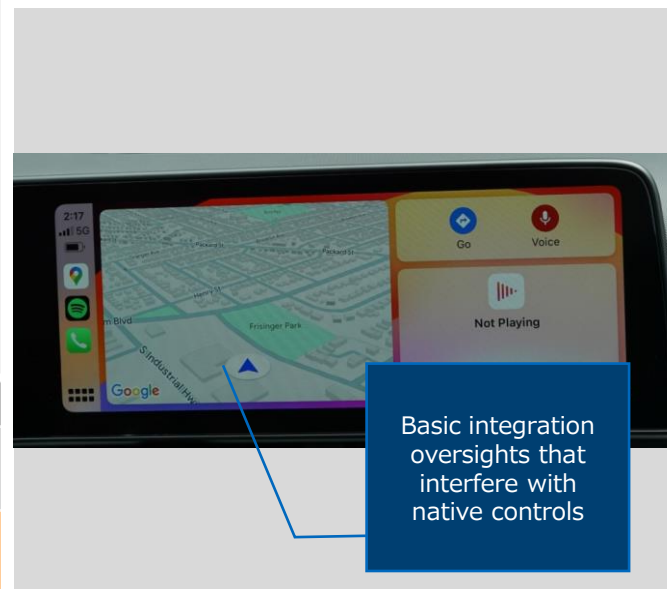
Performance features

Basic / Hygiene features

Fair

Good

Fair



Clear directional warning with audio prioritization

Category	System usage	
System	RCTA	
<p>SBD viewpoint</p>	<p>Providing the system is ON (this is the default setting), activation of the system is automatic when reverse gear is chosen by the driver. This further adds to the convenient and simple operation of the system with minimal requirement from the user.</p> <p>Clear directional visual warnings are provided in the cluster, central display and side mirrors. In the central display, a red warning triangle and direction arrow are shown on the side of the rear-view camera display that the detected vehicle is approaching from. A similar visual is also shown in the cluster. The visual warning is also carried into the side mirrors utilizing the BSM warnings icons. Distinctive audible warnings are also given and are given partial prioritization over other infotainment volume. In addition to visual and audible warnings, the driver is also given a vibration alert through the steering wheel. Automatic braking is also offered if other warnings are not considered enough to mitigate a potential collision.</p> <p>If a pedestrian is detected rather than a vehicle, the system proceeds directly to automatic braking in order to avoid a collision. Visual and audible warning is also given in conjunction.</p>	<p>Clear warnings in cluster and central display</p>
<p>UX impact</p>	<p>Minor Positive</p>	



Offers Hyundai Pay to pay for charging and parking

Integrating Hyundai Pay for Charging at supported chargers and parking facilities facilitates the EV user experience.

- SBD tested the charging aspect of Hyundai Pay at a ChargePoint charger and found it to be easy to use with a few difficult aspects. No instructions are given; however, it is easy for a user to figure out.
- Upon pulling up at the charging station, Selecting the correct charger was straightforward. Next, select 'Pay' on the screen and plug the vehicle in. EV charging then starts
- Select parking structures that allow the user to pay for parking and make a reservation. During testing, this feature repeatedly gave an error, and SBD suspects it was more about the selected parking garage than the vehicle.

Making in-vehicle payments allows for a seamless user experience and eliminates the need for another app to charge or pay for parking the EV.

SBD viewpoint

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



Hyundai Pay being shown for EV charging at a ChargePoint station



Hyundai Pay being shown to pay for a parking reservation



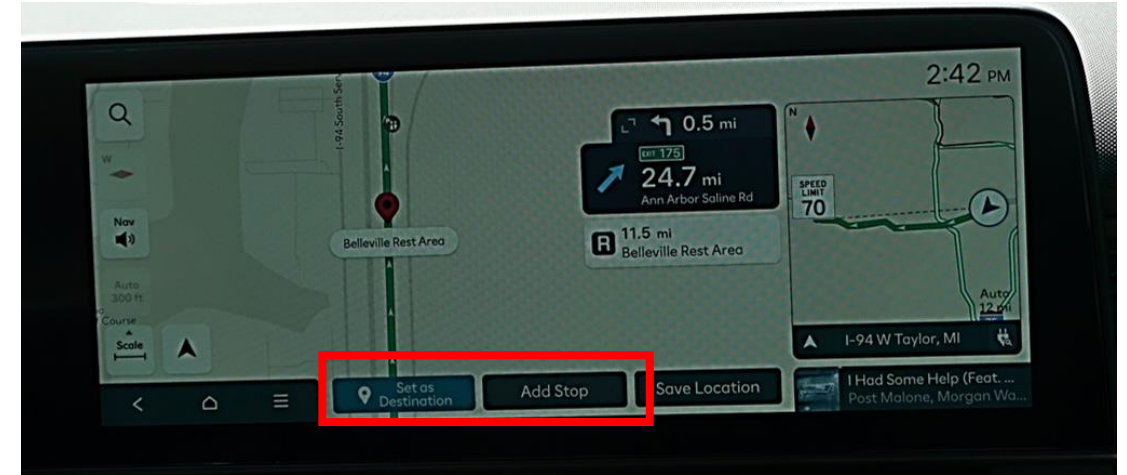
Poor implementation to set a destination and to add a waypoint to a set route

SBD viewpoint

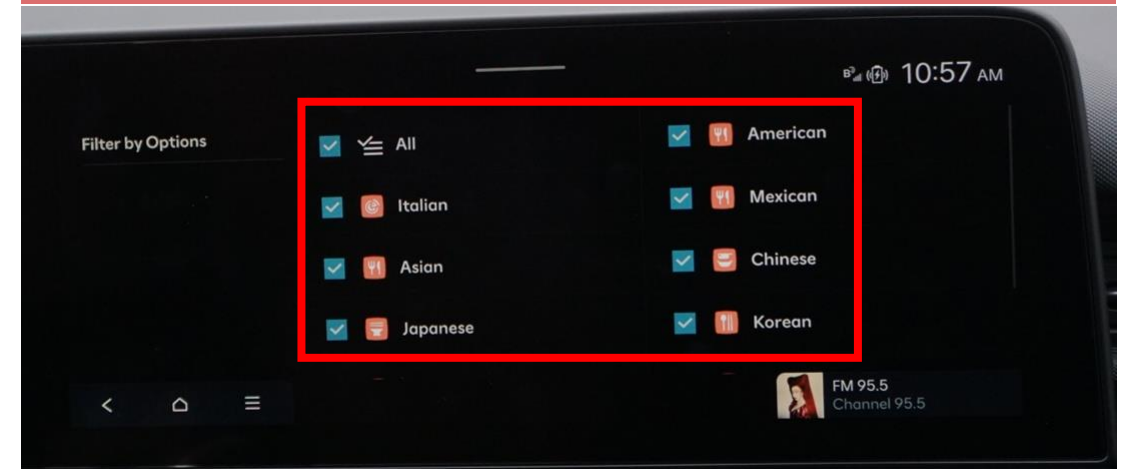
Adding a stop while a route is active could be more user-friendly. Finding POIs takes many steps to find what the user is looking for.

- When a route is active, and the user wants to add another stop, a different button needs to be pressed. This button is right next to the 'Set as Destination' button and often results in misoperation.
- The POI search takes many steps to find what the user wants. For example, to find a Pizza place, the user must select POI search – Restaurants – and use an unintuitive filter function to find the required cuisine. This requires a total of six steps.

The poor implementation of these features can create driver distractions due to its small touch targets and unsupportive interface.



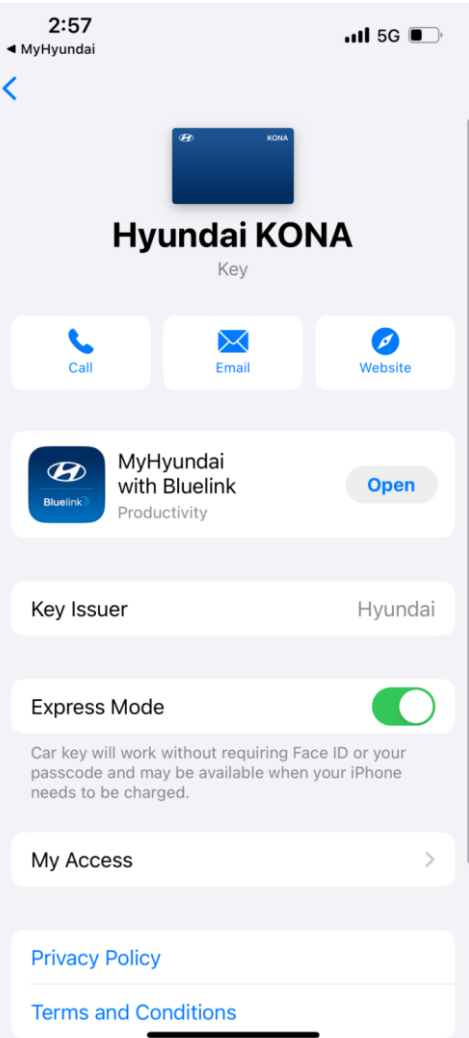
'Add a Stop' button just to the right of the 'Set as Destination' button



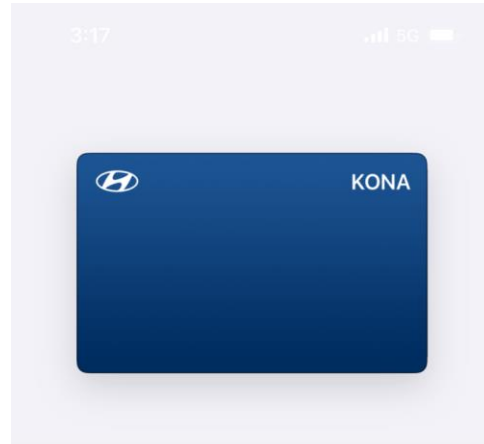
Filter list to find a specific type of restaurant



Digital Key – Usage and Experience



Key settings shown inside the 'Wallet' app where they keys are stored.



Using Car Keys

To unlock the car, hold iPhone near the door handle or side mirror. To start the car, place iPhone on the car's key reader, then press Start/Stop button.

Car keys will work automatically without requiring Face ID or your passcode.

Continue

The first time using a stored key, instructions are given on its use.

SBD viewpoint

Set up of the Digital key is easy to do by following the instructions. Set up time takes a few minutes from start to finish.

When first using the linked device, the vehicle took longer than expected to respond (30 Seconds). The start process is considerably faster. Subsequent uses of the digital key are faster, and no issues are reported.

In order for the system to work, the user must hold the device next to very specific locations on the vehicle. Unlock times vary but all work in an acceptable amount of time after the first attempt.



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