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Comparative Analysis of Steering Wheel Button Types, Layouts and Functions in the Market

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ABSTRACT

Modern steering wheels have evolved into complex human–machine interfaces (HMIs) integrating controls for multimedia, navigation, driver assistance systems, and comfort features. Understanding how manufacturers organize these controls is essential for developing future HMI concepts. This paper presents a comparative analysis of steering wheel button layouts and functions across six benchmark automotive brands. A total of 69 physical controls were classified according to input type (press, touch, roller, and hybrid combinations), functional category (Multimedia and Communication Control, Navigation and Menu Control, Cruise Control, and Customization and Others), and spatial location. The study aimed to identify the most common button types, their relationship with specific functions, and their spatial distribution. A complementary infographic-based visual analysis of six anonymized steering wheel layouts was also performed. Results showed a clear predominance of press-type buttons (59%), which were the most common interaction method across all major functional categories, reaching 65.2% in Multimedia and Communication Control, 57.7% in Cruise Control, and 52.9% in Navigation and Menu Control. Touch controls achieved their highest representation in Cruise Control (34.6%). Cruise Control also showed the greatest consistency in control placement across brands, whereas Customization functions exhibited the lowest level of standardization. These findings provide an empirical benchmark of current steering wheel HMI practices and support future interface development.

Keywords: Steering wheel HMI, Automotive interface design, Human-machine interaction, Benchmarking, Driver distraction

INTRODUCTION

Recent advances in Advanced Driver Assistance Systems (ADAS), digital instrument clusters, infotainment platforms, and connected-vehicle technologies have considerably increased the number of functions that drivers can access directly from the steering wheel (Donnellan, 2018; Wang et al., 2023; Wang et al., 2025). As a result, steering wheels have become one of the most important human–machine interfaces inside modern vehicles,

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requiring careful ergonomic design to balance functionality, usability, and driving safety (International Organization for Standardization, 2019; Rathod & Vyavahare, 2025). Consequently, understanding current market design practices is an essential step towards developing new steering wheel HMI concepts that minimise driver workload while maintaining intuitive interaction, while also complying with emerging safety recommendations for driver engagement (Euro NCAP, 2025).

Modern steering wheels have evolved from purely mechanical steering devices into sophisticated human–machine interfaces (HMIs), integrating controls for multimedia and communication, navigation, driver-assistance, and comfort systems (Wang et al., 2025). This proliferation of functions increases both the number and diversity of physical controls available to the driver, with direct implications for usability, learnability, cognitive workload, and driver distraction (Large et al., 2016; Strayer et al., 2015; Zhong et al., 2024). Human-centred automotive interface design therefore seeks to minimise visual demand while enabling rapid, intuitive, and eyes-free interaction with frequently used functions (Döring et al., 2011). In recent years, steering wheel interaction has progressively expanded beyond conventional push-buttons to include gesture-based and haptic interfaces that aim to improve interaction efficiency while reducing visual demand (Angelini et al., 2014; Hassan et al., 2022; Sarabia et al., 2022; You et al., 2024). Understanding how different manufacturers currently address this design challenge—namely which button types they favour, how they group functions, and where they position controls on the steering wheel—is an essential first step before proposing new interface concepts.

This paper reports a comparative market analysis of steering wheel button layouts and functions, conducted as part of the WP06 – Development and Industrialization of HMI Steering Wheels activity of the GreenAuto project, a collaboration between the University of Minho and ZF Lifetec. The analysis combines a detailed brand-by-brand survey of physical controls with a complementary infographic-based visual analysis of button-type distribution and spatial location. The selected brands include both premium and mass-market manufacturers, providing a representative sample of different HMI design philosophies currently available in the automotive market.

The steering wheel models included in this study were selected in collaboration with the industrial partner ZF Lifetec based on the findings of a focus group conducted during an earlier stage of the GreenAuto project. The analysed steering wheels were required to incorporate the functions identified as most relevant by users, ensuring that the benchmark reflected current interaction needs. Rather than comparing specific vehicle segments, the selection aimed to capture a broad range of steering wheel HMI design approaches across premium, luxury, and mass-market manufacturers. Accordingly, six automotive brands—Porsche, Mercedes, Aston Martin, BMW, Chrysler, and Škoda—were selected. Across these steering wheels, a total of 69 physical controls were identified, catalogued, and classified according to their interaction type, functional category, and spatial location.

As the analysed steering wheels may be shared across different vehicle models within each brand, they are identified by manufacturer rather than by specific model throughout this paper. The steering wheel analysed for each brand is presented in Table 1.

Based on this benchmark survey, the study pursued two objectives: (i) to identify the button types most commonly used in current production steering wheels and their association with specific functions, and (ii) to analyse their spatial distribution across steering wheel layouts.

The goal of HSI is to optimize total system performance, accommodating the characteristics of the user population that will operate, maintain, and support the system, and minimize life-cycle costs (Folds et al., 2008). HSI experts work within the Systems Engineering (SE) process to ensure that all human considerations are integrated throughout system design, development, fielding, sustainment, and retirement. The attention to human systems integration in system development programs drove hundreds of human-centered design improvements. Efforts were concentrated to maximize total system performance through improvements in human workload, ease of maintenance, and personnel safety which resulted in a cost avoidance of billions of dollars and prevention of hundreds of fatalities and disabling injuries for the system (Booher and Minninger, 2003).

METHODOLOGY

The study surveyed the steering wheel controls of the same six vehicle brands identified in Section 1. For each brand, one representative model/trim was analysed using official manufacturer documentation and reference imagery, applying a classification approach informed by prior steering-wheel control taxonomies (Angelini et al., 2014; Euro NCAP, 2025). Each physical control was identified directly from the steering wheel and cross-checked against the corresponding manufacturer's user manual to ensure correct functional classification. The controls were then catalogued according to three dimensions:

(a.) Control input / function — the specific action triggered by the control (e.g., "adjust volume", "answer call", "resume cruise control"); (b.) Button type — the physical interaction mode: press, touch, roller, or a hybrid combination (roller and press, touch and press, rocker and press); (c.) Location — the position of the control on the wheel (left command, right command, or central spoke).

Each control was further assigned to one of four functional categories, established a priori to structure the comparison: Multimedia and Communication Control (MCC) — audio, telephone and voice-command functions; Navigation and Menu Control (NMC) — instrument-cluster and menu navigation; Cruise Control (CC) — activation, speed and following-distance adjustment; and Customization and Others — steering-wheel heating, shortcut assignment and similar functions. A total of 69 controls were catalogued across the six brands.

Each button was classified according to its primary function, interaction type, and spatial location. Button classification was performed by a single researcher and subsequently reviewed by the project team to ensure consistency across the analysed steering wheels.

In addition to the brand-by-brand tabulation, a complementary visual/ infographic analysis was performed. Six steering wheel layouts were represented schematically, mapping button type (by icon shape) and functional category (by colour) onto each wheel diagram. This visual analysis also produced frequency bar charts of button type, both overall and per functional category, together with a map-style representation of the predominant spatial location of each functional category across the six models.

RESULTS

Q1 Table to **Erro! A origem da referência não foi encontrada.** present the full brand-by-brand survey underlying the aggregate analysis, detailing every physical control identified on each of the six steering wheels: its control-input identifier, the specific function it triggers, its button type, and its location on the wheel. Each table is accompanied by a diagram showing the spatial location of the surveyed controls on the corresponding steering wheel.

Table 1: Detailed control survey for Porsche 992 2024.

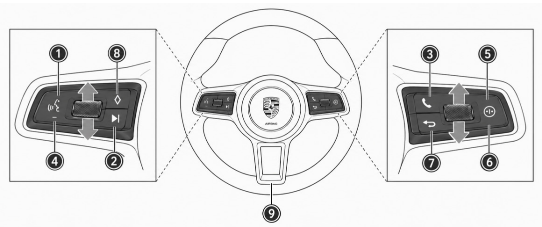
Functional Category	ID	Control Input / Function	Button Type	Command Location
Multimedia and communication control	1	Adjust the volume and mute the audio source	Roller and Press	Left
	2	Play the next/previous station/track	Press	Left
	3	Answer a call	Press	Right
	4	Open voice command	Press	Left
Navigation and menu control	5	Navigate and select menu functions	Roller and Press	Right
	6	Switch between screens	Press	Right
	7	Go back one or more levels	Press	Right
Customization and others	8	Assign quick access buttons	Press	Left
	9	Steering wheel heater	Press	Central spoke
Location of the surveyed controls				

Table 2: Detailed control survey for Mercedes W213 2023.

Functional Category	ID	Control Input / Function	Button Type	Command Location
Multimedia and communication control	1	Make/accept calls	Touch	Right
	2	End/reject calls	Touch	Right
	3	Increase/decrease volume	Touch	Right
	4	Call up telephone favourites	Touch	Right
Navigation and menu control	5	Home screen button	Touch	Right and Left
	6	Touch control (swipe left/right/up/down) and OK button	Touch and Press	Right and Left
	7	Return to the previous menu	Roller	Right and Left
	8	Starts the MBUX Voice Assistant	Touch	Right
Cruise control	9	Select the desired speed	Touch	Left
	10	Deactivates cruise control	Touch	Left
	11	Activates cruise control	Touch	Left
	12	Adopts the stored/detected speed	Touch	Left
	13	Cancels cruise control	Touch	Left
Location of the surveyed controls				

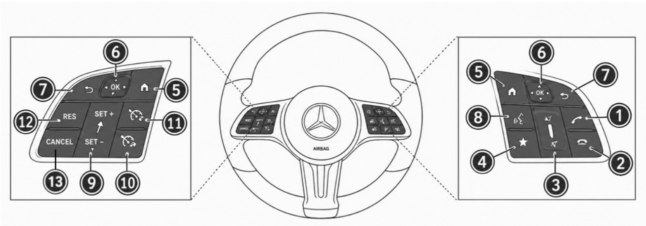


Table 3: Detailed control survey for Škoda KAROQ 2022.

Functional Category	ID	Control Input / Function	Button Type	Command Location
Multimedia and communication control	1	Switch voice control on/off	Press	Left
	2	Switch sound, adjust the volume	Press	Left
	3	Previous track/station	Press	Left
	4	Switch previous track/station	Press	Left
Navigation and menu control	5	Switch/set, confirm	Roller and Press	Right
	6	Control the instrument cluster	Press	Right
	7	Control the instrument cluster	Press	Right
Cruise control	8	Switch some assist systems	Press	Right
	9	Switch between Travel Assist and ACC Travel Assist	Roller and Press	Right
Customization and others	10	Steering wheel heating	Press	Left

(Continued)

Table 3: Continued.

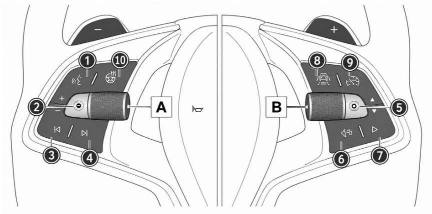
Functional Category	ID	Control Input / Function	Button Type	Command Location
Location of the surveyed controls				

Table 4: Detailed control survey for BMW X4 G02 2023.

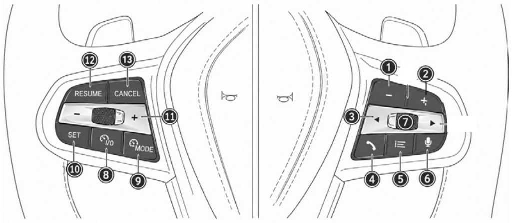
Functional Category	ID	Control Input / Function	Button Type	Command Location
Multimedia and communication control	1	Set – volume	Press	Right
	2	Set + volume	Press	—
	3	Skip songs and change channels	Press	Right
	4	Make calls	Press	Right
	5	Activate voice activation system	Press	Right
Navigation and menu control	6	Display menu	Press	Right
	7	Select configuration menus / cluster head-up display	Press	Left
Cruise control	8	Activate/deactivate cruise control	Press	Left
	9	Select the speed-regulation system	Press	Left
	10	Set the constant speed when the desired limit is reached	Press	Left
	11	Set speed +/–	Roller and Press	Left
	12	Resume cruise control	Press	Left
	13	Cancel cruise control	Press	Left
Location of the surveyed controls				

Table 5: Detailed control survey for Aston Martin DB12 2024.

Functional Category	ID	Control Input / Function	Button Type	Command Location
Multimedia and communication control	1	Tap to answer an incoming call / open the last dialled number; press to end or reject a call	Touch and Press	Right
	2	Adjust volume/mute	Roller	Right
	3	Skip to the next audio track	Touch	Right

(Continued)

Table 5: Continued.

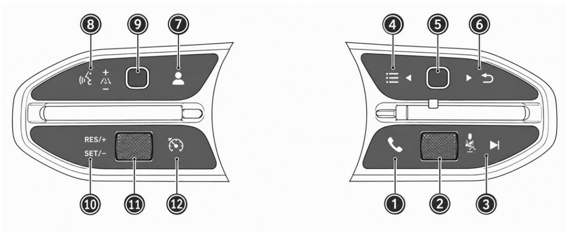
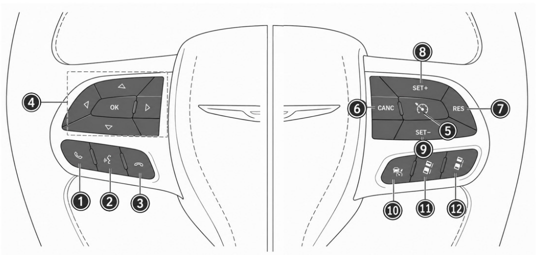
Functional Category	ID	Control Input / Function	Button Type	Command Location
Navigation and menu control	4	Open the instrument cluster menu	Touch	Right
	5	Navigate instrument cluster menu	Touch	Right
	6	**Go back one menu level**	Press	Right
	7	Activate voice control system	Press	Left
Cruise control	8	Cancel the set speed	Touch	Left
	9	Adjust following distance	Touch	Left
	10	Resume/adopt speed	Touch	Left
	11	Adjust the set speed for the ACC	Roller	Left
	12	Switch between ACC and variable speed-limiter functions	Touch	Left
Location of the surveyed controls				

Table 6: Detailed control survey for Chrysler 300S 2022.

Functional Category	ID	Control Input / Function	Button Type	Command Location
Multimedia and communication control	1	Answer call	Press	Left
	2	Voice-recognition activation	Press	Left
	3	End call	Press	Left
Navigation and menu control	4	Instrument cluster display controls	Press	Left
cruise control	5	Fixed cruise control (on/off)	Press	Right
	6	Cancel	Press	Right
	7	Resume	Press	Right
	8	Set + (accelerate)	Press	Right
	9	Set – (decelerate)	Press	Right
	10	Adaptive cruise control (on/off)	Press	Right
	11	Set distance (decrease)	Press	Right
	12	Set distance (increase)	Press	Right
Location of the surveyed controls				

Across the 69 buttons surveyed, press-type controls account for the majority of the sample (59%), followed by touch-type buttons (26%), while roller-and-press (7%), roller (4%), and touch-and-press (3%) controls are used less frequently.

Disaggregating button type by functional category shows that press-type buttons dominate all three major functional categories, although with different proportions. Multimedia and Communication Control (MCC) presents the highest share of press-type buttons (65.2%), followed by Cruise Control (CC, 57.7%) and Navigation and Menu Control (NMC, 52.9%). NMC is also the category with the highest proportion of roller-and-press buttons (11.8%), reflecting the need for precise and confirmable menu navigation. In contrast, Cruise Control exhibits the highest share of touch-type buttons (34.6%), particularly in the Mercedes and Škoda steering wheels, suggesting a growing adoption of capacitive touch interfaces for speed and following-distance adjustment. The Customization and Others category was excluded from this analysis because it comprised only three controls in the entire sample, preventing meaningful comparisons.

Figure 1 presents the infographic mapping of button type (by shape) and functional category (by colour) for the six anonymized steering wheel models (A–F) analysed. The diagrams illustrate that, while all six models place controls symmetrically on the left and right spokes, the specific functional grouping assigned to each side varies considerably between brands.

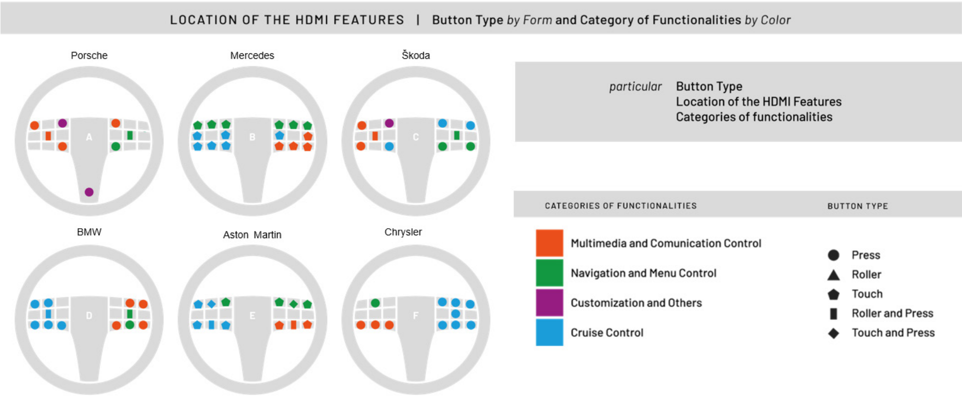


Figure 1: Infographic mapping button type and functional category onto six steering wheel models.

Figure 2 summarizes the predominant spatial location of each functional category across the six models, expressed as the number of models sharing the same predominant zone. Cruise Control shows the strongest convergence, with a shared predominant location in up to 4 of the 6 models analysed. Multimedia and Communication Control and Navigation and Menu Control follow, each converging in up to 3 of the 6 models. Customization and Others is the least standardized category, converging in at most 2 of the 6 models, consistent with its lower overall frequency in the sample.

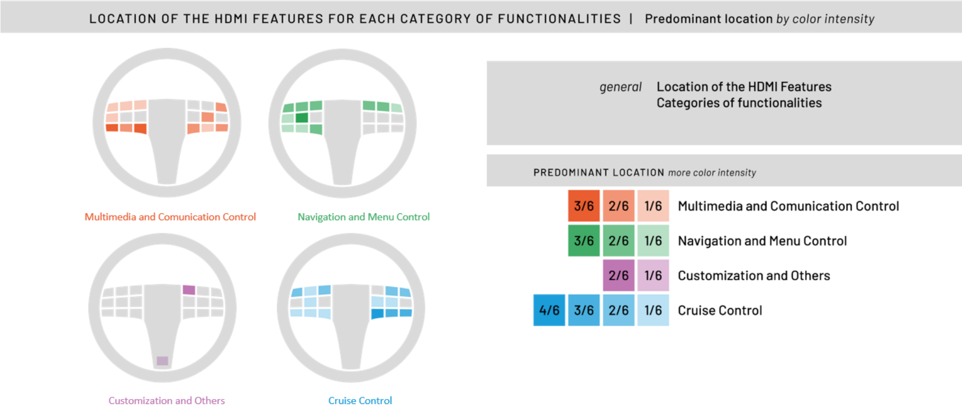


Figure 2: Convergence of predominant button location per functional category, by colour intensity.

DISCUSSION

The comparative analysis indicates that, despite differences in steering wheel HMI design approaches across brands, press-type buttons remain the dominant input method, particularly for multimedia and communication functions, while maintaining a strong presence in menu navigation and instrument-cluster control. This predominance is consistent with studies showing that physical controls reduce visual demand and driver distraction during secondary driving tasks (Zhong et al., 2024), highlighting the continued importance of tactile feedback for frequently used functions.

Touch-type buttons are comparatively more common in cruise-control functions, especially in brands with more digital interfaces such as Mercedes. This suggests a gradual adoption of capacitive interaction for continuous adjustments, while activation and confirmation actions continue to rely primarily on physical controls, in line with previous findings (Abbasi et al., 2024).

The spatial analysis further indicates greater consistency in the placement of cruise-control functions across brands, whereas customization functions exhibit greater variability, suggesting more design flexibility. Overall, these findings support steering wheel HMI concepts that combine physical controls for frequently used and safety-critical functions with touch or hybrid solutions for continuous adjustments.

CONCLUSION

This study presented a comparative analysis of steering wheel button layouts across six automotive brands, examining 69 physical controls according to interaction type, functional category, and spatial location.

The results show that press-type buttons remain the predominant interaction method across all functional categories, while touch controls are more frequently adopted for cruise-control functions. Cruise Control also exhibited the highest consistency in control placement, whereas Customization functions showed greater variability across brands.

These findings provide an empirical benchmark of current steering wheel HMI practices and support the development of future interfaces that balance usability, safety, and innovation. Future work will extend this benchmark through user studies evaluating alternative steering wheel layouts in terms of usability, workload, task performance, and visual demand.

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