# Multi-users of a Product: Emergence of Contradictions

Jean Renaud, Rémy Houssin, Mickaël Gardoni, Mhamed Nour



# Multi-users of a product: Emergence of contradictions

Jean Renaud[1], Rémy Houssin[1], Mickaël Gardoni[2], Mhamed Nour[2]

[1] ICube, UMR-7357, Strasbourg 67, France
jean.renaud@insa-strasbourg.fr
[2] ÉTS, 1100, rue Notre-Dame Ouest, Montréal (QC) Canada

**Abstract**: The use of the product is randomly taken into account in the final phase of the design process, which leads to certain iterations and difficulty in use.
Generally, the designer has taken into account customer requirements without really knowing the end user, sometimes our end users.
By analyzing the different users, it is a question of measuring the functionality of the product for each of them. The various functional analyses must take into account the needs of all these users. Thus, it is necessary to identify: the expectations and cognitive barriers of each user in a competitive environment and to consider the evolution of the use and performance of the product and its interaction with its users.
In this article, it's about listing the product features for each user case. The different functional analyzes must present the expectations for each use case. Thus, in an order of the product use life cycle, it is necessary to identify the purposes and behaviors of users and the level of constraint of each feature. By comparing the functions between them, it is a question of identifying the contradictions or not that can have an effect on the design of the product. A concrete example (baby car seat), is proposed in this article in order to target the different users from the functions and to identify the contradictions that can be resolved by the TRIZ principle.

**Keywords:** Usage, User experience, Multi-user, Contradiction, Design, Functional analysis.

## 1 Introduction

When a customer wishes to acquire a commercial product, tool or technology system, they choose it according to its ultimate intrinsic use, in a well-defined situation at a specific time. The customer does not care if the product may be perceived or used by other users at other times for different purposes or objectives.
These products, which have several users, will be called ‘multi-user products’. The product is designed and manufactured generally for the main function, a purpose of the product for a need of the user. The designer designs a product through experience, out of habit, assuming how the product can be used or handled. The version or model

of the product is generally related to the designer's personality, character, choice criteria and design service. –
In general, the designer does not specify how the user wishes to use the product [1], [2], [3] or how the user should use the product due to the critical lack of tools and methods of design help available for designers. The designer works by habit, persuaded that the product he designs will be suitable for the customer's use, that the product will seduce him in priority over its use.

Generally, the designer puts himself in the user's place, he considers that his design criteria are the best, without worrying about the real needs to integrate the conditions of use of the product [4], [5]. It is not uncommon to find that the product is designed to be used manipulated, or stowed by a single user considered to be the primary user without worrying about potential users at different times in the product life cycle. The designer proposes, generally a user's manual of the product [6]. In this manual, only one user is mentioned.
Many authors have focused on the anthropo-centered approach. This approach concerns the improvement of the design from an ergonomic point of view [7]. It is used for custom design because of its high cost and because it is only feasible for large projects and luxury goods [8][9][10][11][12][13][14]. The techno-centric approach, the technical system is at the center of the design problem. Designers have only the product standards at their disposal. These standards have the obligation of results without specifying how the designer could obtain these results.

Some authors have been interested in the needs of the client. Anthony W. Ulwick [15][16] proposes the method of Outcome Driven Innovation (ODI). It focuses on the customer's "primary" need rather than the solution they use. The method focuses on the "what" and not on the "how". Other methods, such as the QFD [17] or the "Voice of the customer" are commonly used to identify the needs of the client.

It is known that the product can have multiple users. Users have different needs that can lead to contradictions of solutions to be solved early in the design phase. In the next section, we present the notion of the user experience. In section 3, an application on a baby seat, a product that requires several users, is presented to illustrate our point.

## 2 User experience

Analyzing a need means translating the product into "Customer specifications" or "User specifications". The "client user" reasons in solutions rather than needs [18]. When there are multiple users, we talk about multi-users. The functional analysis approach is a response to the search of the needs of the users.
In recent years, some authors have focused on the user experience, called "user experience (UX)". This refers to the experience of a person using a particular product, system or service. It's about making a product, a system easy to use, understandable (immediately, ergonomic, logical ...) by integrating the user experience into product design based on ergonomics and human sciences, the goal of the user experience is to

increase satisfaction with the use of functions by continuously improving the form, content and accessibility of the product [19][20][21][22].

UX stands out as a major marketing asset and becomes at the heart of business strategies. The user comes back to the center of all marketing concerns. The UX therefore contributes to increase the act of purchase. So it is proven that user satisfaction is as much related to the product / service marketing ability as to the perception of the brand by the user, the term refers to essential notions of communication, design and marketing. It is no longer based solely on ergonomic criteria.

In the continuity of the user's explanation, design studies must be able to identify or register different users according to the life cycle of the product. It is not uncommon to find that the product in its operation phase has several users. Designers must transform customer requirements into product performance. It should be noted that the requirements of the customer are not the same as those of the user (there is the first level of contradiction). Subsequently, the designer will have to prioritize these users, to better understand the functionality of the product according to the type of user. The functional analysis makes it possible to answer it. -

Usually, the customer is the person who buys the product and uses it. It is never specified all of all users and how they are used. The customer takes note of the overall product function, cost, efficiency ..., while the end user wants to pay more attention to product reliability, security, usability and operability. This means that designers must transform not only the customer's requirements, but also the user's requirements in product performance.

## 3 Case study: baby car seat

In our study, we chose to study the baby car seat. This product can potentially be unsafe. It presents several users at different level of use, not always identified.

**Fig.1.** Car seat model for baby or child < 12 years old

The baby seat must fulfill two important conditions, be well installed on the car seat and be adapted to the weight and size of the child in case of an accident. Hence, a deadline for using the seat and the safety standards to be respected. Depending on the size of the child or baby, the seat is either facing backwards or forwards. It is mandatory up to 10 years in Canada for example. There are five groups of seats depending on the size and weight of the seat. There are "adaptable" seats depending on the size of the child and his weight.

The design of the seat and its use introduce many criteria or parameters very varied and very complementary. The client (parents) is not the privileged user, it is the baby but who cannot express himself. The parents are also users because they are the ones who install and fix the seat in the car. Hence the interest of taking into account the different types of users. In the following paragraphs, we detail the different phases of the product life cycle, in use.

---

### 3.1 Product-study-background

The usage context must be explained by the use that will guide the product design result. The context must be exhaustive (ease of assembly, use, maintenance, respect of security ...).

### 3.2 Identification of the study phases of the product cycle

A product does not only have one main function to be used. It has several, depending on where we are in the phase of the product life cycle. Thus, it is proposed to detail the different stages of the product life cycle, such as:

- Study and design of the baby seat (seat, headrest, harness, the shape of the secure shell, mandatory standards...), The seat can be in one piece or detachable
- Unpacking the product and reading the instructions for assembly and use of the product,
- Installing the baby seat and checking it,
- Installing the baby seat on the car seat and securing the seat,
- Safe installation of the baby in the seat and its safety,
- Unlock the baby's seat belt.
- Remove the baby safely from the seat,
- Removing the baby seat from the car seat,
- Storing the baby seat in a storage place,
- Drafting and validation of the instructions for use.

Among all these steps, it is necessary to make apparent the various functions of the users which can be different.

We use functional analysis to better understand the product's functionalities according to the type of user and the phase of the product's lifecycle. Before identifying the product's functionalities according to the type of user, it is necessary to position the different users of the product's parts of use. Figure 2 describes the product and the different users.
In this example, we have identified four types of child seat uses for children less than 2 years of age and their function in using this seat (Table 1).

**Table 1.** The different users of the child seat

| N° | Type of use | $UX_j$ | Description or function of the user |
|---|---|---|---|
| **1** | Parent (1) | $UX_1$ | The person who puts the child seat on the seat. |
| **2** | Parent (2) | $UX_2$ | The person who gets the child to cooperate |
| **3** | Child < 2 years | $UX_3$ | Securing the child in his seat |
| **4** | Parent (3)* | $UX_4$ | The person storing the child seat in the storage area |

In the case of Figure 2, the aim is to identify the different links between the different types of users and the different main parts of the product. This link graph makes it possible to visualize the functional roles of the users. These functions can also be specified as: safety, fixing or tying, storage, confidence building... The links can also be contact, removable, manual...

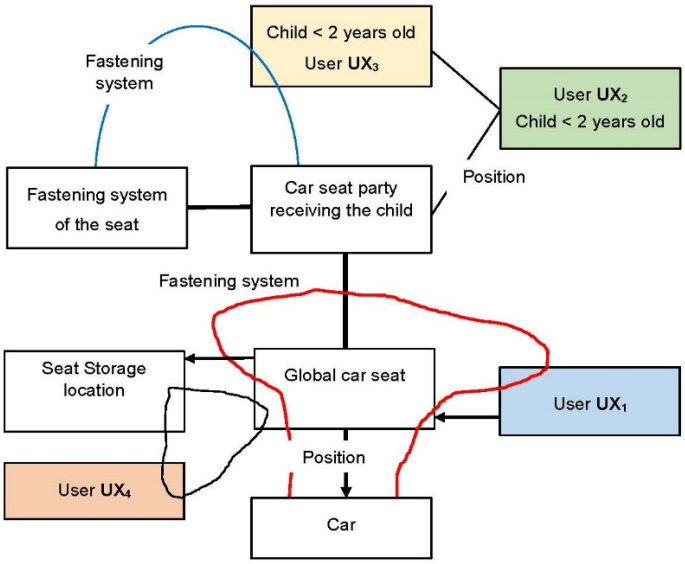


**Fig. 2.** Diagram of links between product parts and users

From figure 2, we report on table 2, the types of users, the types of malfunction, the types of operation or tasks to be performed by the user and the type of phase of the

product lifecycle. Each user thinks differently according to their missions or objectives in relation to the product.

**Table 2.** Comparison of potential malfunctions between the three users

| Type $UX_i$ | User | Types of operations or tasks | Type of malfunctions | Phase of the product cycle |
|---|---|---|---|---|
| $UX_1$ | Father or Mother | Attaching the car seat to the seat of the car | Strap passage, locking system, seat position, secure fastening, | Functional Analysis 1 Phase 1 (fixing the seat on the bench) |
| $UX_2$ | Father or Mother | Position of the child in the child seat and attachment of the seat belt | Baby attachment system, strength of the attachment, optimal position | Functional Analysis 2 Phase 2 (Child positioning and fixation) |
| $UX_3$ | Child < 2 years old | Be properly installed and able to move freely | Freedom of movement in complete safety | Functional Analysis 3 Phase 3 (Child in safe position) |
| $UX_4$ | Father or Mother | Easy to handle and store | Weight too heavy, fastening systems too loose, volume | Functional Analysis 4 Phase 4 (Storage) |

We propose for each phase of the life cycle of the product, to carry out the corresponding functional analyzes. Each functional analysis corresponds to a different user. These functional analyzes are a first reflection. These four functional analyzes focused on the missions of the different users according to the phases of the product life cycle.

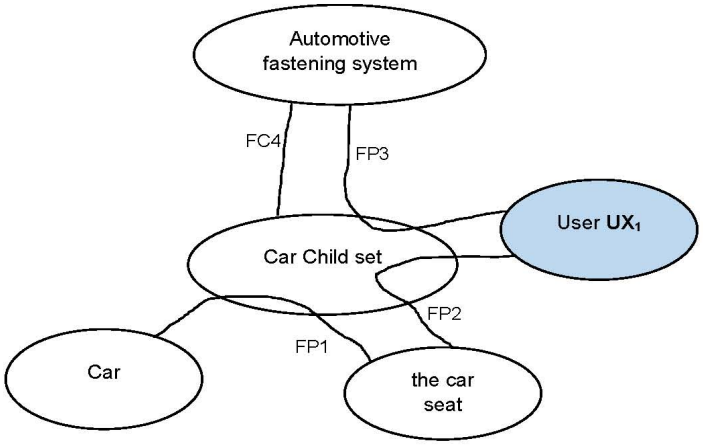


**Fig. 3.** AF of Product from $UX_1$, phase 1

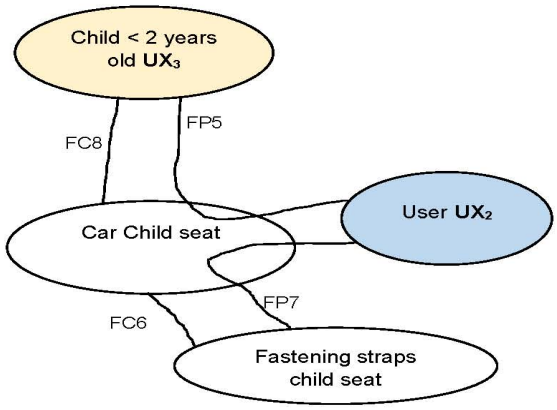


**Fig.4**. AF of the Product from $UX_2$ and $UX_3$, phase 2

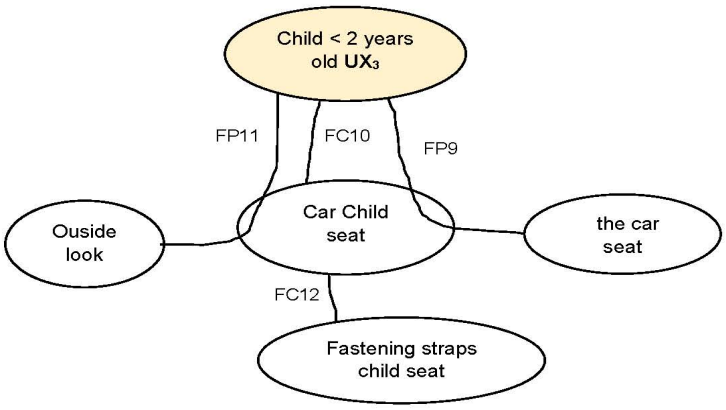


**Fig.5.** AF of the Product from $UX_3$, phase 3

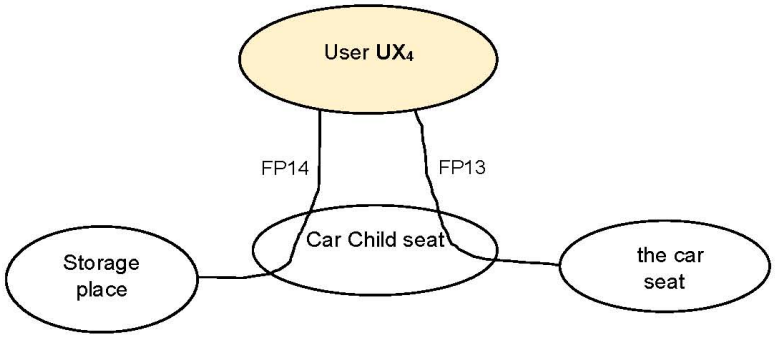


**Fig.6.** AF of the Product from $UX_4$, phase 4

## 4 Discussion

In our example, we can note the presence of four types of users who have four different profiles, four different objectives or missions.

The UX1 user has the concern to make solid the fixing of the child seat. That the fastening system (straps) of the car is efficient, practical and secure. The shape of the seat must marry at best the seat of the car. The shape of the seat for the baby is not the priority for the user UX1. The knowledge of the user UX1 is rather in the technicality and the practical sense. It usually refers to the manufacturer's instructions. Security is at stake in this phase.-

The UX2 user gives priority to the child, his well-being and his safety on the seat, but also the cleanliness of the seat and the ease of its maintenance. The technical knowledge of the UX2 is mainly practical sense, not requiring technical knowledge. Generally the UX2 user looks little or not the product designer's manual. The user UX2 combines the safety and comfort of the child in its implementation on the child seat.

The UX3 user, the baby, must be able to move without the risk of being detached or touching safety components of the car. The child's tether straps must resist the child's mobility force in the seat.

The UX4 user must be able to detach the child seat quickly and efficiently. It does not refer to the manual. His only concern is to untie it, carry it and put it away. The ergonomic shape of the seat must allow the UX4 user to carry it effectively. Reading the missions of the four users, we can observe that their level of technical knowledge, practical, safety, well-being... is totally different from one user to another and taking their needs into account could cause contradictions:

UX 4 needs the seat to be as light as possible, but for UX2 it must be as strong as possible and for UX2 the seat must be as soft as possible.

UX1 is interested in baby seat attachment systems in the car, UX2 is interested in baby seat attachment systems. Then there are two TRIZ point of view fastening systems. There should only be one system.

The UX1 needs the seat to have the simplest form, on the other hand, the UX3 needs the seat to take at most the shape of car seat on course (more complex).

UX2 needs the seat surface to be made of easy to clean material (plastic for example), whereas UX3 needs the seat surface to be made of cotton, for example, because it is more pleasant.
In Annex 1, we summarize all functions, criteria, levels and contradictions by different phases

## 5 Conclusion

In this research work, we wanted to show that products designed today no longer have a single user, but several who may have contradictory needs. Hence the importance of identifying the different users and their missions or functions, in order to better design the product under the angle of the "experienced user".

In our case study, we have broken down the life cycle of product use in stages. Then, we used the functional analysis to list all the features by user type and step. Each function is characterized according to different levels of importance and flexibility.
Then we identify the criteria that conflict or complement each other. Unlike other studies where we seek to better define the functionality of the product according to a single client, here we seek to better define the functionality of each user according to the study of use of the product. All for the purpose of better designing the products.-

This work of identification of contradiction between the criteria or users makes it possible to propose recommendations for the designer of the product in order to eliminate or minimize the consequences of these contradictions on all the uses of the products.

## References


1- Sun, H., Houssin, R., Gardoni, M., de Bauvrond, F. Integration of user behaviour and product behaviour during the de sign phase: Software for behavioural design approach, International Journal of Industrial Ergonomics, 43(1), p. 100-114 (2013).

2- Sun X, R. Houssin, J. Renaud, M. Gardoni, Integrating user information into design process to solve contradictions in product usage, Procedia CIRP 39 (2016) 166 – 172.(2016).

3- Sun, X., Houssin, R., Renaud, J., M. Gardoni, "Towards a use information integration framework in the early product design phase function-task-behaviour." International Journal of Production Research, ISSN: 1366-588X, (2018).

4- Fadier, E., L'intégration des facteurs humains à la conception, Phoebus, la revue de la sûreté, de fonctionnement – numéro spécial : 59 – 78, (1998).

5- Darses, F., Wolff M., How do designers represent to themselves the users' needs ?, Applied Ergonomics 37(6) : 757-764, (2006).

6- Renaud J., Houssin R., Gardoni M., Armaghan N., Hachali H., "Aide à la rédaction d'une notice d'utilisation à partir de l'analyse fonctionnelle comportementale prenant en compte l'usage », Congrès CIGI les innovations numériques, Compiègne, du 3 au 5 mai 2017.

7- Das, B., Sengupta A. K., Industrial workstation design: A systematic ergonomics approach. Applied Ergonomics 27(3), 157-163 (1996).

8- Carballeda, G., La contribution des ergonomes à l'analyse et à la transformation de l'organisation du travail : l'exemple d'une intervention dans une industrie de process continu. Thèse de doctorat d'Ergonomie. Paris, Laboratoire d'Ergonomie du CNAM, (1997).

9- Belliès, L., Jourdan, M., Le retour d'expérience : un outil pour aborder les questions organisationnelles. In Recherche, pratique, formation en ergonomie : évolutions et interactions dans le contexte social, économique et technique. Actes du XXXII° Congrès de la Self, pp. 159-170. Lyon, septembre, (1997).

10- Jackson, M., Entre situations de gestion et situation de délibération : l'action de l'ergonome dans les projets industriels. Thèse de doctorat d'Ergonomie. Paris : Laboratoire d'Ergonomie du CNAM. Jamali M., Roux O. (1998).

11- Norman, Donald A., The design of everyday things. Basic books, p. 190-191, (2002).

12- Garrigou, G., Thibault J.-F., et al., Contributions et démarche de l'ergonomie dans les processus de conception, PISTES, 3(2), 16 p, (2001).

13- Folcher, V., Appropriating artifacts as instruments: when design-for-use meets design-in-use, Interacting with Computers, 15(5), 647–663, (2003).

14- Obradovich, J. H., Woods D. D., Users as designers: how people cope with poor HCI design in computer-based medical devices. Human Factors: The Journal of the Human Factors and Ergonomics Society 38(4): 574-592, (1996).

15- Ulwick W.A., What customers want, CEO. Of Strategyn.inc, (2005).

16- Ullman, D., The Mechanical Design Process, Fourth Edition, in Why Study the Design Process?, McGraw-Hill, New York, p. 2, (2010).

17- Chang, C.H. (1989), Quality function deployment (QFD) processes in an integrated quality information system. Computers ind. Engng VoI. 17, (1989)

18- Marchat H., Gestion de projets par étapes, analyse des besoins, Groupe Eyrolles, 2ème edition, Edition Organisation, 1ère étape, (2008).

19- Gero, J. S., Design prototypes: a knowledge representation schema for design. AI Magazine 11(4), 26-36, (1990).

20- Gero, J. S., Rosenman M. A., A conceptual framework for knowledge-based design research at Sydney University's Design Computing Unit., Artificial Intelligence in Engineering 5(2) : 65-77, (1990).

21- Gero, J. S., Kannengiesser U., The situated function-behaviour-structure framework, Design Studies 25: 373–391, (2004).

22- Maguire, M., Socio-technical systems and interaction design-21st century relevance, Applied Ergonomics, 45(2), p. 162-170, (2014).

Annex 1

| Fct. | Description | Cj | Criteria | Levels | Contradictions (Ct) Complementarity (Cp) | | |
|---|---|---|---|---|---|---|---|
| **PHASE 1** | | | | | | Ct | Cp |
| **FP1** | The child seat must fit into the shape of the seat and be attached to the car | $C_1$<br>$C_2$<br>$C_3$ | Form of the bench<br>Solidity<br>Esthetic | Angle of the car backrest<br>300 daN pressure<br>Design and *color* | $C_{20}$ (Adult forme ≠ Child) | X | |
| **FP2** | The user UX1 quickly and efficiently positions the child seat on the bench | $C_4$<br>$C_5$ | Duration<br>Seat shape | < 10 mn<br>Low gap | $C_1$ (Gap between bench and seat | X | |
| **FP3** | The user UX1 fixes the seat in a flexible, efficient and strong way | $C_6$<br>$C_7$<br>$C_8$ | Fixing type<br>Duration of fixation<br>Handling of bindings | By pressure<br>< 3mn<br>Without notice | | | |
| **FP4** | The straps on the bench must adapt in an efficient and solid way to the child seat | $C_9$<br>$C_{10}$ | Fixing type<br>How to use | Ergonomic<br>Simple Solution | $C_{23}$ (robust and fast mounting) | | |
| **PHASE 2** | | | | | | | |
| **FP5** | The user UX2 comfortably positions the child securely in the child seat | $C_{11}$<br>$C_{12}$ | Shape seat / child shape<br>Comfort | Minimal gap<br>Adapted form | | | |
| **FC6** | The child seat straps must fit the child seat in an efficient and secure manner | $C_{13}$<br>$C_{14}$ | Solidity<br>Effective fastening system | According to regulations<br>Ergonomic | $C_{17}$ et $C_{18}$ (Security and freedom of movement) | X | |
| **FP7** | The user UX2 must handle the straps of the child seat without difficulty to fix the baby in an effective and practical way | $C_{15}$<br>$C_{16}$ | Simple technology<br>Materials | A point of contact<br>Armored fabric | $C_{21}$ et $C_{22}$ (Assembly and disassembly) | X | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **FC8** | The child must adapt to the seat that can move freely | $C_{17}$ | Degree of freedom | According to regulations | C13 et C18 (freedom of movement) | X | |
| **PHASE 3** | | | | | | | |
| **FP9** | The user, UX3, child can move freely in the child seat fixed on the bench of the car | $C_{18}$ | Degree of mobility | According to the regulations | C13 et C17 (freedom of movement) | | X |
| **FC10** | The child is held in the seat safely, attached and free of movement | $C_{19}$ | Pressure, safety | According to the regulations | C22 et C24 (locked and unlocked) | | X |
| **FP11** | The position of the child in the seat must not challenge the external gaze | $C_{20}$ | Seat shape | Rules in force | C1 (inner form of the seat) | X | |
| **FC12** | The locking system (straps) of the child in the seat must adapt according to the movements of the child | $C_{21}$<br>$C_{22}$ | Adaptability<br>Efficiency | 3 anchor points<br>Ergonomic | C17 (Tight and free straps)<br>C17 (Inner seat shape) | X<br>X | |
| **PHASE 4** | | | | | | | |
| **FP13** | The user UX4 must be able to separate the child seat from the car seat | $C_{23}$<br>$C_{24}$ | Efficiency<br>duration | Ergonomique<br>Quelques secondes | C1 et C4 (Assembly and disassembly) | | X |
| **FP14** | The child seat must be able to be stored easily in its place of storage by the user UX4 | $C_{25}$<br>$C_{26}$ | Storage volume<br>Accessibility | Same as the seat<br>Handy | | | |