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Dissemination level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
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Table of contents

List of figures

List of tables

Summary

This deliverable aims to identify the different types of urban furniture that can be typically found in our cities, as well as to characterise them in terms of the materials and processes used for their manufacturing and the technical specifications required. This knowledge will be used during the project for the development of the Green Urban Furniture Tool (GUF Tool), which will allow public authorities to purchase more sustainable urban furniture, taking into account not only economic costs but also environmental impacts of urban furniture products. Furthermore, two different urban furniture products will be selected herein as the most relevant, which will be used in two case studies intended to test and validate the functionality of the GUF Tool (once developed).

1. Introduction

Urban furniture refers to the objects and facilities located in urban public spaces that provide various services and functions to the public. It is one of the important elements of the urban landscape that contributes to humans and their activities. Although comparatively small in scale, urban furniture plays a significant role, along with other urban landscape elements such as architecture and urban space, in determining the quality of an urban environment and urban life. Of all the urban landscape elements, furniture has the closest contact and interaction with people, such as residents and visitors. Concerning residents, they make use of urban furniture once they are out of their dwellings, during their everyday life. Concerning visitors, they spend most of their time in urban spaces and make use of the urban furniture when they are visiting a city. As an important urban landscape element, urban furniture is a complex system and contains a wide range of concerns. Besides providing various uses to satisfy the different needs of users, furniture design takes into consideration the total urban landscape when creating a comfortable and convenient urban environment. Urban furniture should be designed in a coordinated way between its surrounding environment and the development of its location. In addition, well-designed urban furniture, together with other urban landscape elements, can successfully represent the characteristics and the image of a city. As an overall view, the quality of the urban environment, including furniture, is the reflection of the level of the political, economic, cultural and technological development of a city. For the developed countries, urban furniture has already been one of the main elements of “urban characteristics” and public art since the 1960s.

Today, under the influence of rapid urbanisation and globalisation, global warming concern and the emphasis on humanism, urban landscape design is facing unparalleled challenges and requirements. In order to satisfy diverse urban needs and maintain a balance between different aspects in the new era, urban furniture design requires the considerations of different perspectives, for example, to ensure that urban furniture can be manufactured with different materials (e.g., depending on the climatic conditions). Moreover, in the 21st century, many countries have developed city forms and patterns, in which urban furniture is emphasised and considered as a starting point to improve the environment in urban redevelopment and renewal.

The preparatory action A2 of the LIFE FUTURE project aims to comprehensively investigate the main types of urban furniture products and characterise them in terms of materials, manufacturing processes and features, including a series of technical specifications related to mechanical, chemical, biomechanical, environmental and other properties. Moreover, based on these properties, two different urban furniture products will be selected herein as the most relevant, which will be later used in two case studies to test and validate the functionality of the GUF Tool.

To achieve these aims, the research objectives are as follows:

1. To identify and investigate the relevant urban furniture products, classifying them by groups.
2. To establish the specifications required for the various urban furniture products. These specifications will be made based on usability, materials and manufacturing processes, and mechanical, chemical and biomechanical properties.

3. To search information on the environmental impact that different urban furniture products can have. To this end, life cycle assessment (LCA) studies will be consulted, and the information obtained will be also used for the selection of the two urban furniture elements for validation purposes. This information will be also useful to explore ways to reduce the environmental impact of urban furniture products for a better green purchasing.
4. To select two urban furniture elements or groups that will be used to test and validate the functionality of the developed tool (in action B3). Selection criteria will be applied to ensure that the selected elements are highly representative and can be manufactured with different materials, features and designs.

2. Identification and classification of urban furniture

As a starting point of this preliminary action, the different types of urban furniture that can be found in our urban environments were identified. A literature review was done on the existing types of urban furniture and their different classifications (Glickman, 1983; Wan, 2008; IHOBE, 2014; Paryabi, 2015). As a result, different urban furniture products were identified and grouped according to their functionality as shown in Table 1. These are the urban furniture products that will be covered by the tool developed in the LIFE FUTURE project. It should be noted that products that use energy are not included in the project scope.

Table 1. Classification of urban furniture products in LIFE FUTURE project.

Urban furniture categories	**Urban furniture products**
Street furniture products	Benches, seats and chairs Bicycle parking Canopies and kiosks Bins and containers Hydrants Advertising and information panels Planters and pots Tree pits, manholes and lids
Recreational and leisure products	Playgrounds Sports courts Showers and footbaths Fountains and hydrants
Traffic management products	Traffic signs Guardrails, barriers and parapets Milestones and bollards Speed reducers

2. Characterization of urban furniture

The different types of urban furniture products identified and included within the project scope were characterized in terms of materials and processes typically used for their manufacturing as well as the technical specifications required. Moreover, the environmental performance of these products was analysed through some case studies found in literature. Finally, the functional aspects and the current market volume of urban furniture products were also examined.

2.1. Technical characterization

The technical characterization performed herein constitutes the basis to know the different materials and manufacturing processes that can be required for each of the urban furniture elements identified, and gives information on the wide variety of designs that can be made. This information together with technical characteristics in terms of mechanical, chemical and/or biomechanical properties will be essential in order to assess those products that need more maintenance or have lower durability due to weather conditions. All these aspects must be taken into account since they can directly affect the environmental impacts related to the different phases of products' life cycle, which should be evaluated using the tool developed in the project in order to promote GPP of urban furniture.

2.1.1. Benches, seats and chairs

Table 2 shows the technical characterization of benches, seats and chairs, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 2. Technical characterization of benches, seats and chairs.

Materials	Rubber, Corten steel, pinewood and steel, tropical wood and steel plate, pinewood and foundry, pinewood, ductile foundry, ductile foundry and polyethylene, concrete, granite blocks, recycled plastics, aluminium, etc.
Manufacturing processes	Foundry processes, casting, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finish, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (surface treatments, use of resins, paints, galvanic finishing, etc.).
Biomechanical properties	Accessibility and ergonomic requirements to improve usability and safety.
Technical and quality standards	EN 581-1 Outdoor furniture - Seating and tables for camping, domestic and contract use - Part 1: General safety requirements. EN 581-2 Outdoor furniture - Seating and tables for camping, domestic and contract use - Part 2: Mechanical safety requirements and test methods for seating. EN 581-3 Outdoor furniture - Seating and tables for camping, domestic and contract use - Part 3: Mechanical safety requirements and test methods for tables.

Figure 1 shows some examples of benches that can be found in cities, including different materials, manufacturing processes and designs.

Figure 1. Examples of benches.

2.1.2. Bicycle parking

Table 3 shows the technical characterization of bicycle parking, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 3. Technical characterization of bicycle parking.

Materials	Metals (including stainless steel, cast ductile iron, etc.), plastics (e.g., low-density polyethylene), fibreglass, etc.
Manufacturing processes	Foundry processes, casting, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	High impact properties and resistance to long-term fatigue, structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.).

Figure 2 shows some examples of bicycle parking that can be found in cities, including different materials, manufacturing processes and designs.

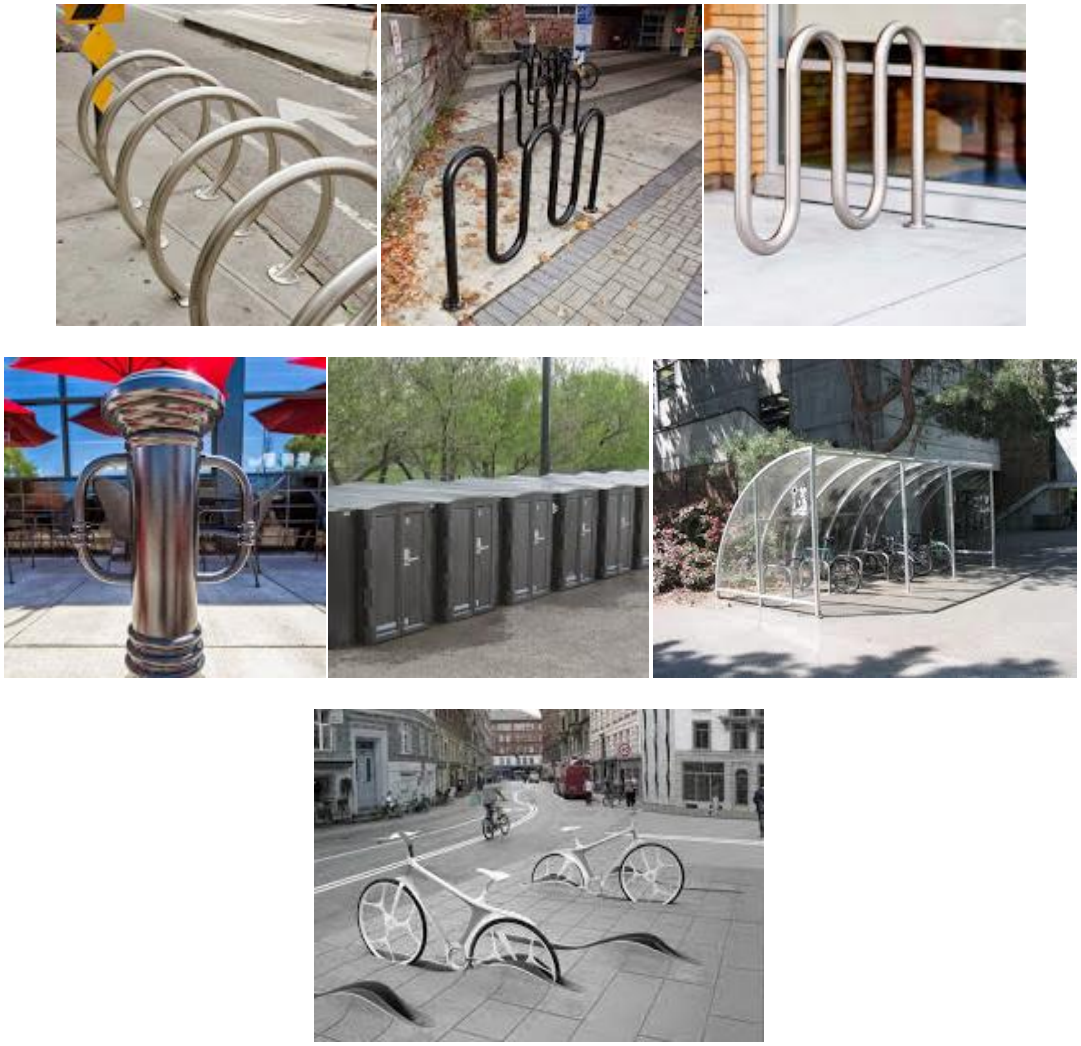

Figure 2. Examples of bicycle parking.

2.1.3. Canopies and kiosks

Table 4 shows the technical characterization of canopies and kiosks, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 4. Technical characterization of canopies and kiosks.

Materials	Aluminium, stainless steel, fibreglass, millwork and plastics, wood, etc.
Manufacturing processes	Foundry processes, casting, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.).

Figure 3 shows some examples of canopies and kiosks that can be found in cities, including different materials, manufacturing processes and designs.

Figure 3. Examples of canopies and kiosks.

2.1.4. Bins and containers

Table 5 shows the technical characterization of bins and containers, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 5. Technical characterization of bins and containers.

Materials	Pinewood, steel, polyethylene, recycled plastics, galvanised steel, rubber, etc.
Manufacturing processes	Rotomoulding processes, foundry processes, casting, injection moulding, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.).

Figure 4 shows some examples of bins and containers that can be found in cities, including different materials, manufacturing processes and designs.

Figure 4. Examples of bins and containers.

2.1.5. Fountains and hydrants

Table 6 shows the technical characterization of fountains and hydrants, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 6. Technical characterization of fountains and hydrants.

Materials	Foundry, galvanised steel, galvanised steel and brass, polyester powder and concrete, etc.
Manufacturing processes	Foundry processes, casting, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.). In addition, this type of equipment is covered by health and hygiene requirements for the prevention of legionella.
Biomechanical properties	Accessibility and ergonomic requirements to improve usability.
Technical and quality standards	EN 14384 Pillar fire hydrants.

Figure 5 shows some examples of fountains and hydrants that can be found in cities, including different materials, manufacturing processes and designs.

Figure 5. Examples of fountains and hydrants.

2.1.6. Advertising and information panels

Table 7 shows the technical characterization of advertising and information panels, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 7. Technical characterization of advertising and information panels.

Materials	Steel, aluminium, bilaminar glass, glass, pinewood, electrical components, etc.
Manufacturing processes	Casting, injection moulding, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.).

Figure 6 shows some examples of advertising and information panels that can be found in cities, including different materials, manufacturing processes and designs.

Figure 6. Examples of advertising and information panels.

2.1.7. Planters and pots

Table 8 shows the technical characterization of planters and pots, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 8. Technical characterization of planters and pots.

Materials	Pinewood, tropical wood, recycled plastics, concrete, stone, steel, iron, etc.
Manufacturing processes	Foundry processes, casting, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.).

Figure 7 shows some examples of planters and pots that can be found in cities, including different materials, manufacturing processes and designs.

Figure 7. Examples of planters and pots.

2.1.8. Tree pits, manholes and lids

Table 9 shows the technical characterization of tree pits, manholes and lids, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 9. Technical characterization of tree pits, manholes and lids.

Materials	Pinewood, tropical wood, recycled plastics, stone, concrete, steel, iron, rubber, etc.
Manufacturing processes	Foundry processes, casting, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.).

Figure 8 shows some examples of tree pits, manholes and lids that can be found in cities, including different materials, manufacturing processes and designs.

Figure 8. Examples of tree pits, manholes and lids.

2.1.9. Playgrounds

Table 10 shows the technical characterization of playgrounds, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 10. Technical characterization of playgrounds.

Materials	Rubber, plywood, pinewood, aluminium, steel, textile, high-density polyethylene, HPL, recycled polythene, etc.
Manufacturing processes	Rotomoulding, autoclave, casting, injection moulding, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Flammability, structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.).
Biomechanical properties	Accessibility and ergonomic requirements to improve usability and safety.
Technical and quality standards	EN 16630 Permanently installed outdoor fitness equipment - Safety requirements and test methods.

Figure 9 shows some examples of playgrounds that can be found in cities, including different materials, manufacturing processes and designs.

Figure 9. Examples of playgrounds.

2.1.10. Sports courts

Table 11 shows the technical characterization of sports courts, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 11. Technical characterization of sports courts.

Materials	Rubber, plywood, pinewood, aluminium, steel, textile, high-density polyethylene, HPL, recycled polythene, etc.
Manufacturing processes	Rotomoulding, autoclave, casting, injection moulding, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Flammability, structural integrity, durability, stability in installation, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.).
Biomechanical properties	Accessibility and ergonomic requirements to improve usability and safety.
Technical and quality standards	EN 14877 Synthetic surfaces for outdoor sports areas – Specification. EN 14904 Surfaces for sports areas - Indoor surfaces for multi-sports use – Specification. EN 15330-1 Surfaces for sports areas - Synthetic turf and needle-punched surfaces primarily designed for outdoor use - Part 1: Specification for synthetic turf surfaces for football, hockey, rugby union training, tennis and multi-sports use. EN 15330-2 Surfaces for sports areas - Synthetic turf and needle-punched surfaces primarily designed for outdoor use - Part 2: Specification for needle-punched surfaces.

Figure 10 shows some examples of sports courts that can be found in cities, including different materials, manufacturing processes and designs.

Figure 10. Examples of sports courts.

2.1.11. Showers and footbaths

Table 12 shows the technical characterization of showers and footbaths, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 12. Technical characterization of showers and footbaths.

Materials	Foundry, galvanised steel, galvanised steel and brass, polyester powder and concrete, etc.
Manufacturing processes	Foundry processes, casting, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (protective powder coating, surface treatments, use of resins, paints, galvanic finishing, etc.). In addition, this type of equipment is covered by health and hygiene requirements for the prevention of legionella.
Biomechanical properties	Accessibility and ergonomic requirements to improve usability.

Figure 11 shows some examples of showers and footbaths that can be found in cities, including different materials, manufacturing processes and designs.

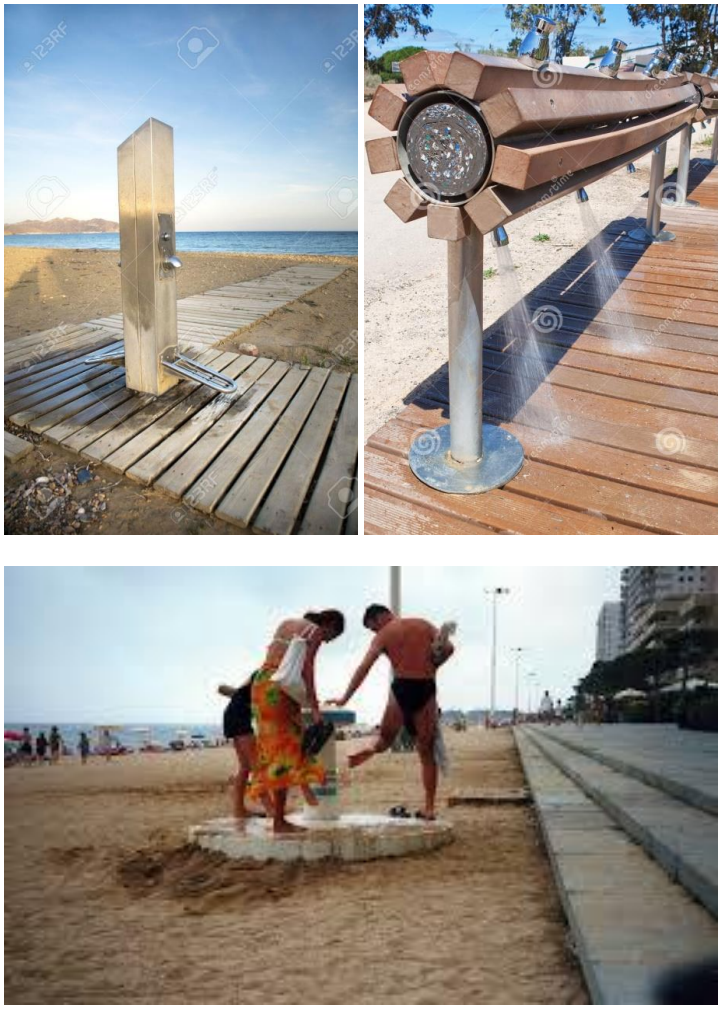

Figure 11. Examples of showers and footbaths.

2.1.12. Traffic signs

Table 13 shows the technical characterization of traffic signs, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 13. Technical characterization of traffic signs.

Materials	Steel, iron and aluminium.
Manufacturing processes	Casting, injection moulding, surface treatments, etc.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (surface treatments, paints, galvanic finishing, etc.).
Technical and quality standards	EN 12966 Road vertical signs - Variable message traffic signs. EN 12899-1 Fixed, vertical road traffic signs - Part 1: Fixed signs. EN 12899-3 Fixed, vertical road traffic signs - Part 3: Delineator posts and retroreflectors. EN 12899-4 Fixed, vertical road traffic signs - Part 4: Factory production control. EN 12899-5 Fixed, vertical road traffic signs - Part 5: Initial type testing. EN 13422 Vertical road signs - Portable deformable warning devices and delineators - Portable road traffic signs - Cones and cylinders. EN 1790 Road marking materials - Preformed road markings.

Figure 12 shows some examples of traffic signs that can be found in cities, including different materials, manufacturing processes and designs.

Figure 12. Examples of traffic signs.

2.1.13. Guardrails, barriers and parapets

Table 14 shows the technical characterization of guardrails, barriers and parapets, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 14. Technical characterization of guardrails, barriers and parapets.

Materials	Foundry, pinewood, steel, aluminium, HDPE and galvanised steel, recycled plastics, etc.
Manufacturing processes	Casting, injection moulding, surface treatments, etc.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (surface treatments, paints, galvanic finishing, etc.).

Figure 13 shows some examples of guardrails, barriers and parapets that can be found in cities, including different materials, manufacturing processes and designs.

Figure 13. Examples of guardrails, barriers and parapets.

2.1.14. Milestones and bollards

Table 15 shows the technical characterization of milestones and bollards, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 15. Technical characterization of milestones and bollards.

Materials	Concrete, steel, iron, polyethylene, EVA polymer, wood, etc.
Manufacturing processes	Casting, blow moulding, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (surface treatments, paints, galvanic finishing, etc.).
Technical and quality standards	EN 12899-2 Fixed, vertical road traffic signs - Part 2: Transilluminated traffic bollards (TTB).

Figure 14 shows some examples of milestones and bollards that can be found in cities, including different materials, manufacturing processes and designs.

Figure 14. Examples of milestones and bollards.

2.1.15. Speed reducers

Table 14 shows the technical characterization of speed reducers, including the materials and manufacturing processes typically applied as well as the different technical properties that can be required for these products.

Table 16. Technical characterization of speed reducers.

Materials	Rubber, steel, cast steel, low-density polyethylene, EVA polymer, etc.
Manufacturing processes	Casting, injection moulding, surface treatments, etc. Processes depend on the type of material used.
Mechanical properties	Structural integrity, durability, stability in installation, rounded finishing, elimination of sharp and pointed parts, etc.
Chemical properties	Stability and resistance to environmental conditions (surface treatments, paints, etc.).

Figure 15 shows some examples of speed reducers that can be found in cities, including different materials, manufacturing processes and designs.

Figure 15. Examples of speed reducers.

2.1.16. Conclusions

Once identified, classified and characterised the different urban furniture elements, we can see that playground equipment is the one that has the greatest variety in terms of possible designs, materials and manufacturing processes. Other urban furniture elements, like benches, bins and containers, planters and pots, or showers and footbaths, also show a wide range of possibilities in design, which results in a large number of materials and manufacturing processes that could potentially be used. For these reasons, the urban furniture elements mentioned above appears to be very interesting for testing and validation of the tool developed in the project, since the tool could in this way be tested against a wider range of possibilities or scenarios.

2.2. Environmental characterization

The environmental performance of urban furniture products is analysed herein, based on environmental quantitative results provided by IHOBE (2014) for different case studies. The study conducted by IHOBE was based on life cycle assessment (LCA) methodology. LCA is the most widely used methodology to evaluate the environmental burdens associated with a product or process by identifying and quantifying energy and materials used and wastes released to the environment; to assess the impact of those energy and material uses and releases to the environment; and to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product or process, which encompasses: extracting and processing raw materials; manufacturing, transportation and distribution; use, reuse and maintenance; recycling and final disposal (SETAC, 1993).

LCA allows to analyse all the environmental aspects of a product in order to identify which are the most significant and, thus, establish measures to act on them. Hence, LCA studies for the different urban furniture products will be conducted in the project (action B1) in order to determine what the key environmental aspects of the products are, as well as to establish weighting factors for different environmental award criteria. It should be highlighted that simplified environmental analysis performed by the GUF Tool will rely on LCA-based factors, while simplifications applied in the tool will be based on the results of the LCA studies.

The environmental information compiled herein is only used to have a prior knowledge of the environmental performance of different urban furniture products: wooden bench, metal bin, metal container, advertising panel, playground, vertical sign, and concrete bollard. This will allows us to include environmental considerations in the selection of the two urban furniture elements that will be used for testing and validating the functionality of the GUF Tool (once developed).

2.2.1. Bench

Wooden bench with cast iron that consists of 18 wooden slats of Canadian pine. Weight: 45.81 kg approx. Material composition of this bench is shown in Table 17.

Table 17. Material composition of the wooden bench assessed.

Material	**Weight (kg)**
Steel	17.25
Pinewood	27.36
Paint	0.20
Varnish	1.00

67% of the overall environmental impact of the bench is due to manufacturing stage (which includes extraction and processing of raw materials), while 5% is due to distribution, 27% due to use, and the remaining 1% is due to the end of life. 44% of the environmental impact is due to the wooden slats of pine, the steel structure represents 21%, while 3% comes from varnish and paint. The use stage has a significant percentage of the overall impact due to the cleaning and maintenance needs. In this regard, the repair of coating is the most remarkable activity,

while cleaning with detergent also has a significant impact in this stage. The end of life, which consists in disposal of materials in landfills, has a percentage of overall impact about 2%.

2.2.2. Bin

Cast steel bin formed by a base body, a bucket and a lid. Although the assembly has multiple pieces, all of them are made of the same material. Weight: 23.815 kg approx. Material composition of this bin is shown in Table 18.

Table 18. Material composition of the metal bin assessed.

Material	**Weight (kg)**
Steel	22.07
Paint	0.25

78% of the overall environmental impact of the bin is due to manufacturing stage, 1% is due to distribution and 21% is due to use, while the impact of end of life stage is negligible. The steel used for the production of the bin components amounts to 44% of the environmental impact, while the galvanised parts accounts for 21%; punching the body constitutes 9% and welding and painting represent 1%. In the use stage, the detergent used for cleaning accounts for 13% of the impact, followed by the replacement of the part of the cover which accounts for 6% and 2% is due to repainting.

2.2.3. Container

Metal container with 2400 L capacity for the collection of municipal waste. The structure is made of galvanised steel, consisting of a pedal mechanism also of galvanised steel, superior airtight seals and rubber wheels. Weight: 92.5 kg approx. Material composition of this container is shown in Table 19.

Table 19. Material composition of the metal container assessed.

Material	**Weight (kg)**
Steel	90.0
Rubber	1.5
Paint	1.0

65% of the overall environmental impact of the container is due to manufacturing stage, 2% is due to distribution, 32% is due to use, while the impact of end of life is limited to 1%. In manufacturing, 30% of the overall environmental impact is due to the galvanising process for the steel structure, while the steel structure itself represent about 29% of the impact, being the impacts of the galvanised steel pedal and rubber wheels about 4% and 1%, respectively. The most significant impact in the use stage is due to detergent consumption for cleaning, which comprises about 23% of overall impact, while repainting and pedal and wheels replacement account for 4% and 5%, respectively.

2.2.4. Advertising panel

Advertising panel made of galvanised steel consisting of two glass screens and 4 fluorescent lamps. Weight: 161.5 kg approx. Material composition of this advertising panel is shown in Table 20.

Table 20. Material composition of the advertising panel assessed.

Material	**Weight (kg)**
Steel	33.89
Aluminium	1.80
Bilaminar glass	125.49
Glass	0.35

Use stage has the highest contribution to overall environmental impact of the advertising panel with 56%, followed by manufacturing with 44%, while the impacts of distribution and end of life stages are negligible. In the manufacturing stage, 38% of the overall impact corresponds to the sides, top and bottom supports made of steel, while the bilaminar glass panel constitutes 5% and the aluminium arm represents 1%. Use corresponds to 56% of the overall impact, mainly due to the maintenance of the different elements. The use of fluorescent lamps contributes with 44% to the overall impact, while the replacement of bilaminar glass panels makes an 11%. Moreover, the consumption of detergent in the cleaning process has a percentage of overall impact of 1%.

2.2.5 Playground

Standard playground that consists of a two-seat swing set on a rubber surface. The swing has 4 plywood poles, 2 plywood, lintel and stainless steel chains and 2 rubber seats with inner aluminium reinforcement. The surface system conforms to the security dimensions required by the installation of the swing and it is made of tiles made from recycled rubber and resins. Weight: 881.97 kg approx. Material composition of this playground is shown in Table 21.

Table 21. Material composition of the playground assessed.

Material	Weight (kg)
Security surface	786.24
Rubber	599.04
Resins	187.20
Swing	91.69
Plywood	4.50
Pinewood	55.00
Painting	8.32
Rubber	4.04
Aluminium	1.31
Steel	1.52

72% of the overall environmental impact of the playground is due to manufacturing stage, 2% is due to distribution, 3% is due to use, while the impact of end of life is in this case about 23%. Concerning manufacturing, 44% of the overall environmental impact is due to the production of the security surface and 28% is due to the swing. Major contributors to the impact of security surface are resin floor tiles with 23% of overall impact, closely followed by recycled rubbers with 21%. The impact of the swing is mainly due to the lintel steel with 24% of the overall impact. The use phase has a percentage of 3% of overall impact, which is mainly due to the detergent used to clean the playground and repainting the swing. The end of life stage contributes to the overall impact by 23 %, which is basically due to the disposal of materials in landfills.

2.2.6. Traffic sign

Vertical traffic sign formed by a post in aluminium alloy and a panel with a circular profile in aluminium alloy. For installation, cylindrical excavation is required. Weight: 94.48 kg approx. Material composition of this traffic sign is shown in Table 22.

Table 22. Material composition of the traffic sign assessed.

Material	Weight (kg)
Steel	1.8
Aluminium	32.5
Paint	0.2
Concrete	60.0

97% of the overall environmental impact of the traffic sing is due to manufacturing stage and 3% is due to distribution, while the impacts of use and end of life are negligible. Manufacturing encompasses almost all the overall environmental impact; 92 % is due to the aluminium alloy used for the post and for the panel, while much smaller percentages of impact correspond to

the galvanised post with 2 %, the concrete used for anchoring the sign on the pavement with 2% and the steel panel fastened to the pole with 1%.

2.2.7. Concrete bollard

Bollard made entirely of polished concrete. 270 mm diameter sphere with a single anchor to the pavement. This is a very simple product with a single material. Weight: 50 kg approx. Material composition of this bollard is shown in Table 23.

Table 23. Material composition of the concrete bollard assessed.

Material	**Weight (kg)**
Concrete	50.0

24% of the overall environmental impact of the bollard is due to manufacturing stage, 69% is due to distribution and 7% is due to end of life. 22% of the overall impact is due to the concrete body production, while the polishing process contributes with 2%. Concerning distribution, 59 % of the overall environmental impact of the bollard is due to trucking, while boat transportation accounts for only 10 %. The use stage is negligible, since this product does not require any maintenance. The end of life process has a percentage of overall impact of 7%, which is due to landfill disposal of materials.

2.2.8 Conclusions

Table 24 shows a brief summary of the environmental results compiled above. It provides an overview of the contribution of each life cycle stage to the overall environmental impact of the different urban furniture products assessed.

Table 24. Environmental impact by life cycle stage for different urban furniture products.

Urban furniture product	**Environmental impacts by life cycle stage (%)**			
	Manufacturing (including materials)	**Distribution**	**Use and maintenance**	**End of life**
Wooden bench	67	5	27	1
Metal bin	78	1	21	0
Metal container	65	2	32	1
Advertising panel	44	0	56	0
Playground	72	2	3	23
Traffic sign	97	3	0	0
Concrete bollard	24	69	0	7

It can be found that manufacturing of products, which also includes the extraction and processing of raw materials, is usually the life cycle stage with the highest environmental impact. The use stage can also be significant for those products that require maintenance during their service life, since important impacts can be associated with the replacement of

parts, the repainting and the use of detergents for cleaning. Transport and distribution do not seem to be very relevant, since their contribution to the overall environmental impact is only relevant for those products composed of materials with very low impact (e.g., concrete bollard). The end of life stage can be significant in some cases, although its impact can be highly variable depending on the end-of-life strategy that is applied to the products (e.g., recycling, incineration or landfill). In action B1 specific LCA studies will be conducted in more detail to have a better knowledge on all these environmental aspects that allow us to take more informed decisions for the development of the tool.

Nonetheless, some conclusions can be drawn related to the selection of the urban furniture elements to be further used for tool validation purposes. We can conclude that playground stands out as having higher environmental impact than other urban furniture products, because this is a voluminous product that requires large amounts of materials and generates waste that are difficult to recover. This could be an interesting product to test and validate the tool since a large number of materials and processes could be involved, as well as different strategies may be provided by suppliers to improve the recycling and reuse of these products. Other interesting products from the environmental perspective are the bench, bin, container and advertising panel, because they generate different impacts throughout their life cycle. Studying these two cases separately, we can see that the advertising panel has a significant environmental impact in the use phase because it usually has electric and electronic components that consume energy (lighting, movement, etc.). However, energy-related products are outside the scope of the project. For this reason, the benches, bins and containers seem to be more suitable for demonstration purposes due to the wide range of possibilities out there for their design, manufacture and use.

2.3. Functionality

Urban furniture functionality can be measured on the basis of the needs of population in terms of: usage, comfort, accessibility, aesthetics, installation and maintenance, safety, urban policy and regulations, and geographic environment and climate.

Usage

The original function of urban furniture is to satisfy both physiological and psychological needs of people in public places. According to particular needs and places, suitable urban furniture should be installed to provide appropriate usage. Some examples of the types of choices that are made when selecting suitable furniture are: public art such as sculptures and waterscapes created to provide decoration and to commemorate special anniversaries; different types and designs of lighting provided for different streets (paths and roads) and different uses; traffic signs provided for both drivers and pedestrians to help them reach their destinations; and special facilities to assist the elderly and people with disabilities.

Comfort

Urban furniture should provide a high degree of comfort to users, meaning that users can make use of furniture without losing physical and/or mental composure. Some examples include the following: seats designed according to human ergonomics and materials discreetly chosen for comfortable resting, the colour and intensity of street lighting accordingly selected and controlled to avoid visual inconvenience; and the types, patterns, and colours of pavers

correspondingly applied to the function and climate of the place. The arrangement of urban furniture is also a significant way to ensure comfort. For instance, railings or bollards should be placed so as not to restrict the smooth flow of pedestrian traffic and human activities. The appearance and style of urban furniture should be thoughtfully designed to create a pleasing environment by providing artistic and visual comfort to the public.

Accessibility

Accessibility plays a major role in fulfilling the people-oriented premise of urban furniture design. The accessibility of urban furniture depends on its quantity, arrangement and design. Visual and distance accessibility are also contributing factors. Users should be able to see, reach and make use of urban furniture effortlessly. For example, pedestrians should be able to find unoccupied seating facilities appropriately located and spaced at regular, short intervals so that they may rest when they feel tired. Another example involves the accessibility of civil facilities like mailboxes and telephone booths, which should be easily recognised in terms of colour and form, and located at specific positions on the street. Using eye catching signage can also increase the degree of accessibility.

Aesthetics

People are always pleased with beautiful, interesting, and vibrant urban furniture. Elegant furniture also beautifies the environment and enhances the quality of the urban landscape. Some types of urban furniture, such as plantings, fountains, water views and sculptures are intended to be decorative, thus their aesthetic side is particularly emphasised. The aesthetics of urban furniture is about providing pleasing, colourful and inspiring environment to the public and their urban life. To achieve this, some simple and reasonable additional shaping on details (without creating pressure on the production cost) can efficiently increase the aesthetic level of street furniture and make it special in different places.

Installation and maintenance

Urban furniture is required to be durable by preventing easy destruction and avoiding frequent repair or replacement, thus generating satisfaction, achieving a green design, and minimising operation costs. The durability of urban furniture mainly depends on the materials used. Since urban furniture is located in public places that are usually outdoors and not under video surveillance, durability may be affected by various uncontrollable elements, including weather conditions and use by numerous users. If possible, durable, weather-resistant materials should be used when manufacturing urban furniture. The methods of installation and maintenance are also important factors that directly affect the durability of furniture, as well as prevent harm to people caused by damage of furniture. An efficient maintenance system ensures the quality of urban furniture. Careful selection of materials and installation methods can lower the consumption of resources and the frequency of maintenance to minimise operating costs.

Safety

Safety issues associated with urban furniture are divided into several categories. One issue deals with scale. Examples of safety regulations related to scale include: restricting the size of spacing within and between railings to avoid trapping passengers; requiring smooth and rounded surfaces; prohibiting unexpected obstacles of urban furniture within reaching

distance; skid-proof vehicular and pedestrian paths; and minimising water depth for waterscapes, such as fountains and pools. Another safety issue is the selection of materials. Some examples include: selection of inflammable materials to avoid fire hazards; unbreakable and tough materials to avoid easy breakage and damage, and slip-proof materials for pavers, stairs and slopes. Usage and arrangement of urban furniture is also a safety issue. Some examples include: railings or bollards to separate vehicles and pedestrians; sufficient lighting provided at night for security; definite signage to provide information for both drivers and pedestrians; and insulating systems for urban furniture connected to power sources, such as street lamps and fountains. In addition, universal and non-handicapping designs are essential to provide a safe urban landscape for those with special needs. Governments and related parties of countries usually take responsibility for setting safety standards and guidelines for urban furniture to which designers refer during the design process.

Urban policy and regulations

Each country has its own policy and regulations for urban planning and design. Therefore, urban furniture should be designed according to the local urban policy and regulations. Some differences can be found in standards related to colour, style and size of the typeface for pedestrian and traffic signage; the height of different types of street lighting; and the height of the pedestrian path from the vehicular path.

Geographic environment and climate

Geographic environment and climate also model the identity of a place, its urban landscapes and its urban furniture. For example, climate plays a role when choosing the colour, materials, and design of urban furniture. If a place has high temperatures and constant sunshine, the colour of the furniture should not strongly reflect sunlight so as to provide visual comfort to its users. In addition, certain materials, like metal, should be avoided when creating urban furniture for this type of climate because of their ability to absorb heat easily. The design of urban furniture in this type of climate may be to provide shelter from the sun. All of these types of geographic environment and climate considerations give urban furniture identity and help it merge with a place.

Table 25 shows the correlation between the functions of urban furniture explained above and various types of urban furniture products. It can be found that some products are expected to provide a lot of urban functions and these will require a more detailed evaluation when dealing with their purchasing, since a larger number of aspects should be taken into account.

Table 25. Correlation between different functions and the type of urban furniture.

Urban furniture product	Urban furniture functions							
	Usage	**Comfort**	**Access.**	**Aesth.**	**Inst. & maint.**	**Safety**	**Urban policy**	**Geo. environ.**
Bench	X	X	X	X	X	X	X	X
Bin	X		X		X	X	X	X
Container	X		X		X	X	X	X
Advertising panel	X	X	X	X	X	X	X	X
Playground	X	X	X	X	X	X	X	X
Traffic sign	X		X			X	X	
Bollard	X					X	X	

Functionality is assumed herein as a key aspect for the selection of the two urban furniture elements to be used for demonstration when testing and validating the GUF Tool. The aim is to choose demonstrative products that are able to provide a wide range of opportunities in terms of functionality. In this regard, benches, advertising panels or playgrounds appear to be the most interesting products.

2.4. Current market

Table 26 shows a breakdown of the volume of urban furniture manufacturers by product type. Although these data are based on information provided by two Spanish associations (Amec-Urbis and AFAMOUR) for the Basque Country, it can be assumed that the distribution of manufacturers by product type should be roughly similar for many other regions in EU, since the main end users in this case are public authorities.

Table 26. Volume of urban furniture manufacturers by product type.

Urban furniture products	**Percentage of manufacturers (%)**
Benches, seats and chairs	11.2
Bicycle parking	5.1
Canopies and kiosks	3.9
Bins and containers	15.5
Hydrants	0.5
Advertising and information panels	5.6
Planters and pots	8.9
Tree pits, manholes and lids	4.5
Playgrounds	7.9
Sports courts	4.5
Showers and footbaths	1.7
Fountains and hydrants	4.5
Traffic signs	8.8
Guardrails, barriers and parapets	8.4
Milestones and bollards	7.9
Speed reducers	1.1

This information is useful for the selection of the products to be used as demonstrators. It should be noted that urban furniture manufacturers are potential users of the tool developed in the project. Hence, the larger the number of manufacturers of a product the more interesting the product can be for demonstrative purposes. Therefore, the following products can be the most interesting for testing and validation of the tool according to the large number of manufacturers available: bins and containers; benches, seats and chairs; planters and pots; traffic signs; guardrails, barriers and parapets; playgrounds; and milestones and bollards.

3. Selection of urban furniture products for demonstration

The preparatory action A2 of the LIFE FUTURE project was also aimed at selecting two different urban furniture products for demonstration purposes; i.e., these products will be later used in two case studies to test and validate the functionality of the GUF Tool (in action B3). The selection of these demonstrative products was conducted herein based on the results of the urban furniture characterization previously conducted. Thus, the following key aspects were taken into account as selection criteria:

1. Design opportunities: products with many design alternatives were considered as more interesting for testing and validation of the tool, since it can be tested against a wide range of possibilities in terms of materials, manufacturing processes, maintenance needs, etc.
2. Environmental aspects: products with high environmental impact were considered as more interesting for testing and validation of the tool, as well as products causing significant environmental impacts through all their life cycle stages.
3. Functionality: products that are required to provide a wide range of urban functions were considered as more interesting for testing and validation of the tool.
4. Current market: products with high volume of manufacturers were considered as more interesting for testing and validation of the tool, since urban furniture manufacturers are potential users of the tool.

Table 27 shows the correlation between the selection criteria explained above and the different types of urban furniture products. Only two types of urban furniture products fulfil all the selection criteria, which are: (1) benches, seats & chairs, and (2) playgrounds. Therefore, these are the urban furniture products that were finally selected for demonstration of the tool functionality.

Table 27. Correlation between different criteria and the type of urban furniture.

Urban furniture products	Selection criteria			
	Design opportunities	**Environmental aspects**	**Functionality**	**Current market**
Benches, seats & chairs	**X**	**X**	**X**	**X**
Bicycle parking				
Canopies & kiosks	X			
Bins & containers	X	X		X
Advertising & information panels		X	X	
Planters & pots	X			X
Tree pits, manholes & lids				
Playgrounds	**X**	**X**	**X**	**X**
Sports courts				
Showers & footbaths	X			
Fountains & hydrants				
Traffic signs				X
Guardrails, barriers & parapets				X
Milestones & bollards				X
Speed reducers				

4. Conclusions

The different types of urban furniture products that can be typically found in our cities were identified. They comprise sixteen different urban furniture products, which can be grouped in three product categories as follows:

- Street furniture products: (i) Benches, seats and chairs; (ii) Bicycle parking; (iii) Canopies and kiosks; (iv) Bins and containers; (v) Hydrants; (vi) Advertising and information panels; (vii) Planters and pots; (viii) Tree pits, manholes and lids.
- Recreational and leisure products: (ix) Playgrounds; (x) Sports courts; (xi) Showers and footbaths; (xii) Fountains and hydrants.
- Traffic management products: (xiii) Traffic signs; (xiv) Guardrails, barriers and parapets; (xv) Milestones and bollards; (xvi) Speed reducers.

These are the products that will be covered by the GUF Tool developed in the project, which will provide GPP criteria for these products and will allow public authorities to environmentally assess them. It should be noted that products consuming energy are outside the scope of the project and, thus, they will not be assessed using the tool.

All these urban furniture products were then characterised in terms of the materials and processes used for their manufacturing and the technical specifications required, including mechanical, chemical, biomechanical and environmental properties. Other key aspects such as functionality and current market of these products were also reviewed. This knowledge will be used during the project for the development of the tool.

Finally, two different urban furniture products were selected as the most relevant for demonstration purposes, which will be used in two case studies intended to test and validate the functionality of the GUF Tool once developed. The selection criteria used for this purpose were related to design opportunities, environmental aspects, functionality and current market. As a result, the products that better comply with all these criteria were selected, namely: (1) benches, seats & chairs, and (2) playgrounds.

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