

# **Safety in Escalators**

## **Barcelona Metro Experience**

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# The public Transport in Barcelona

The Metropolitan Region of Barcelona (MRB) includes a total of 164 municipalities, an area of 3,237.1 km<sup>2</sup> and a population of 4,254,821 (2012).

The Metropolitan Area comprises 36 municipalities, a total area of 636 km<sup>2</sup> and a population of over three million (2012).

The demand for collective public transport within the Integrated Fare System in the Barcelona area was 899.6 million journeys in 2012.

Transport Administrators and Operators in the Metropolitan Region of Barcelona :

## Barcelona Metropolitan Area (AMB)



Bus / Metro

Bus, indirect management

Taxi



## Government of Catalonia



Buses with Directorate-General for Transport and Mobility (DGTM) concession

## Metropolitan Transport Authority (ATM)



TRAMVIA METROPOLITÀ S.A.

# What's TMB?

TMB is the collective name of three companies which manage :

## Metro



8 metro lines (3 driverless) and one funicular.  
102.6 km.  
141 stations.  
138 trains operating in the rush hour.

## Bus



102 lines  
890 km length of network  
2,591 stops  
A fleet of 1072 vehicles

## Leisure Transport



Three Tourist routes  
74 open-top buses  
One cable car  
One historic tram line from the early 20th century (1901)

# Barcelona Metro Network



# Distribution of Passengers

The demand for collective public transport Fare System in the Barcelona area was 899.6 million journeys in 2012.

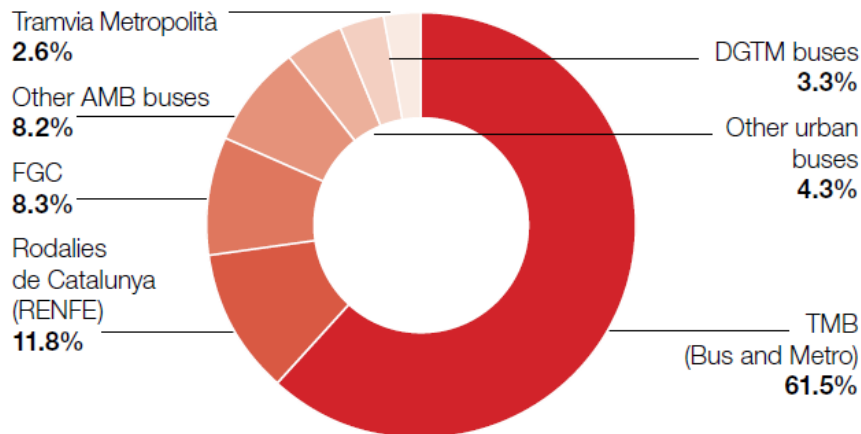
Of the total number of journeys made, over 550 million —61.5%— were made on TMB.

	Journeys 2012*
Metro	373.5
Bus	180.0
<b>Total TMB</b>	<b>553.5</b>
FGC	75.0
Rodalies de Catalunya (Renfe)	105.9
Tram	23.7
AMB buses	73.4
DGTM buses	29.7
Urban buses	38.7
<b>Total</b>	<b>899.8</b>

\* in millions

Source: ATM (2012).

Distribution of public transport passengers by operator



Source: ATM (2012).

# Accessibility

Accessibility is like a string that can be broken in the weakest point and it is necessary to assure accessibility at all links of the string.

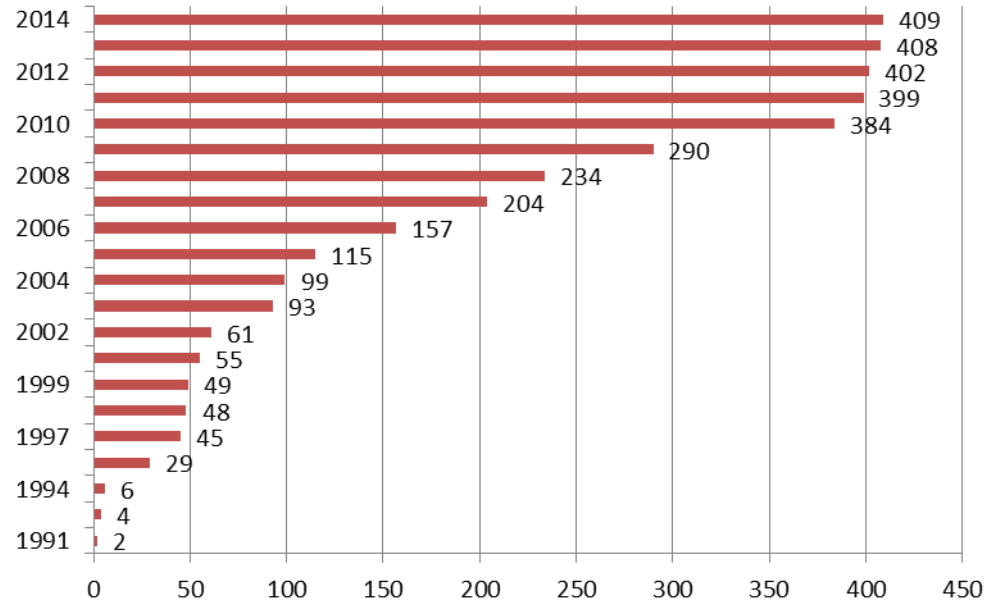


# Lifts

409 LIFTS. 85 % of the network adapted for wheelchair access

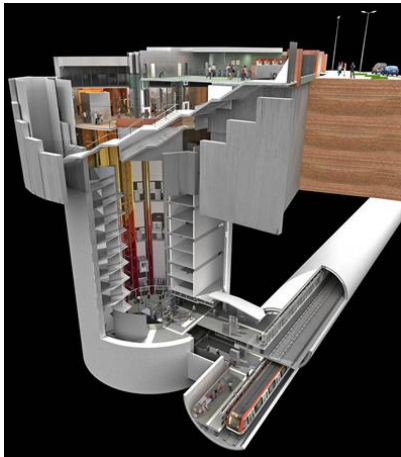


# Lifts



# L9 New line on lifts are key

Access to deep stations (55 m.) only by high capacity lifts



Computer based control of lifts that takes into account numerous parameters, “Intelligent control system”, allowing efficient moving of high number of passengers.



# Overview of escalators

<b>Total number: 602</b>	
<b>Escalators</b>	<b>Moving Walks</b>
<b>582</b>	<b>20</b>

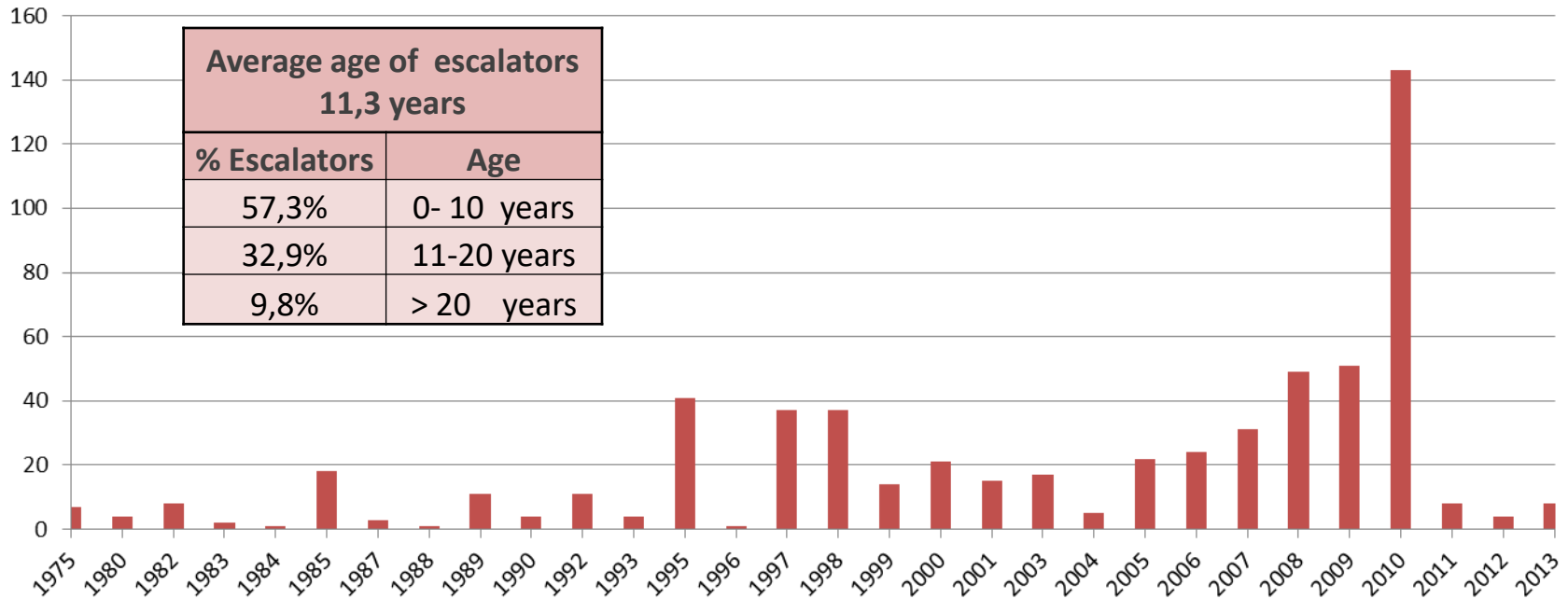
	Escalators	Moving Walks
<b>Ascending</b>	82,5%	40,0%
<b>Descending</b>	13,3%	40,0%
<b>Reversible</b>	4,2%	0,0%
<b>Horizontal</b>	0,0%	20,0%

<b>Length</b>	Average	5,25 m.
	Longest	16,4 m.
	Shortest	1,3 m.
<b>Speed</b>	0,5 /0,65	m/s



# Age of escalators

Number of escalators / year installation



Average age of escalators 11,3 years	
% Escalators	Age
57,3%	0- 10 years
32,9%	11-20 years
9,8%	> 20 years

# Operation & Maintenance

## Metro operating hours

Weekdays (Monday to Thursday), Sundays and public holidays	from 5.00 am to midnight
Fridays and eves of public holidays	from 5.00 am to 2.00 am
Saturdays and 31 December, 23 June, 14 August and 23 September	runs all night
24 December	closes at 11.00 pm

## Escalators, operating hours 2013

All Escalators	4.400.425
Average per escalator	8.074,2
Average hours per day /escalator	22,1
Passengers 2013	369.939.124

Availability				
	2010	2011	2012	2013
Target	99,00%	99,10%	98,70%	98, 70%
Achieved	99,23%	99,58%	99,67%	99,48%

# Regulations of Escalators

Compliance of regulations	
Regulation	% Escalators
Machines Reg.	12,29%
EN 115	60,63%
EN 115-1	27,08%

EN 115-2 aims to reach a level of safety in existing escalator and moving walks equivalent to that of newly installed ones:

- Upgrading all existing units to the state-of-the-art for safety at the same time is not possible.
- Process based on the level of risk. Subdivision of the hazardous situations into priority levels which then can be removed in several timed steps.

# Upgrade to EN 115-2. Hazards to mitigate in our park of escalators

Nr.	Hazard/Hazardous situation	Priority level	Relevant Clause EN 115-2
4	Slipping on steps/pallets/belt and landing areas	H	5.3.1, 5.7.1
6	Trapping between skirting and steps	H	5.3.3, 5.5.3
7	Trapping between step and step or pallet and pallet	H	5.3.4
8	Missing steps or pallets	H	5.3.5
13	Falling due to reduced stopping distance	H	5.4.2.6
16	Climbing on the outside of the balustrade or falling from the landing	H	5.5.2.3, 5.13.1.6
21	Trapping between comb and step/pallet	H	5.7.2, 5.7.3
22	Trapping of users resulting from sagging of the step/pallet	H	5.7.4
24	Insufficient space in workers' area	H	5.8.2, 5.13.2.4, 5.13.2.5, 5.13.2.6
33	Impact on bodies caused by collision with building structures	H	5.13.1.1, 5.13.1.2, 5.13.1.3
38.1	Missing devices resulting in misuse of escalators by transporting other items than persons.	H	5.15.1
19	Drawing-in at handrail entry into the balustrade	H/M	5.6.3.1
12	Effect of excessive stopping distance	L	5.4.2.4
31	Electrostatic discharge from moving components	L	5.11.3
35	Crushing of persons resulting from traffic congestion on succeeding escalators or moving walks	L	5.13.1.5
39	Crushing due to incompatible trolleys on moving walks	L	5.15.2
2	Contact with moving machinery parts normally not accessible to the public	M	5.2.1, 5.4.1, 5.12.2, 5.13.2.1
11	Excessive speed and unintended reversal of direction	M	5.4.2.1, 5.4.2.2, 5.4.2.5
14	Falling over the balustrade	M	5.5.2.1, 5.5.2.2
17	Falling due to handrail speed deviation	M	5.6.1
23	Miscellaneous equipment in workers' area not related to the installation	M	5.8.1
26.2	Inadequate lighting in the workers' area and access to it	M	5.8.4, 5.13.2.2, 5.13.2.3
36	Falling due to inadequate lighting at the landings	M	5.13.1.7
37	Missing safety signs	M	5.14
38.2	Inadequate devices to prevent use of trolleys or baggage carts on escalators	M	5.15.1

# Main causes of users accidents in reported by our main Maintainer

Slipping on steps/pallets/belt and on landings	32%
Entrapment between skirting and steps	8%
Falling from a landing	8%
Entrapment between combs steps/ballets/belt	7%
Entrapment between steps or pallets	5%
Climbing the balustrade	3%
Entrapment at handrail entry points	3%
Improper use of an escalator to move a shopping cart	2%
Crushing fingers between handrail and Balustrade	2%
Falling due to stopping distance being too short	2%
Others	17%
No determined	11%

Main consequence	
Fall	42%
Entrapment	23%
Others / No determined	35%

# Our register of Accidents and typology

## Accidents

Average per escalator / year 0,62  
 Average per passenger 1,00692E-06

Accidents due to an escalator fault are 0,7 % of the total

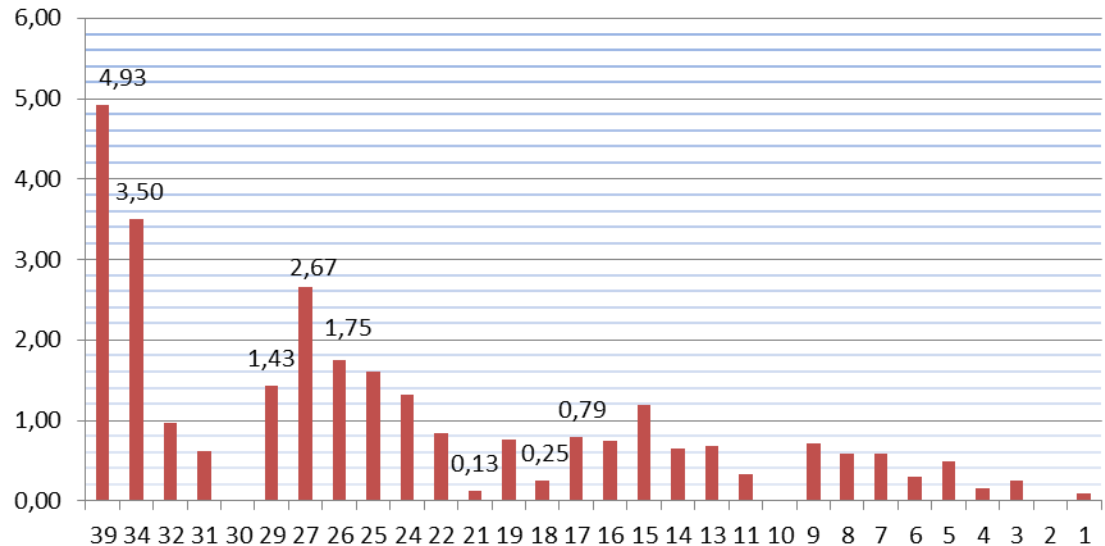
Accident	2010	2011	2012	2013	Total	
Fall without cause	202	163	120	217	702	47,2%
Slipping on steps/pallets/belt/and on landings	112	159	159	162	592	39,8%
Entrapment between comb and step/pallet	22	20	21	20	83	5,6%
Cuts or injuries to hands, arms..	13	12	20	4	49	3,3%
Trapping between skirting and steps	7	17	5		29	2,0%
Massive fall without cause	1	6	5	6	18	1,2%
Falling due to hand rail speed desviation (or stop)	2	2	3	2	9	0,6%
Trapping at handrail entry			2	1	3	0,2%
Fall due to backward motion	1			1	2	0,1%
<b>Total</b>	<b>360</b>	<b>379</b>	<b>335</b>	<b>413</b>	<b>1487</b>	<b>100,0%</b>
					Average per year 371,75	

	2010	2011	2012	2013
<b>Number of days with rain</b>	128	101	102	108

# Accidents versus age

Average accidents per year and escalator/  
age of the escalator

Age (years)	Accidents/escalator per year
>30	2,74
21-30	1,29
11-20	0,74
0-10	0,32





# Accidents versus location

Location	% Escalators	% Accidents
Indoor	77,98%	85,30%
Outdoor	22,02%	14,70%

Number of accidents per year/escalator		
Indoor	0,773	210 % More accidents indoor escalators
outdoor	0,368	
Descending	0,576	19,7 % More accidents ascending escalators
Ascending	0,689	

	Descending	Ascending
Indoor	0,750	0,777
outdoor	0,319	0,388

# Accidents versus standards compliance

Standard compliance	Number of accidents per year/escalator
Machines Regulation	1,70
EN115	0,61
EN115-1	0,15

Please note that the escalators that meet EN 115-1 are the newer in network and usually are installed in new stations of extensions of the network, with less passengers than the stations in the city center.

# Top 15 stations with more accidents

Station	Accidents / year	Accidents / escalator	Age	Avg per age	Difference / average per age	Passengers 2013	% passengers / average stations	Lift ?	Other	Logical ?
Sants Estació 5	30,75	10,25	39	4,93	207,91%	6.075.201	231,55%	NO	Train station -> Bags	YES
Pça Espanya1	10,5	5,25	34	3,5	150,00%	8.591.271	327,45%	NO		YES
Paral·lel 2	6,5	3,25	19	0,76	427,63%	5.567.535	212,20%	YES		NOT SO
Hospital Bellvitge	6,5	3,25	25	1,61	201,86%	1.149.985	43,83%	YES	HOSPITAL	NO
Rbla Just. Oliveres	6,25	3,13	27	2,67	117,04%	1.257.090	47,91%	NO		NO
Vallcarca	10,25	2,56	29	1,43	179,20%	1.975.738	75,30%	NO	Long escalator	NO
Urquinaona 4	5,75	1,92	16	0,75	255,56%	3.299.544	125,76%	NO		YES
Fabra i Puig	10,75	1,79	15	1,12	159,97%	4.193.565	159,84%	YES		YES
La Pau 2	10,25	1,71	17	0,79	216,24%	1.511.777	57,62%	YES		NO
St. Antoni	7,75	1,55	19	0,76	203,95%	2.673.209	101,89%	YES		NO
Pça Catalunya 3	6	1,50	13	0,68	220,59%	7.050.143	268,71%	YES		YES
Diagonal 5	8,75	1,46	9	0,76	191,89%	7.576.749	288,78%	YES		YES
Fondo	7,25	1,21	22	0,89	135,77%	3.183.355	121,33%	YES		YES
Lesseps	5,5	1,10	34	3,5	31,43%	3.886.587	148,13%	YES	Less acc., than expect.	YES
Fontana	6	1,00	6	0,3	333,33%	3.208.782	122,30%	YES		NOT SO

53 % top stations have some correlation and can be logical, in the other stations not or not so much, but accidents depend on chance...

# Impact on service of accidents

After an accident an escalator is stopped until a technician verifies that everything is correct.

Average stop time of escalators caused by accidents per year	624,25 hours
Average stop time of escalators by each accident	1 hour 42 minutes
Impact on availability of escalators of accidents	0,0142%



# Plan to upgrade to EN 115-2

Number of escalators / moving walks affected	Indoor	Outdoor
	344	88

## Upgrading has an important cost

Priority	Estimated cost of adaption in all equipment
HIGH	4.150.000 €
MEDIUM	1.000.000 €
LOW	1.050.000 €
Total	6.200.000 €

- Implementation schedule: 4 years
- Assignment of individual priority for each escalator depending on the classification of hazards of the standard, the number of passengers, history of accidents and organizing different adaptations required to minimize the number of interventions in each machine.

# What can we expect from upgrading?

	Accidents/ year	Accidents/year network	
	per escalator	#	Variation
Average number of accidents per year currently	0,618	372	
Average number of accidents per year if all escalators updated to EN 115-2 achieve the ratio of accidents of our current escalators that meet EN 115-1	0,150	90	<b>-75,71%</b>
Average number of accidents per year if all escalators updated to EN 115-2 achieve half the ratio of accidents of our current escalators that meet EN 115-1	0,300	181	<b>-51,42%</b>

# Thanks for your attention

