NEW DEPENDABLE ROLLING STOCK FOR A MORE SUSTAINABLE, INTELLIGENT AND COMFORTABLE RAIL TRANSPORT IN EUROPE

D6.6. Attractiveness & Comfort Features

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EXECUTIVE SUMMARY

This task reviewed work of tasks 6.1 to 6.5 to create a list of features in a train interior that are important to passengers in terms of comfort and attractiveness. This list contained 24 features that covered a multitude of areas that would affect a passenger's journey experience.

Each of the features was then evaluated as to what is deemed to be a preferred, tolerable and unacceptable level for a passenger on a journey for each feature. These assessments were made to be as objective / measurable as possible, although a few are still subjective their effect on the overall rating of an interior is small.

The scoring metric allows comparison and objective measurement across different trains, even if using some subjective criteria like ambience. A weighting for the features to highlight which are most important to passengers was also created.

A weighting for the 24 features was also adapted for 4 different train types (metros, commuter, regional and intercity) as some of the features have a different priority on different services provided. This adaptability standardises the scores more across the different train types.

The absolute score in the Metric is not important but that it is quantifiable and gives a result that is comparable.

By creating a comfort score for a train interior it then places a value against certain key criteria. When this is done then a ranking or league table is the obvious progression. Having league tables of interior comfort will create Push / Pull factors that will ensure scores are important to operators and others in the rail industry, and so will place a value on attractive / comfortable train interiors. Transparency of the comfort / attractiveness of passengers' journey experience could drive several different ways of how "the voice of the passenger" is captured and acted upon to make rail travel the more preferred mode of transport in the future.

Creating this value perception of interiors it will in turn lead to more creative freedom of developing new and innovative interiors.

ABBREVIATIONS AND ACRONYMS

Abbreviation / Acronym	Definition
ALS	Alstom Transportation
ATD	Anthropomorphic test device
BT	Bombardier Transportation
CCTV	Closed Circuit Television
dBA	A-weighted decibels - relative loudness of sounds in air as perceived by the human ear
EN	European Standard
EU	European Union
HVAC	Heating, Ventilation, and Air Conditioning
ISO	International Organization for Standardization
ITT	Invitation to Tender
LCC	Life Cycle Costs
lux	Measure of illuminance
NVM	Ride comfort evaluation according to CEN 12299
OEM	Original Equipment Manufacturer
PIS	Passenger Information Systems
PRM	People with Reduced Mobility
RSSB	Rail Safety and Standard Board
SNCF	Société Nationale des Chemins de fer Français
TOCs	Train Operating Companies
TSI	Technical Specification of Interoperability
UIC	International Union of Railways (Union Internationale des Chemins de Fer)
WP6	Work Package 6
%ile	Percentile - 100 equal groups into which a population can be divided according to the distribution of values of a particular variable; often uses 5^{th}, 50^{th} and 95^{th} %iles

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1. INTRODUCTION

This document describes the work done in **Task 6.6 Attractiveness & Comfort Features**. The objectives of this document are:

- Use the outputs from tasks 6.1 to 6.5 [1, 2, 3, 4, 5] to wrap up the investigation phase of WP6 and create a list of the features that are relevant for the attractiveness and comfort of a train interior.
- Put an objective value against these features so that a train interior can be evaluated to allow comparison with another train considering the multiple features affecting its attractiveness to customers.
- Reflect the fact that different train types have different journey missions which place a different priority on the interior features. Create a weighting that should reflect this prioritisation and allow high quality metro vehicles to score higher than mediocre intercity trains thereby recognising design features which address passenger comfort needs.

2. FEATURES VALUED FOR ATTRACTIVENESS & COMFORT

2.1 DESCRIPTION OF FEATURE AND SCORING SCALE

The following is a list of 24 features considered to have an important influence to a vehicle's attractiveness and comfort to a passenger. These features figured in one or more of the earlier work packages as important to the passenger journey experience, and then a judgement has been made on what is deemed to be a preferred, tolerable and unacceptable level for each feature. There is a short descriptive paragraph on each and a score ranging from 4 to 0, with illustrations to quantify the score allocation for each feature.

Noise – standstill

Description – this is the noise that a seated passenger would experience sat in a vehicle waiting at a station with the doors and windows closed. Can be measured by a simple hand held device.

Scoring Range

4	3	2	1	0
under 60 dBA	under 63 dBA	under 66 dBA	under70 dBA	over 70 dBA

Noise - service speed

Description – this is the noise that a seated passenger would experience sat in a vehicle when it has achieved maximum running speed with the doors and windows closed. Can be measured by a simple hand held device.

Scoring Range

4	3	2	1	0
under 65 dBA	under 68 dBA	under72 dBA	under75 dBA	over 82 dBA

Ride

Description – ride comfort is important to both seated and standee passengers as they would experience discomfort in a vehicle if it is moving around too much when in transit. The scoring range uses a NMV value, which is a ride comfort evaluation according to CEN 12299 [7] and a mean value measured from it. Can be measured by a simple hand held device.

Scoring Range

4	3	2	1	0
under 1.5 NMV	1.5-2.4 NMV	2.5-3.5 NMV	3.6-4.5 NMV	over 4.5 NMV

Seat comfort

Description – seat comfort is an area of significant focus. As discussed in previous tasks it would benefit from the creation of an objective scoring metric. In the absence of such a metric, the assessment is limited to subjective judgement by the assessor on the seat ride comfort or more accurately lack of discomfort. The typical journey time for the train should be known to allow equal assessment between seats with different target markets. On this basis, a metro seat will not need the same level of comfort as an intercity seat, for example. The score is determined by the time before the assessor feels discomfort compared to the typical journey time. It could be argued that no passenger should ever feel any discomfort from any seat, but unfortunately, in reality, some level discomfort is tolerable in the short term even if it just means a passenger making a conscious effort to adjust their position on the seat. The assessment should be on typical standard seats used on the train, not tip up seats.

Scoring Range

4	3	2	1	0
No discomfort felt over complete journey time	Discomfort felt after 95% of complete journey time	Discomfort felt after 85% of complete journey time	Discomfort felt after 75% of complete journey time	Discomfort felt after less than 50% of complete journey time

Seat Legroom - seat dimensions for standard seats (not PRM seats)

Description – the space a passenger has for their legs is important as if the position is too cramped it will lead to discomfort very quickly. The legroom is not just the seat pitch dimension as this measurement does not allow for the seat back angle or thickness of backrest to be taken into account. The measurement we have used is a buttock to knee measurement for a 95%ile male plus a 10mm allowance for clothing (5mm per layer). The value for the comfort angle for the leg below the knee has been discounted as the seat back angle for all seats on the market is similar to the diagram below where the bottom of the seat is further away than the knee contact point. The lower seatback angle and the leg comfort angle are similar, so any delta in distances will be

minimal and so ignored. The diagram from UIC 567 [8] shows the measurement position. The measurement for a 95%ile male plus a 10mm allowance using the ergonomic dataset of PeopleSize 2008 for the UK is 683mm, for the Netherlands (who are the tallest Europeans) it is 699mm. Not all countries have data in PeopleSize but of the other countries included, so Germany, Sweden and Belgium have similar values to UK dimension. The anthropometrically shorter countries such as Italy and Spain were not in the data set but would bring down the European average, so the UK dimension was selected as an average. A true European average dimensions are missing at present but could easily be used when the anthropometric data is available. For bay seating pitch it is double the 683mm dimension plus 50mm knee clearance as a minimum dimension and assuming passengers would move their feet to between their opposing passenger's feet.

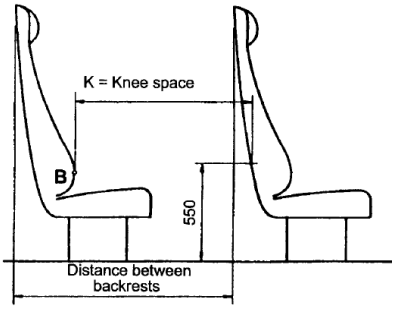

Figure 1 - Method of determining seat legroom – unidirectional seats

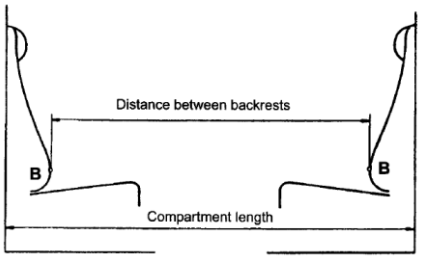

Figure 2 - Method of determining seat legroom – bay seats

Scoring Range

4	3	2	1	0
airline over 800mm bay over 1650mm	airline 800 - 750mm bay 1650 - 1540mm	airline 750 - 720mm bay 1540 - 1480mm	airline 720 - 683mm bay 1480 - 1416mm	airline under 683mm bay under 1416mm

Seat - window alignment

Description – having a clear unobstructed view for passengers is important particularly on mainline trains with transverse seating layouts. For metros and other trains with longitudinal seating the score is again based on how easy it is to see out of the train for both seated and standing passengers. A metro with plenty of large windows will score well, but a vehicle with fewer or small

windows will not score as highly. Deadlights are the vertical interior trim between windows and hide the carbody structure holding the windows.

Scoring Range

4	3	2	1	0
All seats aligned		Deadlights in no bays, maximum 6 airline seats without clear window access		Deadlights in all bays, more than 70% airline without clear window access

Seat - airline to bay ratio

Description – seating in bays or face to face arrangements are generally preferred by passengers particularly those travelling in groups or with children. It is more sociable than other seating arrangements and generally perceived to give the passenger more space (although the opposite maybe true in reality). Bay seating does reduce total seat numbers on a given train and also some passenger may prefer to have a more private airline style seating, where only one other passenger is in their direct space.

Scoring Range

4	3	2	1	0
Over 50% seating in bays		2 bays per car		no bays

Seat armrests

Description – armrests were seen by most passengers as a positive comfort feature for seating. They help define the passenger's personal space and help prevent incursion in to it by others, as well as supporting a passengers arm. Although desirable feature, a poorly designed armrest can soon cause discomfort for the passenger and give a negative impact on comfort, and this has been incorporated in to the scale, rather than a binary armrest yes / no answer.

Scoring Range

4	3	2	1	0
all seats, padded, correct width and height	all seats, unpadded, too narrow but correct height	all seats, unpadded, wrong height	some seats, unpadded, fixed position, too narrow or wrong height	none fitted

Air Management

Description – this is the saloon environment created by the vehicle's HVAC unit or equivalent. It is the temperature as well as the air flows around the saloon. The performance levels are harder to achieve and maintain in more extreme climates or on vehicles that have many doors with lots of stops, but these performance criteria have been kept constant as vehicles operating in those environments should have been designed to meet acceptable levels without sacrificing passenger comfort in which air management plays a huge part.

Scoring Range

4	3	2	1	0
22-23 C constant, no draughts		20-25 C, with draughts for standees		Under 18 or over 28C, with draughts at seats

Luggage storage provision and visibility

Description – luggage storage can be an important feature for some passengers. There is hand luggage such as briefcases, laptop bags and jackets which usually go in the overhead luggage racks. There is also larger items of luggage which are less frequently carried but their safe and secure storage is an important attractiveness feature. Having large suitcases blocking aisles / doorways or resting on seats is not desirable for operational or safety reasons. Also for security reasons passengers prefer to see their possessions if they are not directly next to them. This is why luggage stacks separated from seating areas have lower scores.

Scoring Range

4	3	2	1	0
Racks & Stacks -all visible		racks only, stacks unseen,	partial coverage of racks only	none

Toilets – provision

Description – access to a toilet on a train is important on longer journeys. TSI PRM [6] helps define the numbers of universal toilets on a train, with mandatory requirements for wheelchair user's access. PRM passengers are only a small percentage of the customers and the vast majority would be satisfied with access to standard or space saver toilets, depending on the seating layouts.

Scoring Range

4	3	2	1	0
one per car	one per 2 cars	one per train		none

Toilets - cleanliness and functioning

Description – Once a passenger has access to a toilet then it is important that toilet is hygienic and "ready to use". It is most unattractive if the facilities are dirty, smelly or broken. Part of this score is made up from cleaning and maintenance of the toilets, so can vary day to day, but it still a valid score to use when assessing the attractiveness of a train service.

Scoring Range

4	3	2	1	0
clean, fully functioning and easy to use. No smell inside or outside cubicle		difficult to use, mild smell inside cubicle		out of service, broken, intrusion smell in saloon

Catering

Description – access to provision of food and drink is a basic human desire and is important on longer journeys. There are no standards on defining the quality of provision, but passengers soon judge the food service provided and sales will indicate its successfulness or not. The provision can be a full buffet car or "at seat" service or trolley service. The score is based on the availability of catering not how it is done. The possibility of a business traveller saving time by having breakfast on the train increases the attractiveness of a train service. Similarly, off peak travellers being able to have a coffee and slice of cake to pass the time all add to the positive rail travel experience.

Scoring Range

4	3	2	1	0
Full - quality hot food & drinks		Hot drinks & snacks		none

Vibration & Rattles - build quality

Description – build quality may be hard to quantify but it easy to access aboard a train in service. When the vehicle is moving it is subject to vibrations and movements and these can cause loose or poor fitting trim to vibrate. If on a stationary vehicle trim quality can be seen by misalignment of panels creating gaps, or panels flexing under normal expected service loads. A high build quality gives the passenger the feel of being in a robust, dependable train which adds to the positive travel experience.

Scoring Range

4	3	2	1	0
none noticeable, trim alligned		small gaps or flexing of trim		panels vibrating, flexing, gaps in trim

Litter bins

Description – passengers being able to deposit their rubbish after finishing with their snack or drink is important to them. Passengers do not want to carry litter with them trying to find a bin on their onward journey, nor do many want just to leave litter for others to put up with as they know how unattractive it is to them to sit in a train with others rubbish around them. Having enough litter bins and them being emptied often enough not to be overfull is a feature valued by passengers.

Scoring Range

4	3	2	1	0
one per saloon / vesti - large enough and emptied regularly		2 per car, not sufficient size		none

Visual ambience

Description – this is one of the few subjective assessments of the tool, but can be done on how the passenger (assessor) feels being in the train interior.

Scoring Range

4	3	2	1	0
Desirable, attractive, pleasant		Tolerable environment		Do not want to be here !

Ease of Access / Egress

Description – getting onto or off a train is an area of travel where passengers feel stress particularly if the train has a short platform dwell time and / or the doorways and aisles are crowded. Making this stage of the journey as simple as possible helps reduce stress and makes the journey experience more attractive to the passenger.

Scoring Range

4	3	2	1	0
numerous, large automatic doors with level entry		restrictions to entrances		entry with steps, narrow doorway, manual handles to open, too few doors per car

Sufficient handholds

Description – this is an assessment of the designated handles or poles for a passenger to use to brace themselves against train movements. Firstly there will be areas of the train floor where handholds are out of reach, but this should be small areas with the vast majority (95%) having coverage. The dimensions are based on ergonomic data for the maximum reach envelope diameter. The 650mm is the maximum reach envelope diameter for a 5 %ile female without her taking any steps, as the dimensions increase then the amount of people who could reach the pole without taking steps decreases until only a 95th %ile male can reach the handholds

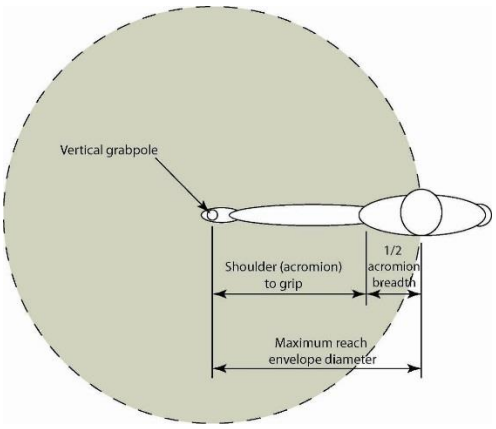

Figure 3 - Method of determining maximum reach envelope

Scoring Range

4	3	2	1	0
designated hand hold within 650mm of 95% of standing area	designated hand hold within 750mm of 95% of standing area	designated hand hold within 800mm of 95% of standing area	designated hand hold within 1000mm of 95% of standing area	no designated hand holds

Lighting level correct

Description – these lux levels are based on the values within EN 12464-1:2011 [9] for the minimum required illuminance defined for various different situations and different tasks. The values being covered give a minimum and a maximum lux value. The minimum value should ensure there is enough light for passengers to carry out their usual tasks when traveling (reading a book, working on laptop, etc). If these are not achieved passengers will struggle to carry out the desired task and the train journey becomes less attractive. The maximum value is given as many people dislike lighting being too bright because it can cause discomfort. Below 150 lux is non-compliant to EN13272 [10] which establishes the minimum requirements of lighting, although this is driven more from a safety than a comfort perspective. Over 500 lux is a very bright operating theatre value, not a lux value to give any kind of comfort.

Scoring Range

4	3	2	1	0
250-325 lux	225-350 lux	200-375 lux	above 450 lux, below 175 lux	above 500lux, below 150 lux

WiFi connectivity

Description – in todays' world being "connected" is seen as essential for many. When those online apps that seem to have touched every facet of our modern day life are off line some people's stress levels rise. The journey time on the train that could have been useful time either as downtime to relax playing games, or doing the daily chores like online banking or grocery shopping, is now seen as wasted time with the passenger anxious to get off the train and restart their day's routine. And this frustrated passenger is more likely to find other faults with train travel they would have never thought had they been distracted by their online devices.

Scoring Range

4	3	2	1	0
full, seamless free wifi		patchy, slow, subscription wifi		none

Cleanliness

Description – cleanliness of the trains or more the lack of it is a very important feature for passengers' satisfaction of a train journey, and ranks highly in many of the surveys carried out. The cleaning and maintenance regimes for the interior do contribute to passengers' perceptions but from a design perspective, the ease of cleaning and the likelihood of dirt build-up or staining is

more important, and it this the feature is trying to capture, rather than when in the day the train is assessed. Some stains in carpets etc can be tolerable if they have been treated as well as practicable. Similarly, graffiti damaged parts are unfortunately common on some trains and affect the perception of the normal passenger. Untreated old graffiti is not acceptable as it implies a lack of maintenance. Parts showing signs of graffiti removal, as long done by using an appropriate process, should not be penalised with a low score when assessing the attractiveness of a train service.

Scoring Range

4	3	2	1	0
No litter, no stains, no grafitti, clean interior		Clean interior but with some treated stains visible		residual litter or embedded dirt, stains / liquids pools

Information systems – static

Description – access to correct information is very important to passengers. It has been split into 2 areas static and dynamic. Static are the signs / labels that are permanent or non-changing giving passengers' journey or safety information. Dynamic is the info that can be altered or updated given a specific need during a journey. TSI PRM [6] helps define how and what information is displayed on a train.

Scoring Range

4	3	2	1	0
clear, distinct info for route and vehicle		few labels using text only	unclear meanings, hard to read	none

Information systems – dynamic

Description – on a recent rail survey not knowing the train was going to be late was the number one complaint, even higher that the train actually being late which was second. Getting up to date, correct information is very important to passengers, and there should be audible announcements or updating display screens to inform passengers quickly should there be an issue.

Scoring Range

4	3	2	1	0
clear, distinct updated info for route and vehicle		only audio or visio info updated infrequently	poor quality audio, excessive or intrusive audio, not updated visio info	none

Security / feeling safe

Description – this feature is also subjective as it depends on the passenger's emotional response to their surroundings and the perception of their surroundings. Safety and security are important aspects to a person's feeling of well-being, particularly if the environment is unfamiliar. Certain

security aspects are out of the hands of the train industry, such as the recent terrorist attacks on mass transit systems, but trying to allay travellers' fears can still be done with good design and train operating practices.

Scoring Range

4	3	2	1	0
Feel secure and safe, help easily contactable, fast response expected, staff visible		Help contactable but not easily, unsure of response		No visible security or monitoring visible, no staff to help

3. NEED FOR SCORING METRIC TO BE ADAPTABLE

3.1 DIFFERENT TRAIN JOURNEY TYPES

Trains have different journey types or missions and the importance to their passengers of certain features also varies. Some will remain constant at a high (or low) importance while others will vary depending on the mission type. The table below gives the 24 comfort features with their weighting which varies for the 4 main journey types: metro, commuter, regional and intercity.

	Metros	Commuter	Regional	Intercity
Noise - standstill	0.8	0.5	0.4	0.4
Noise - service speed	0.8	0.9	1	1
Ride	1	1	1	1
Seat comfort	0.5	0.8	1	1
Seat Legroom - seat for std seats (not PRM seats)	0.6	0.8	1	1
Seat -window alignment	0.3	0.6	0.7	0.8
Seat - airline / bay ratio	0.2	0.4	0.5	0.5
Seat armrests	0.1	0.3	0.5	1
Air management	0.8	0.8	0.8	0.8
Luggage storage provision and visibility	0.1	0.3	0.5	0.8
Toilets - provision	0	0.2	0.8	0.8
Toilets - cleanliness and functioning	0	0.8	0.8	0.8
Catering	0	0	0.5	0.7
Vibration & rattles - build quality	1	1	1	1
Litter bins	0	0.2	0.4	0.4
Visual ambience	0.7	0.7	0.7	0.7
Ease of access / egress	1	1	0.6	0.6
Sufficient handholds	1	1	0.2	0.1
Lighting level correct	0.7	0.7	0.7	0.7
WiFi connectivity	0.3	0.4	0.7	1
Cleanliness	0.4	0.5	0.7	0.8
Information systems - static	1	1	0.8	0.6
Information systems - dynamic	0.8	0.8	0.8	0.7
Security / feel safe ?	0.6	0.6	0.6	0.6

Figure 4 – Weighting of comfort features for different train types

As can be seen, many of the 24 features have a stable (and usually high) importance across the 4 different train types. These constant comfort features are:

- Noise - Service Speed;
- Ride;
- Air management;
- Vibration & Rattles - build quality;
- Visual ambience;
- Lighting level correct;
- Information systems – dynamic;
- Security / feel safe?

Certain features are more important on trains with a longer journey times. These higher speed journeys will tend to have more expensive ticket prices and therefore a higher comfort expectation.

- Seat comfort;
- Seat Legroom - seat for std seats (not PRM seats);
- Seat -window alignment;
- Seat - Airline bay ratio;
- Seat armrests;
- Luggage storage provision and Visibility;
- Toilets – provision; Toilets - cleanliness and functioning[*1];
- Catering; Litter bins;
- WiFi connectivity;
- Cleanliness

[*1] = Toilets - cleanliness and functioning; is important on ALL builds where toilets are provided, but toilets are not a feature required for metros and commuters hence their classification here.

Likewise there are certain features that are more important on mass transit trains. These typically have shorter journey times and are really designed to move a lot of people in a short a time as possible, and often comfort expectations and required features are different

- Noise – Standstill;
- Ease of Access / Egress;
- Sufficient handholds;
- Information systems - static

The weighting of these features for each of the train types is probably the area most likely to be debated in the scoring metric. The scores chosen have been discussed within the group and also validated by an independent reviewer. These weighting values are subjective and could be debated again with whichever group will use the tool, but the values is not what is important it is that there is a clear and simple metric that makes a quantified comparison between train interiors. The aim of the weightings is simply to moderate the scores so that a good metro achieves a similar score to a comparable good regional train.

3.2 CUSTOMISATION POSSIBILITIES AND LIMITATIONS

As previously stated the scoring metric can be adapted to suit the type of traffic. If a specific region / country wanted to customize the scoring metric to for example remove a feature from the scores, this could happen but it would not be recommended. The purpose of the metric is to allow comparison, if the scoring system has been altered then that direct comparison link has been lost, so the pool for comparison is smaller without getting biased results.

Removing a comfort feature from the metric does not mean the customers on those trains will not place a value against having that feature. Those passengers would still desire to have that feature, and the train would lose some attractiveness related to that feature in comparison to other trains or modes of transport. Ignoring a feature by not considering it, does not mean it does not have a value in passengers' eyes.

Likewise the opposite can be true if adding a new feature. New trends in passengers' expectations are unpredictable and evolve quickly. For example, the perceived need to be continuously online has grown from a dream to a luxury to an essential requirement over a timescale shorter than some rolling stock development projects. To ensure that features are only included when they have a value to the customer, additions to the metric should be based on passenger survey evidence rather than attempting to follow fashion.

4. SCORING METRIC TOOL

4.1 DESCRIPTION OF TOOL.

As previously described there is a list of 24 features to be evaluated to create a value for a vehicle's attractiveness and comfort to a passenger. Each of these features are scored on a scale of 0 to 4 by the assessor. Zero was chosen for the lowest band as a feature reaching this level is at an intolerable or unacceptable level for each feature. Taking for example the lighting levels, where to score 0 means the lighting levels is above 500 lux or below 150 lux. Being below 150 lux means that the train is below the level set as a minimum in the EN13272 [10], so if the train is on a TSI network it would need to reach this level to be compliant. Of course some trains are on separate networks so do not have to follow TSI and ENs, but below 150 lux is a really poorly light room not suitable for transporting people in safety so a zero is a valid score. For having an excessive lighting level we have put a limit of over 500 lux, this is a judgement call as 500 lux is a very bright intense lighting level which would cause discomfort to most passengers, hence it scores zero also.

Lighting Levels Correct - Scoring Range

4	3	2	1	0
250-325 lux	225-350 lux	200-375 lux	above 450 lux, below 175 lux	above 500lux, below 150 lux

Likewise to score a maximum 4 a judgement call again was made on selecting the optimum range of lighting levels for most passengers to carry out the tasks that they would expect or desire to do during a train trip, like read the newspaper or text on phone. The values chosen correlate back to EN12464 [9] values for similar tasks and relate to there being adequate light to see relatively small detail without being too high creating issues with glare off surfaces.

All the other features follow a similar logic where a 0 score is an intolerable or non-compliant position, and ranges to a 4 being a desirable and optimal position. Some of the scales are based on ergonomic data and best practices for passenger comfort. Other features are based on the availability of a feature. Whilst a few of the features have subjective scales based on an assessor's opinion, the impact of the subjective scores has been limited by the other objective measures.

Most of the scoring scales are very self-explanatory and after only a couple of uses a person the user will soon would be able to score any train interior with just a couple of few basic hand held tools (tape measure; lux meter; dBA meter and a ride meter). It may also be possible to use which can even be an applications on modern smart phones rather than expensive, and sensitive laboratory equipment.

5. LIMITATIONS OF TOOL

5.1 DESCRIPTION OF WORK AND METHODOLOGY USED FOR THE STUDY.

To use this metric to score a train interior an assessor will need to ride the target train in service. Some of the features could be assessed remotely but some scoring is only possible on the actual train in motion or stationary at a platform. Due to potential fluctuation in the values across a vehicle it is recommended to assess a vehicle at 3 different points to get an average reading for most features. To try to balance the readings it is recommended to assess the following areas:

1. Middle of central saloon seating area
2. Seated area at the inter end nearest to gangway
3. Seat in saloon closest to doorway

These 3 locations should give a good average for the car. If the train has different car types which are significantly different in terms of passenger features, such as a first class car then these cars should be assessed separately so the train would get 2 scores. One for the standard class and one for the first class cars.

There are some exceptions to using these 3 locations, where specific details should be applied in obtaining the measurement. Most of them are covered by conducting a walk-through inspection of the interior, looking for the features or lack of them. These exceptions, including the walk through inspection ones, are listed below:

- Seat comfort – need to ensure that the seats at the three locations are the typical seat for the train (i.e. the assessment should not be done on a tip up or perch seat or similar).
- Seat Legroom – should be assessed on the worse case seat pitch on the train. A quick walk through with a tape measure would quickly discover this location for both in line and bay configurations. If all seat pitches are typical then location is less important. But care should be taken if using the location 3 position, as seats located here are often priority seats and subject to TSI PRM [6] dimensional constraints, so are often different pitch to standard seats.
- Seat - window alignment - should be assessed on a walk-through of the train
- Seat - airline / bay ratio - should be assessed on a walk-through of the train
- Luggage storage provision and visibility - should be assessed on a walk-through of the train

- Toilets – provision - should be assessed on a walk-through of the train
- Catering – should be assessed by asking member of staff or seeing if there are any catering facilities on walk-through.
- Vibration & rattles - build quality – alignment of panels and general feel of the quality assessed on walk-through, rattles assessed at locations.
- Litter bins - should be assessed on a walk-through of the train
- Ease of access / egress – assessed as enter the train
- Sufficient handholds - should be assessed on a walk-through of the train
- Cleanliness - should be assessed on a walk-through of the train

There will be a need for the assessor to have some hand held measuring equipment to be able to accurately quantify the results. To measure the noise dBA values a basic hand held device will be needed to measure the noise on a static train at the station and a train running at normal top speed. The basic hand held device will give an accurate enough reading for the assessment, there will be no need for the vast array of acoustic equipment often seen when measuring noise. Absolute accuracy of dBA values is not important here, instead it is the usability and repeatability of the measurements that matters.

Measuring the ride again requires a hand held device to give a NMV value. Specialist measuring devices are available although during the studies there have been some smart phone apps to measure ride released. These were targeted for bus market but could easily be transferred to rail applications, although this was not done during this study.

A basic digital thermometer would measure the temperature for the “Air management” metric. A light meter to measure the lux value would also be needed, although with experience an assessor could get to a stage of putting the train in the correct scoring band by visual assessment without an accurate lux meter reading.

The final piece of equipment and probably most heavily used, apart from note book and pen, would be a tape measure for the legroom and handhold assessments

5.2 THE WEAK LINK IN THE SCORING METRIC.

As with every tool or process there is a weak link or place where there could be a problem in its accurate implementation. With this tool the weak point or potential area for issues is the assessors themselves. At present it is unclear who or where these assessors would be employed by. They should be independent of the TOC’s, as the public is sceptical about companies making claims about improving their lives, when often they experience the opposite in their daily routine. Independence would give the assessors credibility.

The assessing group could be at either European or national level. Both have advantages and drawbacks and the grouping will probably depend on the funding route. A national groups could be run from a government’s transportation ministry similar to Transport Focus who conduct the UK National Rail Passenger Survey twice a year. This is an independent body with good connections to government. Such an arrangement would probably be a good way to trial this attractiveness and comfort assessment tool.

Conducting attractiveness and comfort assessments would require a relatively trivial amount of funding in the context of the overall spend on rail travel. Nevertheless finding a sponsor is essential and may prove difficult under current financial constraints.

6. THE SCORING METRIC TABLE

The scoring tool is a simple excel sheet as shown below, with another sheet for the weighting per train type. It would be possible to develop it into a more user friendly template or even a smart phone app, where the assessor selects the scores for each feature from a "pull down menu". The full metric for the 24 comfort features as described in detail in section 2 is shown below:

	4	3	2	1	0
Noise - standstill	under 60 dBA	under 63 dBA	under 66 dBA	under70 dBA	over 70 dBA
Noise - service speed	under 65 dBA	under 68 dBA	under72 dBA	under75 dBA	over 82 dBA
Ride	under 1.5 NMV	1.5-2.4 NMV	2.5-3.5 NMV	3.6-4.5 NMV	over 4.5 NMV
Seat comfort	No discomfort felt over complete journey time	Discomfort felt after 95% of complete journey time	Discomfort felt after 85% of complete journey time	Discomfort felt after 75% of complete journey time	Discomfort felt after less than 50% of complete journey time
Seat Legroom - seat for std seats (not PRM seats)	airline over 800mm bay over 1650mm	airline 800 - 750mm bay 1650 - 1540mm	airline 750 - 720mm bay 1540 - 1480mm	airline 720 - 683mm bay 1480 - 1416mm	airline under 683mm bay under 1416mm
Seat -window alignment	All seats aligned		Deadlights in no bays, maximum 6 airline seats without clear window access		Deadlights in all bays, more than 70% airline without clear window access
Seat - airline / bay ratio	Over 50% seating in bays		2 bays per car		no bays
Seat armrests	all seats, padded, correct width and height	all seats, unpadded, too narrow but correct height	all seats, unpadded, wrong height	some seats, unpadded, fixed position, too narrow or wrong height	none fitted
Air management	22-23 C constant, no draughts		20-25 C, with draughts for standees		Under 18 or over 28C, with draughts at seats
Luggage storage provision and visibility	Racks & Stacks -all visible		racks only, stacks unseen,	partial coverage of racks only	none
Toilets - provision	one per car	one per 2 cars	one per train		none
Toilets - cleanliness and functioning	clean, fully functioning and easy to use. No smell inside or outside cubicle		difficult to use, mild smell inside cubicle		out of service, broken, intrusion smell in saloon
Catering	Full - quality hot food & drinks		Hot drinks & snacks		none
Vibration & rattles - build quality	none noticeable, trim alligned		small gaps or flexing of trim		panels vibrating, flexing, gaps in trim
Litter bins	one per saloon / vesti - large enough and emptied regularly		2 per car, not sufficient size		none
Visual ambience	Desirable, attractive, pleasant		Tolerable environment		Do not want to be here !
Ease of access / egress	numerous, large automatic doors with level entry		restrictions to entrances		entry with steps, narrow doorway, manual handles to open, too few doors per car
Sufficient handholds	designated hand hold within 650mm of 95% of standing area	designated hand hold within 750mm of 95% of standing area	designated hand hold within 800mm of 95% of standing area	designated hand hold within 1000mm of 95% of standing area	no designated hand holds
Lighting level correct	250-325 lux	225-350 lux	200-375 lux	above 450 lux, below 175 lux	above 500lux, below 150 lux
WiFi connectivity	full, seamless free wifi		patchy, slow, subscription wifi		none
Cleanliness	No litter, no stains, no grafitti, clean interior		Clean interior but with some treated stains visible		residual litter or embedded dirt, stains / liquids pools
Information systems - static	clear, distinct info for route and vehicle		few labels using text only	unclear meanings, hard to read	none
Information systems - dynamic	clear, distinct updated info for route and vehicle		only audio or visio info updated infrequently	poor quality audio, excessive or intrusive audio, not updated visio info	none
Security / feel safe ?	Feel secure and safe, help easily contactable, fast response expected, staff visible		Help contactable but not easily, unsure of response		No visible security or monitoring visible, no staff to help

Figure 5 – The scoring metric

7. CONCLUSIONS AND FUTURE OPPORTUNITIES

A scoring metric to assess the attractiveness and comfort of train interiors has been developed from a similar scoring tool used for many UK train fleets and a few European ones. This version built on that original idea by adding several other features from the research delivered in tasks 6.1 to 6.5 [1, 2, 3, 4, 5]. These features were found to be relevant to the comfort and attractiveness of a train interior.

The work attempted to make the comparative assessment as quantifiable as possible by allocating measurable ergonomic measures against which it is possible to make an objective assessment. The scoring ranges to zero to 4, so that an unsatisfactory feature scores zero rather than a low value.

It also introduced the idea of weighting the comfort features differently for the four different types of train service – metro, commuter, regional and intercity. The absolute values for the scoring metric or weighting applied for the different train types is less important than the comparative results for two different train interiors. Some aspects of the metric and associated weighting is inevitably subjective and will change as passenger desires evolve.

This tool allows the rail industry and its passengers to quantify and compare the comfort and attractiveness of different trains. By conducting a quantitative assessment, such requirements stop being a “soft” requirement and become ‘hard” requirement, and make it is easier to attribute a monetary value.

This scoring metric alone will not increase the passenger orientation of train interior designs but its successful deployment would demonstrate a positive attitude within the industry. Some further improvement is possible further work should focus on ensuring the validity of the data assumptions behind the scoring allocations. The goal is to support the creation of league tables for the comfort and attractiveness of interiors. This will lead to Push / Pull factors for improved interiors which will get stronger the more league tables get publicised. Once the league table of scores is widely recognised and valued, it will ensure the scores are important to operators, and they will place a “hard” value on attractive / comfortable train interiors. Having such a comfort score empowers passengers and gives data to the rail industry to support its business decisions.

The main Pull factor would be from the creation of league tables to drive competition amongst the TOCs to improve customer comfort. Gaining the title of most comfortable train in a particular category might be a great marketing tool to draw in extra passengers, demonstrate value for money and win franchises or routes from governments. A similar effect may be seen in the “Golden Spanners” awards for maintenance.

Another Pull factor is in comparing rail to other modes of transport for a given journey. Having a comfort score can provide empirical data to attract customers onto the rail network. Similarly, such data may help passengers choose between trains on the same route or assist in justifying the business case for a refurbishment.

Push factors can be very strong, and in the “connected” society we live today pressure for change can come from several sources at the same time. Having a scoring system which drives a “published” league table, would lead to pressure for poor performers to improve. Passengers could see where their train is on the comfort league, and whether passengers on a different route

enjoy better service. They could challenge the value for money of their ticket compared to others and give evidence to explain their dissatisfaction.

Where a train service has a route monopoly there is not likely to be scope for commuters to change their travel choices based on comfort scores. Discretionary travellers however, could migrate to other modes of transport. The scoring tool will not change passenger satisfaction on its own but it can make a quantifiable assessment of a subjective quality. Transparency for all parties can only lead to better satisfaction of the travellers, provided there are proactive actions to sustain or improve the quality of train service provided.

Government or regulatory bodies could set minimum attainment scores on routes both for the initial commissioning but also the long term performance of a service, so they could justify they are accounting for the "voice of the passenger". This would turn the metric's scores into a "hard" Push factor which can be included as a boundary condition early in the design process.

By placing a real tangible value to comfort and attractiveness, the rail industry can become better at "reading" passengers' needs and desires, leading directly better services that more passengers want to use, more often. Which is where everyone in the rail industry should want to be as happy passengers, travel more often and spend more money, so a win win for all in the industry.

8. REFERENCES

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