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What's in a railway station? Developing a scientific model for sustainable railway stations of the future

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Railway stations as sustainability promoters



- Key role of railway stations for rail transportation to become an attractive means of mobility in everyday life
- Unique position of stations in the urban environment, provision of integration between different transport networks and physical urban spaces – "gate" for transit-oriented development (TOD) (Otsuka & Reeve, 2023; Pucci, 2019)
- However: Stations fall in the gap between transport and urban agendas, as well as diverging responsibilities, being overlooked by planners and policymakers (Lunardon et al. 2023)

But... why?

To date, no cohesive model for railway stations that

- Looks at stations as promoters of sustainable mobility
- Identifies context-specific transformation pathways
- Is highly applicable for different stakeholders

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Methodological approach for literature review









Methodological approach for literature review



- European geographical context
- Publications had to include a classification system which can be/is applied to more than N=1 railway stations and/or catchment areas
- Only passenger stations
- No classification methodologies originating from railway companies aiming to be used in internal operations









- Railway type where the classification approach was tested
- Goal of the classification approach
- Possible connection to the Node-Place model (if any)
- Method of the station classification
- Classification criteria
- Subject of classification and catchment area
- Number of stations of the classification case study
- Location of the case study
- Number and naming of the resulting categories/classes
- Use of spatial graphical representation methods within the classification approach/case study







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Characteristics examined

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Classification approach

Case study application characteristics







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- Duality of either node and/or place characteristics
 From 700m (Bertolini, 1999) to 25 km (Marti-Henneberg, 2015)
 Comparison of diferent catchment areas - Isochrones or fixed radius
- Number and naming of the resulting categories classes
- Use of spatial graphical representation methods within the classification approach/case study







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- Mostly quantitative criteria
- Criteria about station as a transport hub or about station context

						Marti-					Stoilova and						Wenner and	I	Borghetti et al.		Soczówka Kruszyna				
	Bertolini 1999	Reusser e 2008	etal Zempeta 2011	 Ivan et al. 2012 	Papa et al. 2013	Henneberg 2015	Vale 2015	Vale et al. 2018	Pucci 2019 (node plac	9 Pucci 2019 (TOD)	Havlena et al. 2014	Nikolova 2016	Monzon et al. 2016	Caset et al. 2018	Nigro et al. 2019	Wenner et al. 2020	Thierstein 2021	Borghetti et al. 2021	2021 (relationship)	Eichhorn et al. 2021	and Żochowska	and Makuch 2023	Pazzini et al 2023	Panzaru and Aun 2023	Ross 2000
1. Train services and transport network	×	x				x	x	x	x		x			x	x										
Type of train services		x	х						x		x						х								
daily frequency of train services / number of stopping trains	x	x		х			×	x	х		х			x	x					x					
amount of stations within 20/45 minutes of train travel Passenger frequency (incl. comparison between weekdays and weekends)	х	x	х				x	x	x			×	×	x											
travelled passenger - kilometers												x													
closeness/betweenness centrality/shortest distance between nodes					×									х											
international travel possibilities gravitational accesibility																x								x	
utilization of transit services										х															
More than one railway companies																								x	
Detays/waiting times																								x	
2. Station characteristics																									
Services/ facilities/staffing at the station		x											×		x							×		x	
functional types																									x
number of foster starting tracks cash												x													
Station construction cost																	х								
3. Intermodality																									
number of directions by bus, tram, underground (not necessarily all three) / existence of these t	in x	x	v				x	x	х				×	x	x					x		х			
accesibility of bus/tram/metro stop/car parking	^	^	~	^			^	^						^	x			x		^		×			
distance from the closest motorway access	х	х					х	х						х											
car parking (capacity) / P + R	x						х	х	x					x	х					х		х			
eneric importance of station as public transport change node/station accesibility	x								x		x	x		x			x					x			
presence of car/bike/ride sharing service/EV charging points														х				х						x	
distance travelled by passengers from the station										×		x													
car dependency to reach the station										×															
1. Mobility infrastructure/streetscape																									
bicycle (paths) infrastructure	х	х												х	х								х		
length, traffic, intersection density and other characteristics of roads within catchment area							u.	x						x	x					v		×			
number of HSR stations in the area							*	x							*		х			~					
2. Demographics number of residents in the area / population density	x	×	x	×	×	x	×	x		×	x	×		x	x	x	x			×					
Rate of unemployed with basic education				x																					
Number of students									х			х			х										
number of senior citizens Average distance to jobs and residents / Number of population reachable in a given time			x									x								x					
 Economy number of workers (or jobs) per each of four economic clusters (not necessarily in all) 	×	x	x	×	×		x	x	x			×		x	x										
Income factors (purchase power parity (PPP) / average wage)						х						x													
number of firms			v								v					x									
station surroundigs as a tourist of recreational target? Arriving tourists per 2000 residents			~								^														
4. Functional mix																									
Surface/presence/distance of POIs industrial activities/commercial & tertiary activities/service	* es or educatio	x onax					x	x	x		x	x	x	*		x		x	x	X	x	x			
Proportion of services to trains										x															
Number of flats / residential buildings																									
5. Relation to centrality and centrality characteristics																									
distance to town centre / location in comparison to city/cities		х				х							×				х					х			
Core urban area (Built-up area) / Building density Area of nearby town				x						×		x													
characteristics of nearby centrality (e.g. main station of regional centre district/administrative	center)		x									x													
C Proticipanying				×					х												х				
o. Spanar pranning Integrated development plan													×												
Land prices/development costs				x																x					
Densification/new building potential/Transformability										x						х				x					
Presence of protected areas										×															
7. Other																v									
The surplus or deficit of local place value compared to accessibility. The surplus or deficit of local population size compared to jobs and facilities																x x									
Accessibility Change (2019–2028)																x									



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- Basis for the transit-oriented development of station areas
- Integration between land-use and transport
- Urban design scale (e.g. integration between transportation accessibility)
- Develop/complement a classification method (e.g. add pedestrian friendliness)
- Specify requirements for station equipment/services
- Specific goals (e.g. bicycle and train intermodality, station and 15-minute city)
- Use of spatial graphical representation methods within the classification approach/case study







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- Type of train (stations) mostly not defined
- HSR specific studies (e.g. Wenner & Thierstein, 2021)
- Suburban train specific studies (e.g. Pucci, 2019)
- Regional train specific studies (Caset et al., 2018)
 - Integrating other means of mobility (e.g. ferry stops, Vale, 2015)
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Mostly urban regions
Varying from all stations in a country (e.g. Reusser et al. 2008) to 4 selected stations in a region (Borghetti, Longo, et al., 2021)

- Comparing stations and/or areas in the European context (e.g. (Wenner & Thierstein, 2021)







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(Some) results

- Challenges of conceptualizing a model for railway stations, which is applicable in a variety of situations
- No uniform naming of "classification" approaches -> challenge for the identification of relevant papers
- Limitations of solely quantitative description of station contexts
- Importance of urban design and built environment of catchment area
- Different goals of classification call for different and specific criteria
- Limited/no application of academic classification systems by railway companies and/or other stakeholders







Railway station (draft) model









Railway station (draft) model









THANK YOU FOR YOUR ATTENTION



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