Parallel Session 8 – Station Management & Financing

New Approach to Classification of Railway Stations

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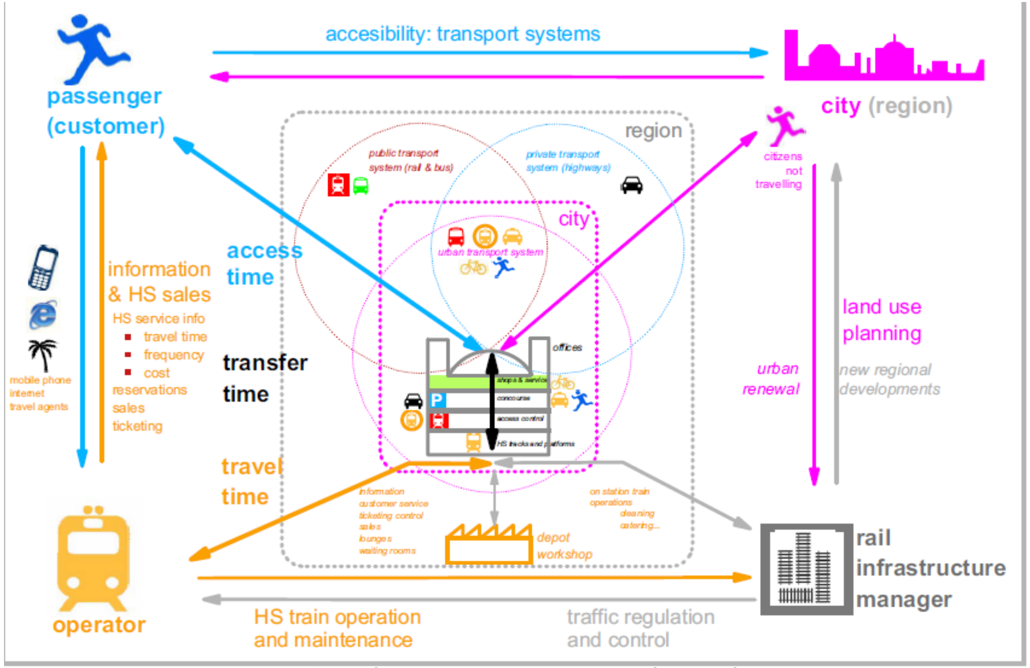
Brief overview of this research

- Why classification of stations
- Current approach
- Challenges of the current approach
- Proposed methodology to classify stations



Importance of stations

(UIC, 2010)

Why classification of stations?

- Stations vary in size, number of passengers that use them, number of platforms, etc. …

- Better management of them
- Allocation of resources
- Standardization of procedures
- …

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Current Approach

180

Classification of Rail Passenger Stations

Format : Paper document

Ed. no.1 , February 2015

EN

Product information

Contact

5 criteria for categorizing railway stations:

1. Attendance (passengers per day)
2. Number of trains per day
3. Number of platforms
4. Station area (square meter)
5. Intermodality

Criterion no.1

Total number of passengers using a train per working day

• A< 400 persons	K (A)=1
• 400 <= A< 7 500	K (A)=2
• 7500 <= A< 20 000	K (A)= 3
• 20000 <=A < 200 000	K (A)= 4
• A > 200 000	K (A) = 5

(UIC, 2015)

Final score

- Thresholds for each criterion
- Weights are given to each criterion
- sum of the values of all 5 criteria yields a total score of C
- Based on the value of C stations are classified into class A, B, C, D or E

Challenges of the current approach

One size does not fit all!!!

- Japan 9 billion railway passengers
- India 8 billion
- Germany 2 billion
- China 1.7 billion
- France 1.2 billion
- ….

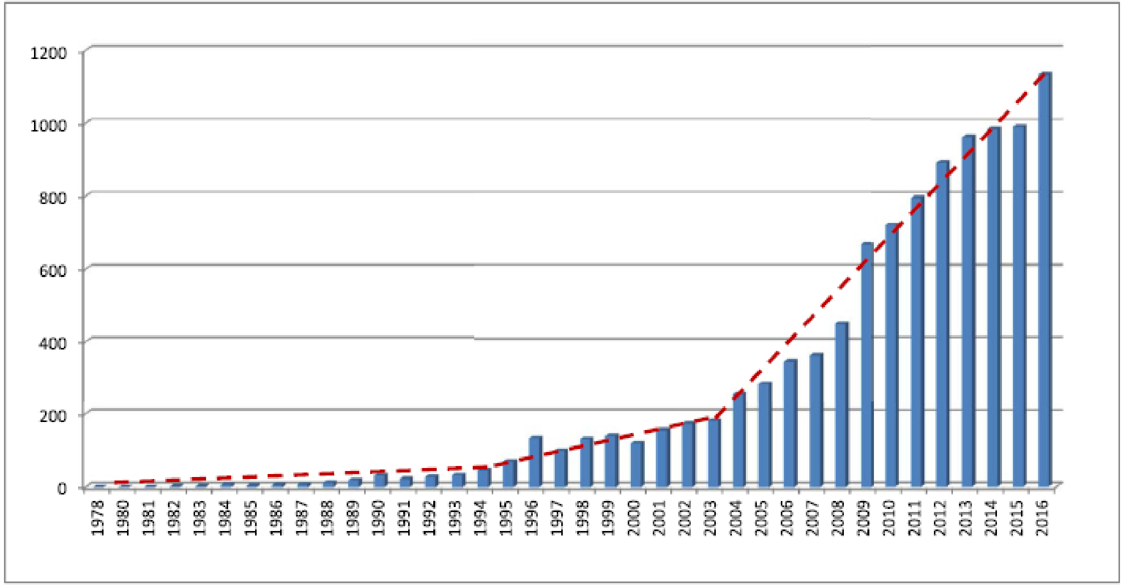
Some railways transport less than 50 million passenger per year (such as Bulgaria, Sweden, Finland and Iran)

(UIC, 2019)

Index Number Problem

- “complex that is made up of individual measurements for which no common physical unit exists” (Frisch, 1936)

- Data envelopment analysis is a method that can measure relative efficiency



Number of papers published using DEA

(Emrouznejad and Yang, 2018)

DEA Model

$$\max h_o = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}}$$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \qquad j = 1, \ldots, n$$

$$u_r, v_i \geq \varepsilon \qquad r = 1, \ldots, s \qquad i = 1, \ldots, m$$

h_o = efficiency of the unit under assessment

u_r = weight given to output r

y_{ro} = amount of output r for unit under assessment

v_i = weight given to input i

x_{io} = amount of input i for unit under assessment

g_o = efficiency of the unit under assessment

ω_i = weight given to input i in the linear model

μ_r = weight given to output r in the linear model

(Charnes et al., 1978)

Some of DEA applications in railways

Study	Sample	Inputs	Outputs
(Oum and Yu, 1994)	19 railways in Europe and Japan	Staff; energy consumption; rolling stock	Passenger-km; freight-tonne-km
(Coelli and Perelman, 1999,Coelli and Perelman, 2000)	17 European railways 1988-1993	Staff; rolling stock; track length	Passenger-km; freight-tonne-km
(Cantos et al., 2002)	17 European railways 1970-1995	Operating cost; track-km	Passenger-km; freight-tonne-km
(Growitsch and Wetzel, 2009)	54 railways in 27 countries 2000-2004	Staff; rolling stock; track-km; operating expenditure	Train-km; passenger-km; freight-tonne-km
(Driessen et al., 2006)	14 European railways 1990-2001	Staff; track length; rolling stock	Passenger-km; freight-tonne-km
(Cantos et al., 2010)	16 European rail systems 1985-2004	Staff; rolling stock (Passenger vs. freight); network length	Passenger-km; freight-tonne-km
(Merkert et al., 2010)	43 Swedish, German and British train operating firms	Material (Annual amount spent on operation including depreciation and rolling stock lease costs but excluding all staff costs); total staff	Train-km
		Material; managerial and administrative staff; the remaining production staff	Train-km; passenger-km
		Material; managerial and administrative staff; the remaining production staff	Train-km; Tonne-km

(Merkert et al., 2010) (Khadem Sameni and Kashi Mansouri , 2017)

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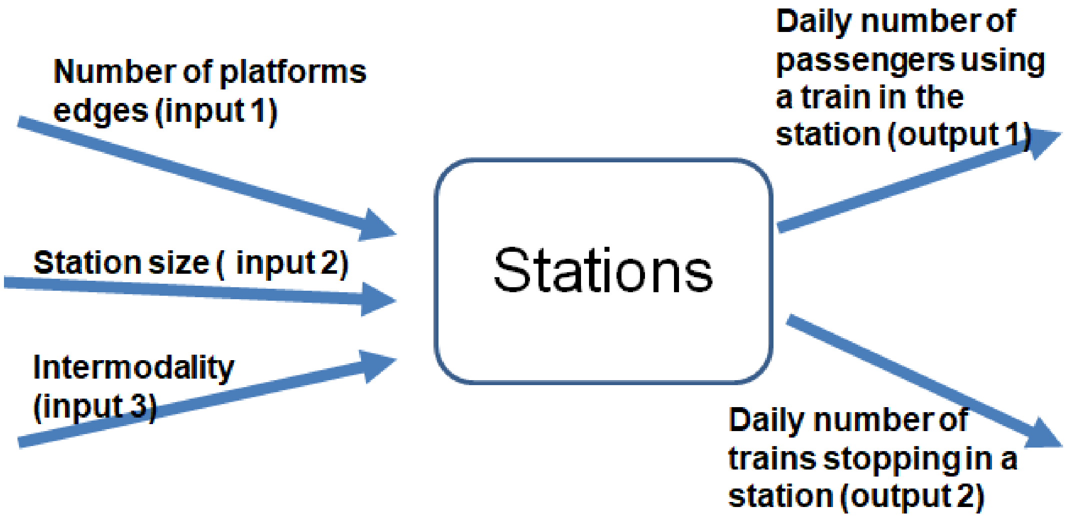

Proposed DEA Model

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Case Study: Major stations in Iran

- Decision Making Unit (DMU)

Abbreviation signs	Full name
DMU 1	Tehran
DMU 2	Mashhad
DMU 3	Isfahan
DMU 4	Tabriz
DMU 5	Gorgan
DMU 6	Sari
DMU 7	Arak
DMU 8	Qom
DMU 9	Ahvaz
DMU 10	Zahedan
DMU 11	Andimeshk
DMU 12	Tabas
DMU 13	Shahrud
DMU 14	Semnan
DMU 15	Zanjan
DMU 16	Shiraz
DMU 17	Kerman
DMU 18	Bandar Abbas
DMU 19	Yazd

Descriptive statistics of the data

Data was provided by Iranian Railways

	Platform	size	Intermodality	Passenger	Trains
Mean	3.947	1953.892	4.263	4491.058	24.368
Median	3	1,049	4	1,863	11
Standard Dev	3.597	2302.076	0.991	8410.166	40.111
Minimum	1	215	3	403	4
Maximum	14	10,331	7	30,699	169

Results

- Models were solved by output orientation
- Constant return to scale (CRS)
- Variable return to scale (VRS)

DMU	Basic model	
	CRS model	VRS model
Tehran	1	1
Mashhad	1	1
Isfahan	0.175	0.41
Tabriz	0.464	0.667
Gorgan	0.348	1
Sari	0.513	0.528
Arak	0.524	0.624
Qom	1	1
Ahvaz	0.696	1
Zahedan	0.256	0.301
Andimeshk	0.828	1
Tabas	0.663	1
Shahrud	0.56	0.676
Semnan	0.434	0.497
Zanjan	0.637	0.711
Shiraz	0.212	0.243
Kerman	0.629	0.774
Bandar Abbas	0.344	0.492
Yazd	0.653	0.747

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Conclusions

- Fixed thresholds of UIC 180 does not fit for all railways due to huge differences in the volume of their work
- Concept of efficiency of stations seems more promising than classification
- DEA seems to be a promising approach and yielded some good results in the early phases of this research

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Thank you

for your kind attention

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