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RESILIENCE FINDINGS

Did Research Address the Pandemic, Epidemic, or Infectious Risk in Public Transport Scenarios before the COVID-19 Pandemic?

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Findings

The Covid-19 pandemic strongly impacted public transport (lockdowns, distancing measures). The relevance of pre-pandemic transport scenarios is explored by investigating how the epidemic, pandemic, or infectious (EPI) risk was addressed. This review uses a Factor Analysis of Mixed Data (FAMD) to see how EPI risk and health are discussed in transport scenarios and guidance documents. Of the 110 investigated documents (scientific and grey literature), 101 address health, with only 4 addressing the EPI risk comprehensively, 7 mentioning it directly, and 37 mentioning it indirectly. The risk is exclusively addressed as a health issue despite being recognized as a global disruptor.

1. Questions

Through Covid-19 lockdown and distancing measures, transport suffered a historic stop and metamorphosis, quickly raising many questions: will people use public transport in a pandemic context? How will public transport be cleaned? How green is a train conveying one passenger every two seats? Already in 1918, Charles W. Berry, pointed out the importance of sanitation in the navy to avoid infections. Later, public transport was defined as a key driver in the spread of epidemic/pandemic or respiratory infections (Alirol et al. 2011; Colizza et al. 2017). Saunders-Hastings and Krewski (2016) even go as far as stating that 'mobility [...] became the primary vector of disease spread'. Then, the World Energy Council encourages including the Epidemic, Pandemic, or Infectious (EPI) risk in future work, such as scenarios, since 'the world remains poorly prepared to even modest biological threats' (WEC, 2019). Nevertheless, it is not systematically discussed, even in documents addressing transport health. Khreis et al. (2019) forgot to address it in their conceptual model, which describes the health beneficial and detrimental transport factors. Consequently, are pre-Covid-19 transport scenarios still relevant? Is the EPI risk discussed? The apparent unpreparedness of most transport networks during the Covid-19 peak undermines the idea of an appropriate inclusion of the risk in transport predictive studies. Then, the hypothesis is made that, pre-Covid-19, research and transport players poorly addressed the EPI risk in transport future scenarios.

2. Methods

Were considered as scenarios, peer-review, and grey literature documents that detail a vision of future transports (Paez 2017). English and French keywords were used with 17 search engines (Tables 1, 2), representing 334 requests, without time restriction (Gusenbauer and Haddaway 2020). All transport that

Table 1. Systematic review keywords

English	French
future transport	future mobilité
future transports	futur mobilité
future mobility	scénario mobilité
transport scenario	scénarios mobilité
transport scenarios	transport futur
transports scenario	transports futur
transports scenarios	scénario transport
mobility scenario	scénario transports
mobility scenarios	scénarios transport
future transportation	scénarios transports
transportation scenario	
transportation scenarios	

Table 2. Search engines and languages

Engine	Address	EN	FR
BU Library	*internal platform*	X	X
HAL	hal.archives-ouvertes.fr	X	X
Google Scholar	scholar.google.com	X	X
Microsoft Academic	academic.microsoft.com	X	X
CORE	core.ac.uk	X	X
BASE	base-search.net	X	X
Science.gov	science.gov	X	
Semantic Scholar	semanticscholar.org	X	X
Refseek	refseek.com	X	X
Science Direct	sciencedirect.com	X	X
PubMed	pubmed.ncbi.nlm.nih.gov	X	
UN Digital Library	digitallibrary.un.org	X	X
TRID	trid.trb.org	X	X
Google	Google.com *keyword+filetype:pdf*	X	X
ECDC	ecdc.europa.eu/en/publications-data	X	
WHO	through google.com: *keyword+site:who.int filetype:pdf*	X	X
The National Academies	nationalacademies.org	X	

can be shared was considered a form of public transport. Documents discussing transport facilities or providing guidance on transport scenario development were qualified. Field-specific, but still broad, documents were accepted (e.g., transport for the elderly).

All documents were categorised according to whether the EPI risk was addressed, mentioned, indirectly mentioned, or not mentioned (Table 3). Guidance documents and transport scenarios had separate criteria to meet the "addressed" category. A guidance document only needed to mention the EPI risk to be considered to address it, while a scenario document had to propose actions and solutions to be considered to address it. The assumption was made that transport cannot be described as comfortable if it lacks cleanliness. Hence, this review considers the discussion of transport's comfort as an indirect

Table 3. Documents categorization

Addressed	Addresses the EPI risk, offers guidance, proposes solutions
Mentioned	Mentions the EPI risk, without addressing it
Indirectly mentioned	Mentions related issues (cleanliness, comfort, terrorism, overpopulation, etc.)
Not mentioned	The EPI risk is not addressed or mentioned

mention of the EPI risk. With both qualitative and quantitative data, a Factor Analysis of Mixed Data (FAMD), using R, was used to explore the variability of the sample and reveal important features. These include potential factors or patterns fostering the discussion of the EPI risk (Pagès 2004).

3. Findings

The 5 dimensions of the FAMD explain 35.91% of the dataset variation (Figure 3). The scree plot (Figure 1, A) shows that dimensions 1 and 2 explain 19.9% of the variation. Despite being the first variable in dimension 1, the discussion of health in documents is extremely low in dimension 2 (Table 6, Figure 1, C, D). Across the two selected dimensions, entity and type are the most contributing variables (Figure 1, B). Figure 2 shows that the more the number of addressed health topics is high, the more the EPI is likely to be addressed, or at least mentioned.

The EPI is addressed in 4 documents, mentioned in 7, and indirectly mentioned in 37. Exclusively on the global and national scales. Public health strategies are always defined by governments, while inter-governmental institutions coordinate nation interactions on global issues (Alexander 2015; Kickbusch et al. 2013). The EPI risk is discussed as complex to integrate into scenarios. This can explain why it is mostly addressed in grey literature, which remains more flexible on methodology. The discussion around the risk is carried out in two stages. First, documents rely on a past event (e.g., the Black Plague, etc.) before expanding their scope. And to remind us that each pandemic brings new parameters and uncertainties. 'Cleanliness' and 'comfort' are the main references to the EPI risk found among the 37 documents mentioning indirectly the risk.

Health is discussed in 101 documents, with an average of 3.45 health topics discussed per document. The main discussed health topics are those described by Kjellstrom et al. (2003): air pollution, safety, active transport, and noise. Documents addressing or mentioning the EPI risk are among documents that discuss more health topics (respectively 4.00 and 3.57) (Figure 3). The more health topics are addressed, the more the EPI risk will be addressed or mentioned. Documents that mention indirectly the EPI risk explore a smaller range of health topics. Some scenarios provide comprehensive health-related analysis while leaving aside the EPI risk. Over time, the number of health topics discussed increased.

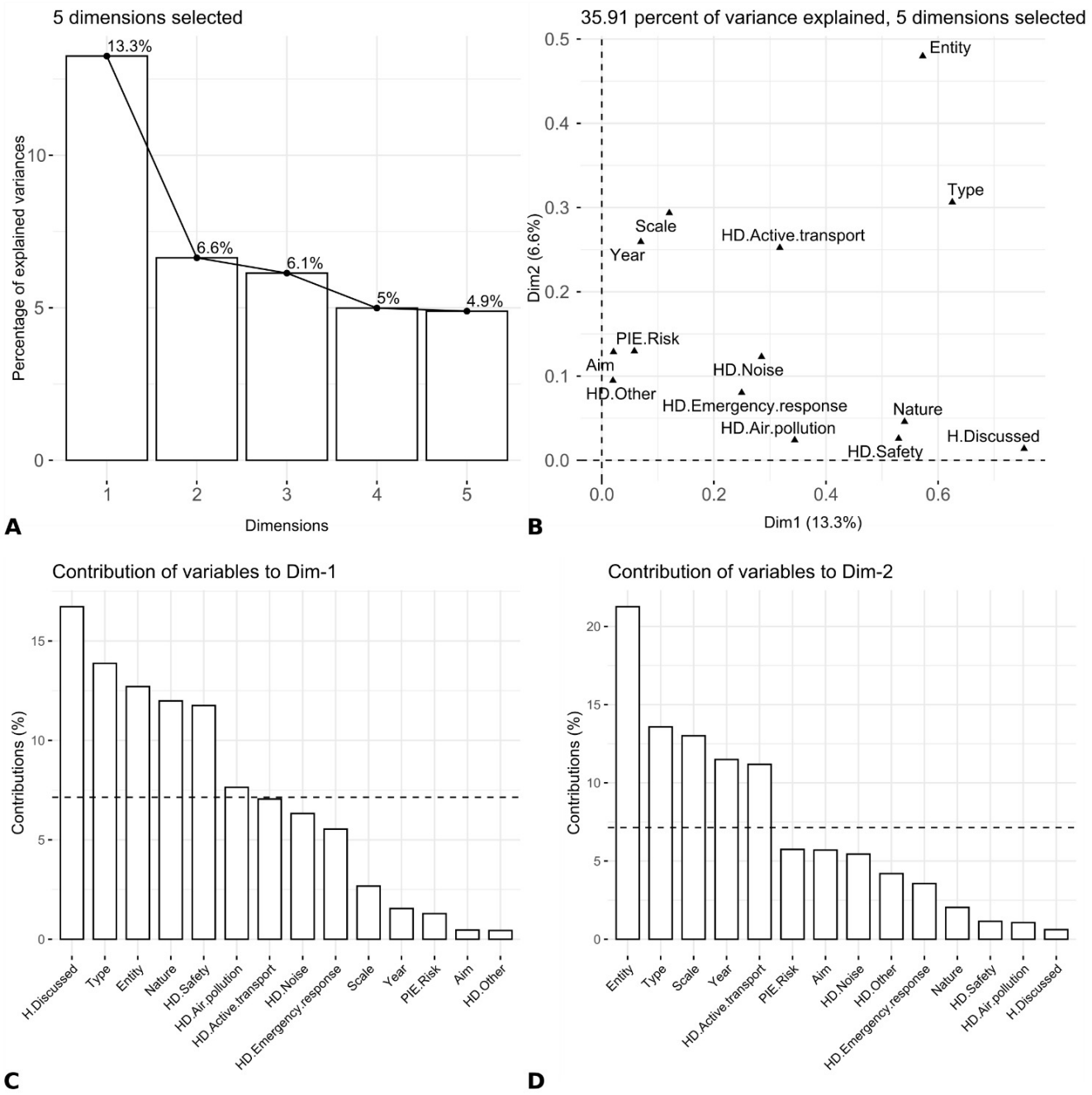

Figure 1. Factor Analysis of Mixed Data: contribution of the variables explaining the most the variation of the dataset.

(A) 5 dimensions scree plot showing the percentage of explained variation per dimension. **(B)** The plot of variables from dimensions 1 and 2. **(C)** Contribution of variables to dimension 1. The dashed line shows the expected average value if the contributions were uniform. **(D)** Contribution of variables to dimension 2. The dashed line shows the expected average value if the contributions were uniform. HD for 'Health Discussed'.

The range of health topics discussed remains context-dependent. Seven documents that aimed to address health in transport provide a poor discussion of the EPI risk. Despite they address more health topics (4.14 on average) than documents discussing transport future through a wider lens. The report 'Health 2020: Transport and Health' (WHO, 2015) is particularly disturbing as it does not mention the EPI risk. That, despite the World Health

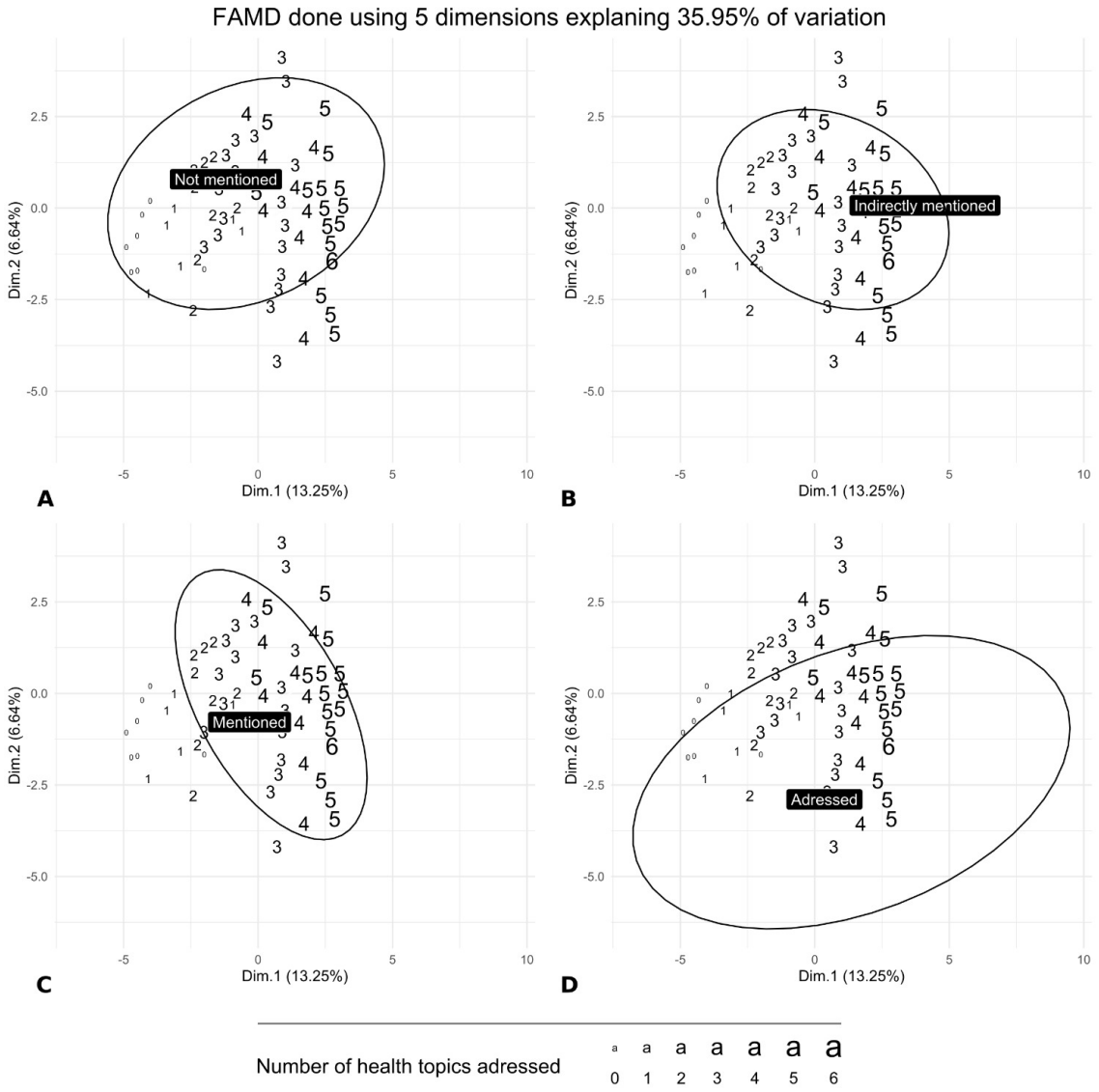

Figure 2. Factor Analysis of Mixed Data: representation of the first two dimensions, in terms of how the EPI risk was discussed, based on the number of health topics addressed.

Displayed values are the number of health topics addressed per document. All four graphs show a multivariate confidence ellipse: **(A)** Documents not mentioning the EPI risk, **(B)** documents mentioning the EPI risk indirectly, **(C)** documents mentioning the EPI risk, and **(D)** documents addressing the EPI risk.

Organisation publishing reports and procedures on pandemic preparedness. With, for example, dedicated web pages on Ebola and zoonotic diseases (WHO, 2020a, 2020b).

The review reveals some transport means are poorly represented. Few or no papers were found addressing future scenarios for maritime passenger transport or lifts. The latter is of critical importance to the EPI risk as they offer a confined space and a control panel touched by all users. Moreover, it is one of the primary shared transport means, with 100 million trips/day only in France (Franceinfo 2016; Fédération des Ascenseurs 2020). In addition, the use of elevators has other health impacts by discouraging the use of stairs (Yang,

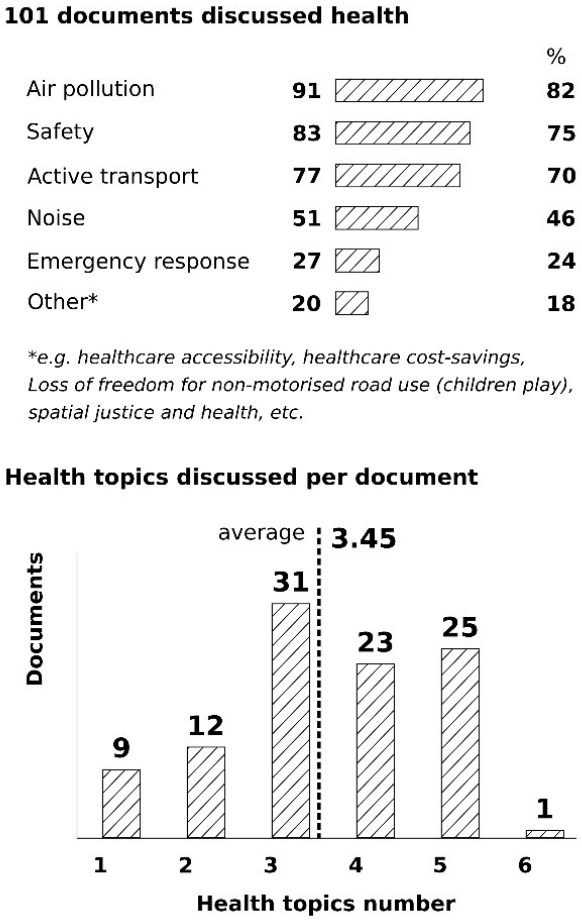

Figure 3. Health topics discussed in reviewed scenarios and guidance documents.

Sun, and Xu 2007). With most pre-Covid documents being now obsolete, the EPI should be considered in future work, like done by, for example, Schultz et al. (2020) and Cieśla et al. (2021).

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