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PRACTICAL INVESTIGATION OF FUTURE PERSPECTIVES AND LIMITATIONS OF MAGLEV TECHNOLOGIES
Results of an International Survey among Transport Experts and Specialists Maglev

With the aim of tracking current trends in the market perspectives of magnetic levitation, or maglev technologies, the non-profit International Maglev Board conducted a primary study in the spring of 2018 among maglev specialists and transportation professionals. More than 1 000 professionals took part in the survey. Main topics of the study are questions comparing the suitability of conventional wheel-on-rail and maglev technologies according to application areas. Predicted opportunities and developments in maglev technology, acceptance issues and research needs are analyzed. The results are broken down by expertise and nationality of the participants. This short version presents selected findings of the survey in compressed form.

Background: There is an obvious need for information on international trends in the application of Maglev transport technologies. The study attempts to grasp the global dimension of magnetic levitation developments in a structured way.

Aim: To track current trends in magnetic levitation transport system innovation. Identify perspectives, research tasks and implementation barriers. Comparison of magnetic levitation systems with steel wheel systems. Analysis of the key topics of the debate.

Methods: Primary study in spring 2018 among 1 058 maglev specialists and transport experts. Internet-based online survey.

Results: The ratings vary greatly according to the expertise and origin of the respondents. In certain fields of application, wheel-rail systems remain the preferred transport technology. But in certain other fields of application, maglev technologies have become preferred over conventional steel-wheel-rail by a majority of transport professionals. This is particularly the case for high-speed maglev transport and for the new application of maglev elevators in buildings. At the same time, many respondents see a continuing need for research.

Conclusion: Overall, there is a differentiated picture. Respondents from North and South America, Russia and Asia are on average particularly open to an implementation of certain maglev technologies.

Keywords: Maglev, wheel-rail systems, urban maglev, high-speed transportation systems, Transrapid, Linear, Chuo maglev, Hyperloop, evaluation, perception, suitability

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1. METHODOLOGY & THEORETICAL APPROACH

The study examines the acceptance and prospects of maglev systems in the transport sector. Basically, the suitability of maglev systems in comparison with conventional wheel-rail systems is considered and differentiated according to different fields of application. Barriers are analyzed and research needs are determined. Overall, a picture of the future suitability of maglev systems is developed from a technical point of view.

The study was funded exclusively from internal funds of a non-profit organization, The International Maglev Board (www.maglevboard.net). There was never any influence of third parties, neither on the research aims nor the evaluation process. It was carried out anonymously and the analysis and evaluation strictly followed well-established scientific standards.

The relevant topic areas for the survey were defined in an expert workshop in the spring of 2018. The primary theoretical foundations were the current standard works on maglev technologies [1, 2] and analyzes of historical development [3]. The survey's 22 questions from 10 question groups were then developed in several further workshops with more experts from the transport sector and maglev technology specialists. Based on the original English version, the study was subsequently translated into German, Chinese and Russian.

The announcement of the survey took place from May of 2018 primarily via the newsletter of the International Maglev Board and via social networks (twitter, Facebook groups, Xing, Linked-in, transport forums on the web). Between May and June 2018, more than a thousand participants (1058) from the transport sector took part in the survey, see Fig. 1.

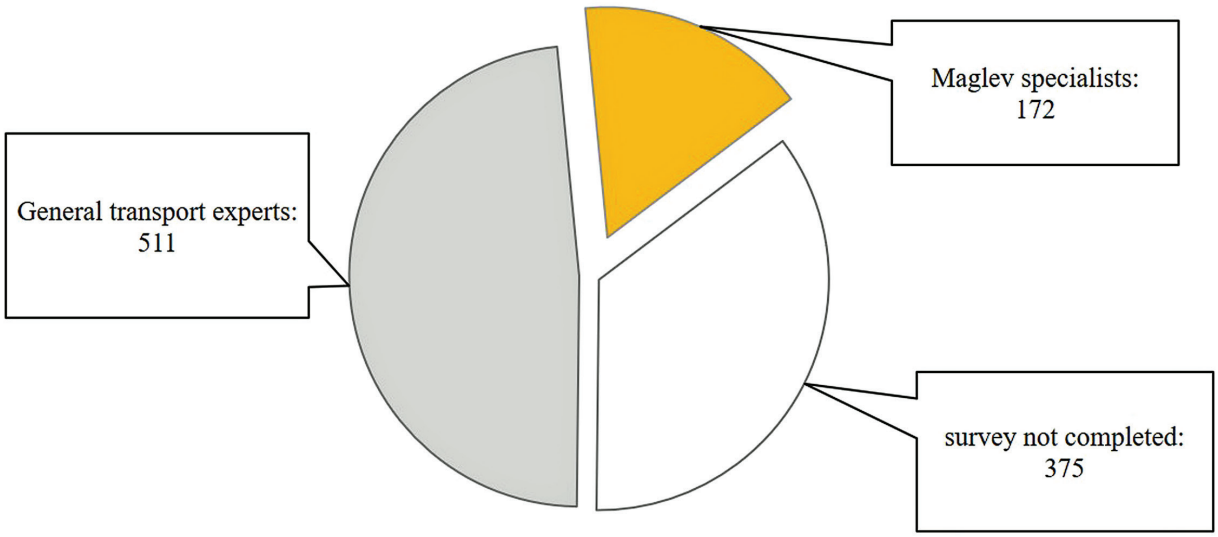

Fig. 1. Participants of the study (Total participants = 1 058; maglev specialists = 172)

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Participants' responses were analyzed on the basis of demographic criteria (country of origin, age) as well as on the basis of their respective knowledge about maglev technology (maglev specialist / general transport experts).

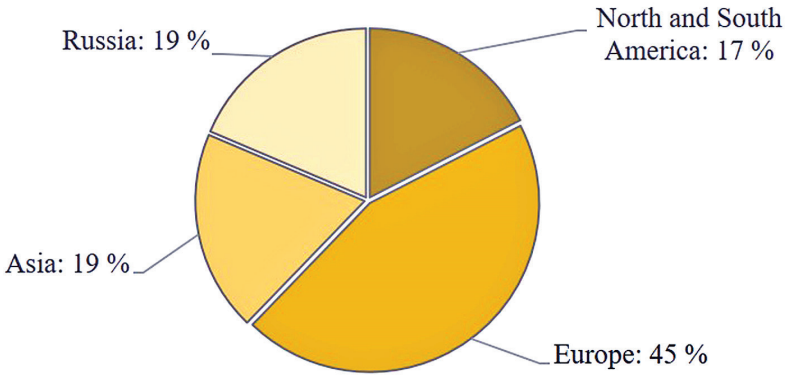

Fig. 2. Geographical origin of maglev specialists in this survey.
(Total participants = 1 058; maglev specialists = 172)

Participants were defined as Maglev experts if it was possible to demonstrate in-depth Maglev know-how according to several defined criteria. The self-assessment of the participants was just one criterion among several others, here. Without demonstrable Maglev qualification, participants were grouped into the category of general transport experts. There were no participants from the African or Australian continent that could meet the defined criteria for maglev specialists. The selection procedure is described and explained in detail in the German long version of the study.

About 16 % of the study participants appeared so well versed in maglev subjects that they could be narrowed down as maglev specialists.

In the field of high speed ground transport, the maglev systems Chuo Linear Shinkansen and the Shanghai Transrapid were considered (and compared with conventional steel-wheel-rail systems). In the field of urban transport, the Japanese Linimo, the South-Korean Ecobee and Chinese urban maglev systems were compared with conventional urban transport systems. Maglev cargo systems are still under development; they were discussed from a more theoretical perspective.

Limitations of the project: The study is not representative of the total population of the respective countries, but it is an indicator of the view that transport experts and citizens with a professional connection to transport have on the subject of maglev. In countries where there is only a limited freedom of the press or little freedom of expression, there may be "politically desirable" answers (despite individual anonymity), especially when maglev technologies are a central government research

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program and / or the Internet is a censored medium. The study cannot prevent such influence or control for possible impacts.

The situation on the African continent could only be studied to a limited extent, only a few transportation experts from Africa could be found for the survey. The same applied to Australia and New Zealand, where public transport experts with some expertise in maglev technologies seem to be rare.

2. COMPARISON AND SELECTION OF MAGLEV TRANSPORT SYSTEMS

Research question: Which track-guided system should prevail in the future (depending on the area of application)?

Results:

Transport experts and maglev specialists from all countries currently see the central suitability of maglev technologies in high-speed passenger transport over long distances. In general, the ratings are relatively close to each other for general transport experts and maglev specialists. The statistical deviations are less than 10 % even in the maximum case, see Fig. 3.

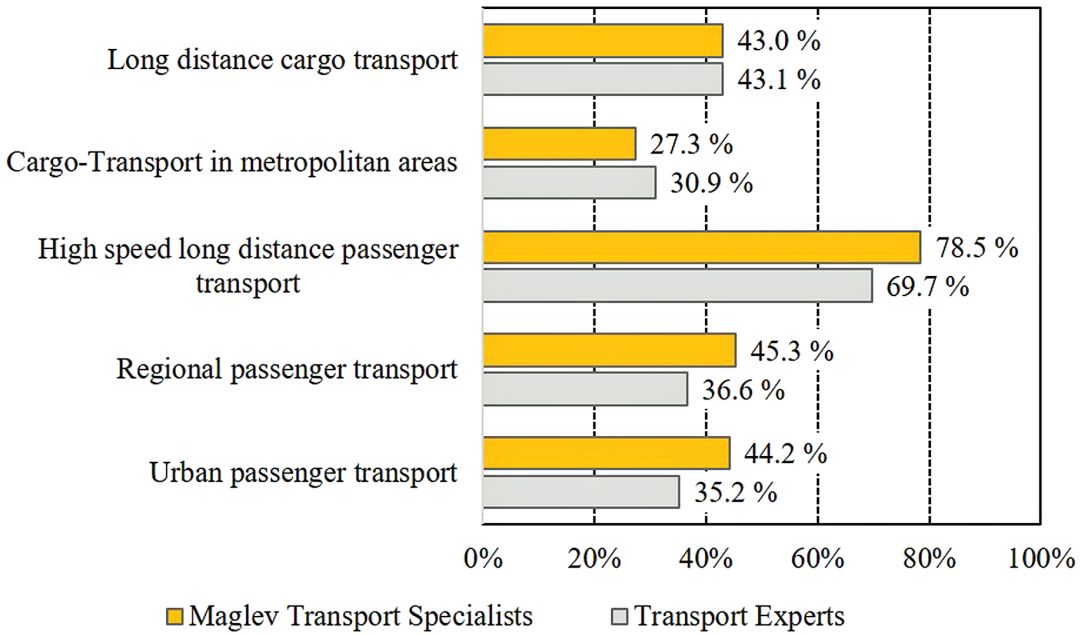

Fig. 3. Maglev system preference over wheel-rail, by field of application. Percentage of respondents that have chosen maglev technologies as their preferred system for the respective field of application.
Question: "If you should decide today which track-guided system should prevail in the future: How would you decide on the following fields of application?"
(number of respondents = 683)

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For maglev specialists the average approval rate (for high-speed maglev over long distances) is especially high, approaching 80 %. Russian and American maglev specialists vote particularly strongly, with approval rates up to 90 %, see Fig. 4.

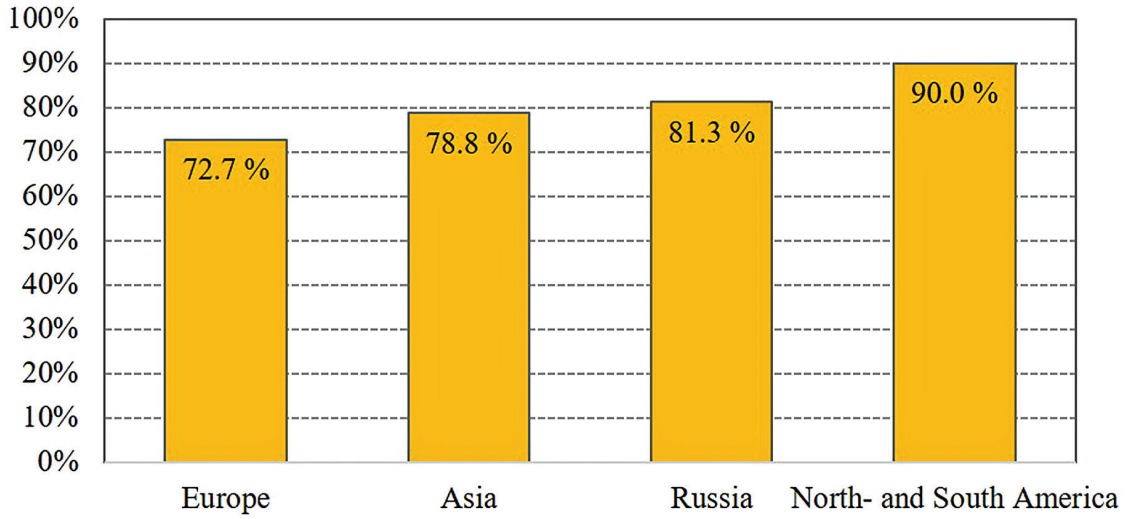

Fig. 4. Maglev specialists' degree of support for high speed maglev systems for long-distance transport applications.
Question: "If you should decide today which track-guided system should prevail in the future: How would you decide on the field of high-speed long distance passenger transport?" Opinion of maglev specialists (number of respondents = 172)

The analysis also shows a correlation between the age of respondents and their assessment of high-speed maglev, with younger maglev specialists particularly in favor of maglev systems for long-distance passenger traffic.

Maglev specialists tend to rate the suitability of technologies quite differently. They see strengths of wheel-rail systems in several application fields. In urban and regional public transport, for example, the majority of maglev specialists see an overall high suitability for wheel-rail systems.

Overall, all participants are relatively critical of urban maglev and regional maglev technologies. The reasons for this are difficult to pin down, but in general it has been shown in recent debates that maglev specialists and other transport experts are reluctant to supplement existing wheel-rail mass transit systems with maglevs too quickly, in order to avoid additional economic costs arising from the simultaneous operation of different technical systems. Another factor in favor of this interpretation is that countries in which public transport operating at grade level (not in tunnels) tends to underperform are much more radical in terms of launching the new maglev systems. For example, maglev specialists from North and South America and Russia strongly support the use of maglev systems in urban and regional transport. Many of these nations have excellent subway systems in

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their cities, but their urban surface transport (bus, tram, suburban train) is often considered to be in great need of development.

In the field of long-haul cargo transport, wheel-rail systems should continue to be used from the point of view of a narrow majority of the maglev specialists surveyed, who most clearly advocated the field of cargo transport in urban areas and voted in favor of wheel-rail systems (55.2 %). A particularly clear advocacy of wheel-rail systems was also provided by Asian maglev specialists — with a share of 72.7 %, they voted in favor of wheel-rail in the field of cargo transport in urban areas.

In the application field of long-distance cargo transport, Russian maglev specialists hold a national special position: In contrast to about 43 % of all surveyed specialists who advocate the use of maglev systems for long-haul cargo transport, 75 % of Russian specialists would prefer maglev systems in this field of application.

An explanatory interpretation for this unique Russian position is that the transport problems in Russia, due to its enormous geographic extent, have a significantly different dimension than, for example, in the rather small, multi-state confines of Western Europe. Therefore, in the Russian Federation, the factors of time requirement and transport speed are likely to have a much more urgent dimension which requires a special readiness for innovative transport solutions.

3. FUTURE RELEVANCE OF MAGLEV TECHNOLOGIES

Research question: How will the relevance of maglev technologies develop worldwide in the next 20 years?

Results:

The results of the study show that maglev specialists and transportation experts around the world generally expect a significant increase in the importance of maglev technologies. From the point of view of maglev specialists, the increase in importance in the coming 20 years will mainly concern the following areas:

- High speed passenger transport;
- Urban maglev;
- Regional maglev;
- Applications of maglev technologies in buildings and public spaces (elevators and escalators);
- Military applications (e.g., maglev launch pads for missiles and aircraft carrier catapults).

The assessment seems highly dependent on the geographical or cultural context. Most skeptical and cautious are the specialists from European countries

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who regard maglev's prospects as relatively low in almost all aspects. One exception concerns maglev elevator technologies, which are seen by European experts as a growth industry, see Fig. 5.

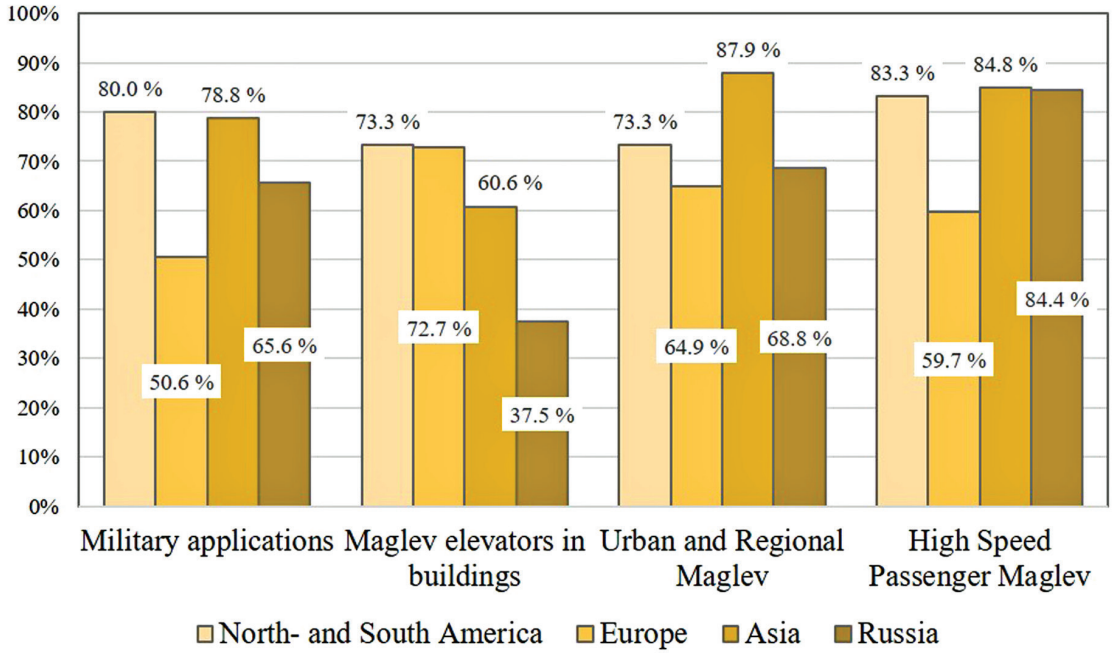

Fig. 5. Maglev Technologies with growth potential. Percentage of maglev specialists that see maglev grow in the respective application field.
Question: "During the next 20 years, how will the situation of maglev technologies develop worldwide?" Opinion of maglev specialists (number of respondents = 172)

At the same time, the majority of maglev specialists as well as the majority of general experts assume that urban cargo transport by maglev technologies will remain irrelevant over the next 20 years (maglev specialists: 55.8 %; general experts: 59.9 %).

Overall, an average of 73.3 % of all maglev specialists see an increase in the importance of maglev high-speed passenger transport systems over the next 20 years. More than 80 % of maglev specialists from North and South America, Asia and Russia even expect that the relevance of maglev systems in the field of high-speed traffic will grow. Again, European maglev specialists remain skeptical, with only about 60 % seeing a growth potential here, see Fig. 5.

4. PROBABILITY OF MAGLEV IMPLEMENTATION

Research question: In which countries / continents will a realization of a new maglev project (passenger or freight) begin in the next 20 years?

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The question investigates whether maglev specialists assume that a relevant project will be realized within their respective home country within the next two decades.

Results:

Looking at the four selected continents, it becomes clear how strong the Asian expectation is that maglev projects will be implemented. Nearly 91 % of the Asian maglev specialists expect the construction of a new maglev project in passenger or freight traffic in their respective home countries within the next 20 years. Russian and American specialists share equally strong expectations regarding the realization of a maglev project in their respective countries, see Fig. 6.

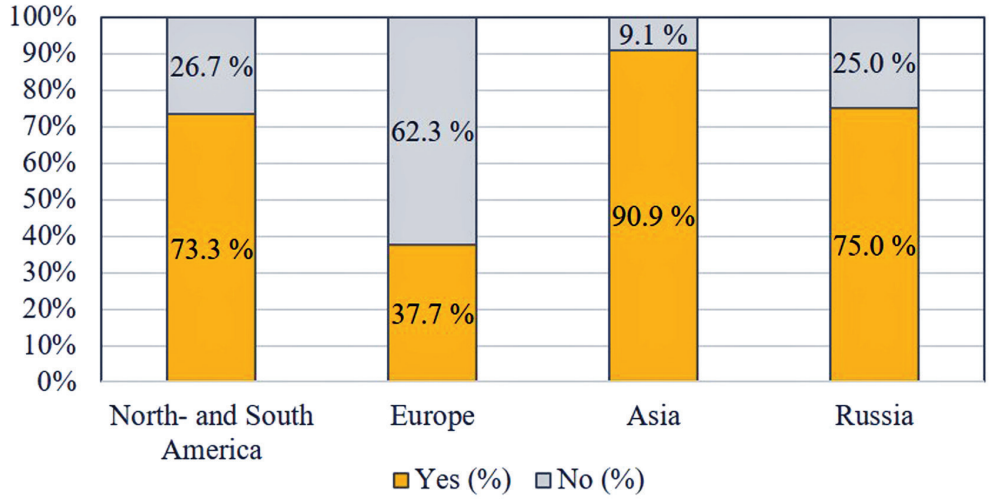

Fig. 6. Realization of a maglev project in the country of respondent in the next 20 years. Question: "Do you think a new maglev transport construction project – either for passenger transportation or cargo transportation – will begin in your country in the next 20 years?" Opinion of maglev specialists (number of respondents = 172)

In contrast to this high expectation stands the skepticism of European specialists, of whom only a good third expect a maglev project in a European country to become reality in the future.

If the global opinion of all maglev specialists is compared with the average opinion of general transport experts, the following Fig. 7 emerges:

While maglev specialists consider a realization to be quite likely, general transport experts see this almost exactly the opposite way and expect to only about 40 % such a realization of maglev projects in their countries. This global assessment is significantly influenced by strong European skepticism and the high proportion of European transport experts in the study.

In general, it seems to be true: maglev transport specialists are, as a group, much more optimistic about the chances of realizing maglev technologies than

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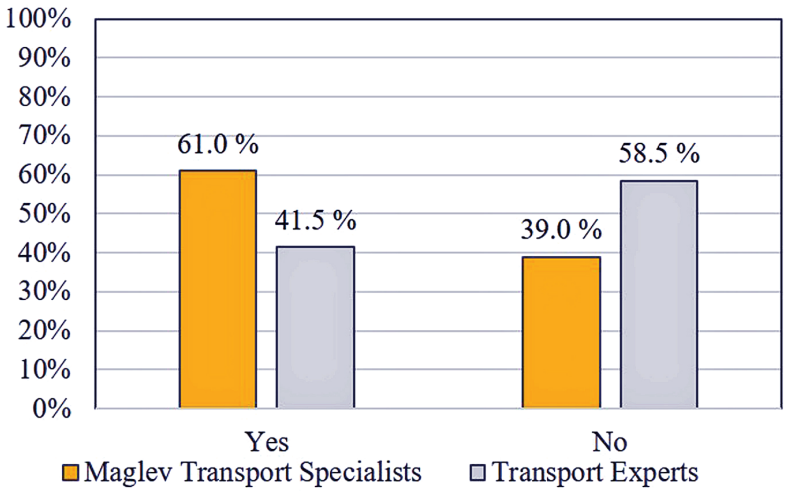

Fig. 7. Realization of a maglev project in the country of respondent in the next 20 years. Worldwide perspective, comparison of maglev Transport Specialists and Transport experts. Question: "Do you think a new maglev transport construction project – either for passenger transportation or cargo transportation – will begin in your country in the next 20 years?" (number of respondents = 683)

the majority of classic transport experts who do not possess in-depth maglev knowledge.

5. KEY FACTORS AND POSSIBLE WEAK POINTS

Research question: Which topics can play a crucial role in *preventing* a maglev project?

The question seeks to narrow down those aspects that can be regarded as weak points in the realization of maglev projects for the contemplated continents [1, 2]. In order to increase the sensitivity of the participants for the topic, the questions refer to the respondent's home country.

Results:

Aspects are addressed that are usually intensively debated in the public debate (regardless of whether they are factually correct or not) in order to prevent the realization of a planned maglev project in the respective country. The analysis of these aspects is at the same time an indication of which topics should be discussed particularly intensively and seriously when communicating with transportation experts, politicians, researchers and citizens, in order to increase the chances of success of meaningful maglev projects — or to either optimize or prevent projects which appear to be unsuitable.

The results show that from the point of view of maglev specialists, the question of infrastructure investment costs is by far the most critical aspect, see

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Fig. 8. However, more than half of the specialists also consider the question of whether or not the existing wheel-rail systems could be cannibalized or threatened with their business results. Russian specialists have a special role to play here: only 21.9 % consider the risk of economic damage to already existing systems as a critical issue (average of all specialists: 51.7 %).

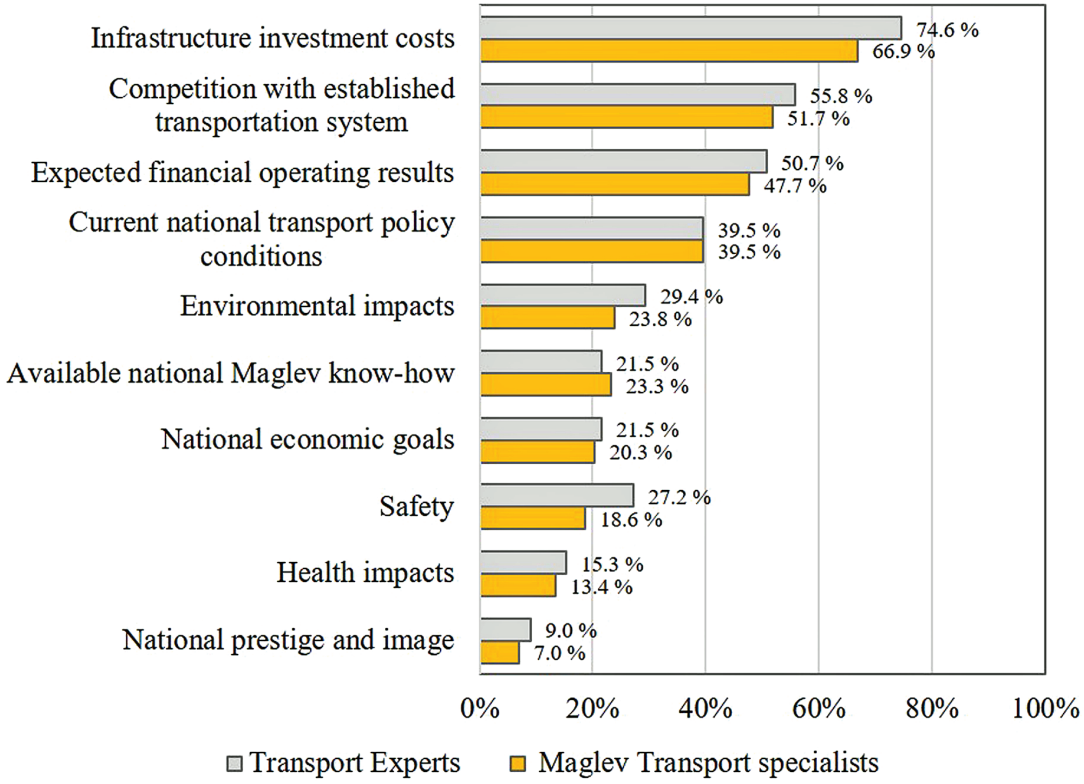

Fig. 8. Topics that are critical to success in project communication. Comparison of maglev specialists and general transport experts.
Question: “Please imagine the following situation: There is a plan to build a maglev transport project in your country. You are opposing its realization. Which aspects would you address to successfully prevent its realization?” (number of respondents = 683)

Overall, the ranking of topics reveals striking differences between the continents: the aspect of ‘national economic objectives’ is ranked by the North and South American experts (30 %) among the top five most frequently cited aspects. This aspect ranks much lower on other continents.

The aspect of ‘technical system safety’ can be found among Asian and Russian maglev specialists among the five most chosen aspects. By contrast, this technical safety aspect is much less relevant for North and South American experts.

The aspect, ‘forecasted financial results,’ was selected by 47.7 % of all maglev specialists as decision-relevant and is placed by all expert groups in the five most frequently mentioned aspects.

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A comparison of maglev specialists and general transport experts on this topic shows a high level of agreement between the opinions for the global perspective. Although differences appear again concerning continents and age groups, the overall strong agreement appears quite striking.

At the same time, it has become clear that general transport experts are more frequently and more strongly selecting the different topics than maglev transport specialists. In the interpretation, this may be considered a heightened caution, or perhaps a sensitivity of general transport experts to these issues and possible shortcomings of maglev technologies.

6. MAGLEV RESEARCH NEEDS AND RESEARCH TASKS

Research question: In which areas are the most important research needs for maglev systems?

When considering and selecting possible research needs for maglev systems, a distinction is made between the following four areas of application:

- High-speed passenger transport;
- Urban and regional transport;
- Cargo transport / container transport;
- Transport in Buildings.

Result 1 (High-speed passenger transport):

For the evaluation of the results, the assessments of the general transport experts and the assessments of the maglev specialists are compared.

Most of the maglev specialists surveyed (73.8 %) see infrastructure investment costs as the most important area for research needs for further development of high-speed maglev systems. Just over half of the experts (52.3 %) also selected the area of energy efficiency, see Fig. 9.

Third in nomination, maglev specialists from North and South America and Russia chose the Infrastructure Maintenance Costs section. European experts chose the area ‘investment costs of maglev vehicles.’

In contrast to the average opinion of all maglev experts, of whom only 17.4 % see research needs in the environmental impact of high-speed maglev systems, the environmental aspect is far more relevant to Asian experts, who see the value as almost twice as high, at 30.3 %.

Of note is the high percentage at which Asian maglev specialists have selected 'vehicle aerodynamics' (27.3 %) as a task to improve. An interpretation of this result may suggest that the selection of this aspect recognizes the minimization of noise emissions and the reduction of energy consumption at high speed [1].

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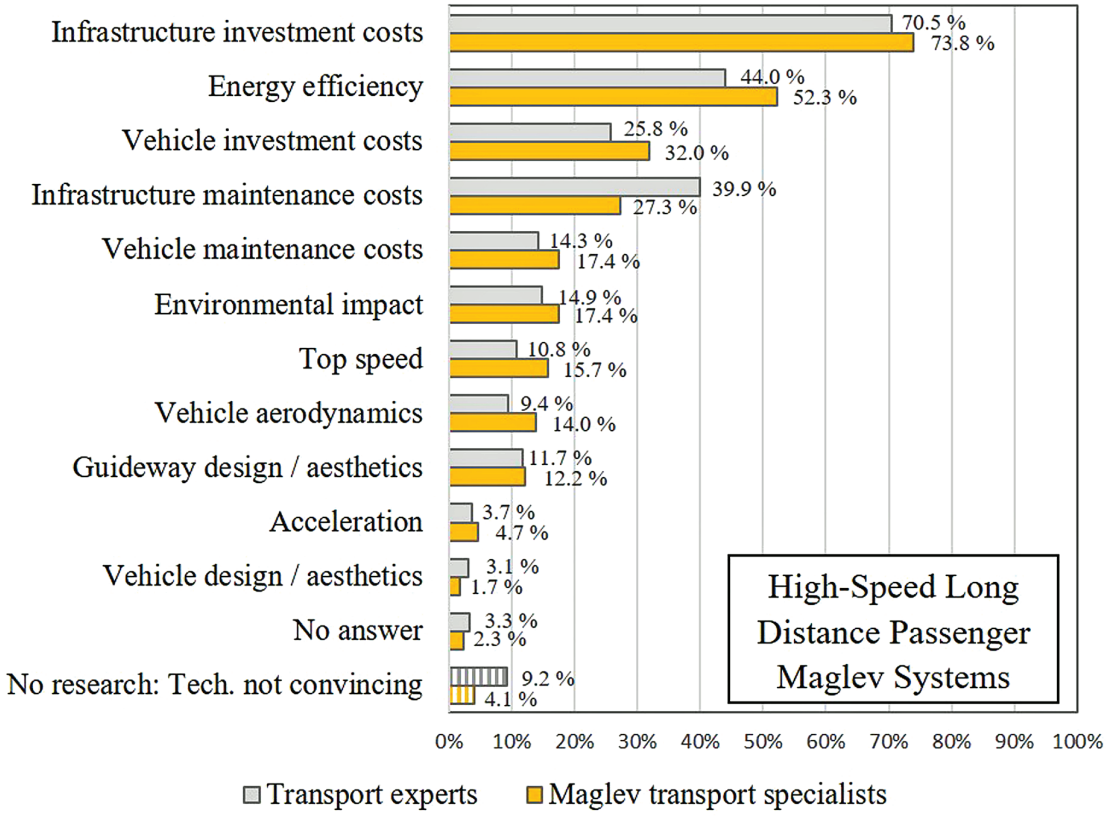

Fig. 9. Important research tasks for further development of high-speed maglev systems, comparison of maglev specialists and general transport experts.
Question: “What do you consider the most important tasks for further improvement of high-speed maglev systems?” (number of respondents = 683)

To note is, that 9.1 % of the European maglev specialists determined the considered technologies (high-speed maglev systems) are not convincing and therefore no further research is required.

In total, the opt-out answer, “No further research needs: The technologies are not convincing,” was chosen by 4.1 % of all maglev specialists and by 9.2 % of all general transport experts.

Result 2 (Urban / regional transport):

More than two thirds (68.6 %) of the maglev specialists see particularly important research needs for the further development of urban / medium-speed maglev systems in the area of ‘Infrastructure investment costs.’, see Fig. 10.

When analyzing by continents, there are differences: the field of energy efficiency was the second most frequently chosen aspect by maglev specialists from Europe, Asia and Russia. Energy efficiency appears less important to the maglev specialists from North and South America as a whole (30 %).

For 40 % of the maglev specialists from North and South America, the area, 'design / aesthetics of the track,' is particularly important.

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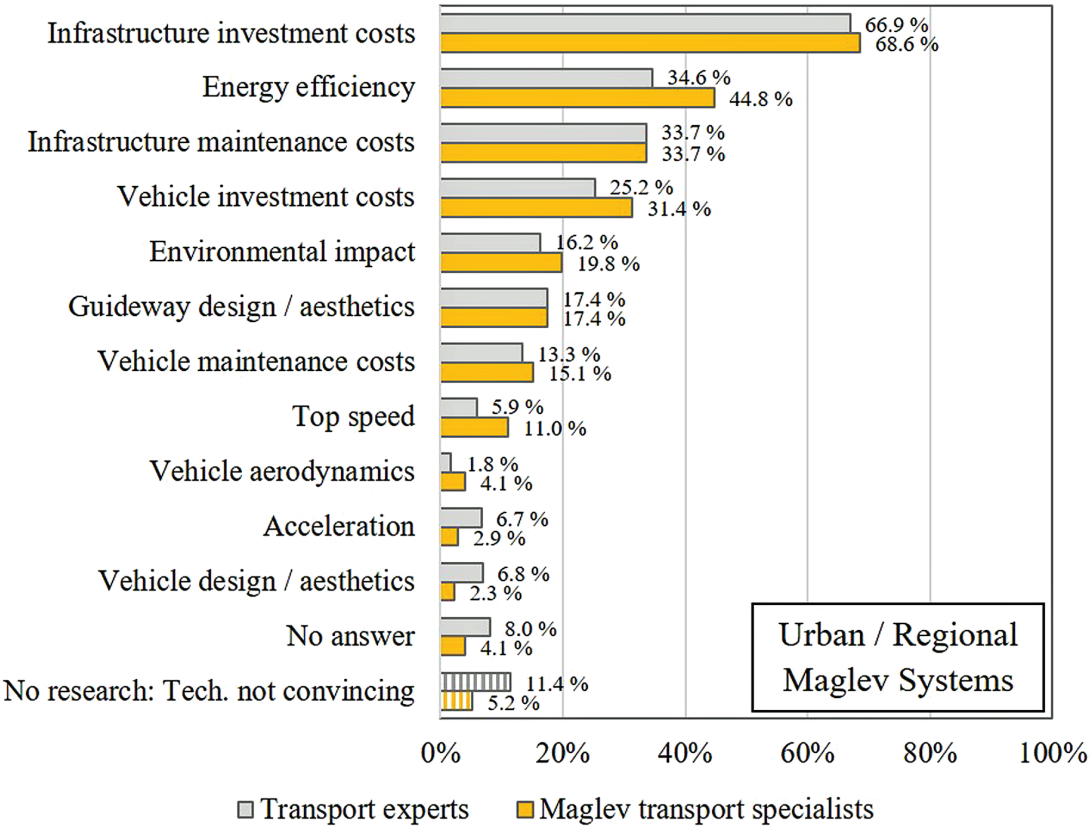

Fig. 10. Important research tasks for further development of urban and regional maglev systems, comparison of maglev specialists and general transport experts.
Question: “What do you consider the most important tasks for further improvements of urban / medium-speed maglev Systems?” (number of respondents = 683)

The opt-out answer, “No further research needs: The technologies are not convincing,” was chosen by 5.2 % of the maglev specialists and by 11.4 % of general transport experts.

Result 3 (Cargo / container transport):

For a further development of cargo maglev systems, a majority of maglev specialists (64.5 %) sees research needs in the area of ‘infrastructure investment costs.’ An improvement in the area of energy efficiency is also considered very relevant for the further development of cargo maglev systems, according to 43 % of maglev specialists worldwide, see Fig. 11.

The opt-out answer, “No further research needs: The technologies are not convincing,” was chosen by 12.2 % of the maglev specialists and by 14.3 % of general transport experts. This number appears to be relatively high, at least for the maglev specialists, who obviously doubt that the technology is convincing for cargo transport.

There are valuation differences between the continents that are not visible in the categories shown above: For maglev specialists from North and South

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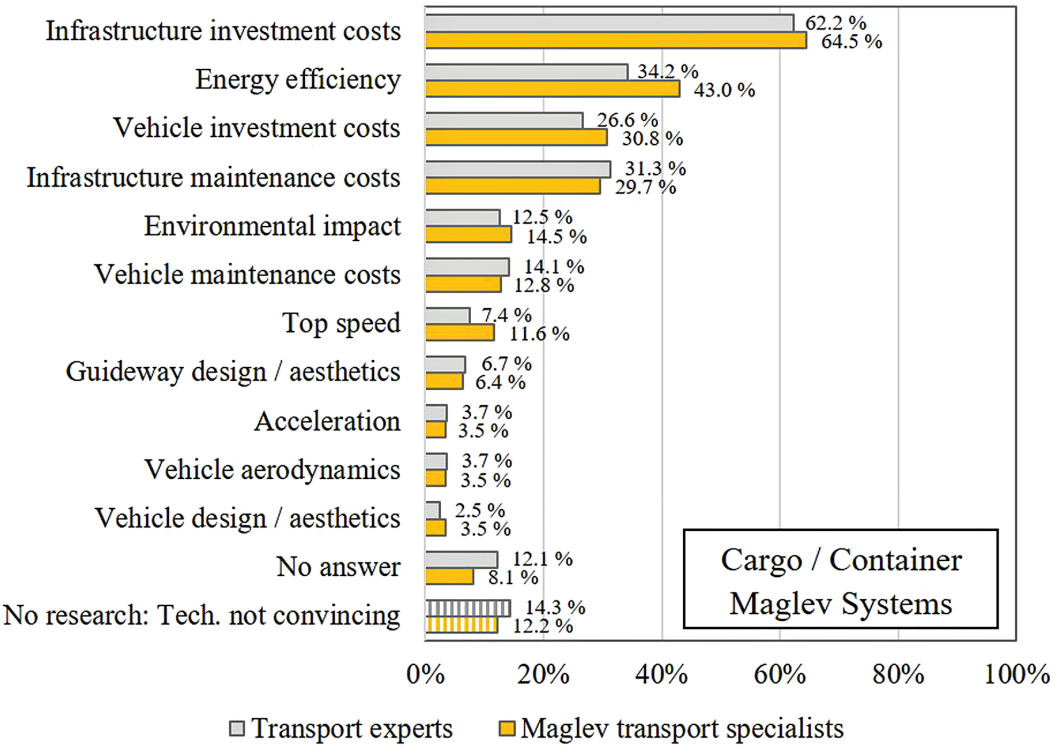

Fig. 11. Important research tasks for further development of cargo maglev systems, comparison of maglev specialists and general transport experts.
Question: “What do you consider the most important tasks for further improvements of cargo maglev Systems?” (number of respondents = 683)

America, Asia and Russia, 'Infrastructure maintenance costs' appeared very important. For European experts, 'vehicle investment costs' were especially relevant (33.8 %).

A relatively high proportion of Russian experts (31.3 %) sees (higher) 'top speed' as an important research necessity for further development of the cargo maglev systems.

European maglev specialists are particularly critical of the cargo maglev systems. About one fifth does not consider the maglev technology to be convincing here and does not see any further research needs for it.

7. HYPERLOOP – MORE THAN A SHORT-LIVED FAD?

Research question: Are Hyperloop evacuated-tube technologies suitable for passenger or cargo transport?

The current discussion of Hyperloop technology, which relies on maglev systems components, are controversial in both public and transportation expert communities. Analyzing this topic requires a differentiated point of view.

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A clear majority of maglev specialists and transportation experts consider Hyperloop evacuated-tube technologies unsuitable for passenger transportation, see Fig. 12.

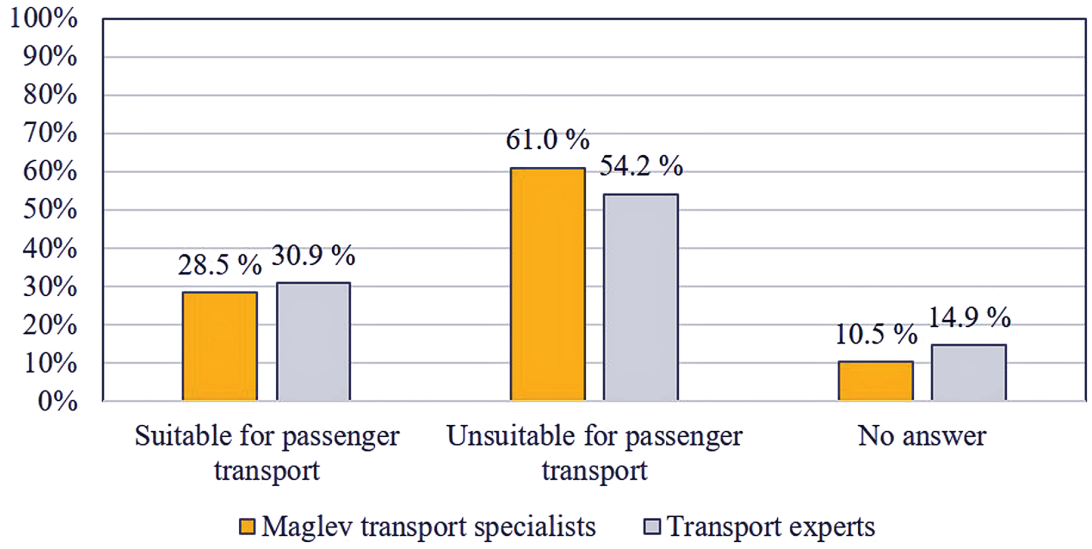

Fig. 12. General evaluation of the suitability of Hyperloop vacuum tube technologies in passenger transport, assessment of maglev specialists and general transport experts. Question: "Are Hyperloop evacuated-tube technologies in practice suitable or unsuitable for passenger transport?" (number of respondents = 683)

The majority of maglev specialists on all continents do not see suitability for Hyperloop operation in passenger transport. Nevertheless, the degree of rejection varies widely.

Roughly 40 % of Asian transport specialists are convinced of the suitability of this technology for passenger transport, which is the highest in the international ratings. This group of 40 % of maglev specialists, then, who see a transport suitability, can be considered a particularly strong minority.

The clearest rejection of Hyperloop systems is shown by maglev specialists in Europe, where almost 70 % of the European specialists surveyed do not assume that Hyperloop systems are suitable for transporting people. The rating by American specialists is quite similar, since the rejection level is almost two-thirds of the respondents (63.3 %), see Fig. 13.

Also striking is the high proportion of Russian experts who do not give a rating here (28 %).

Result 2 (cargo transport):

Hyperloop evacuated-tube technologies should be generally suitable for the transport of small and special designed containers, like air cargo boxes according

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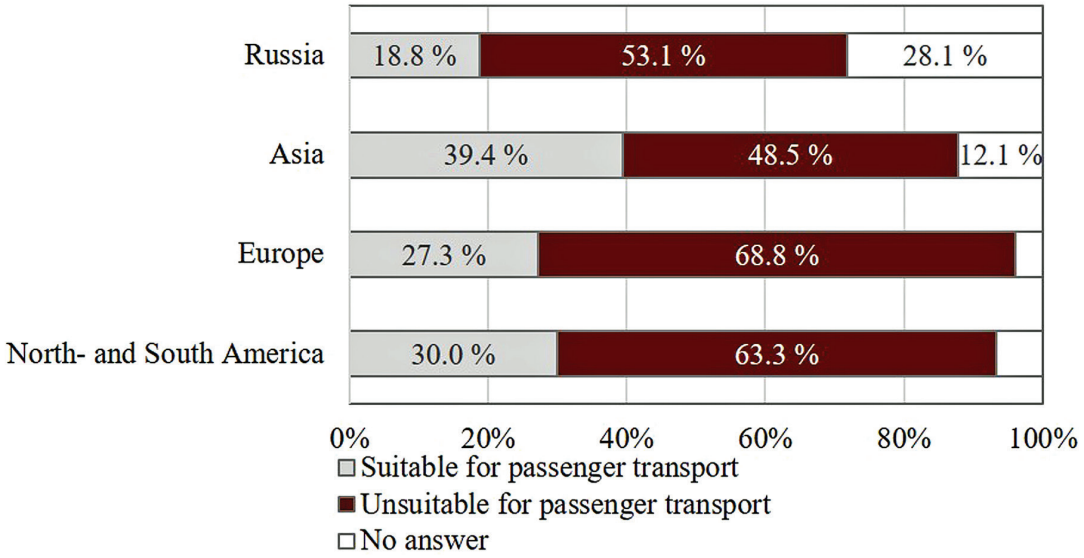

Fig. 13. Evaluation of the suitability of Hyperloop vacuum tube technologies in passenger transport, assessment of maglev specialists by continent.
Question: "Are Hyperloop evacuated-tube technologies in practice suitable or unsuitable for passenger transport?" (number of respondents = 172)

to a majority assessment of maglev transport specialists and general transport experts, see Fig. 14.

The analysis of the assessments by continents shows clear deviations, see Fig. 15.

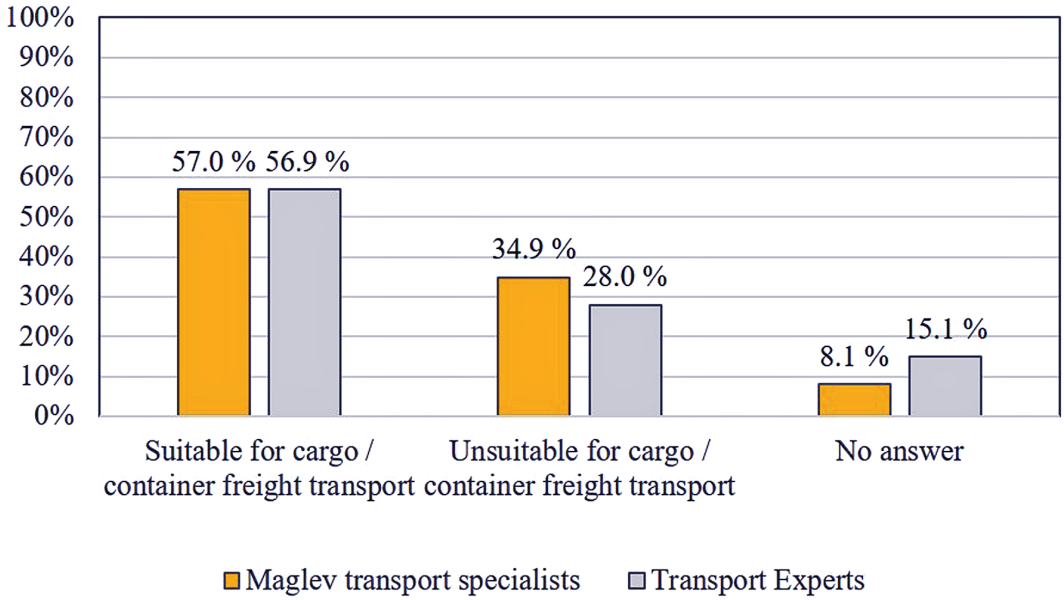

Fig. 14. Evaluation of the suitability of Hyperloop vacuum tube technologies in cargo transport, assessment of maglev specialists and general transport experts. Question: "Are Hyperloop evacuated-tube technologies in practice suitable or unsuitable for passenger transport?" (number of respondents = 683)

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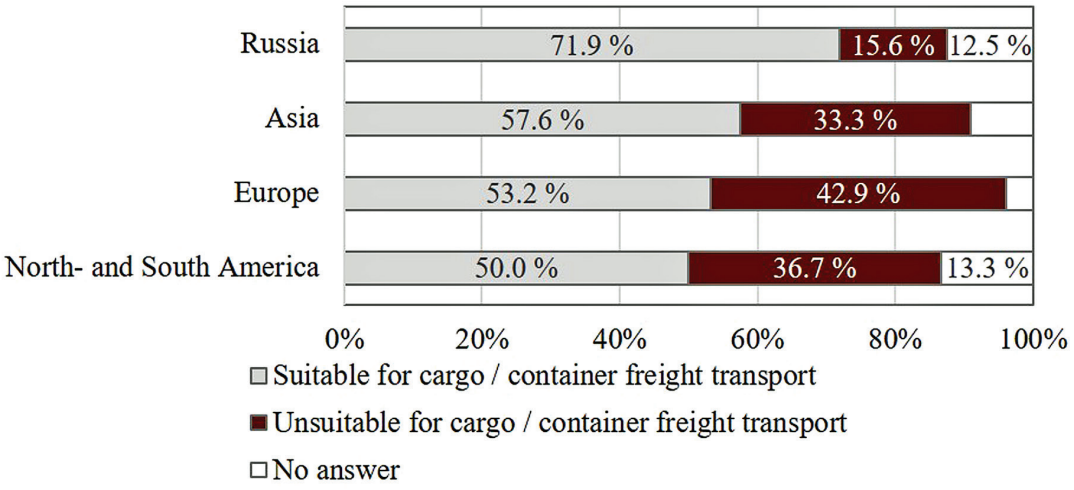

Fig. 15. Evaluation of the suitability of Hyperloop vacuum tube technologies in cargo transport, assessment of maglev specialists by continent. Question: "Are Hyperloop vacuum-tube technologies in practice suitable or unsuitable for passenger transport?" (number of respondents = 172)

As is the case with several other topics, the maglev specialists from Europe seem particularly skeptical about the cargo transport suitability of Hyperloop systems (42.9 %). Nevertheless, the majoritarian opinion of maglev specialists in Europe still is that Hyperloop can be suitable for the cargo application.

Russian maglev specialists appear particularly convinced of the applicability of Hyperloop systems in the cargo area. With a share of 71.9 % approval, they are at the top of the ratings, well ahead of their Asian, European and American counterparts.

8. CONCLUSION

The following summarizes the results of the study according to the main fields of maglev applications.

1) High-Speed Passenger Transport

Transport experts and maglev specialists from all countries currently see the central suitability of maglev technologies in high-speed passenger transport over long distances (Fig. 3). Russian and American maglev specialists vote particularly strongly, with approval rates up to 90 %. Maglev specialists from Europe are significantly more skeptical here (Fig. 4).

Most of the maglev specialists surveyed see infrastructure investment costs as the most important area for research needs for further development of high-speed maglev systems. Just over half of the experts also selected the area of energy efficiency (Fig. 9). 27 % of Asian maglev specialists have selected 'vehicle aerodynamics' as a task to improve.

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2) Urban and regional transport

In urban and regional public transport, the majority of maglev specialists see an overall high suitability both for wheel-rail systems and maglev systems (Fig. 3).

More than two thirds of the maglev specialists worldwide see particularly important research needs for the further development in the area of 'Infrastructure investment costs' (Fig 10). The field of energy efficiency was the second most frequently chosen aspect. For maglev specialists from North and South America, the area, 'design / aesthetics of the track,' is particularly important.

3) Cargo transport

In the field of long-haul cargo transport, wheel-rail systems are expected to continue to be used from the point of view of European, Asian and American maglev specialists. Meanwhile 75 % of Russian specialists would prefer maglev systems for cargo transport.

In general, no positive perspectives are seen for urban cargo maglev systems in metropolitan areas. European maglev specialists are particularly skeptical of all variants of cargo maglev systems.

For a further development of cargo maglev systems, a majority of maglev specialists sees research needs in the area of 'infrastructure investment costs' (Fig. 11). An improvement in the area of energy efficiency is also considered very relevant for the further development of cargo maglev systems.

4) Future application of maglev technologies

From the point of view of maglev specialists, an increase in maglev importance in the coming 20 years (approximately to the year 2040) will mainly concern the following areas:

a) High-speed passenger transport;

b) Urban and regional (medium-speed) maglev transport;

c) Maglev elevators and escalators in buildings and public spaces;

d) Military applications (e.g., maglev launch pads for missiles and aircraft carrier catapults).

The majority of both maglev specialists and general experts assume that urban cargo transport by maglev technologies will remain irrelevant over the next 20 years.

The assessments of the experts seem highly dependent on the geographical or cultural context. Most skeptical and cautious about future developments are the specialists from European countries, who regard maglev's prospects as relatively low in almost all aspects (Fig. 5). But there is one exception: maglev elevator technologies are seen by European experts as a growing industry.

5) Probability of maglev project realizations

In general, maglev transport specialists are, as a group, more optimistic about the chances of realizing maglev technologies than the majority of classic

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transport experts. Maglev specialists consider a realization to be quite likely, while general transport experts see this almost exactly the opposite way and expect (up to about 40 %) such a realization of maglev projects in their countries (Fig. 7). Again, this global assessment by general transport experts is heavily influenced by strong skepticism from Europe.

Nearly 91 % of the Asian maglev specialists expect the construction of a new maglev project for passenger or freight transport in their respective home countries within the next 20 years. Russian and American specialists share equally strong expectations. In sharp contrast to this high expectation stands the skepticism of European specialists, where a vast majority doubts that a maglev project in a Western European country will become reality in the future (Fig. 6).

6) Key factors and weak points of maglev systems

From the point of view of maglev specialists, the question of infrastructure investment costs is by far the most critical aspect. More than half of the specialists also consider the question of whether or not the existing, conventional transport systems could be cannibalized or threatened with their business results sensitive. The aspect, 'forecasted financial results,' was selected by about 50 % of all experts (Fig. 8).

Overall, there are striking differences between the continents: the aspect of 'national economic objectives' is ranked high by the North and South American experts, but this aspect ranks much lower on other continents. The aspect of 'technical system safety' is rather irrelevant, except for Asian and Russian maglev specialists.

7) Hyperloop technologies

On average, a clear majority of maglev specialists and transportation experts considers Hyperloop evacuated-tube technologies unsuitable for passenger transportation. The main reason for this consideration could be unsolved safety issues. The clearest rejection of Hyperloop systems is shown by maglev specialists in North and South America and Europe.

For cargo transport, the valuation is different: Hyperloop evacuated-tube technologies are seen as generally suitable for transporting cargo containers, according to a majority assessment of maglev transport specialists and general transport experts worldwide. Russian maglev specialists appear particularly convinced of the applicability of Hyperloop systems in the cargo area.

Basic statistics:

In total, 1 058 experts participated in this study. Of this, 172 persons were maglev specialists and 683 participants were general transport experts. The study was conducted between May and June 2018 as an internet survey.

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