

Questionnaire Results

WP 0 – Feasibility Study Questionnaire – Preliminary Assumptions (Kick-off Meeting)

- Selection of Mining Companies (minimum 20 to receive 10 filled questionnaires)
 - Partners of EIT RM (LKAB, Boliden, KGHM, Atlantic Copper/Freeport MacMoRan)
 - Personal contacts (RAG, Glencore, Anglo American,)
 - Contacts through CLC Managers
 - Ideas? e.g. Internet Search, Associations
- Preparation of questionnaire
 - On basis of existing DMT questionnaire
 - All partners for their WPs: What do you need to know? Which questions will help you to get this information? What documents/images/drawings do you need?
- Reassessment of the proposal with deeper analysis of the substantial questions asked by the announced “Template for the Feasibility Study Report”

Questionnaire - A1. General Approach

- For the analysis of market requirements we developed an online questionnaire (available under: <http://www.ideepmon.eu/questionnaire/#>).
- In July 2016 we sent out a request to answer this questionnaire to approx. 60 people in companies who are operating deep mine shafts.
- Until 15th October 2016, we finally received 19 filled questionnaires, which is a response quote of 31.6%.
- Most answers came from Europe (including former Soviet Union countries) with 11 responses, 3 are from South Africa, 3 from Australia and 2 are of unknown regional origin.
- We are aware that this is only a very small section of the overall market, however as mostly all of the answers are very consistent and in good correlation with our general assumptions, we are convinced that the resulting assumptions are representing the major market requirements.
- In particular our long term business experiences with shaft operating companies is additional value to underpin the questionnaire results.

Questionnaire - A2. Results from Questionnaires

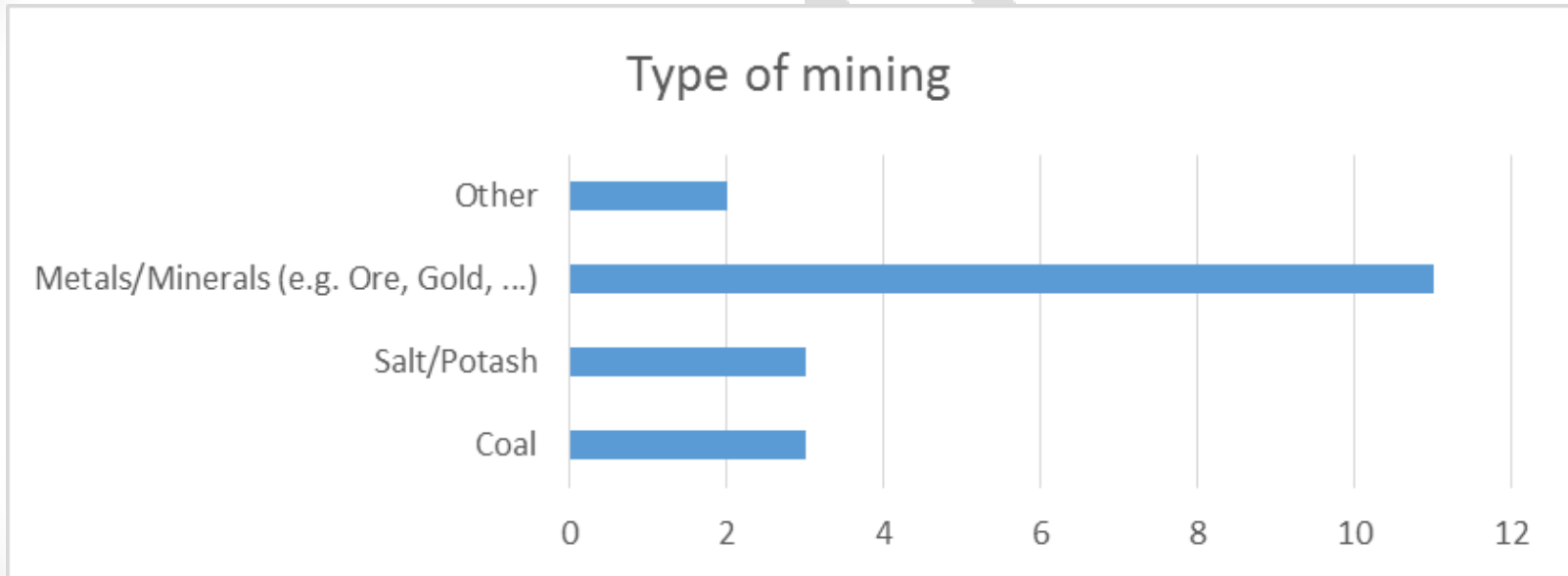
A2.1 Characterization of shafts

- Our first bundle of questions (question 1 to 9) was asked to understand which shafts we are talking about.
- First result is, that 18 answers to Question 1 are dealing with vertical shafts, only one answer is about declined shafts.
- As direct consequence from these answers we decided to focus the complete iDeepMon project to vertical shafts.
 - In particular, this decision has consequences to the content and focus of WP2.
 - The designing of a carrier systems for the sensors can be limited to vertical shafts, any solution for declined shafts is dispensable.

Questionnaire - A2. Results from Questionnaires

A2.1 Characterization of shafts

- Second question was about type of mining. The results are presented in following Figure 1.



- As 60% of the answers are from metals and minerals, the answers are relevant to the focus of the EIT RawMaterials. However, answers from other mining areas are helpful for comparison and give an impression for these sub-markets.

Questionnaire - A2. Results from Questionnaires

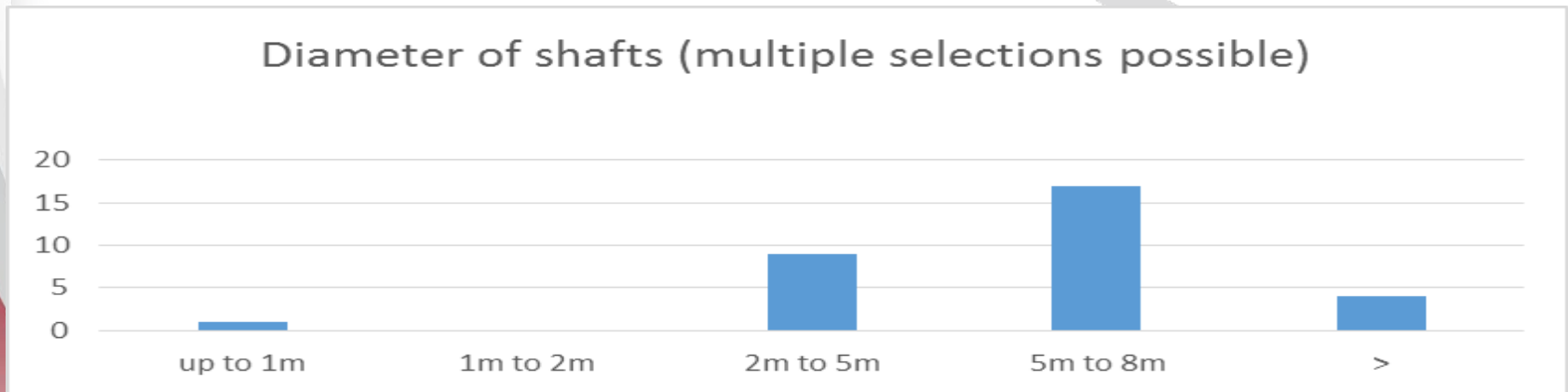
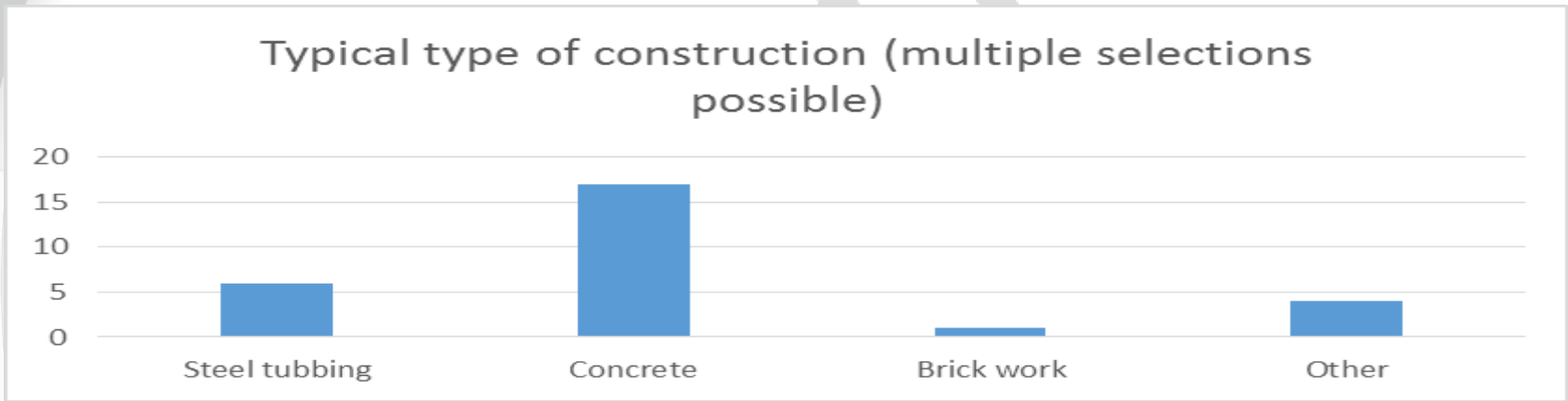
A2.1 Characterization of shafts

- Even we received only 19 filled questionnaires, we know from questions 3 to 5 that these answers are representing:
 - in minimum 57, probably more than 100 mines
 - in minimum 102 shafts with hoisting facilities, probably up to 200
 - in minimum 48 shafts without hoisting facilities, probably up to 140
- The majority of the shafts has a depth between 500m and 1,000m, however seven respondents have shafts with a depth of more than 1,000 m (questions 6 and 7).

Questionnaire - A2. Results from Questionnaires

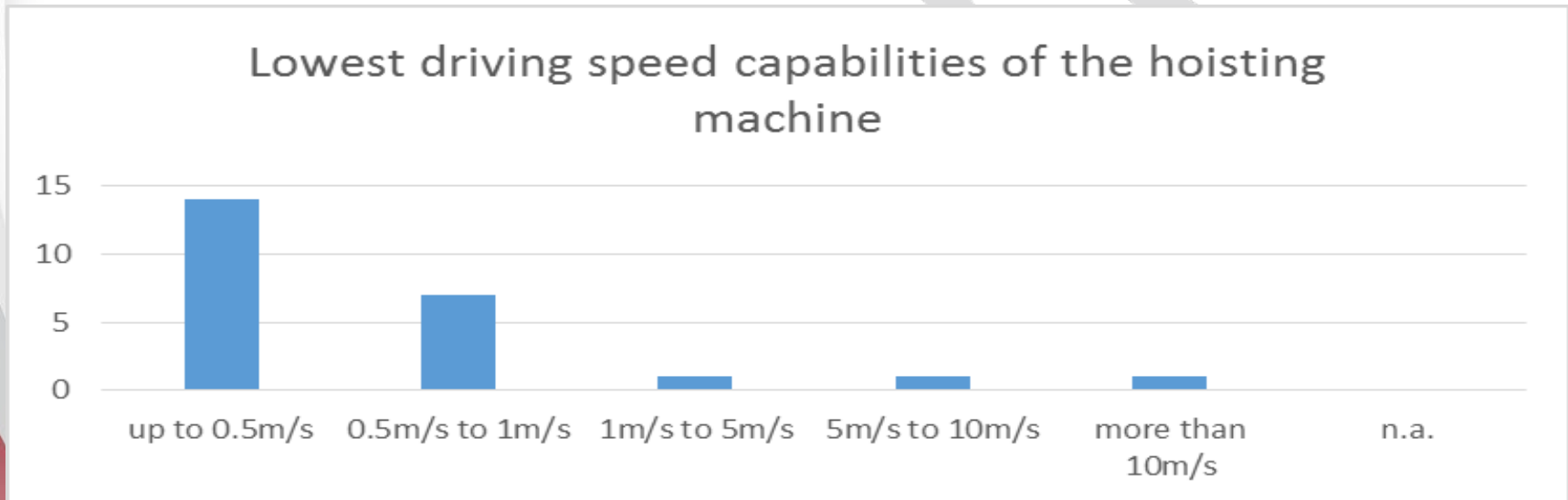
A2.1 Characterization of shafts

- Question 8 asked after the construction of the shaft (Figure 2) and question 9 after the diameter of the shafts (Figure 3).



Questionnaire - A2. Results from Questionnaires A2.2 Demands on Shaft Inspection

- The second group of questions (Question 10 to 12) asked for the particular conditions in the shafts with relevance to the sensor design of the planned inspection system.
- Large majority of all shaft hoisting machines are able to drive low velocity, which is an important pre-condition for high quality results from the inspection system (Question 10, Figure 4).

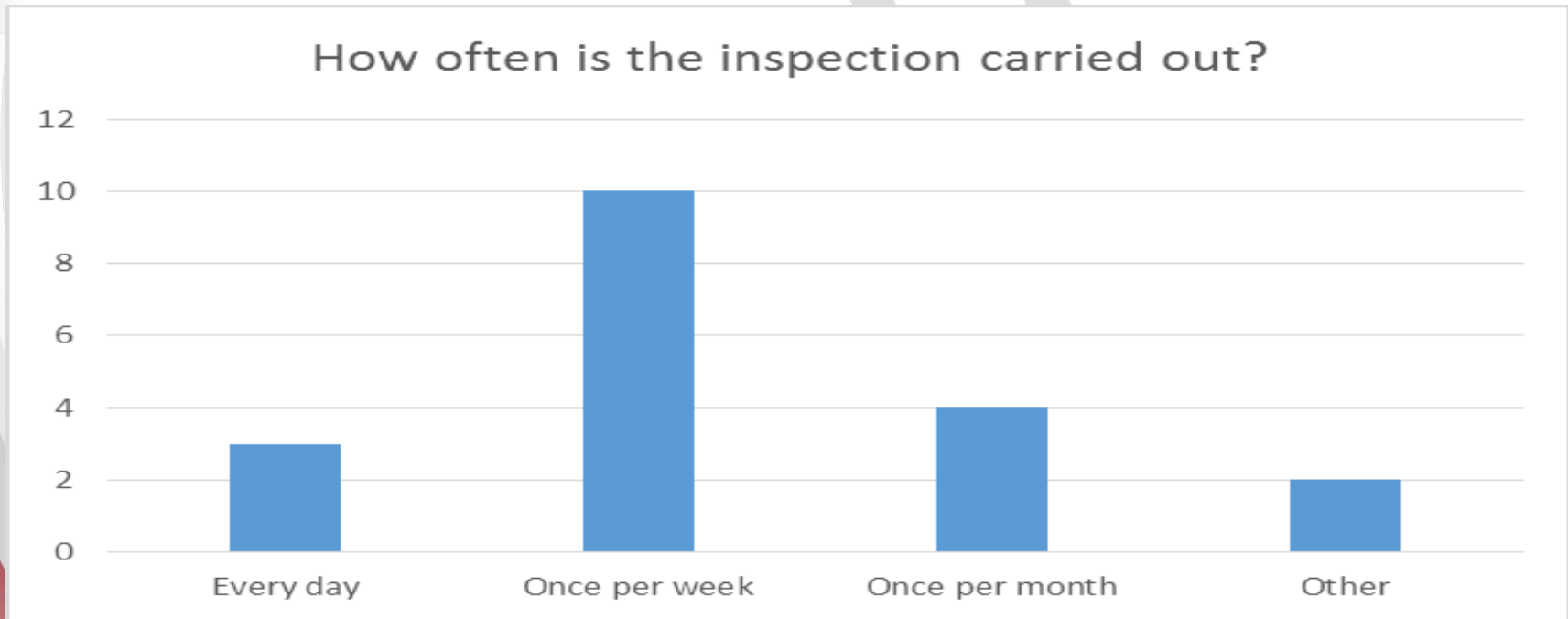


Questionnaire - A2. Results from Questionnaires A2.2 Demands on Shaft Inspection

- Questions 11 and 12 dealt with the environmental conditions in the shafts. The answers are very much mixed up, so there is a serious need to operate the system already under harsh conditions:
 - Water inflow (13 answers)
 - Condensing humidity (12 answers)
 - Dust (14 answers)
 - High temperature of more than 50°C (7 answers)
 - Low temperature of less than -10°C (4 answers)
 - Explosive atmosphere (5 answers)
- Of course, these environmental requirements have direct influence to the selection of needed sensors and the design of the integrated sensor system (see Chapter XXX).

Questionnaire - A2. Results from Questionnaires A2.2 Demands on Shaft Inspection

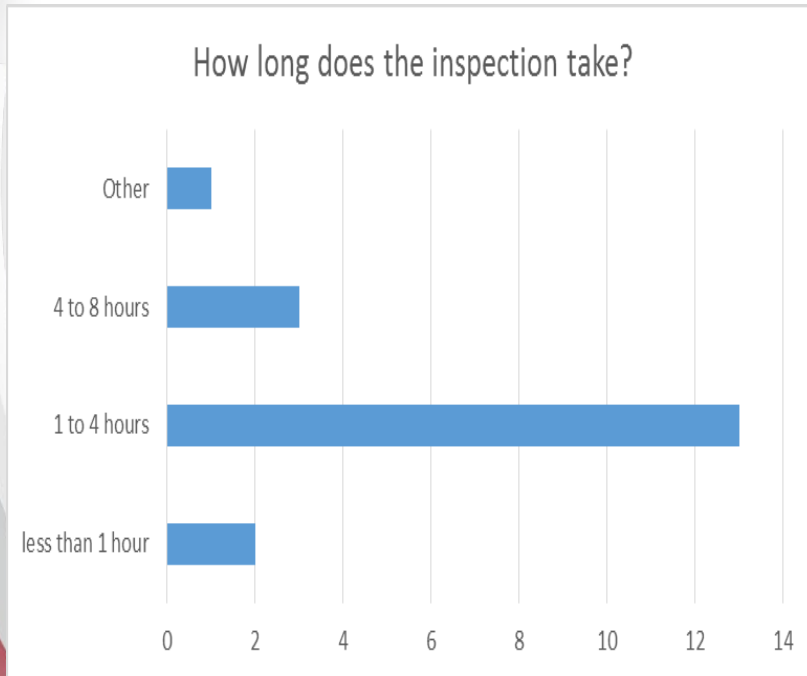
- Next important part of the questionnaire (Questions 13 to 17 and question 23) is asking for the relevance and the current procedure of shaft inspections.
- One of the most important findings are the answers to question 13 about the frequency of inspections (Figure 5).



Questionnaire - A2. Results from Questionnaires

A2.2 Demands on Shaft Inspection

- Together with information about the needed inspection time (Question 14, Figure 6) and the demanded human resources for the inspections (Question 15, Figure 7) we received a clear picture about the very high relevance and demand for the regular shaft inspections.



Questionnaire - A2. Results from Questionnaires A2.2 Demands on Shaft Inspection

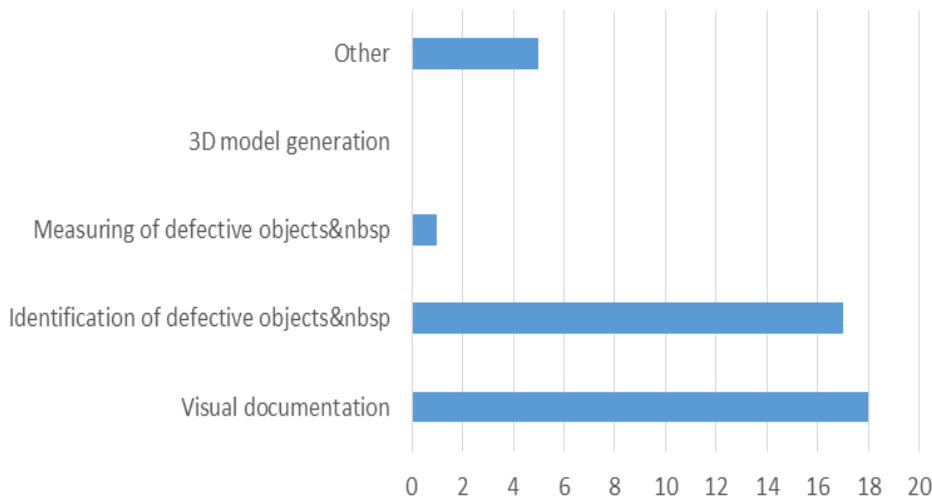
- Most of the inspections are executed by own company staff (18 answers), only one mine does contracting a service provider and in 5 cases official representatives from mining authorities execute additional control inspections (mainly in Europe, partly in South Africa).
- However, from answers to question 23 we learnt that in 15 cases the inspections are obligations by governmental/legal requirement, but at the same time 17 answers pointed also out that there is a Company standard to inspect the shafts.
- In conclusion it is obvious that in minimum in Europe (including former Soviet Union Countries), South Africa and Australia the regular shaft inspection is an important part of mine safety procedures and operational mine efficiency programs.
- However, it can be assumed that the situation in other mining region with underground mines, e.g. North and Latin America or China, might be similar.

Questionnaire - A2. Results from Questionnaires

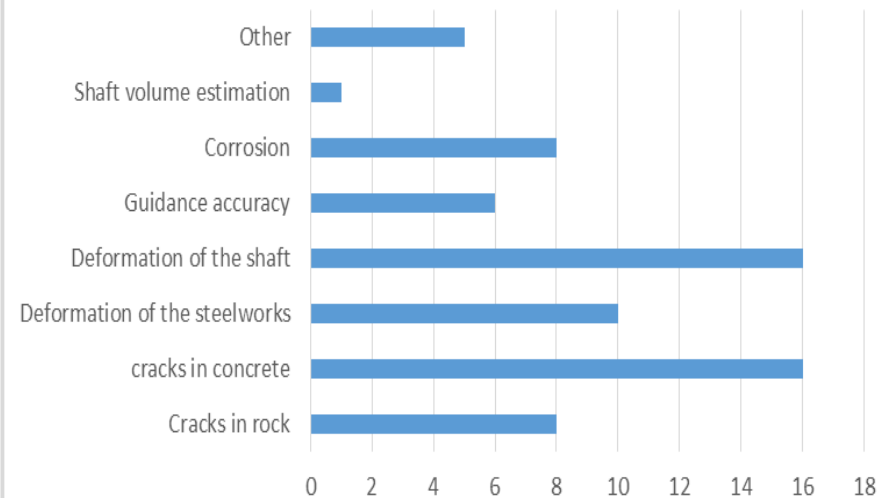
A2.3 Demands on Results from Shaft Inspections

- Finally answers to questions 17 to 22 give us an impression about the requested results as well as the state-of-the-art of execution.
- Figure 8 shows that visual inspection for detection of defect objects is the mostly requested inspection approach, while the range of relevant objects is wide-spread (Question 18, Figure 9).

What are the aimed results of inspection?

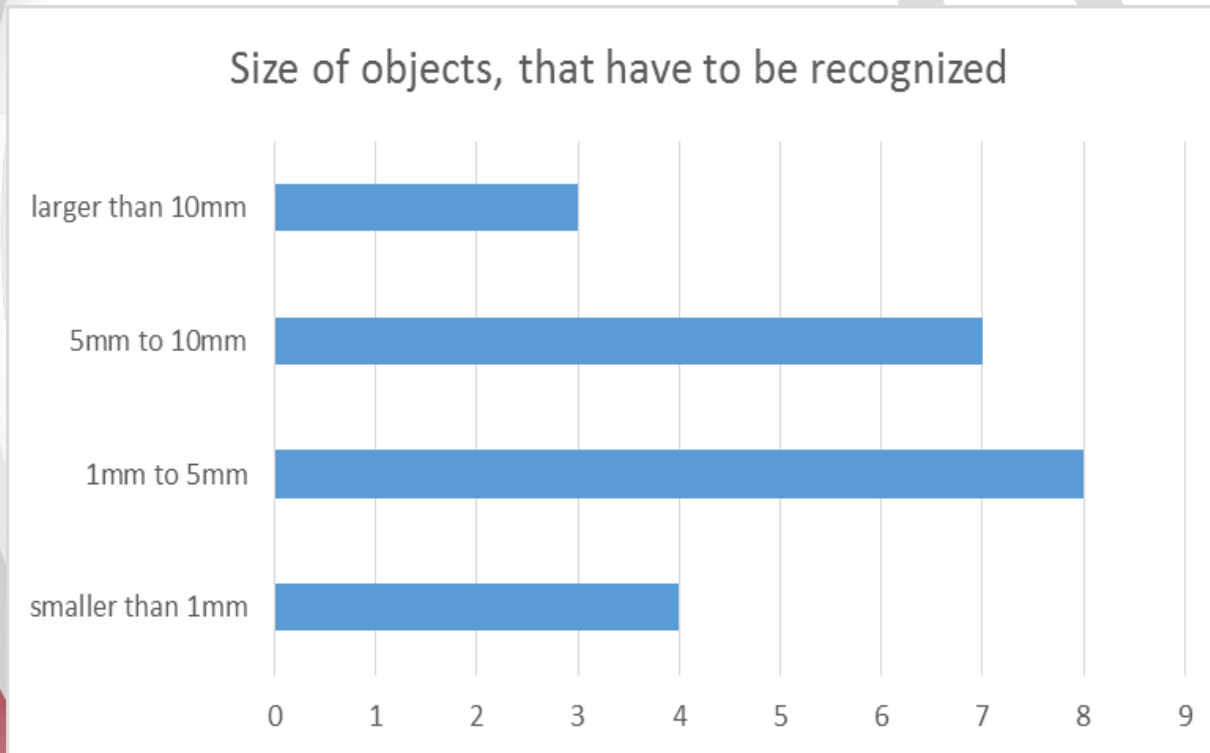


What kinds of objects have to be recognized?



Questionnaire - A2. Results from Questionnaires A2.3 Demands on Results from Shaft Inspections

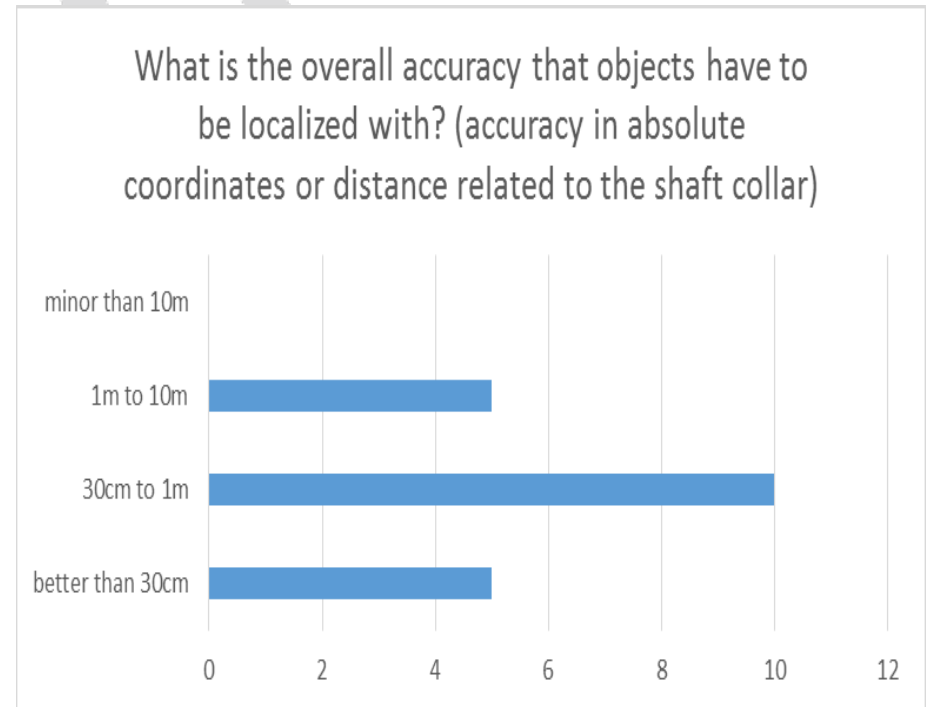
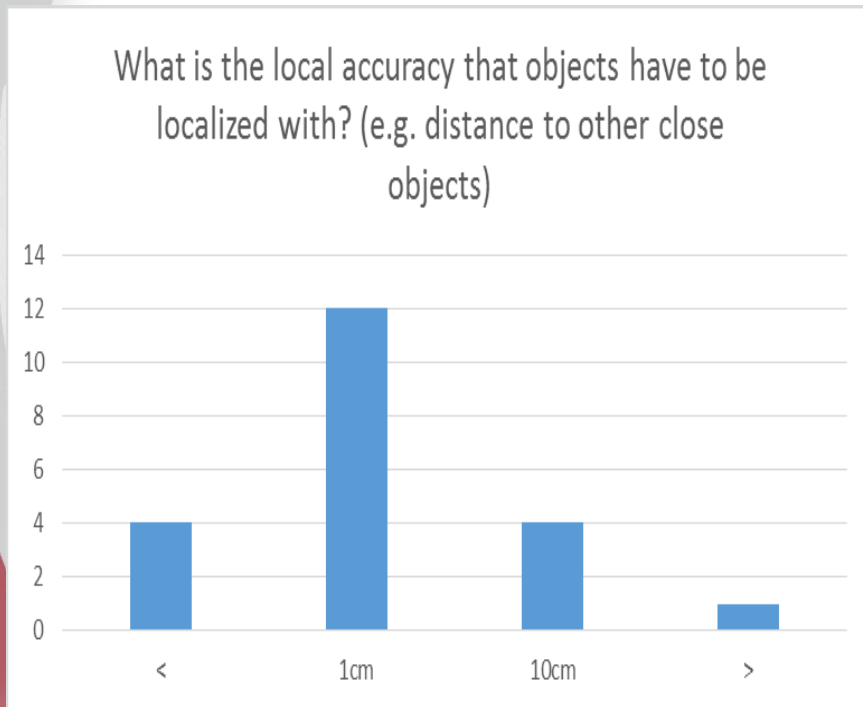
- Questions 20 to 22 ask for size of objects that have to be recognized (Figure 10), as well as for local accuracy (Figure 11) and absolute accuracy (Figure 12).



Questionnaire - A2. Results from Questionnaires

A2.3 Demands on Results from Shaft Inspections

- Questions 20 to 22 ask for size of objects that have to be recognized (Figure 10), as well as for local accuracy (Figure 11) and absolute accuracy (Figure 12).



Questionnaire - A2. Results from Questionnaires

A2.3 Demands on Results from Shaft Inspections

- Even the answered are varying, it is clearly shown that the requirements on detail detection and accuracy are quite high.
- This leads directly to an intensive discussion about the sensors and system design as well as about the features of any data evaluation software tool (see Chapter ...)
- However, under considering these quality demands the answers to Question 19 are in direct contrariness, because mostly all inspections are currently only documented by hand-written records (18 answers), only 6 shaft operations are taking additional photos and only 3 shaft operators are using other documentation feature, unfortunately we got no indication which type of documentation.
- **As a major finding we see that the proposed inspection system has definitely the potential to overcome the discrepancy between needs and currently used approach in terms of quality, reliability and documentation.**