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Health and Safety Executive

# Mobile elevated work platforms

## Phase 3

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Research Report

HSE

Health and Safety Executive

# Mobile elevated work platforms

## Phase 3

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HSE has carried out a programme of research projects focused on MEWPs , in order to provide a better understanding of some of the issues involved and to help work towards their improved and safer design and operation.

An initial phase of work, reported in HSE Research Report RR961, examined the human factors involved in such accidents as a means of identifying possible solutions. The subsequent phase of work (to be published later in 2013) went on to critically evaluate MEWP control interfaces and platform environments.

The work detailed in this current report is the third phase of MEWPs research and has aimed to capture MEWP end users knowledge in relation to the key risk factors for entrapment/crushing whilst operating MEWPS, using insights gained from their experiences of near misses/incidents. Suggestions for how these might be addressed are also considered.

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# KEY MESSAGES

Critical knowledge gaps have been exposed by this research, in particular where end users have explicitly stated that certain issues are not risk factors for entrapment, yet these have been identified as such by subject matter experts.

Mobile Elevated Work Platform (MEWP) training is not fully effective in instilling the right knowledge, both offsite (MEWP training courses) and onsite (inadequate risk assessments, vague emergency procedures, lack of refresher training, lack of toolbox talks and low awareness of the "Best Practice Guidance for MEWPs"). Cumulatively, this may be an indication of industry's lack of comprehension of the risks of entrapment.

This lack of knowledge should be addressed by interventions, for example, enhancing the MEWP training courses and calling for contractors to address the lack of toolbox talks. Particular focus should be placed on the risk factors for entrapment that subject matter experts agree are most critical. A recommendation to achieve this would be to ask industry experts, for example the International Powered Access Federation (IPAF) safety forum, to produce a risk ranking of the critical knowledge gaps, which can then be reflected in a MEWP training programme. It is recommended that additional support be specifically targeted at individual trades where critical knowledge gaps were evident.

There is a lack of standardisation in MEWP control systems design, so that there are safety critical differences in control functions between MEWP manufacturers, and also differences between models within the same manufacturer.

End users suggested ways to improve MEWP design, which demonstrates the importance of effective worker involvement. In the long term, changes should be put in place to establish a standardised MEWP design. In the mean time, an implication for this identified lack of standardisation and consequent negative transfer of learning effect is the necessity for improved on-site familiarisation processes.

Although this research has been focused on the risk factors for entrapment, the implications will be of wider interest and may be common for other risk factors, such as overturning.

# EXECUTIVE SUMMARY


**Background**

There have been a number of fatal and serious accidents in Mobile Elevated Work Platforms (MEWPs) where occupants have become crushed against overhead obstructions. In 2009 the project started by looking at the human factors involved in such accidents as a means of identifying possible solutions. Phase 2 critically evaluated MEWP control interfaces and platform environments. This third stage is aimed at capturing MEWP end users knowledge of the hazards and risks. By comparing this information with that obtained from subject matter experts, knowledge gaps relevant to MEWP crushing/entrapment risks can be identified. Suggestions for how these might be addressed are also considered.

**Aims and Objectives**

The overall aim of this research is to identify knowledge gaps of the end user in relation to the key risk factors for entrapment with insights gained from their experiences of near misses/incidents. The findings will influence ongoing inspection (enforcement and investigation) work and inform sector guidance.

**Methods**

*Capture and illustrate subject matter experts' knowledge on key entrapment risks*

A review of the information ascertained in Phase 1 (PH05097 MEWP Incident Analysis) and Phase 2 (PH05096 Critical Evaluation of MEWP control interfaces and platform environments) was undertaken to identify possible key entrapment risks for a MEWP operator becoming trapped/crushed whilst on the platform. Key risk factors were also extracted from the Best Practice Guidance for MEWPs Annex 1, published by the Construction Plant-hire Association, as this represents the collective knowledge of a host of industry experts.

A group of people recognised by HSE for their expertise of MEWPs, and all with slightly different perspectives (health and safety, engineering, and the delivery of training), were chosen for the subject matter experts' interviews. To verify the key entrapment risks created, a semi-structured open-ended question set was prepared and the resulting interview guide was piloted on an HSL expert. The interviews, with the consent of the interviewees, were recorded and took between 80-120 minutes, and were then transcribed by an external source. The National Centre for Social Research (NATCEN) approach was then used to ensure a standardised technique for eliciting the key themes from the interviews.

*Capture end users knowledge on key entrapment risks*

Thirty end user interviews were undertaken to investigate whether critical concepts of the subject matter expert model are included in the perceptions of operators. The interviews were pre-arranged spanning over 10 different organisations and a number of sub-contractors, and included eight painters and decorators, eight electricians, seven steel erectors and seven racking installers.

A slightly modified semi-structured question set (from the subject matter experts' protocol) was created to ensure that the questions were put in a way that would permit suitable discussion, yet not be too direct or detailed to allow the end users to produce a response if they had not previously been aware of that risk before the interview. The interviews, with the consent of the interviewees, were recorded and took on average 40 minutes. During the interview, photographs of a number of ground and platform control panels and emergency lowering devices were used to act as an aide memoir regarding design issues, and also to help participants to articulate points they were making. As for the subject matter experts, the NATCEN approach

was used to ensure a standardised technique for eliciting the key themes from the end user interviews.

*Identify and present knowledge gaps by use of a mental models diagram.*
In order to map the end users' knowledge onto the subject matter experts' knowledge, a coding system was developed which consisted of the following:

- Knowledge demonstrated (the interviewee discusses the risk factor);
- No knowledge demonstrated (either the interviewee would have articulated that they do not believe that this particular issue is a risk or no mention is made of the issue altogether, either by the topic not being raised at all or by not responding to prompts where stipulated in the interview guide);
- New factors (it was expected that end-users may identify some risk factors not identified by subject matter experts).

**Results**

*A comprehensive list of entrapment risk factors*
A comprehensive list of key entrapment hazard and risk factors was compiled from all expert sources (four subject matter expert interviews, and the results from Phase 1, Phase 2 and Best practice MEWP Guidance) to include over 260 issues. Topic areas include the environment, control errors, human error, lone working, management factors, leaning over/standing on the guard rail, poor observation, condition of MEWP, lack of knowledge/experience, control panel design, poor position of MEWP and poor route planning.

*Painters and decorators' knowledge of the risks of entrapment*
All eight painters and decorators demonstrated their knowledge regarding: uneven ground; leaning over/standing on guard rail; obstructions/obstacles and a need for familiarisation. The painters and decorators *explicitly articulated* that some issues were not risk factors. These included: fatigue and time pressure. There does not appear to be robust failsafe emergency procedures, and nearly half were uncertain whether the risks of entrapment were identified in the risk assessments for their work. New potential risk factors included: operating under the influence of alcohol or drugs, illness, limitations in an operator's neck movements and a lack of driver handover. Risk reduction measures suggested included: a proximity sensor and sounder on platform, solid sided platforms to prevent operators climbing the rails, and simplified control panels to help reduce control errors.

*Electricians' knowledge of the risks of entrapment*
All eight electricians demonstrated their knowledge regarding: inadequate lighting; damaged/obscured legends; obstacles/obstructions; insufficient/lack of access/space; importance of familiarisation; and a lack of familiarisation. The electricians *explicitly articulated* that some issues were not risk factors. These included: distractions, wind, ground obstacles and knocking controls. There does not appear to be enough information provided to the end users regarding the risks of entrapment via risk assessments and toolbox talks. The platform overload cut-out feature was thought beneficial by half the electricians, although a few commented on the design flaw that it consequently left the operator trapped as there is no release feature at platform level. New potential risk factors included: an inappropriate match of operator to task, a lack of toolbox talks for each new MEWP, and the use of incorrect tools/equipment for the task. Risk reduction measures suggested include: a release function on the platform and a purpose built tool storage area.

*Racking installers' knowledge on the risks of entrapment*
All seven racking installers demonstrated their knowledge regarding: lack of competent ground operator; obstacles/obstructions; proximity to structures; and insufficient/lack of access/space. The racking installers *explicitly articulated* that some issues were not risk factors. These included: inadequate lighting, thickness of gloves and outside overhead obstacles. One racking installer stated that the reasoning behind climbing on the guard rails was if operators were too short to reach. However, it is the author's opinion that it may partly be down to incorrect MEWP selection. New potential risk factors included: unauthorised use, other operators ignoring segregation areas, and ground operators ignoring safety procedures. Risk reduction measures suggested include multi-function controls to be equipped with a time delay that would require re-activation and emergency controls to be situated on more than one side (for example, in circumstances where a structure/vehicle is blocking access to one side of the MEWP).

*Steel erectors' knowledge on the risks of entrapment*
All seven steel erectors demonstrated their knowledge regarding: lack of competent ground operator; awareness of legend; obstacles/obstructions; proximity to structures; and lack of knowledge. The steel erectors *explicitly articulated* that some issues were not risk factors. These included: horseplay, leaning over or standing on the guard rail and limited training. One steel erector commented that logbooks are not practical and can be easily misplaced, and that the reasoning behind leaning out over the guard rail was that equipment sometimes catches on steel beams so they need to lean over to release it. New potential risk factors included: operators using a MEWP that's already on site, and an operator unaware that the MEWP platform is resting on a structure e.g. a beam whilst in a stationary position. Risk reduction measures suggested included MEWP training to more closely reflect the realities of site conditions, and the standardisation of lone working procedures across the industry.

## Conclusions

It is intended that the findings of this report will be disseminated to the appropriate stakeholders with a view to influencing positive change within the industry. This should be done by considering the safety issues and knowledge gaps identified, as well as the risk reduction measures suggested by participants. Knowledge gaps may be addressed through revised training content, toolbox talks and improved on-site familiarisation processes.

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# 1. INTRODUCTION

## 1.1 BACKGROUND

There have been a number of fatal and serious accidents in Mobile Elevated Work Platforms (MEWPs) where occupants have become crushed against overhead obstructions. In 2009, this project started by looking at the human factors involved in such accidents as a means of identifying possible solutions. Phase 2 critically evaluated MEWP control interfaces and platform environments.

This third stage is aimed at capturing MEWP end users' knowledge. By comparing this information with that obtained from subject matter experts, knowledge gaps relevant to MEWP crushing/entrapments can be identified. Suggestions for how these might be addressed can also be developed.

## 1.2 AIM AND OBJECTIVES

The overall aim of this research is to identify knowledge gaps of the end user in relation to the key risk factors of entrapment as identified by subject matter experts with insights gained from the end users experiences of near misses/incidents. The findings will influence ongoing inspection (enforcement and investigation) work and inform sector guidance.

The following stages are:

1. Capture and illustrate subject matter experts' knowledge on key entrapment risks;
2. Capture and illustrate end users' knowledge on key entrapment risks;
3. Identify and present knowledge gaps by use of a mental model diagram.

# 2. METHODOLOGY

## 2.1 CAPTURE AND ILLUSTRATE SUBJECT MATTER EXPERTS' KNOWLEDGE ON KEY RISKS OF ENTRAPMENT

### 2.1.1 Ascertaining the key risks of entrapment for a MEWP operator becoming trapped/crushed whilst on the platform

A review of the information found in Phase 1 and Phase 2 of this project was undertaken to identify possible key risks of entrapment for a MEWP operator becoming trapped/crushed whilst on the platform. Phase 1: *Mobile Elevated work platform (MEWP) Incident Analysis* (1) highlighted the key risk factors that contributed to MEWP incidents, with the focus on MEWP occupants being trapped against overhead/adjacent objects whilst in the platform, particularly when the operator becomes trapped over the controls (sustained involuntary operation of controls).

Information for this was obtained from a range of MEWP incidents in the UK, USA, New Zealand and Australia. Forty-seven out of the 290 incidents analysed in Phase 1 involved operators becoming trapped or crushed by the MEWP that they were operating.

Consequently, for this Phase, these 47 incidents were analysed in order to create a list of possible key risks of entrapment/crushing.

Phase 2: *Critical evaluation of mobile elevated work platform control interfaces and platform environments* (2) consisted of a literature review (focused on recognised standards/guidance for control design and layout), task analyses and familiarisation visits in order to obtain information about current MEWP design, control design, platform environments and circumstances of use. Using this information, nine MEWPs were critically evaluated to identify current design features that might contribute to operator entrapment occurring and/or mitigate or exacerbate the severity of the incident. A review of this report produced additional potential key entrapment risks that were incorporated into the list created from the information ascertained in Phase 1.

In addition to a review of Phase 1 and Phase 2, key risk factors have also been extracted from the outputs of the Strategic Forum plant safety group (3), published by the Construction Plant-hire Association, as this represents the collective knowledge of a host of industry experts.

The output was sent to HSE to consider if there were any obvious gaps/omissions. It was considered a comprehensive list and ultimately any other key risk factors missed would be likely to be identified in the subject matter expert interviews, on provision of sufficient prompting.

Refer to Section 3.1, content at Appendix 8, for the key entrapment risks identified.

### 2.1.2 Subject matter experts interviews

A group of people considered and renowned for their expertise of MEWPs, and all with slightly different perspectives (Health and Safety, engineering, and the delivery of training), were chosen for the subject matter experts' interviews.

The interviewees came from two UK market leaders in the rental of powered aerial work platforms and consisted of a:

- Senior training instructor;
- Performance service engineer;

- Director of a leading rental company;
- Qualified trainer and engineer.

To verify the key entrapment risks identified in section 2.1.1 and listed in Appendix 8, a semi-structured question set was prepared based on this list. Advice from a psychologist was sought to help construct open-ended questions to allow the subject matter experts to extract their information. Comments from the customer were also provided on the structure and content of the interview. The resulting interview guide was piloted on an HSL expert who has undertaken both Phase 1 and Phase 2 of the project and who has also successfully completed the IPAF Powered Access Licence (PAL) cardholder training. Following this a few changes were made. The resulting interview guide can be found in Appendix 1.

An information document and consent form was prepared (see Appendices 2 and 3) and given to the interviewee before the interview started.

One researcher conducted two subject matter expert interviews and another researcher conducted the remaining two. It was considered that research bias would not be a problem as both interviewers used the same semi-structured question set. The aim was to elicit as much information as possible about the risks of operating a MEWP in order that a comprehensive and collective picture is made of the subject matter experts' knowledge.

Photographs of different platform and ground control panels and emergency lowering systems were presented to each interviewee to act as an aide memoir regarding design issues, and also to help articulate points they were making (see Appendix 4).

The interviews, with the consent of the interviewees, were recorded and took between 80-120 minutes, and were then transcribed by an external source.

The National Centre for Social Research (NATCEN) approach (4,5) was then used to ensure that a standardised technique was used for eliciting the key themes from the interviews. Following their approach on framework analysis, there are three stages to consider for analysing qualitative data. These are:

1. Data management stage;
2. Descriptive stage/thematic analysis (what);
3. Explanatory stage/thematic analysis (why).

For the purposes of this research, stage 1 and part of stage 2 were used.

The first step of stage one (data management) consisted of familiarisation with the transcripts. A conceptual framework was developed using an Excel spreadsheet (see Appendix 5) where initial concepts/categories were identified. This was derived from the interview questions in Appendix 1. The categories were entered into the spreadsheet in separate columns with each row representing an interview case.

The transcripts were divided up between the two researchers according to who had carried out that particular interview. This enabled the researcher to bear in mind any inferences made in the interview that otherwise may have been lost in written translation.

The transcript data was summarised and entered into the relevant Excel spreadsheet cells. This is essentially compressing long statements into briefer statements in which the main sense of what is said is rephrased in a few words. A line number corresponding to the transcript numbering system followed each summary so that an audit trail is available.

The framework spreadsheet was piloted by a technical expert to check for consistency between the two researchers by comparing category information.

For stage two (descriptive/thematic analysis), elements and dimensions were developed by one of the researchers. This was achieved by selecting each category from the framework template and pasting into different sheets of the excel spreadsheet. Following convention, the case number column was copied and pasted alongside the summarised transcript column in order to identify later, which dimensions belong to which case. Elements/dimensions were developed from the transcript chart by grouping together common ideas and recorded alongside the column. Appendix 6 illustrates the template used to do this and includes a worked example.

The result of this exercise was a list of key elements from the subject matter experts. Please refer to Section 3.2, content at Appendix 9, for this list. An amalgamation of risk factors identified by the subject matter experts and those presented in Appendix 8 is recorded in Section 3.3.

### 2.1.3 Mental Model diagram of subject matter experts' knowledge on the key risk factors of entrapment

The mental model approach as described by Cox et al (2003) and Bostrom et al (1992) (6) consists of the following key points:

- Capture and represent expert understanding/knowledge;
- Map non-expert knowledge/understanding of the same risks using interview protocols derived from the expert model;
- Identify non-experts' knowledge gaps/misunderstandings;
- Develop risk communication materials that target these gaps.

As described earlier, the NATCEN approach was used to capture and analyse the transcripts in order to establish the key aspects of the subject matter experts' knowledge. In order to represent the subject matter experts' knowledge, an influence diagram was created using Microsoft Visio 2003 (refer to Section 3.4, content in Appendix 10). Mental models can be represented in many forms but are usually represented as influence diagrams, *"a directed network that represents dependencies and events in a process"* (6).

The first page of the mental model diagram (Appendix 10) illustrates the top-level risk factors for entrapment. This structured illustration of subject matter experts' knowledge is a subjective representation by the author primarily influenced by the structure of the interviews and responses provided by the subject matter experts. As more risk factors were added to the diagrams, natural headings and links emerged to form what is intended to be a logical framework for representing subject matter experts' knowledge. It is acknowledged that different researchers are likely to illustrate the subject matter experts' knowledge in slightly different structures although content should remain the same. It would be possible to carry on finding links and re-organising but this would be a process with ever diminishing returns.

Subsequent pages illustrate the main risk factors in further detail (as identified in the top level diagram) and captured in red capital letters with links to influencing factors. Risk factors circled but **not** in capital letters are those risk factors that have a number of influencing factors. Links to identified top-level risk factors (circled in capital letters) are also represented. This has resulted in some repetition throughout the model, but has been purposely provided in order that each diagram is a stand-alone page and the reader is able to identify all influential links, rather than requiring reference to multiple pages.

For example, in the diagram 'POOR POSITION OF MEWP', a lack of attention can lead to operators poorly positioning a MEWP; it can also lead to poor observation and control errors. A lack of attention is a factor of human error. Consequently, 'lack of attention' is recognised in the diagrams representing HUMAN ERROR, POOR OBSERVATION and CONTROL ERRORS with links to each one of these risk factors.

Links between the top-level risk factors have not been represented on the top-level diagram as it was considered that this would become very complicated; however each top-level factor has been considered for each main risk factor on their own individual diagrams. For example one diagram may show six top-level risk factor influences, but again their interaction between each other has not been shown but has been represented in the appropriate main risk factor diagram.

Where one risk factor has many influences, detail has not been represented in all diagrams but refers to the diagram where it has. For example, on the diagram CONTROL ERRORS, a risk factor is 'Legend' and reference is made to 'see CONTROL/PANEL DESIGN' where this risk factor has been explored in more detail.

There are a couple of instances where both positive and negative connotations are expressed in relation to certain risk factors. For example, subject matter experts differed in their opinions as to the benefits or otherwise of guarding over the control panel.

Every time an individual operates a MEWP, it would be implausible that all risk factors represented on the diagrams are present, and what may be influential in one situation may not be in another. Consequently, this mental model diagram represents the sum of all risk factors and influences as identified by the four subject matter experts and previous research. Consequently it is acknowledged that there may be risk factors and influential links inadvertently overlooked.

## 2.2 CAPTURE END USERS' KNOWLEDGE ON KEY ENTRAPMENT RISKS

Thirty end user interviews were undertaken to investigate whether critical concepts of the subject matter expert model are included in the perceptions of operators.

The group of interviewees was selected from four identified end user occupational groups as identified by HSE.

They were:

- Painters and decorators (eight participants);
- Electricians (eight participants);
- Steel erectors (seven participants) and;
- Racking installers (seven participants).

HSE and Powered Access Stakeholder assistance was required to provide the necessary contacts for recruiting participants. The interviews were pre-arranged spanning over 10 different organisations and a number of sub-contractors, including industry associations providing participants from their biggest members to those from smaller organisations.

It was thought beneficial to select a number of organisations per occupational group so that a cross-industry snapshot is taken rather than one organisation contributing the beliefs and knowledge on entrapment for that sector. It was also considered beneficial to have end users at varying levels of management responsibility, e.g. directors (10%), supervisors (20%), other management (7%) and operators (63%), to ascertain their views on the key risks of entrapment, should further analysis reveal any interesting differences.

A slightly modified semi-structured question set from the subject matter experts' protocol was created with advice from a psychologist to ensure that the questions were of a structure that would permit suitable discussion, yet not be too direct or detailed to allow the end users to produce a response if they had not previously been aware of that risk before the interview. However, providing prompts for some of the questions was considered necessary as it was thought better than failing to elicit tacit knowledge from the end users.

Comments from the customer were also provided on the content of the interview and also from a pilot of the interview with a colleague who has background knowledge of MEWPs. Slight changes were made accordingly. The resulting interview guide can be found in Appendix 7.

The same information document and consent form used for the subject matter experts was given to each interviewee prior to the interview commencing.

The same two researchers who conducted the subject matter expert interviews conducted the 30 end user interviews. It was considered that research bias would not be a problem as both interviewers used the same semi-structured question set, with the aim of eliciting as much information as possible about the risks of operating a MEWP.

The interviews, with the consent of the interviewees, were recorded and took on average 40 minutes. During the interview, photographs of a number of ground and platform control panels and emergency lowering devices were used to act as an aide memoir regarding design issues and also to help respondents articulate points. Information on critical incidents (if applicable) was also captured in these interviews. An external contractor then transcribed the interview recordings.

As for the subject matter experts, the NATCEN approach was used to ensure a standardised technique for eliciting the key themes from the end user interviews (refer to Section 2.1.2).

## 2.3 IDENTIFY AND PRESENT KNOWLEDGE GAPS BY USE OF A MENTAL MODELS DIAGRAM

The subject matter experts influence diagram was converted into a tabulated format using Microsoft Excel to enable an easier process for comparing the end users' knowledge with the subject matter experts' and to assist comparisons between occupational groups.

In order to map the end users' knowledge onto the subject matter experts' knowledge, a coding system was developed in collaboration with HSE. This consisted of the following:

- Knowledge demonstrated
  - The interviewee discusses the risk factor.

- No knowledge demonstrated
  - There are two strands to this. Either the interviewee would have said that they do not believe that this particular issue is a risk (an incorrect understanding of a risk was treated as being functionally equivalent to no knowledge demonstrated) or no mention is made of the issue altogether, either by the topic not being raised at all or by not responding to prompts where stipulated in the interview guide.

- New factors
  - It was expected that end users might identify some valid risk factors not identified by subject matter experts.

The key elements and dimensions gained from the interviews were then input as a positive response into the appropriate cell for each individual end user, corresponding to the key risk factors identified from the subject matter experts. This indicates an end user demonstrating their knowledge. No response indicates no knowledge was demonstrated. However a distinction is made within this category in the constructed table to indicate where an end user explicitly states that they do not believe that this is a risk factor. Each new risk factor stated by the end users was added to the bottom of the table.
The responses from each occupational group were collectively put side by side in the table. A calculation was made to the number of end users who identified each risk factor and converted into a percentage. For example, four out of eight painters (50%) identified a complicated emergency procedure as a risk factor.

In order to represent this information onto an occupational group influence diagram, each risk factor is represented with a corresponding percentage (rounded to a whole number) of those end users who demonstrated *no knowledge.* This required all percentages on the Excel table to be converted from knowledge to 'no knowledge'. Where no knowledge is shown of the risk factor, text is highlighted red with the percentage of that occupational group who have no knowledge. Consequently, in the example above, 50% of painters demonstrated no knowledge that complicated emergency procedures are a risk factor. Text in Sections 3.5, 3.6, 3.7 and 3.8 accompany each diagram to indicate where an end user explicitly states "this is not a risk factor". Where all end users of that occupational group demonstrate knowledge of the risk factor, the text is highlighted in green. New factors identified by the end users have the font colour orange, with the percentage of users in that occupational group who showed *knowledge* of it.

An amalgamation of all end users' knowledge was made to create an overall end user diagram (refer to Section 3.9 and Appendix 20). This composite diagram is constructed as above, but to summarise:

- No knowledge demonstrated (red font and percentage of those who demonstrated no knowledge);
- New factors (orange font and percentage of those who demonstrated knowledge);
- Knowledge demonstrated (green if all demonstrated knowledge).

Although the subject matter experts' diagrams looked at influencing factors, the end users diagrams are purely to identify whether the end users demonstrated their knowledge of the risk factors regardless of interactions between them. Consequently, the percentages do not add up; for example, three sub-risk factors will not add up to the main risk factor, as one end user may only have identified one of the risks.

# 3. RESULTS

## 3.1 A LIST OF KEY ENTRAPMENT RISKS FROM PREVIOUS WORK

The list in Appendix 8 is the result of a review and collation of Phase 1, 2 and the outputs of the strategic forum plant safety group (3) regarding the risks of entrapment.

## 3.2 A LIST OF KEY ENTRAPMENT RISKS FROM SUBJECT MATTER EXPERTS INTERVIEWS

Appendix 9 is the result of the final distillation of elements and dimensions from the four subject matter expert interviews.

## 3.3 A COLLATED COMPREHENSIVE LIST OF KEY ENTRAPMENT RISKS

The following table (Table 1) lists a combination of key entrapment risk factors from all expert sources (four subject matter expert interviews, and the results from Phase 1, Phase 2 and Best practice MEWP Guidance).

**Table 1** A collation of key entrapment risk factors identified from all expert sources

| | | |
|---|---|---|
| **HUMAN ERROR** | | |
| Lack of/reduced attention | Competition | Motivation to work quickly |
| Lack of care | Complacency | Not thinking |
| Fatigue | Cutting corners | Other demands/multitasking |
| Horseplay | Deliberately | Over confident |
| Influence of others work speed | Distraction | Peer pressure |
| Personal pride | Familiarity e.g. with the route/controls | Poor work attitude |
| Time pressure | State of mind | Poor judgement |
| Lack of worker engagement | Stress | Rushing |
| Work pressures | Skilled operator in one make of MEWP applies procedure to another make of MEWP | Treatment e.g. of MEWP |
| Bypass safety systems | Unauthorised modifications | Heavy handedness |
| Attire | Hypothermia | |
| Colour blindness | Literacy levels | Eye sight/vision |
| Dexterity | Dehydration | Visibility in rain e.g. rain on eye protection |
| Complexity of job | | |
| **LACK OF KNOWLEDGE/EXPERIENCE** | | |
| Lack of/insufficient knowledge/experience | Content of training is inconsistent across training providers | Lack of/insufficient familiarisation |
| Lack of familiarisation with range of control panels | Variability in application of learning | Lack of awareness of risks of entrapment |
| Familiarisation not consistently received | Unfamiliar with MEWP | Lack of awareness of entrapment incidents/fatalities |
| Inadequate training | Limited competence | Awareness of familiarisation |
| Insufficient time on training course | Training can not cover all varieties of MEWPs | |

| CONTROL PANEL DESIGN | | |
|---|---|---|
| Cleanliness of control panel | Awareness of legend | Mixture of proportional and un-proportional controls |
| Poor control design | Legend damaged/obscured | Un-proportional controls |
| Controls not recessed | Legend clarity | Lack of multistep process to activate controls |
| Non functional grouping of controls | Legend low contrast to control panel | Variation in legend position |
| Multi-function controls not beneficial | Lack of wrist support for fine adjustment | Legend unintuitive |
| Multi-function controls beneficial | No/lack of feedback | Lack of colour coding on base and/or controls |
| Control panel layout does not support ambidextrous use | Delays after operating controls | Legend incorrect/unmarked |
| Unable to control drive/lift speed | Complicated controls | Awareness of guarding |
| Visibility of legend | Inconsistent emergency controls | Guarding prevents accidental activation |
| No/lack of sufficient tool storage area | Complicated/time-consuming emergency controls (e.g. number of elements) | Guarding reduces visibility/light onto controls/legends |
| Awareness of emergency controls | Unintuitive emergency controls | Guarding may trap hands |
| Parts missing e.g. lever/instructions of emergency controls | Unclear emergency controls | Control panel layout unclear |
| Height/angle (maybe) of control panel | Lack of awareness of position of emergency controls | Control panel preferences |
| Scissor control panel repositioned incorrectly | Inconsistent control panel layout | Guarding restricts access to controls |
| Visibility of controls/symbols | Control panel in a fixed position | Tools on top of guarding |
| Inconsistency between MEWPS | Inconsistent position of scissor steps | Inconsistent ramp setting |
| Inconsistent control panel layout | Inconsistent pump characteristics | Inconsistent legend design |
| Inconsistent over run/response time | Inconsistent control functions (e.g. reversed) | Inconsistent overload cut off |
| **CONTROL ERRORS** | | |
| Knock controls | Knock controls due to size of controls | Forget to change function |
| Knock controls with body part | Lack of awareness of current mode selection | Unexpected outcomes |
| Knock controls with work materials/tools/clothing | Lack of feedback | Over reaching |
| No dead mans switch/pedal | Thickness of glove | Accidental/incorrect selection |
| MEWP orientation reversed (e.g. forwards is now backwards) | Ineffective or no guarding between controls | Limited space on platform |
| Unnecessary tools | Trip hazards | Other operators on platform |

| CONDITION OF MEWP | | |
|---|---|---|
| Condition of MEWP | Missing operator manual | Poor standard of maintenance e.g. lights not working |
| Mechanical fault | Age of MEWP | Shortage of maintenance personnel |
| Mechanical fault with hydraulics | Standard variations | Visual appearances influences perceptions of condition |
| Speed does not reduce when elevated | After market parts | Competence of maintenance personnel |
| Not maintained to requirements | Off hire treatment | Lack of checks (pre-use/daily/weekly) |
| Lack of/damaged ground key | Poor housekeeping on platform | Lack of lights on MEWP |
| **POOR OBSERVATION** | | |
| Awareness of obstacles/obstructions | Awareness of other plant | Visibility when manoeuvring |
| Overhead obstacles/obstructions | Awareness of people | Lack of segregation between working area and obstacles/obstructions |
| Falling obstacles | Ground obstacles/obstructions | Hidden obstacles/obstructions |
| Moving obstacles/obstructions | Working at height | Perspective at height |
| **POOR ROUTE PLANNING** | | |
| Poor route planning | Insufficient/lack of access/space | Lack of ground checks e.g. working loads |
| **POOR POSITION OF MEWP** | | |
| Proximity | Not allowing sufficient space above guard rail | Moveable control panel |
| Proximity to structures | Proximity to vehicles | Poor position of MEWP |
| **LEANING OVER/STANDING ON GUARDRAIL** | | |
| Leaning over/standing on guard rail | Lack of pre-use survey prior to selection | Incorrect MEWP capabilities |
| Not wearing lanyard | Selection of MEWP on familiarity | MEWP hired on cost |
| Incorrect MEWP selection | Over specification of MEWP | Financial pressure |
| Advice to clients not taken | Inappropriate equipment selection | |
| **ENVIRONMENT** | | |
| Bright sunlight | Cold | Damp |
| Dirt | Dust | Noise |
| Fumes | Uneven ground | Rain |
| Gradient | Vibration | Shadows |
| Ground conditions | Visibility of surroundings | Soft (e.g. mud) |
| Heat | Wet ground | Trenches/excavated |
| Ice | Wind | Winter |
| Inadequate lighting | Platform movements-cantilever effect | Platform movements- time delay from base movement |
| Lightning | Lateral/overloading | Magnification of ground conditions |
| Wind -platform movements | Cold effecting oil viscosity | Lack of MEWP storage from effects of weather |

| | | |
|---|---|---|
| Inconsistencies in how MEWPs cope with weather conditions | | |
| **MANAGEMENT FACTORS** | | |
| Lack of supervisor/manager appreciation of MEWP capabilities and risks re: cold weather | Lack of supervision/management | Managers lack of competence |
| Inadequate site survey/Risk Assessment/Method Statement | Lack of support | Managers lack of knowledge |
| Lack of reporting | Manager in remote location | Managers lack of training |
| Lack of rest periods | Managers lack of awareness of day to day pressure of operators | Working conditions |
| Shift pattern | Secondary status of MEWP relative to main task | |
| **LONE WORKING** | | |
| Lack of competent ground operator | Lone working | Mobile phone beneficial |
| Poor plan to rely on mobile phone | Poor/no emergency plan | Lack of mobile reception if used as part of emergency plan |
| Insufficient permit to work/other site policies | | |

## 3.4 SUBJECT MATTER EXPERTS KNOWLEDGE ON THE RISKS OF ENTRAPMENT

A mental model diagram of the subject matter experts' knowledge on the key risk factors for entrapment is illustrated in Appendix 10.

### 3.4.1 Risk reduction suggestions from subject matter experts

As an addition to the objective of this research, the subject matter experts throughout the interviews suggested risk reduction measures for entrapment. These were thought beneficial for the industry as a whole and have been collated as a list in Appendix 11.

## 3.5 PAINTERS AND DECORATORS' KNOWLEDGE ON THE RISKS OF ENTRAPMENT

Refer to Appendix 12 for the mental model diagram of the painters and decorators combined knowledge on the key risk factors for entrapment when mapped onto the subject matter experts' knowledge.

All eight painters and decorators were male, with experience ranging from approximately 2-30 years, with one at supervisor level. All are IPAF trained for both scissors and booms.

### 3.5.1 Knowledge of risk factors

All eight painters and decorators demonstrated their knowledge on the following risk factors:

- Uneven ground;
- Leaning over/standing on guard rail;
- Obstructions/obstacles;
- Need for familiarisation.

### 3.5.2 No knowledge of risk factors explicitly articulated

An interviewee not broaching a subject throughout the interview was typically used to demonstrate *no knowledge* of that particular risk factor. However, there were occasions where it was *explicitly articulated* that certain issues were not a risk factor for entrapment. These instances have been recognised below, as they are not identifiable from the mental model diagram alone.

- Fatigue (one painter and decorator);
- Time pressure *"There's no chance for a mistake here", "not with us...you're given enough time to do the job right"* (two painters and decorators);
- Awareness of position of emergency controls *"...Can't see anywhere where you couldn't get to them at all"* (one painter and decorator).

### 3.5.3 No knowledge of risk factors

As this occupational group demonstrated a lack of knowledge for the majority of risk factors (of varying degree), a select few (based on what the author perceives as interesting/surprising) have been highlighted below where all 8 demonstrated no knowledge:

- Many issues regarding poor control design were not acknowledged by the painters.

- They did not recognise a lack of feedback from the controls as a risk factor of entrapment.

- Regarding the emergency controls, no painters and decorators demonstrated knowledge regarding complicated or time-consuming controls as a risk factor of entrapment or that parts may be missing, although it would be reasonable to assume that they thought that it would be a factor for injury mitigation, rather than whether entrapment would occur or not.

- Although all painters and decorators were aware of obstacles/obstructions, no painter or decorator was aware of falling obstacles/moving vehicles.

- A lack of training was not considered a risk factor by any of the painters and decorators (conceivably illustrating that 'you don't know what you don't know').

### 3.5.4 Summary of interview discussions

Discussions/issues relevant to the risks of entrapment highlighted in the interview process are summarised below:

- There is debate within the subject matter experts regarding the benefits or otherwise of multifunction controls. One painter and decorator stated that it's *"...best just to leave one lever to do one job"*.

- As one of the subject matter experts noted, and also a painter and decorator, there are inconsistencies between MEWPs, for example the introduced use in some MEWPs of self-correcting controls. *"...A colleague of mine recently came across a machine...this machine automatically changed the sensor so when you went around the other way if you push forward to go forward that's where you'd go, whereas on these machines we're using now, you push forward to go forward you're actually pushing reverse because you've changed the turret by 180 degrees"*. Consequently a learned effect in one MEWP may incorrectly transfer to another MEWP resulting in an unexpected movement outcome.

- It has emerged that the use of hand rests is not favourable. One painter and decorator was unaware of the purpose of a hand rest to help with fine adjustments by stating, *"...they're not worth anything",* another stated that it was uncomfortable to use and another two commented that they do not use them.

- Subject matter experts have acknowledged that there is a lot to cover in a one day training course due to the variation of MEWPs and this was echoed by one painter and decorator who felt that after one days training *"...You're left to fend for yourself after that really"*.

- An area of concern is that the painters and decorators are vague on their emergency procedures. Three painters and decorators made this apparent. For example, when asked what would happen in an emergency situation, answers were *"...attract their attention somehow", "just have to shout verbally or something", "would either phone or shout"* and *"there's nobody really checking on you"*. These are not robust failsafe emergency procedures, especially as an entrapment scenario may result in an inability to attract attention.

- Another area of concern is that there is a lack of knowledge by management as demonstrated by nearly half of the painters and decorators being uncertain whether the risks of entrapment were identified in the risk assessments. *"I don't think ours has entrapment in it. I don't think it has."* Two painters and decorators were not aware that MEWP entrapment incidents have occurred, although two have had personal experiences of near misses.

- A concern is that after a number of years (e.g. a painter and decorator of 20 years experience) they have had no further training, and bad operating habits may have been developed, as well as important safety knowledge forgotten.

- The overload cut off feature was thought to be beneficial by half of the painters (to stop tipping). However, a painter and decorator commented on a flaw of the feature by stating that it is counterproductive as when you get stuck its *"like telling you (you're) in trouble but not letting you out of it",* as the operator in the platform is reliant on a ground operator to lower them down.

- Although knowledge was demonstrated that incorrect MEWP selection is a risk factor, one painter and decorator adds that *"getting the right machine to do the right job on every aspect of the job is nay on impossible"* due to ever changing site conditions.

### 3.5.5 New potential risk factors

New potential risk factors for entrapment identified by the painters and decorators are as follows:

- Guarding was perceived to be beneficial as it prevents the control panel from weather elements and consequently, as the subject matter experts identified, slippery controls. It was also identified as a means to prevent hands from getting crushed due to obstacles outside of the MEWP platform. However, negative comments were that it may encourage some operators to rest their hands on top of the guarding and hence be more susceptible to crushing injuries. It was also commented that some guarding can prevent a MEWP getting to the required position and from the authors perspective, this may encourage operators to lean or stand on the guard rail.
- Operating under the influence of alcohol or drugs (can affect judgement);
- Illness (can affect judgement);
- Limitations in an operator's neck movements (may restrict their observation skills);
- Memory lapse;
- Operator travelling too fast to be able to stop before a possible entrapment scenario
- Not activating stop whilst working from the platform;
- A lack of awareness that controls can fail;
- Inappropriate anchor points for lanyards (could either restrict the operator or give too much flexibility);
- Operators not acting safely;
- A lack of driver handover when the MEWP is delivered.

### 3.5.6 Risk reduction measures

Risk reduction measures for entrapment identified by the painters and decorators are detailed in Appendix 13.

## 3.6 ELECTRICIANS' KNOWLEDGE ON THE RISKS OF ENTRAPMENT

Refer to Appendix 14 for the mental model diagram of the electricians combined knowledge on the key risks of entrapment when mapped onto the subject matter experts' knowledge.

All eight electricians were male, with experience ranging from approximately 3-20 years, with two supervisors and one Health and Safety Officer. All those who specified to the interviewer who they were certified by, were IPAF trained with many predominantly using scissors.

### 3.6.1 Knowledge of risk factors

All eight electricians demonstrated their knowledge on the following risk factors:

- Inadequate lighting;
- Awareness of legend;
- Damaged/obscured legend;
- Obstacles/obstructions;
- Insufficient/lack of access/space;
- Awareness of familiarisation;

- Insufficient familiarisation.

### 3.6.2 No knowledge of risk factors explicitly articulated

Occasions where it was *explicitly articulated* that certain issues were not a risk factor for entrapment were:

- Four electricians commented that there are situations where leaning over/standing on the guard rail is *needed,* for example when you "*…can't see any other way of doing it",* "*…there's no other way of getting into it" or "if the cage is obstructing you*". Leaning over the guard rail however, may be influenced by incorrect MEWP selection;
- Fatigue (one electrician);
- Time pressure *"What as in pressure to get the job done? No, not really no"*(one electrician);
- Distractions *"...not seen personal problems effect work"* (one electrician);
- Wind speed (one electrician);
- Lack of ground key. One electrician stated that the key can be kept in the basket but did not elaborate by identifying that this could be a risk factor;
- Age of MEWP *" no I think they're tested so I don't think the age should make a difference"*(one electrician);
- Ground obstacles. Although all eight electricians acknowledged the risks of entrapment from obstacles/obstructions, one electrician commented that there are *"not usually any"* ground obstacles*;*
- Knock controls *"...not possible"* (one electrician);
- Thickness of gloves (three electricians).

### 3.6.3 No knowledge of risk factors

As this occupational group demonstrated a lack of knowledge for the majority of risk factors (of varying degree), a select few (based on what the author perceives as interesting/surprising) have been highlighted below where all 8 demonstrated no knowledge:

- Although the electricians identified a new risk factor of lack of confidence, none identified that over confidence is also a risk factor for entrapment.

- Many of the key environmental risk factors for entrapment were not recognised, for example cold, damp, ice, noise and shadows.

- All electricians were unaware of the risk of entrapment from a moveable control panel and the increased likelihood of an operator activating the MEWP in the opposite direction from his expectations.

- All were unaware that guarding may reduce the amount of light falling onto the controls and legends and consequently reduces visibility of them.

- No one identified falling obstacles, although all were aware of obstacles with the majority demonstrating knowledge regarding overhead obstructions.

- Knowledge was not demonstrated for the risk factor of a MEWP being inappropriately selected for a task.

### 3.6.4 Summary of interview discussions

Discussions/issues relevant to the risks of entrapment highlighted in the interview process are summarised below:

- Three electricians were perplexed as to the potential (debated) benefits of guarding with the comments *"...no idea why"* it's there*, "not aware"* that it's to prevent accidental activation and another who stated that he could see *"...no benefit safety wise"*.

- It was commented that the colour red is associated with STOP so an emergency lowering device feature that is coded in this colour may not be immediately apparent or intuitive to an operator to use as a function to actively release a trapped operator. *"...A lot of the time the emergency release handle is not exactly the clearest, it doesn't strike you as "this is the emergency release handle." ...say for example...a guy took a heart attack on the platform and he was the only one up there there's no "lets pull this red lever" because you don't know what that lever does and the last thing you want to do is pull that lever when you don't know what it does. Because it might send it up for all you know."*

- There appears to be a lack of information provided to the electricians regarding the risks of entrapment. One electrician was uncertain whether the risks of entrapment were mentioned in the risk assessment, one electrician was unaware that entrapment incidents have occurred when using MEWPs and two others commented that they have had no toolbox talks on issues of entrapment.

- Regarding hand rests, two electricians were unaware as to their purpose *"I wouldn't even know what that was for?" "No I didn't know, I didn't notice them before...we haven't got time for that"* with another stating that they are *"...not needed"*. An additional comment was that the placement of it was too close to the joystick for it to be used comfortably.

- The platform overload cut-out feature was thought beneficial by half the electricians although a few of the electricians commented on the design flaw that it consequently left the operator trapped, as there is no release feature on the platform level. *"I think they could be dangerous...if you go up and you hit something and you haven't noticed it cuts out and you cant go down and you could have your arm or anything crushed...it might be an idea if they could design something that you could release yourself...that's probably the worse, the worse thing I think ...it wouldn't hurt to have it would it...you have got a better chance then of getting down"*.

- Although one of the electricians demonstrated his knowledge regarding the importance of having a competent ground operator it does expose the vagueness in emergency procedures as he commented that *"other colleagues on site would know how to lower the MEWP in an emergency but may not be close by at that specific time"*.

### 3.6.5 New potential risk factors

New potential risk factors for entrapment identified from the electricians are as follows:

- Operators placing or dropping their tools on top of the controls (subject matter experts had highlighted placing tools on top of the *guarding* but not specifically the controls although it could be assumed that this risk factor was covered by subject matter experts as knocking controls with equipment);

- Inadequate position of anchor points for lanyards by either restricting the operator or giving too much flexibility;
- Lack of driver handover on delivery of MEWP;
- Lack of confidence;
- Management pressure *"it's like every other company you've got a manager pushing you, well you know it takes an hour but the manager thinks it takes half an hour to do so your rushing to get a job done";*
- Lack of courage to speak out if one does not feel safe *"you should never feel pressured into doing something that you know is not safe…it does happen if you've not got the***** *[courage] to say I ain't doing that"*;
- Risk taker *"guys take calculated risks and some guys are more risky than others";*
- Culture *"it's a culture thing a lot of the time and I think unfortunately MEWP [operators] fall into that kind of culture that is…they're immune from policies…they've all got superman on their chest";*
- Lack of team morale;
- Work ethic of individual;
- Guarding prevents control panel from weather elements;
- Guarding prevents crushing of hands;
- Poor manoeuvring of MEWP;
- Snow/sleet;
- Poor management attitude;
- Wearing a harness in a scissor lift *"if your wearing a harness it becomes a tangle or a restriction…in that case there's a lot more cause for getting yourself into more [b]other when you've got that tangling you up…there's nowhere even to attach a harness in a scissor lift…so you end up finding guys putting them on all the wrong bits of equipment just so someone walks around and sees that they're doing it";*
- Visibility of the ground when the platform is extended;
- MEWP not being visible to others on site;
- Inappropriate match of operator to task;
- Lack of toolbox talks for each new MEWP;
- Incorrect tools/equipment for task;
- Inaccuracies of controls;
- Weather effects on the workings of the MEWP. The subject matter experts acknowledge a risk factor that *management* are not aware of weather effects on a MEWP.

### 3.6.6 Risk reduction measures

Risk reduction measures for entrapment identified by the electricians are detailed in Appendix 15.

## 3.7 RACKING INSTALLERS' KNOWLEDGE ON THE RISKS OF ENTRAPMENT

Refer to Appendix 16 for the influence diagram of the combined racking installers' knowledge on the key risk factors for entrapment when mapped onto the subject matter experts' knowledge.

All seven racking installers were male with experience ranging from approximately 2.5 months to 27 years, including one supervisor, three directors and one project manager. Aside from the project manager, who has had experience of driving MEWPs and is responsible for the correct selection of MEWPs, all racking installers predominantly use scissor lifts although they are trained in both scissors and booms.

### 3.7.1 Knowledge of risk factors

All seven racking installers demonstrated their knowledge on the following risk factors:

- Lack of competent ground operator;
- Obstacles/obstructions;
- Proximity to structures;
- Insufficient/lack of access/space.

### 3.7.2 No knowledge of risk factors explicitly articulated

There were occasions where it was *explicitly articulated* that certain issues were not a risk factor for entrapment. The most inexperienced racking installer (2.5 months) articulated a lack of knowledge regarding the following key risk factors:

- Extremes of weather;
- Wind *"not for entrapment";*
- Inadequate lighting;
- Platform movements *"Maybe wobbly but can not see how you can trap yourself";*
- Thickness of gloves.

Additionally, other racking installers articulated a lack of knowledge on the following issues:

- Fatigue of operator;
- Inadequate lighting;
- Age of MEWP (although this racking installer commented that it was more condition than age, which is a valid reason);
- Leaning over/standing on guardrail *"for accessibility";*
- Overhead obstacles (outside) *"there's normally nothing above you apart from clouds".*

### 3.7.3 No knowledge of risk factors

As this occupational group demonstrated a lack of knowledge for the majority of risk factors (of varying degree), a select few (based on what the author perceives as interesting/surprising) have been highlighted below where all 7 demonstrated no knowledge:

- In relation to the environment, many risk factors were not identified and all racking installers did not identify (for example) gradient, ground and wet conditions. This may be due to racking installers predominantly working inside;

- No knowledge was demonstrated for poor route planning as a risk factor of entrapment;

- No knowledge was demonstrated for inadequate training as a risk factor of entrapment.

### 3.7.4 Summary of interview discussions

Discussions/issues relevant to the risks of entrapment highlighted in the interview process have been summarised below:

- An area of concern is that three racking installers explicitly stated that the risk assessments for their work do not mention the risk of entrapment. A fourth racking installer was unsure, and it is considered that it did not, as his response was "…*like a rescue plan*" and another stated that it would *"just come under working at height won't it?"* Consequently, it is considered that over half of the racking installers interviewed were not provided with knowledge regarding the risks of entrapment. This is especially alarming considering that one of the racking installers is responsible for preparing risk assessments, although he has subsequently acknowledged that these would now be altered to include this issue. Further evidence of a lack of knowledge is that one of the racking installers is unaware that entrapment incidents have occurred, whilst three others have had no toolbox talks regarding the risk of entrapment and two of them have been operating MEWPs for 10-17 years. Consequently, it is unlikely that many of the racking installers are able to learn about the risks of entrapment.

- Five racking installers stated that they were unaware of the hand rest feature *"I haven't noticed that but why would you particularly need a hand rest? I can't see the point of the hand rest."*

- Six racking installers commented that the overload feature was beneficial as many operators are likely to be unaware of the weight of their tools *"I think they're a good idea, because most people don't weigh anything they put in [the] scissor lift. As a general rule, I think it'd probably be better if they all had one because you chuck your tools in and you don't carry scales about."* However, it was commented that a ground operator is required to release the platform operator.

- A concern from one of the racking installers was that once you are certified, there are essentially no restrictions on the size of the machine that you can operate.

- It was commented by one racking installer that operators of a shorter stature may climb onto the guard rail (although the author acknowledges that this may be due to incorrect MEWP selection).

### 3.7.5 New potential risk factors

New potential risk factors for entrapment identified from the racking installers are as follows:

- Under the influence of drugs or alcohol;
- Memory lapse *"If they're doing something repetitive and they just get used to pressing certain things and then they just sort of have a lapse and then they press the wrong button or something";*
- Lack of driver handover on delivery of MEWP *"...once you sign it off the gentleman that drops the equipment off should instruct you on how to do it…but nine times out of ten they're already dropped off before you actually get there";*
- Unauthorised use *"...they have not been qualified and they have not got a license and trained to operate it. To be fair, I mean a long, long time ago, people used to drive them and they didn't have licenses and they didn't exist it was just a person that looked competent and seemed to know what they were doing and they'd jump on it and use it, but I mean that has all changed nowadays";*
- Poor manoeuvring of MEWP;
- Snow/sleet;

- Other operators ignoring segregation areas *"...because even though we barrier areas off you get people that come through your barriers..." and "...we do actually have barriers to cordon the area off although you do get, not personal entrapment but you do get staff that decide to, shall we say, ignore the barriers. They work there so they feel entitled to breach the cordon";*
- Ground operators ignoring safety procedures *"...you get people that come through your barriers and if it were dark...and they didn't have on their hi-vis vest, there's a chance you might not see them";*
- Magnification of bumps when the platform is extended;
- Tools placed on or dropped onto the controls;
- Unenthusiastic operators;
- Lack of communication for example to the grounds person;
- Correct MEWP not in stock and hence the hire company send the incorrect MEWP;
- Management pressure;
- Poor management attitude;
- Contrary to the subject matter experts, racking installers have identified accessible emergency controls as a risk factor as this does not prevent horseplay;
- Not working in designated areas;
- Wearing harness *"...if it does go over and your harnessed in [a scissor] and it falls on you then you've no chance have you...it's a bad idea. Because if it goes you can't jump free of it can you? Your just stuck";*
- Deafness/hard of hearing*;*
- Height of operator in relation to guarding *"...sometimes its hard to get them into the exact place that you want to get them because there's stock in way and barriers in way and when your only after an extra inch or two then you just want to stand...";*
- Slow reaction times;
- Incorrect information provided to hirer.

### 3.7.6 Risk reduction measures

Risk reduction measures for entrapment identified by the racking installers are detailed in Appendix 17.

## 3.8 STEEL ERECTORS' KNOWLEDGE ON THE RISKS OF ENTRAPMENT

Refer to Appendix 18 for the influence diagram of the steel erectors combined knowledge on the risks of entrapment when mapped onto the subject matter experts' knowledge.

All seven steel erectors were male with experience ranging from approximately 3 - over 8 years with two end users at supervisor level. The majority are IPAF trained for both scissors and booms.

### 3.8.1 Knowledge of risk factors

All seven steel erectors demonstrated their knowledge on the following risk factors:

- Lack of competent ground operator;
- Legend;

- Obstacles/obstructions;
- Proximity to structures;
- Lack of knowledge.

### 3.8.2 No knowledge of risk factors explicitly articulated

Occasions where it was *explicitly articulated* that certain issues were not a risk factor for entrapment were:

- Horseplay *"...does not come into it"* (one steel erector);
- Age of MEWP …but *"...depends on maintenance"* which is a valid point;
- Leaning over or standing on the guardrail *"...as I'm short that's why*", *"...its just one of those things", "...occasions when need to"*(three steel erectors);
- Awareness of position of emergency controls, *"...not thought about it before", "...never come across it where can't be easily accessed"* (two steel erectors);
- Thickness of gloves *"...doesn't affect control usage"*(three steel erectors);

### 3.8.3 No knowledge of risk factors

As this occupational group demonstrated a lack of knowledge for the majority of risk factors (of varying degree), a select few (based on what the author perceives as interesting/surprising) have been highlighted below where all 7 demonstrated no knowledge:

- All steel erectors were unaware about some of the risks of the environment for example, bright sunlight, cold, damp, heat, noise, shadows and maintaining a safe distance from excavations to prevent the edges giving way into the trench;

- All steel erectors did not mention a lack of wrist support for fine adjustment as a risk factor for entrapment;

- No knowledge was demonstrated that guarding can restrict access to the controls;

- Although all steel erectors knew about obstacles as a risk factor, they did not mention falling or moving obstacles;

- Steel erectors did not demonstrate knowledge about allowing sufficient space above the guard rail;

- No knowledge was demonstrated for a risk factor of operators forgetting to change function on a multi-function control.

### 3.8.4 Summary of interview discussions

Discussions/issues relevant to the risks of entrapment highlighted in the interview process have been summarised below:

- One steel erector explicitly stated that the risk assessments do not identify the risks of entrapment and a second steel erector, when asked about this commented, *"...ground would be the only reason".* This shows a lack of knowledge regarding the risks of entrapment.

- Steel erectors commented that there's *"...usually somebody not too far"*, *"...you might not be able to see them but they know that you are there"* and *"...you'd hear someone scream"* in response to their emergency procedure. These are not robust failsafe emergency procedures especially in an entrapment scenario where the operator may lose the ability to communicate.

- Six steel erectors commented that the overload feature was beneficial as it was hard to judge equipment weight. However, it was commented that a negative aspect of it was that it could lead to the operator getting stuck at height due to no release feature on the platform. *"Well sometimes you do get wedged up against the steel you know, your basket could be touching too much…but some baskets or machines are different to others, you know, its very hard to get two machines the same…I mean with some machines you could just touch a bit of steel there and it jams, just stops…you get somebody else to move if for you…some machines do let you and some wont… [If it worked] it'd be a lot easier to get yourself out of.."*

- In regard to hand rests, steel erectors commented that they were not aware of the function or that it was there *"I don't even know why that's there, it's pretty pointless really"* and others commented that it would be awkward to use whilst operating the control *"I cant say I've ever used them anyway…I mean it's a bit awkward anyway because you have to lift that to get it to operate anyway."*

- It was commented that symbols are better than words; multi-function controls are beneficial as they speed up operations but on the negative side they are *"... easy to get confused like that so your better off having it totally separate",* and that larger controls are preferred.

- One steel erector commented that logbooks are not practical and can be easily misplaced.

- Reasoning behind leaning out over the guard rail was that equipment sometimes catches on steel beams *"...lean out sometimes when the net's caught, and then you have to lean out…putting nets up you see and taking them down…sometimes you've got the net, you've got to lean over for it, its just one of them things".*

### 3.8.5 New potential risk factors

New potential risk factors for entrapment identified from the steel erectors are as follows:

- Guarding prevents hands becoming crushed;
- Operators using a MEWP that's already there;
- Memory lapse *"sometimes you just forget you know";*
- Training does not cover all ground conditions;
- Use of MEWP when aware it is faulty *"...could have one where the flashing light…anything like that the warning light, the buzzers not working, certain hydraulic controls don't go up or down, you cant use it then";*
- Unauthorised use - all keys fit all machines;
- Lack of confidence *"you find that…people that…just got the training for the MEWPs, they just come to site and you say put that net up and they're like, you can tell, you can tell they're not very confident in their ability I suppose…but if all you've been shown is to go up and down and touch a light then, you know its, your not gonna be confident are you?";*
- Ever changing site conditions and consequently incorrect MEWP selection *"things can change overnight, they could come one week and then something could change when we come to site say the week after. Ground conditions can change or the circumstances can change, a lot of things can happen in a week or so";*

- No guarding;
- Panicked *"if the pressure is on people there starting to panic a bit and you know, you would, people are inclined, you're inclined to make mistakes";*
- Lack of 'all else fails' emergency pump on some MEWPs *"…they should all really have, have the pump system as well because that's if everything else fails…so basically you always will get down";*
- Training not carried out on a variety of site conditions;
- Poor manoeuvring of MEWP;
- Inadequate preparation of ground;
- Snow/sleet;
- Other operators ignoring segregation areas *"I mean we're bunting off on site here but as soon as you put bunting up it attracts people under…just easier to walk under*";
- Tools placed or dropped onto the controls *"well you shouldn't obviously put them on the controls";*
- Resting platform on structure (unaware) then it falls when drive away *"say if there's a beam underneath you and you lowering him down and the beam holds your basket up and then when you drive off your basket will just fall";*
- Working under the influence e.g. drugs/alcohol;
- If a beam for example hit them from behind, they may get trapped between the beam and the guarding;
- Poor work methods.

### 3.8.6 Risk reduction measures

Risk reduction measures for entrapment identified by the steel erectors are detailed in Appendix 19.

## 3.9 THE COMBINED END USERS KNOWLEDGE ON THE RISKS OF ENTRAPMENT

Refer to Appendix 20 for the influence diagram of the combined users' knowledge mapped onto the subject matter experts' knowledge for key entrapment risks.

All 30 end users were male, with experience ranging from approximately 2.5 months – 30 years with six at supervisor level, one health and safety officer, one project manager, three directors and 19 operators. The majority are IPAF trained for both scissors and booms, however racking installers and electricians predominantly use scissors.

### 3.9.1 No knowledge of risk factors explicitly articulated

Interviewees not broaching topics throughout the interviews were typically used to demonstrate *no knowledge* of that particular risk factor. However, there were occasions where it was *explicitly articulated* that certain issues were not a risk factor for entrapment. These instances have been collated for all end users, as they are not identifiable from the influence diagram alone:

- Fatigue;
- Time pressure;
- Horseplay;
- Distractions (personal problems);

- Access to emergency controls;
- Hand rests for fine adjustment;
- Lack of ground key;
- Age of MEWP;
- Benefits of guarding;
- Inadequate time for training for a wide variety of MEWPs;
- Leaning over or standing on the guard rail;
- Knocking controls;
- Thickness of glove;
- Extremes of weather;
- Inadequate lighting;
- Wind;
- Ground obstacles;
- Overhead obstacles;
- Platform movements.

It is a concern that these issues are clearly articulated as non-risk factors for entrapment by some end users (especially leaning over or standing on the guard rail which amounted to just under a quarter of the end users commenting on this). It is consequently suggested that these risk factors are target areas for interventions.

### 3.9.2 Knowledge of risk factors

Another area of concern is that there was only one risk factor for entrapment that all 30 end users could demonstrate a knowledge of: obstacles/obstructions.

Exploring this risk factor further reveals that 57% were aware of overhead obstacles presenting a risk factor for entrapment, 43% of ground obstacles, 27% for hidden obstacles, 17% aware of people, 7% of other plant and 3% from falling obstacles as a risk factor for entrapment. A lack of segregation from such risks was mentioned by 30% of end users.

However there were other areas where the majority of end users demonstrated knowledge about a particular risk factor. One such risk factor was '*legend'* with 80% acknowledging that it was a risk factor to entrapment if it is damaged or obscured (which may suggest the user is heavily reliant on the legend to tell them 'what control does what'); 47% demonstrating knowledge of the importance of legend clarity; and 23% commenting on an incorrect or unmarked legend; 13% of an unintuitive legend and; 3% for a legend varying in position between MEWPs.

Ninety percent of end users demonstrated knowledge of insufficient/lack of access/space as a risk factor for entrapment.

Ninety percent of end users were aware of the importance of familiarisation, with 60% indicating that a lack of or insufficient familiarisation is a risk factor. However 37% acknowledge that a risk factor is a lack of familiarisation with a range of control panels, and 10% identify that familiarisation is not consistently received.

### 3.9.3 No knowledge of risk factors

There were many knowledge gaps evident in the combined model relating to the risk of entrapment where *all* interviewees demonstrated no knowledge, either by not mentioning the risk factor, or by specifically articulating that it was not a risk factor. These risk factors are

displayed below. In the authors opinion it is conceivable why the end users have not mentioned many of these risk factors, as they are highly focused/specific. For example, various risk factors are subsidiary to those that may have been identified by some operators in a more general way such as the risk factor "cold" (but no further elaboration has been made to detail specifically "hypothermia"). Comment has been made in the table (in the authors opinion) on the risk factors that are likely to be implausible for operators to acknowledge.

**Table 2 Risk factors where no knowledge was demonstrated**

| | | |
|---|---|---|
| **HUMAN ERROR** | | |
| Competition between operators | Lack of worker engagement | Not thinking |
| Influence of others work speeds | Over confident | Personal pride |
| Stress | Colour blindness | Hypothermia *(too specific, more likely to be "cold" that is identified)* |
| Heavy handedness | Treatment of MEWP *(too specific, more likely be "condition of MEWP" that is identified)* | Literacy levels *(too specific, more likely to be "legend" that is identified)* |
| **LACK OF KNOWLEDGE/EXPERIENCE** | | |
| Variability in application of learning *(the end user is unlikely to be able to comment on this risk factor if they have only had training by one provider)* | Inconsistent training across training providers *(the end user is unlikely to be able to comment on this risk factor if they have only had training by one provider)* | |
| **CONTROL PANEL DESIGN** | | |
| Poor control design *(although this generalised risk factor was not mentioned specifically, some operators were aware of subsidiary risk factors, for example complicated controls)* | Controls not recessed | Non-functional grouping of controls |
| Unable to control drive/lift speed | Control panel in fixed position | Guarding may trap hands |
| Delays in control response | Mixture of proportional and un-proportional controls | Inconsistent position of scissor steps |
| Inconsistent pump characteristics *(highly specific)* | Unintuitive emergency controls *(this could be perceived as injury mitigation rather than a risk factor for entrapment)* | |
| **CONTROL ERRORS** | | |
| Height/angle of control panel | | |
| **CONDITION OF MEWP** | | |
| After market parts (*implausible to assume operators would know this)* | Shortage of maintenance personnel *(implausible to assume operators would know this)* | Standard variations (*implausible to assume operators would know this)* |
| **ENVIRONMENT** | | |
| Fumes | Heat | Vibration |
| Damp | Dirt | Dust |
| Cold effecting oil viscosity *(highly specific)* | Poor storage – effects of weather on MEWP | Platform movements - time delay from base movement |
| **LEANING OVER/STANDING ON GUARDRAIL** | | |
| Advice to clients not taken *(the majority of end-users would not be involved in this decision process)* | MEWPs hired on cost *(the majority of end-users would not be involved in this decision process)* | |
| **MANAGEMENT FACTORS** | | |
| Managers lack of knowledge *(implausible to assume operators would* | Managers lack of training *(implausible to assume operators would* | Working conditions |

| | | |
|---|---|---|
| *know this)* | *know this)* | |
| Managers lack of awareness of day to day pressures of operators *(implausible to assume operators would know this)* | Lack of supervisor/manager appreciation and risks re: cold weather *(implausible to assume operators would know this)* | |
| **LONE WORKING** | | |
| Poor plan to rely on mobile phone *((this could be perceived as incident mitigation rather than a risk factor for entrapment)* | Mobile phone beneficial *(this could be perceived as incident mitigation rather than a risk factor for entrapment)* | |

This table demonstrates where all end users have no knowledge and consequently intervention methods should aim to target those thought most important in addition to the risk factors where end users explicitly articulated a lack of knowledge.

A number of risk factors have been selected (based on the authors opinion of their considered apparent risk for entrapment) with their corresponding percentage of end users who demonstrated knowledge in this area (detailed in Appendix 21). Implementing a subject matter expert's risk ranking of the identified risk factors would help to identify priorities for action.

### 3.9.4 Summary of interview discussions

Discussions/issues relevant to the risks of entrapment highlighted in the interview process have been summarised below:

Improvements need to be made to emergency procedures. It was a concern that many remarks by the end users revealed vagueness on what would happen in an emergency situation. For example, when asked what would happen in an emergency situation, typical example answers were, *"...attract their attention somehow"* and *"would either phone or shout"*. These are not robust failsafe emergency procedures, especially as entrapment scenarios may leave an operator with the inability to communicate.

In regard to providing operators with knowledge of risk factors for entrapment, some end users were unaware that entrapment incidents have occurred when using MEWPs and others commented that they have had no further training or toolbox talks on issues of entrapment. There were no end users who indicated awareness of the Best Practice Guidance for MEWPs. Additionally, end users stated that they were uncertain whether the risk assessments included the risks of entrapment whilst using a MEWP. This is a worrying combination, as it appears that many end users are not provided with an understanding of the risks of entrapment. This is a key area where intervention methods may be effective.
The platform overload cut-out feature was thought beneficial by many end users to help prevent the MEWP tipping, although many identified a design flaw that consequently left the operator trapped due to the lack of a release feature on the platform. It is considered that this could be explored further as it is a noticeable issue for many MEWP end users (and a subject matter expert also identified this issue as needing more investigation due to the inconsistencies between MEWPs).

More information needs to be provided to end users regarding the purpose of hand rests to support fine adjustments of the MEWP as many end users were unaware of this functionality, with some stating that they were not necessary. Additional comments were that the placement of the hand rest was too close to the joystick and that it was uncomfortable so this may need investigating.

Both subject matter experts and end users alike raised both positive and negative issues regarding guarding around the control panel. In summary, guarding was perceived to be beneficial because it prevents accidental activation of the controls, prevents hands getting crushed and limits the effects of the weather on the control panel. However, negative comments were that it may encourage operators to rest their hands on top of the guarding and therefore be more prone to crushing. Placing tools on top of the guarding may restrict visibility of the controls and legend. Additionally, the presence of the guarding may prevent light reaching the control panel and consequently visibility of the controls and symbols may be reduced. It was also commented that the presence of guarding might restrict where the operator wishes to position the MEWP. Guarding was also said to restrict hand access to the controls.

Insights have been gained from incidents or near misses that end users have directly experienced or witnessed or have good information about. Extracts from the interview dialogue have been collated in Appendix 22 to reflect this. Risk factors common to these incidents were ground conditions, overhead obstacles, moving plant, proximity to structures, poor observation, standing on the guardrail, poor attitude, lack of concentration, lack of experience, insufficient/lack of access, MEWP as a secondary task, cutting corners, unauthorised modifications, unfamiliarity and lack of awareness that the MEWP basket is resting on a structure.

### 3.9.5 New potential risk factors

Although the overall aim was to identify knowledge gaps between the end users and subject matter experts, some gaps were also identified in the subject matter experts' knowledge regarding possible risk factors for entrapment. It is acknowledged by the author that subject matter experts would almost certainly have been aware of some of these risk factors and it was just that the interviews failed to elicit them. Additionally, some of these issues are very similar to those identified by the subject matter experts, and could be used to demonstrate end users' knowledge, however for completeness, all are listed below. It is worth pointing out that these are only potential risk factors, and that after reviewing this list the subject matter experts may indicate that some do not present a risk of entrapment.

**Table 3 Potential risk factors identified by the end users**

| **HUMAN ERROR/INDIVIDUAL** | | |
|---|---|---|
| Illness | Memory lapse | Unauthorised use |
| Under the influence (e.g. drugs/alcohol); | Lack of confidence | Lack of communication (e.g. to grounds operators) |
| Panicked | Unenthusiastic | Slow reaction times |
| Work ethic | Deafness/hard of hearing | Lack of courage to speak out if not feeling safe |
| Lack of team morale | Risk taker | Culture |
| **LACK OF KNOWLEDGE/TRAINING** | | |
| Lack of driver handover | Travelling too fast to stop | Training not carried out on a variety of site conditions |
| Training does not cover all ground conditions | Lack of toolbox talks (for each new MEWP) | Not activating STOP whilst elevated |
| **CONTROL PANEL DESIGN** | | |
| Guarding restricts manoeuvrability of MEWP | Guarding encourages hands to rest on top of it | Guarding prevents the effects of weather on the control panel |

| | | |
|---|---|---|
| Red associated with STOP not to actively release the platform | Guarding prevents hands becoming crushed | No guarding |
| Accessible emergency controls | Lack of "all else fails" emergency pump | Guarding can contribute to entrapment |
| **CONTROL ERRORS** | | |
| Inaccuracies of controls | Tools dropped/placed on controls | |
| **CONDITION OF MEWP** | | |
| Use of MEWP when aware its faulty | Unaware that mechanics can fail | |
| **POOR OBSERVATION** | | |
| MEWP not visible to others | Inadequate preparation of ground | Other operators ignoring segregation areas |
| Lack of operator mobility in neck | Platform extended | |
| **POOR ROUTE PLANNING** | | |
| Poor work methods | | |
| **POOR POSITION OF MEWP** | | |
| Lack of communication to ground operator | Manoeuvring MEWP | Resting platform on structure (unaware) then when drive it falls |
| Not working in designated area | | |
| **LEANING OVER/STANDING ON GUARDRAIL** | | |
| Ever changing site conditions | Operators using a MEWP that's already there | Correct MEWP not in stock-hire company send incorrect MEWP |
| Incorrect information provided to hirer | Wearing a lanyard | Inadequate position of anchor points for lanyard |
| **ENVIRONMENT** | | |
| Weather effects operation of MEWP | Snow/sleet | Platform extended magnifies ground conditions |
| Protecting oneself from weather elements rather than observation | Deafness/hard of hearing | |
| **MANAGEMENT FACTORS** | | |
| Inappropriate match of operator to job | Other operators not safely operating their MEWP | Ground operators ignoring safety procedures |
| Incorrect tools/equipment for task | Unauthorised use | Management pressure |
| Poor management attitude | | |

### 3.9.6 Risk reduction measures

Risk reduction measures suggested by both subject matter experts and end users have been collated and listed below. More detail on each measure is detailed in Appendices 11, 13, 15, 17 and 19.

**MEWP Design Enhancements**

- Built in temperature display

- Built in anemometer
- Built in light monitor
- Improved tool storage areas
- Solid platform side
- STOP control to be at front of panel
- Proximity sensor/sounder on platform
- Simplified control panel
- Hydraulic levelling
- Emergency controls situated on more than one side
- Improved position of anchor points
- Improved overload feature (consistency between MEWPs)
- Release function on platform
- Multifunction controls with time delay feature

**Standardisation across MEWPs of:**
- Control panel layouts
- Factory settings
- Symbols
- Control functions
- Emergency controls and position
- Rebuild cycle
- Lone working procedures

**Training Improvements:**
- To reflect more site conditions
- Longer
- Refresher courses for occasional users
- Consistency across providers
- Requirement for managers to attend MEWP for Managers

**Individual:**
- Mandatory eye tests
- Encourage reporting of unsafe acts
- Charge operator for damage
- Licensed for both scissors and booms regardless of use

**Other**
- Pragmatic familiarity procedures
- Better communication of MEWP developments
- Better management of different trades on site

It is hoped that these risk reduction measures will be disseminated to the appropriate key influential stakeholders to influence positive design changes and contribute as one way to reduce the risks of entrapment.

# 4. IMPLICATIONS

- Off site training is not fully effective

Implications of the finding that 19 key issues (identified by subject matter experts as risk factors for entrapment) were clearly articulated as "non risk factors" for entrapment by some end users is that off site training may not be fully effective. For example, just under a quarter of end users articulated that leaning over or standing on the guardrail would not be a risk factor for entrapment.

Although the overall aim was to identify knowledge gaps in the end user population, gaps were also identified in the subject matter experts' knowledge. It is not possible to specify whether these were omissions by the subject matter experts when recalling their knowledge, or whether they are indeed new potential key risk factors identified by those that operate MEWPs on a regular basis.

An implication of the identified critical knowledge gaps is that current MEWP training material needs to be revised (with suggested emphasis on risk factors that were explicitly stated as "non" risk factors by end users in this research). This should be combined with effective training techniques to aid learning. It may also be that those involved in disseminating MEWP knowledge on the key risk factors of entrapment are advised to review the new potential key risk factors identified by the end users to determine which (if any) of these issues are most critical and should be added to the training material.

- On site training is not fully effective

It is a concern that many remarks by the end users revealed vagueness on the procedures in an emergency situation. The research also revealed that some end users are not provided with adequate information regarding key risk factors for entrapment. This was evidenced by research findings which confirmed a lack of toolbox talks on this issue and/or inadequate risk assessments, a lack of awareness of entrapment incidents occurring and no awareness of the Best Practice guidance for MEWPs. Consequently, an implication of this lack of knowledge is that on site training is not fully effective and is an area that needs addressing by contractors to ensure, for example, that toolbox talks are provided on the key risk factors for entrapment. This also suggests the significance of supervisors/management undertaking the MEWPs for Managers training[1].

- Necessity for familiarisation

End users would often comment on measures that they believed would reduce the risks of entrapment when operating MEWPs. Although this was not in the original scope of work, it highlights the importance of effective worker involvement. The risk reduction measures suggested by both end users and subject matter experts were found to focus mainly on MEWP design. In the long term, changes could/should be made to establish standardised MEWP design. In the mean time, an implication for this lack of standardisation and consequential negative transfer of learning is the necessity for improved on site familiarisation processes.

Although this research has been focused on the risk factors for entrapment, the implications will be of wider interest and may be common for other risk factors such as overturning.

[1] *IPAF www.ipaf.org/en/training/courses/*

# 5. REFERENCES


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# 6. APPENDICES

Twenty-two appendices follow the content of this report.

## APPENDIX 1

## Subject Matter Expert Interview Guide
## Grey highlighted sections = Notes/probes for interviewer

### INTRODUCTION

Good morning / afternoon, my name is ; I work at HSL as an Ergonomist.

I would like to thank you for being here today and taking the time to contribute to this research.

Firstly, I will provide some background details of this research and explain the purpose of the interview today.

There have been a number of fatal and serious accidents where operators have become crushed against overhead obstructions whilst operating MEWPs.
Our research is looking at the human factors involved eg control panel design in such accidents as a way of identifying possible solutions.
So far we have conducted familiarisation visits, a literature review of standards and guidance on control design, creating a task analysis for operating three types of MEWPs and developing an assessment template which has been used on 9 representative MEWP types to identify key entrapment risks and hazards.
Next stage (why here today) is to gather expert knowledge of the key issues for entrapment. This is the reason why you have been selected as you are highly regarded as an expert in this field.
We will then be undertaking end user interviews to identify if there are any knowledge gaps between the two groups.
Essentially we want to provide suggestions to address any identified knowledge gaps and the findings will help to influence ongoing inspections and inform sector guidance.

Just to remind you that participation in this interview is entirely voluntary and you may withdraw at any time without giving any reason for doing so.
Our discussions today will be treated with the utmost confidentiality. We will not report any personally identifiable information.
The interview should take no longer than 90 minutes.
With your permission we would like to record the interview. This recording will only be used for the purpose of this research and will be stored on a secure network. Do you agree to the interview being audio recorded?

***** Note for researchers: Obtain agreement to record the interview *****

Please could you complete the consent form before we start.

***** Note for researchers: Obtain signed consent *****

I plan to take about a 5 min break half way but at any time you wish to have a break please let me know and we can do so.

Thanks very much. I will start the audio recording now.

***** Note for researchers: Start the audio recording hardware *****

**BACKGROUND**
I will start by asking about your work background.

What does your job role consist of?
(Training, maintenance)

Have you had any MEWP training? What MEWP training have you had?
(Certification, types, models)

What experience do you have in relation to MEWPs?
(Years, types, models, frequency of use)

---

**INTRODUCING THE TOPIC**

I am going to start by asking you a very broad question…we will explore it in more depth throughout the rest of the interview.

What are all the different situations or circumstances that you can think of in which it might be possible for an operator to become trapped/crushed by the MEWP that they are operating?

(Allow all answers; note what needs to be talked about in more depth later)
What have they seen/heard …

---

**1. LOCATION (outdoors/indoors/weather/ground)**

Can you think of any potential problems that might lead to entrapment when operating the MEWP **outdoors**? How would these risks be reduced?
Poor lighting levels to identify hazards and controls

Are there any **weather** conditions that could increase the potential risk of entrapment? Can these risks be reduced – how do you measure?
Platform movements - wind/strong draughts
Platform slippery - Heavy rain

Can you think of any **ground** conditions that may potentially increase the risk of an operator becoming trapped/crushed? Can these risks be reduced?
Platform movements

- Wet
- Slope
- Uneven
- Trenches

Can you think of any potential problems that might lead to entrapment when operating the MEWP **indoors**? Can these risks be reduced?
Poor lighting levels to identify hazards and controls
Narrow isles – why?

---

## 2. CONTROL ERRORS (knock controls/choose wrong control/choose wrong direction/

What sort of errors might an operator make whilst using the controls? (Opener to subject – allow all answers, note what needs to be talked about in more depth later)

Can you think of any issues or situations where an operator might unintentionally **knock** or move the controls? How might these risks be reduced?
Spacing between controls
No guarding – between/over controls
Loose materials on guardrails or on platform
No tool storage area
Loose clothing

Can you think of any issues or circumstances that would result in an operator choosing the **incorrect control**? How might these risks be reduced?
Unable to identify - Why?

- Dirty/contaminated/paint over symbols/controls
- Controls not labelled
- Poor lighting levels

Unfamiliar with control panel – why?

- Variation in position of symbol (above/below/to side of control) between makes/models of MEWPs
- Variation in control identifying names/symbols between makes/models of MEWPs

Angle of control panel
Height of operator
Non-functional grouping of controls

Can you think of any issues or circumstances that would result in an operator choosing an **incorrect function or movement** e.g. moving the MEWP forwards rather than backwards. How might these risks be reduced?
Labels/symbols not visible when actuating control
Movement of control does not follow direction on label
Ambiguity regarding position selected
Poor lighting levels

---

## 3. OTHER ERRORS (rushing/distractions/deliberate)

Can you think of any circumstances where an **operator might make an error** that is not related to the design of the controls for example the operator is rushing? How might these risks be reduced?
Lack of care/rushing
Poor route planning

Can you think of any situations where or why an operator might make a **deliberate error?**

Can you think of instances when an operators demand for attention is elsewhere? How might these risks be reduced?
Distractions (e.g. phone/personal problems)
Focus on task
Lack of attention to surroundings (e.g. looking at controls/pedestrians/vehicles in path of MEWP which diverts attention from overhead objects)
Familiarity with route

---

## 4. DESIGN
## (good/bad/size/reversed/position/access/multifunction/similarity/ overload cut-off)

Looking at the photographs of different controls and control panels both for ground and platform, can you identify any good or bad features between them?
(Open question, allow all thoughts, then use prompts below)

Is it possible to override any of the controls?
What about the size of the controls? (Gloved hand)
Would a hand rest be beneficial or not? (control for joystick)
Is it possible for the controls to be reversed (e.g. platform rotated)?
Absence of corresponding coloured directional *arrows*

- Scissor lift *control panel* repositioned inappropriately
- Inconsistent position of scissor lift *steps*

What about the position of the controls?

- Joystick not in middle - non dominant hand

Are multifunction controls beneficial or not?

- Forget to change functions
- Function selected not identifiable

Can you perceive any difficulty in accessing the controls?

- Below minimum British Standard dimensions
- Parked close to wall/structure therefore emergency controls harder to access

- Requires casing/cover to be lifted/removed

Are the designs similar or not? Inconsistent between makes and models of MEWPs

- Variation in position of symbol above/below/to side
- Skilled operator in one make/model applies same "procedure" to another make/model

Are you able to identify the controls? Label not independent of language/long winded

What are desirable features of the speed function for example?

Control speed
Reduce when elevated

What are desirable features of other functions eg consistent overrun?
Settings and overrun consistent across functions
Feedback when operating controls

Can you think of any potential problems that an operator might have if guarding was situated over the control panel?
Insufficient/no guarding over controls to prevent accidental activation
Restricts view of symbols and controls
Restricts arm/hand movements
Placement of tools on top (restricts view of controls/symbols)

Can you think of any potential benefits of having guarding over the control panel?
Inadvertent activation

What are your views on the overload cut off fitted to many MEWPs?
(both positive and negative)

Can you think of any examples of how poor design may contribute to MEWP crushing risks?

---

## 5. TRAINING*/EXPERIENCE/FAMILIARISATION

***Pick up on this throughout***

**Training courses/wrong type/sequence/height/emergency procedure/plan/unfamiliar)**

Can you think of any operations or methods that an operator may carry out due to a lack of experience or training. for example driving at height.
(Opener – allow all answers, note what needs to be questioned later)

Lack of awareness of hazards
Inappropriate sequence of boom movements (slew last) what is the correct sequence?
Using wrong type/size of MEWP for access required when should you use certain types/sizes?
Driving at high speed what should be done?

Driving at height (poor visibility) what should be done?
Unfamiliar with emergency descent procedure
Complicated boom manoeuvre what should be done?
No emergency plan what should this involve?
Unfamiliar controls and layout of control panel – different makes/models how do you combat that?

Are there a number of training courses that operators can go on?

If so, is there a set of competencies that they must cover?

---

## 6. LEANING OVER GUARDRAIL

In what circumstances might an operator lean over the guardrail?

What would be the correct action in these circumstances?

---

## 7. LONE WORKING

If an operator was working by themselves, how might that increase the risk of an entrapment scenario occurring?

---

## 8. CONDITION OF MEWP

What faults or condition of MEWP could potentially increase the risk of entrapment?
Age
Mechanical fault/failure (e.g. controls not re-centring) – poorly maintained

How might these failings be addressed?

---

## 9. POSITION OF MEWP

Can you think of any positions that a MEWP could be situated in that might increase the risk of an operator becoming trapped? How could they be addressed?

Not allowing sufficient space above guardrail
Too close to objects at height
Parked close to wall/structure – why? emergency controls harder to access

---

## 10. NEAR MISSES/INCIDENTS

Have you witnessed any entrapment near misses or incidents?

If yes, what happened?
What actions did the operator take that led to this?
What do you think would have been the correct actions to avoid the increased risk?

Have **you** had any entrapment/crushing near misses or accidents?

If yes, what happened?
What actions did you take that led to this?
What do you think would have been the correct actions to avoid the increased risk?

---

## 11. AND FINALLY…. PREDICTION OF END USER KNOWLEDGE GAPS

Do you have any predictions of where end users may have gaps in their knowledge regarding any of the risks that you have identified?

---

## ENDING

Thank you
That's everything I wanted to talk to you about today, is there anything else that you would like to say?

Reassurance - Your views and contributions are anonymous but if you would like to be formally acknowledged for your contribution to the research please let me know. Check with company

************TURN OFF AUDIO RECORDING********

## CHECKLIST

1. LOCATION
    a. Outdoors
    b. Weather
    c. Ground
    d. Indoors
2. CONTROL ERRORS
    a. Unintentionally Knock
    b. Choose incorrect control (identify)
    c. Choose incorrect function/direction
3. OTHER ERRORS
    a. Rushing
    b. Attention elsewhere
    c. Deliberate
4. DESIGN
    a. Good
    b. Bad
    c. Size
    d. Hand rest
    e. Controls Reversed
    f. Position
    g. Access
    h. Multifunction
    i. Similarity
    j. Guarding
    k. Desirable features
    l. Over load cut-off
5. TRAINING/EXPERIENCE/FAMILIARISATION
    a. Courses/competencies
    b. Type of MEWP
    c. Sequence
    d. Height
    e. Emergency plan/controls
    f. Unfamiliar
6. LEANING OVER GUARDRAIL
7. LONE WORKING
8. CONDITION
    a. Age
    b. Maintenance
9. POSITION
    a. Guardrail
    b. Objects
    c. Wall
10. NEAR MISSES/INCIDENTS
11. PREDICTION OF END USER KNOWLEDGE GAPS

**Probing Questions**

Are there any other factors? I am thinking of things like….
Why? How? What?
In what way was it…?
This may sound like an obvious question but….

## APPENDIX 2

## Mobile Elevated Work Platform (MEWP) Entrapment – what are the key risks and hazards?

**Information document**

**Who is conducting this research?**
The Health and Safety Executive (HSE) commissioned Health and Safety Laboratory (HSL) Ergonomists to undertake this research. HSL undertakes research on behalf of HSE.

**What is the purpose of this research?**
The research is looking at the human factors involved in incidents where occupants have become crushed against overhead obstructions when using MEWPs. Specifically, we are looking at control design and gathering knowledge from both experts (e.g. MEWP trainers and engineers) and typical end users of MEWPs (e.g. painters and decorators, electricians, steel erectors and rackers) to identifying key entrapment risks and knowledge gaps. The results of the study will aim to inform HSE guidance.

**What does the research involve if I agree to take part?**
HSL would like to invite you to take part in an interview to discuss the factors you consider relevant to operator entrapment when using MEWPs. Example questions will include:

- Your views on any potential problems that might lead to entrapment when operating MEWPs indoors/outdoors.

- From your experience, are any good or bad features between different MEWP control panels? For example the size of switches.

- Can you think of any circumstances when MEWP operators might make an error?

The interview will take about 60 minutes of your time and will be carried out by a researcher at your place of work. If you are happy for us to do so, we would like to audio record the interview so that we have an accurate record of the discussion although some notes will be taken.

**Do I have to take part?**
Taking part in this research is entirely voluntary. If you do decide to take part you will be given a consent form to sign agreeing that HSL hold the information you provide for research purposes only. You may withdraw from the research at any time without giving a reason. Also, feel free to ask the researcher any questions if anything is unclear. If, for whatever reason, you are not happy to answer any specific questions, please make this known to the researcher who will be happy to leave that topic and move to the next one.

**Will the information I provide be treated in confidence?**
If you choose to take part in this important research, we ask that you complete the consent form. Under no circumstances will personally identifiable information be reported. The information that you provide will be used to develop a list of key risk factors for entrapment. Information you share with us will be held at HSL on a secure network and will be only used by researchers involved in the project for the purposes of this research.

If you have any other questions or would like any further clarification, please contact:

Amy Jones
Health and Safety Laboratory
Harpur Hill
Buxton
Derbyshire
SK17 9JN

01298 218359

amy.jones@hsl.gov.uk

## APPENDIX 3

# Mobile Elevated Work Platform (MEWP) Entrapment – what are the key risks and hazards?

## Consent form for Interview

I understand that participation is voluntary and that I may withdraw at any time, without giving any reason for doing so.

(Write initial here)……

I understand that I will be interviewed for no longer than 90 minutes and that the interview will only be audio recorded if I am happy for an audio recording to be made.

(Write initial here)……

I understand that any recordings will only be used for the purposes of this research, and will not be stored beyond the duration of this research.

(Write initial here)……

I understand the reason for this research and agree to participate.

(Write initial here)……

Your name……

Date……

Signature……

Name of Researcher……

Date……

Signature……

**APPENDIX 4**


# A. Platform control panel



# B. Platform control panel


# C. Platform control panel

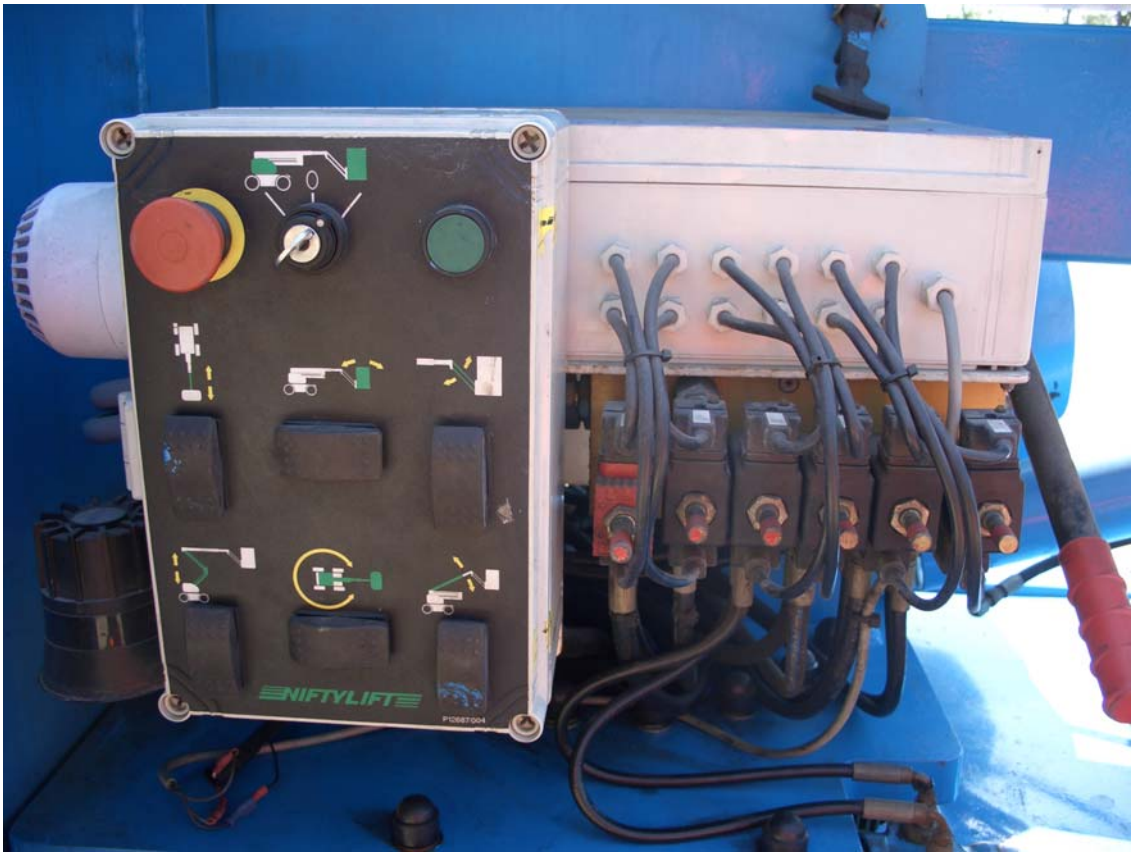
# D. Platform control panel

# E. Platform control panel


# F. Platform control panel

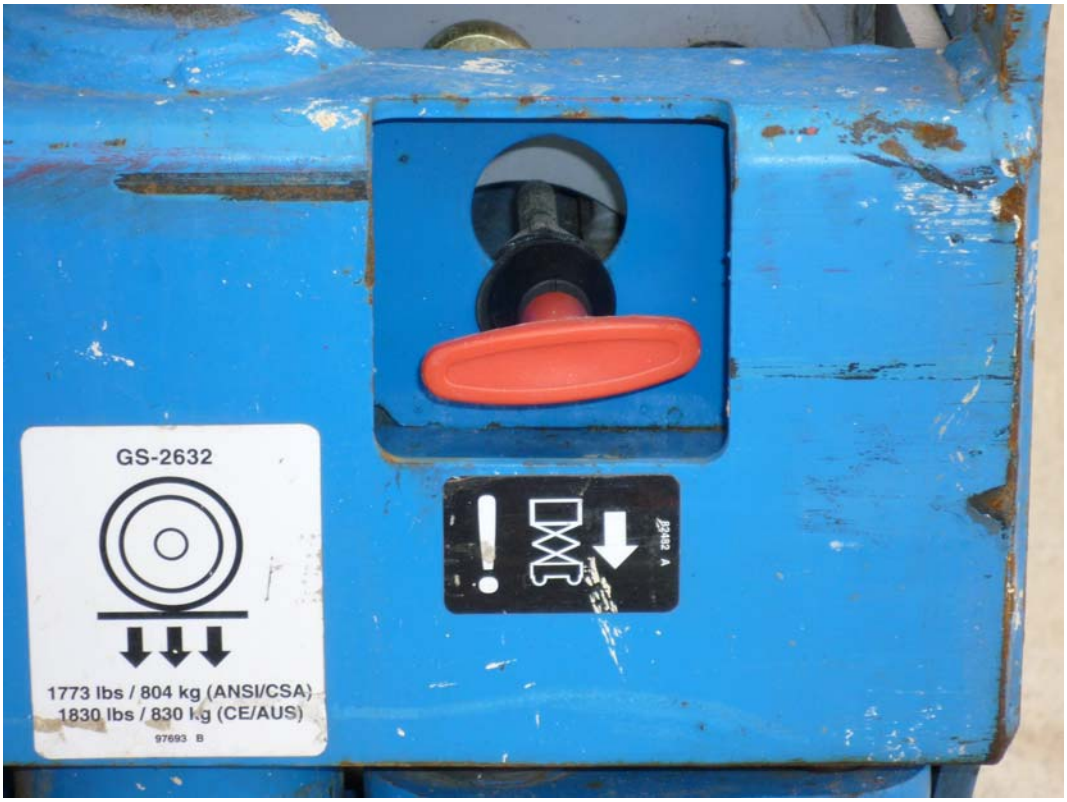

# G. Ground control panel


# H. Ground control panel




I. Ground and emergency controls

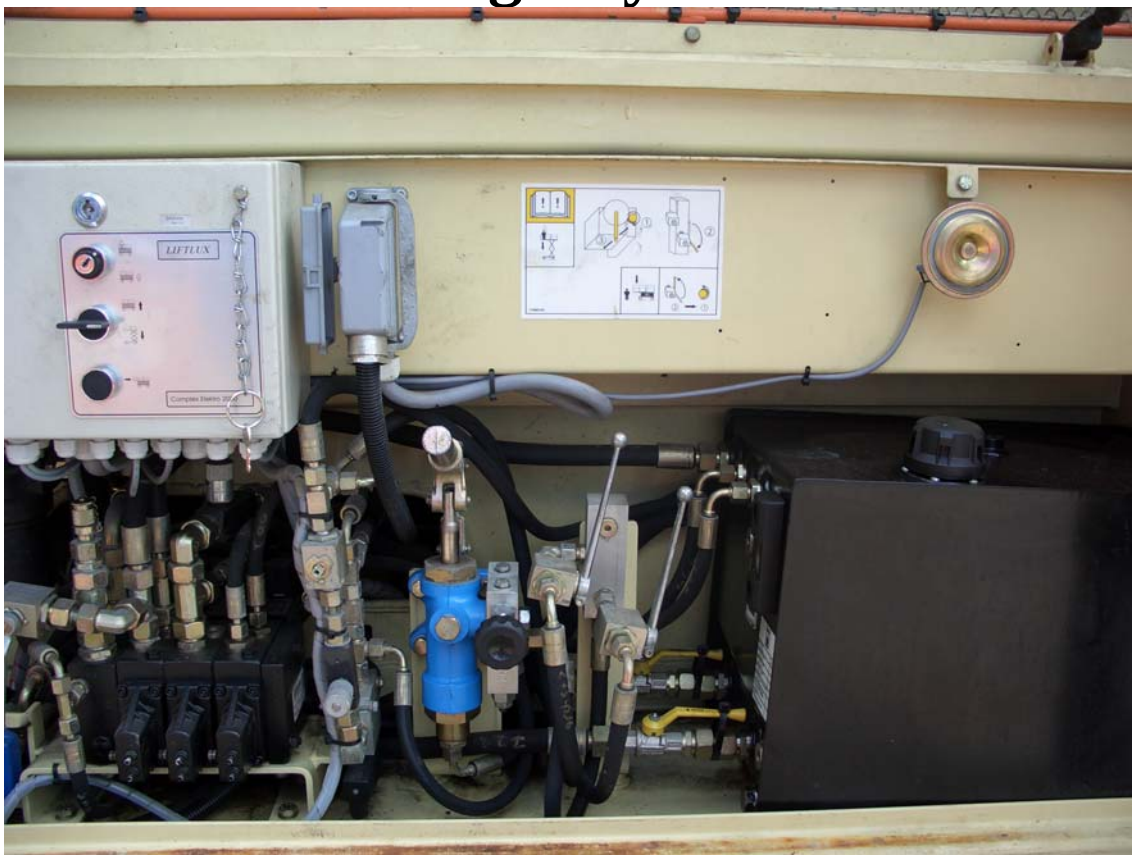

J. Ground and emergency controls



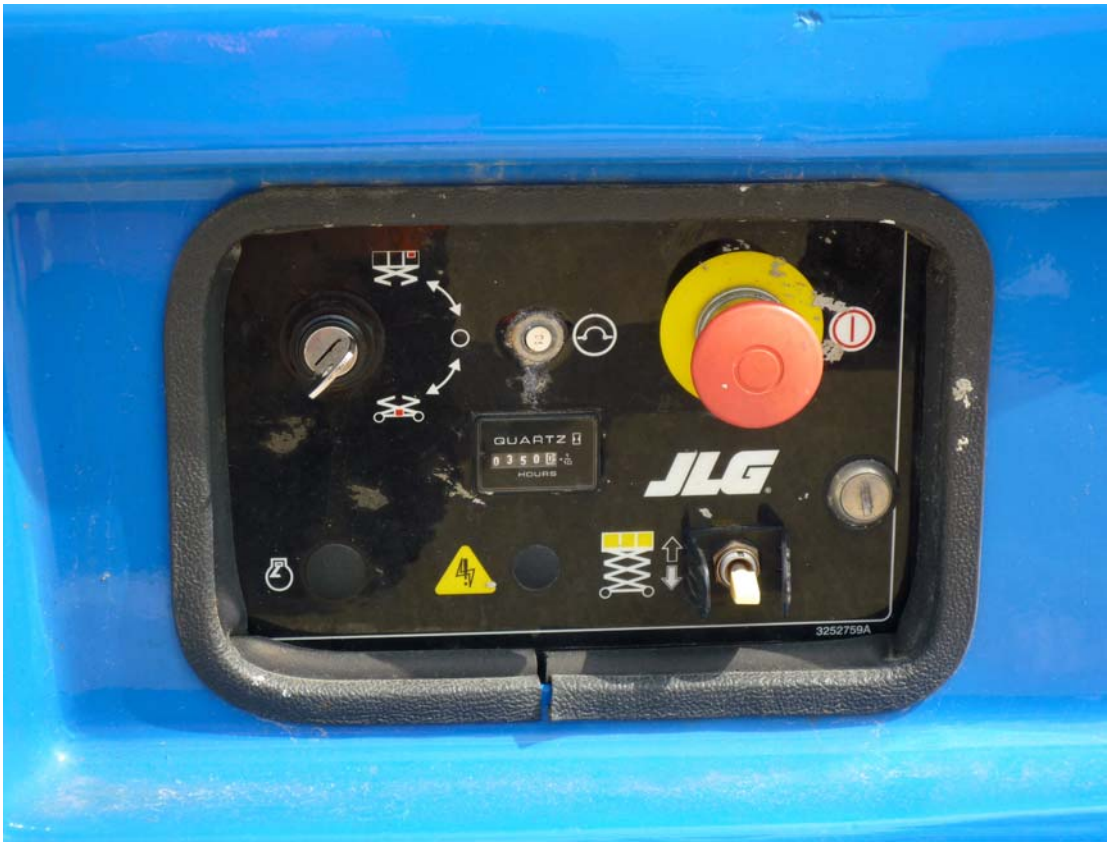

# K. Emergency descent


# L. Emergency descent

# M. Emergency controls




# N. Emergency controls




# O. Ground control panel

# APPENDIX 5

The template used for Stage 1 NATCEN

| PH05339 MEWPS Qualitative Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Case identidier | Analytical Comments | A. Background | 1. Entrapment - General | 2. Location | 3. Control errors | 4. Other errors (Human errors) | 5. Design | 6. Training & Experience |
| | Include comments on participant engagement, general regard for MEWP topic, and any other contextual comments from analysis | Include all comments on background information, experience, etc. | Include all comments from introductory question on different situations or circumstances leading to entrapment | Include all comments relating to outdoors, indoors, weather, ground, and any other location related information | Include all comments relating to knocking controls, choosing wrong controls, incorrect function, and any other control error related information | Include all comments on operator errors, e.g. rushing, distractions, deliberate errors | Include all comments on operator errors, e.g. rushing, distractions, deliberate errors | Include all comments on training, experience, familiarisation |
| Expert 1 | | | | | | | | |
| Expert 2 | | | | | | | | |
| Expert 3 | | | | | | | | |
| Expert 4 | | | | | | | | |

| 7. Leaning over guardrail | 8. Lone working | 9. Condition of MEWP | 10. Position of MEWP | 11. Near misses / incidents | 12. Prediction of end user kr | 13. Other |
|---|---|---|---|---|---|---|
| Include all comments relating to leaning over the guardrail | Include all comments relating to lone working | Include all comments relating to condition of MEWP | Include all comments relating to position of MEWP | Include all comments relating to experience of near misses and incidents | Include all comments relating to end user knowledge gaps | Include any useful information not captured in the previous columns |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## APPENDIX 6

One theme used in the template for Stage 2 NATCEN

| | Theme: Other (human) errors. Include all comments on operator errors, e.g. rushing, distractions, deliberate errors | Elements and Dimensions | Final distillation of elements and dimensions |
|---|---|---|---|
| 1 | Issue to see surroundings in dark (62-63), ground surface and the consequent effect of different machines e.g. if chassis keeps level or one wheel comes off ground (63-65) wind a factor especially in wide open area, not so bad against building (90-97) inside - lighting, moving from different levels e.g. on loading bay where kicks you up (not so much on scissors), driving off loading bays on scissors (101-103) beams, girders, racking, getting machines into awkward tight situations (112-113) | Outdoors: light levels, ground conditions, inconsistencies in how MEWPS cope with conditions, wind. Indoors: light levels, slopes, overhead obstacles, tight spaces. | |
| 2 | | | |
| 3 | | | |
| 4 | | | |

## APPENDIX 7

## End User Interview Guide
**Grey highlighted sections = Notes/probes for interviewer**

**INTRODUCTION**

Good morning / afternoon, my name is ; I work at HSL as .

I would like to thank you for being here today and taking the time to contribute to this research.

Firstly, I will provide some background details of this research and explain the purpose of the interview today.

There have been a number of fatal and serious accidents where operators have become crushed/entrapped against overhead obstructions whilst operating mobile elevated work platforms (MEWPs).

Our research is looking at ways of exploring operators understanding of what factors contribute to such accidents as well as identifying possible solutions.
So far we have conducted visits to become familiar with MEWPs, a literature review of standards and guidance on control design, and developed an assessment template, which has been used on 9 representative MEWP types to identify key entrapment risks and hazards.
Next stage (why here today) is to gather operator's knowledge of the key issues that could lead to an operator becoming entrapped.

Essentially we want to provide suggestions to address any identified knowledge gaps between experts and operators, as often it is operators who are aware of risks that even experts may be unaware of. The findings will help to influence ongoing inspections and inform sector guidance.

Just to remind you that participation in this interview is entirely voluntary and you may withdraw at any time without giving any reason for doing so.

Our discussions today will be treated with the utmost confidentiality. We will not report any personally identifiable information.

The interview will take no longer than 60 minutes.

With your permission we would like to record the interview. This recording will only be used for the purpose of this research and will be stored on a secure network. Do you agree to the interview being audio recorded?

***** Note for researchers: Obtain agreement to record the interview *****

***** Note for researchers: Obtain signed consent *****

Let me know if you wish to take a break at any time. Thanks very much. I will start the audio recording now.

***** Note for researchers: Start the audio recording hardware *****

---

**BACKGROUND**

I will start by asking about your work background.

What is your job title?

What does your job role consist of?

Have you had any MEWP training?
(Who by, certification, machine types)

What experience do you have in relation to MEWPs?
(Years, machine types, frequency of use)

---

**INTRODUCING THE TOPIC**

I am going to start by asking you a very broad question…but we will explore it in more depth throughout the rest of the interview through my set of questions to follow.

Can you think of any situations or circumstances in which it might be possible for someone to become trapped/crushed by the MEWP that they are operating?

(Allow all answers; note what needs to be talked about in more depth later)
What have they seen/heard …

---

**1. LOCATION (outdoors/indoors/weather/ground)**

Can you think of any potential dangers/situations that might lead to entrapment if you are using a MEWP outside?
Could lighting be an issue? Why?

Is there anything that could be done to reduce that danger/situation?

Are there any weather conditions that could increase the risk of entrapment?
Could wind be an issue? Why?

If you needed to use a MEWP and it was (what they said or windy), what would you do?

Can you think of any ground conditions that could increase the risk of entrapment?

If you needed to use a MEWP and (what they said or the ground was uneven), what would you do?

Can you think of any potential dangers that might lead to entrapment if you are using a MEWP inside?
Could space be an issue? Why? Could lighting be an issue? Why? General obstacles

Is there anything that could be done to reduce that danger/situation?

---

## 2. CONTROL ERRORS (knock controls/choose wrong control/choose wrong direction/

Can you think of any errors that someone might make when using the controls that could lead to entrapment?
(Opener to subject – allow all answers, note what needs to be talked about in more depth later)

Would it be possible for somebody to accidentally knock or move the controls? Why? How? (If yes) Is there anything that could be done to prevent this?

Can you think of any reasons why someone might accidentally choose the wrong control?

How do you know what controls to move?

Have there been any situations where you have not recognised or not been able to see the controls? If yes can you explain?

Is there anywhere that an operator should or shouldn't put their tools/materials when they are in the platform? Why?

Have you ever worn gloves when you are operating a MEWP? (If yes) Does it affect you operating the MEWP controls?

Can you think of any situations when an operator starts to use a MEWP with different controls and control layouts from those he has been use to where he might inadvertently operate the wrong control or where the MEWP may not behave in the way that he is expecting?

---

## 3. OTHER ERRORS (rushing/distractions/deliberate)

Can you think of any reasons why somebody might make mistakes (but which are not related to the MEWP they are using)?
Could the amount of time to carry out the job be a factor? Fatigue/personal problems

Can you think of any instances when somebody's attention might be reduced?
Distractions (e.g. phone/personal problems)

Is there anything that could be done about this (distractions such as a mobile phone)?

Can you think of any reasons why somebody might behave unsafely? What?
For example standing on the guardrail.

---

## 4. DESIGN (good/bad/size/position/access/multifunction/overload cut-off)

Looking at the photographs of different control panels both for ground and platform:

Are you familiar with any of these control panels?

For those that you are not, do you think you would know what each control might be for/how to operate the MEWP?

Do any of the control panel designs look better/worse than others? Why?

From your experience, what do you think about the size of the controls?

What do you think of a hand rest? (Point to photographs)

What are your views on multifunction controls? (E.g. drive and lift on same control on a scissor lift) How would you know which function you are in?

Can you think of any potential problems or benefits of having guarding situated over the control panel?

Are you aware of an overload cut off feature on some MEWPs? (if yes) What are your views on it?
(both positive and negative)

---

## 5. EXPERIENCE

**(Type/sequence/unfamiliar/RA)**

Are you able to choose the MEWP that you need to use for the job? If not, who does/why?

What would you do if you were provided with a MEWP that you were unfamiliar with?

Is there a correct sequence of movements when trying to position a MEWP? If yes – what is it? Are you able to do that?

Before you start a job, has the content of a RA and/or method statement been communicated to you?

What did you think of your training?

Do you think it was adequate or not?

Have you had further toolbox talks etc on the use of MEWPs or on specific MEWP issues for example entrapment?

---

## 6. LEANING OVER GUARDRAIL

Are there situations when it would be necessary to lean over or stand on the guardrail? (If not answered in Section 3)

Is there anything that could be done so that someone would not need to lean over the guardrail?

---

## 7. LONE WORKING

Do you ever work by yourself when using a MEWP?

(If yes) If there were an emergency, would anyone know you are in trouble? Regular phone contact

(If no) Would there be someone who would know how to lower the MEWP if there was an emergency?
If yes – Buddy? What's the procedure - do you have to let them know your using the MEWP?

Where is the MEWP key kept when you are in the platform?

---

## 8. CONDITION OF MEWP

Is there anything about the condition of the actual MEWP that could potentially lead to entrapment?
Age/maintenance/modifications

---

## 9. POSITION OF MEWP

Does it matter where you position the base of the MEWP when you are working?

Are there any situations where the base controls cannot be easily accessed?

---

## 10. INCIDENTS AND NEAR MISSES

Have you had personal experience of a crushing/ entrapment incident or a near miss?

Have you ever witnessed a crushing/ entrapment incident or near miss involving someone else?

Have you heard of crushing/ entrapment incidents or near misses occurring on sites that you have been working on?

---

## ENDING

Thank you
That's everything I wanted to talk to you about today, is there anything else that you would like to say?

Reassurance - Your views and contributions are anonymous but if you would like to be formally acknowledged for your contribution to the research please let me know. Check with company

************TURN OFF AUDIO RECORDING********

## APPENDIX 8

### A List of key entrapment risks ascertained from previous research

The list below is the result of a review and collation of Phase 1, 2 and the Best Practice Guidance for MEWPs.

**Control Actuation Error**

- Inadvertently knocking control with body/arm/hand/tools
  - Spacing between controls smaller than recommendations
  - Ineffective/no guarding between controls (not in direction of control movement)
  - Ineffective/no guarding over controls
  - No tool storage area - Loose materials on guardrails or on platform
- Choosing incorrect control
  - Unable to identify
    - Dirty/contaminated/paint over symbols/controls
    - Controls not labelled
    - Poor lighting levels
  - Unfamiliar with control panel
  - Variation in position of symbol (above/below/to side of control) between makes/models of MEWPs
  - Variation in control identifying names/symbols between makes/models of MEWPs
  - Angle of control panel (combined with height of some operators) may make it difficult to see control/symbol
  - Non functional grouping of controls
- Incorrect operation (e.g. wrong direction)
  - Labels/symbols not visible when actuating control
  - Movement of control not lead to expected movement of MEWP
  - Movement of control does not follow direction on label
  - Ambiguity regarding position selected
  - Poor lighting levels
- Controls reversed (e.g. platform rotated)
  - Absence of corresponding coloured directional arrows on base and panel
  - Scissor lift control panel repositioned inappropriately
  - Inconsistent position of scissor lift steps that would aid the operator to identify the MEWP direction

**Poor design of control panel/controls**

- Absence of hand rest decreases fine movement control for joystick
- Control dimensions smaller than recommendations (may affect gloved hand)
- Unable to control drive/lift speed
- Speed does not reduce when elevated
- Speed settings inconsistent across functions
- Able to circumvent controls
  - Able to position body in compromising position
- Position of controls

        - Joystick not in middle, non dominant hand may be used in precision control
- Inconsistent overrun across functions
- No feedback when operating controls
- Multifunction controls
    - Forget to change functions
    - Function selected not identifiable
- Access to controls
    - Below minimum British Standard dimensions
    - Parked close to wall/structure therefore emergency controls harder to access
    - Requires casing/cover to be lifted/removed

**Inconsistent design between makes and models of MEWPs**
- Indicator warning lights
- Variation in position of symbol above/below/to side
- Skilled operator in one make/model applies same "procedure" to another make/model

**Environment**
- Platform subject to movements in windy conditions/strong draughts
- Platform slippery (in heavy rain)
- Poor lighting levels to identify hazards and controls
- Poor ground conditions leading to platform movements
    - Wet
    - Slope
    - Uneven
    - Trenches

**Operator leaning over guardrail**

**Lone working**

**Poor MEWP condition**
- Age
- Mechanical fault/failure (e.g. controls not re-centring) – poorly maintained

**Position of MEWP**
- Not allowing sufficient space above guardrail
- Too close to objects at height
- Parked close to wall/structure therefore emergency controls harder to access

**Guarding**
- Insufficient/no guarding over controls to prevent accidental activation
- Restricts view of symbols and controls
- Restricts arm/hand movements
- Placement of tools on top (restricts view of controls/symbols)

**Insufficient/lack of familiarisation with specific make and model of MEWP**
- Unfamiliar controls and layout of control panel

**No training or experience**
- Lack of awareness of hazards
- Inappropriate sequence of boom movements (slew last)
- Using wrong type/size of MEWP for access required
- Driving at high speed
- Driving at height (poor visibility)

**Demand for attention elsewhere**
- Distractions (e.g. phone/personal problems)
- Focus on task
- Lack of attention to surroundings (e.g. looking at controls/pedestrians/vehicles in path of MEWP which diverts attention from overhead objects)

**Familiarity with route**

**Unaware/untrained grounds person**
- Unfamiliar with emergency descent procedure
- Label not independent of language/long winded

**Key not in ground controls**

**Lack of care/rushing**

**Poor route planning**

**Complicated boom manoeuvre**

**No emergency plan**

**Crouching over controls**

## APPENDIX 9

## Elements and dimensions ascertained from the subject matter expert interviews

The table below is the result of the final distillation of elements and dimensions from the 4 expert interviews and is presented in no particular order.

**Table 4** Key risks of entrapment from the 4 expert interviews

| | | |
|---|---|---|
| Outdoors | Light levels | Lack of lights on MEWP |
| Shadows | Bright sunlight | Extremes of weather |
| Cold | Wind | Ice |
| Lightning | Uneven ground | Soft ground |
| Poor ground conditions | Other plant | Overhead obstructions e.g. power cables |
| Inconsistent controls (leading to diverted attention) | Lack of supervisor/manager appreciation of MEWP capabilities and risks re cold weather | Slopes |
| Trenches | Proximity to building | Visibility |
| Perspective | Eye protection steams up in rain | Reduced concentration in extreme weather |
| Hidden obstacles | Inconsistencies in how MEWPs cope with conditions | Falling objects |
| Spatial awareness | Platform movement | Access arrangements |
| Moving obstructions | Overhead power distribution | Dirt and dust |
| Noise | Heat | Fumes |
| Overhead obstructions, | Moving machinery | More driving elevated indoors |
| Dehydration | Narrow isles | Overhead cranes |
| Public | Light levels | Slopes |
| Tight spaces | Falling objects | Spatial awareness |
| Incorrect selection | Incorrect direction | Incorrect speed |
| Accidental selection | Interrelated functionality | Unfamiliarity, |
| Lack of awareness of current mode selection | Unexpected outcomes | Proportional v direct controls |
| Inconsistently reversed controls when MEWP rotated 180° | Light levels | Visibility |
| Clarity of legends | Damaged/obscured legends | Management knowledge of MEWP issues |
| Additional work materials & equipment | Lack of experience | Lack of knowledge & understanding |
| Inconsistent control panel layout | Height and angle of control panel | Lack of wrist rest |
| Complex controls | Variety of hydraulic pump characteristics | Oil viscosity |
| Inconsistent ramp in and out | Heavy handedness | Poor observation |
| Attempting to bypass safety systems | Work pressures | Complacency |
| Limited space in platform | Delays in controls | Human errors |
| State of mind | Tiredness | Lack of sleep |

| | | |
|---|---|---|
| Working conditions | Stress | Shift patterns |
| Rest periods | Complexity of the job | Height level |
| Influence of others' work speeds | Work schedule | Work pressures |
| Poor route planning | Deliberate damage | Unauthorised modifications |
| Distractions e.g. phone | Personal issues & problems | Horseplay |
| Attire | Not undertaking pre-use checks | Manual dexterity |
| Visibility of legend | Lack of supervision & training | Poor attitude |
| Over-reaching | Peer pressure for deliberate error | Misjudgement |
| Other demands on attention | Environmental conditions | Management style |
| Motivations to work quickly | Competition | Multitasking (divided focus of attention) |
| Rushing | Cutting corners | Secondary status of MEWP relative to main task |
| Design | Proportional controls preferred | Compact controls preferred |
| Cleanliness of panel | Clarity of legend | Poor access to emergency controls |
| Simple emergency controls preferred | Guarding around emergency controls restricts access | Double-action controls force attention |
| Double-action controls minimise horseplay | Controls should be rugged | Colour coding helps |
| Controls designed for right-handers | Prefers one control per function | Inconsistent panel layout |
| Inconsistent symbols | Symbols not always intuitive | Inconsistent overload cut-outs |
| Inconsistent tilt alarm functioning | Inconsistent control functions | Inconsistent ramping |
| Inconsistent emergency controls & functioning | Overload cut-outs good | Wrist supports help fine adjustment |
| Clear stop button preferred | Literacy skills | Recessed and protected controls could be an improvement |
| Guarding between toggles good | Multifunction controls good | Operator preferences |
| Symbols preferred to reading | Guarding and gaskets prevent water ingress | MEWP storage |
| Guarding reduces visibility | Guarding could trap hands | Guarding prevents accidental operation |
| Cantilever effect | Specific comments in regards to Photograph A: Standard design | Specific comment in regards to Photograph A: Stop control should be nearer front panel |
| Specific comment in regards to Photograph A: Protection around panel | Specific comment in regards to Photograph D: Two main controls too far apart | Specific comment in regards to Photograph G: Unclear layout of ground controls e.g. platform level icon |
| Specific comment in regards to Photograph G: Colour coding clear | Specific comment in regards to Photograph G: Emergency descent not intuitive | Specific comment in regards to Photograph H: Good platform level icon |
| Specific comment in regards | Specific comment in regards | Specific comment in regards |

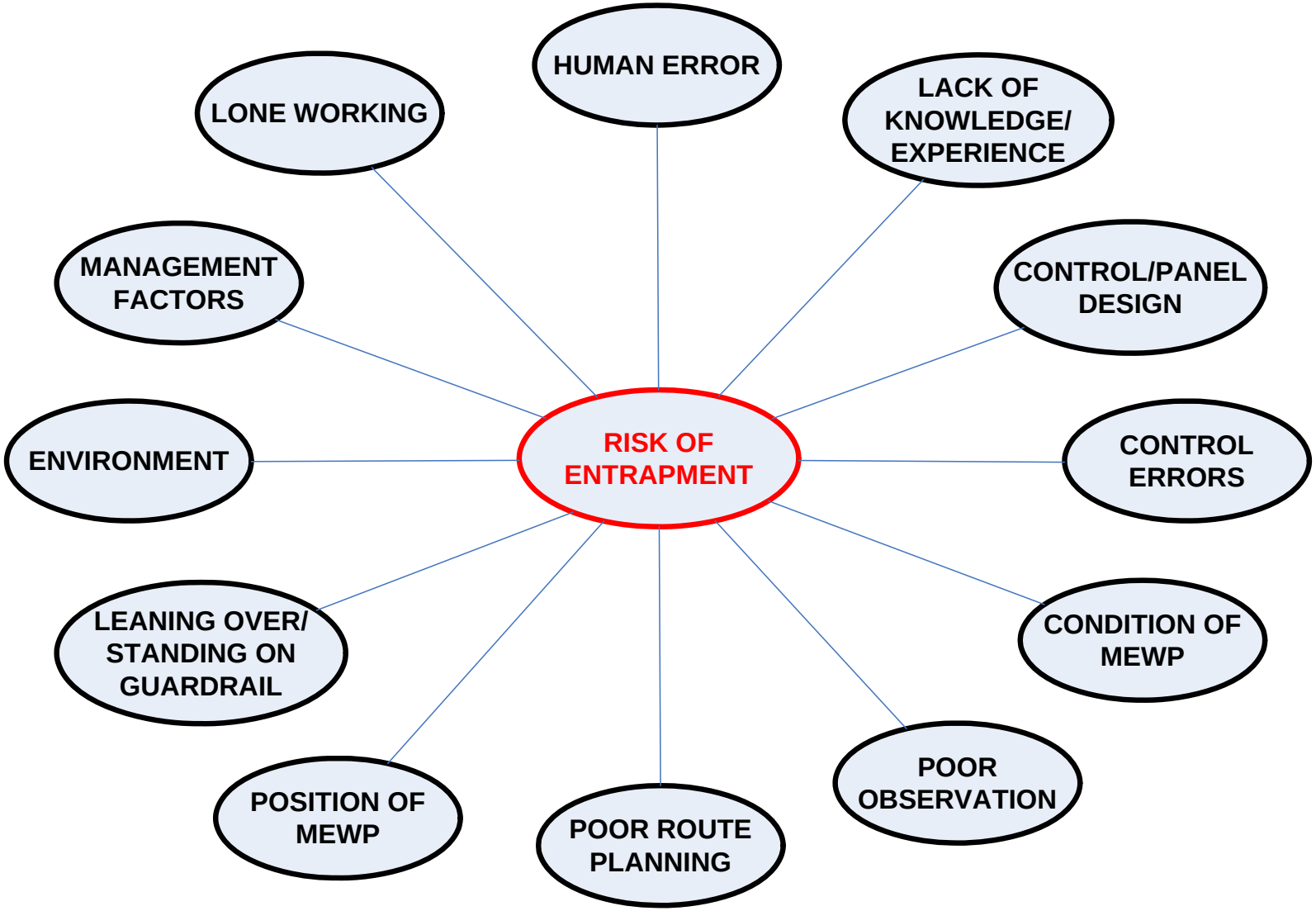
| | | |
|---|---|---|
| to Photograph B: Cover obscures panel | to Photograph B: Good wrist guard | to Photograph B: Retrofitted guarding |
| Specific comment in regards to Photograph B: Guard can restrict visibility | Specific comment in regards to Photograph B: Controls could be recessed | Specific comment in regards to Photograph B: Guard helps to protect panel from paint etc |
| Specific comment in regards to Photograph B: Lots or written information - more pictures could help | Specific comment in regards to Photograph B: Symbols should be standardised | Specific comment in regards to Photograph B: Toggles quite small |
| Specific comment in regards to Photograph B: Warning lights not clear | Specific comment in regards to Photograph B: Joystick too big | Lack of training and experience |
| One-day training develops limited competence | Variety of MEWPs - cannot cover all | Trial and error - fail course |
| Industry demand evidence of training | Training must be 'suitable and sufficient' | Industry wants one day training |
| Familiarisation not consistently received | Consistency of operation an issue | MEWPs for managers - more detail on prep and selection, Familiarisation requests increasing |
| Inconsistent functionality | Limited time to cover all issues | Multifunction requires good observation |
| Hirer offers visits and advice | Training more consistent than before | Client legally responsible for selection |
| Training covers theory and practice | Training covers 4 main categories: boom, static, non static, scissor | Industry demand evidence of Construction plant competency scheme (CSCS) or IPAF training |
| 2 days training would allow more detail | Approx 6% failure rate of training course | Instructors audited |
| Develop training for industry and HSE | MEWP operators need training due to risks | Inconsistencies across training providers |
| IPAF - specific MEWP training | CSCS - Construction training with MEWP category | Consistency of training |
| IPAF covers ISO8878 - international standard for operator training on MEWPs | MEWP selection is critical | CSCS aligns to NVQ standards |
| Challenge driving elevated | Training covers main issues | Risk Assessments help with selection |
| Incomplete knowledge of range of MEWPs | Incomplete knowledge of correct sequence of movements | Operators confident with familiar MEWPs |
| Leaning over guardrail | Incorrect MEWP selection | Inconsistent MEWP specifications |
| Lack of Method Statement | Lack of supervision | Lack of Risk Assessment |
| Lack of training | Planning | Lack of understanding of risks |
| Commercial pressure | Personal pride | Lack of reporting |
| Observation when manoeuvring | During horseplay | Peer pressure |
| Shouldn't happen (Lack of Risk Assessment, lack of Method Statement) | Inconsistency in emergency controls | Lone Working |

| | | |
|---|---|---|
| MEWP use requires management planning and supervision | Mobile for emergencies | Can't employ lone workers |
| Duty of care to have rescue plan | Query permanent 2nd man or frequent check visits | Site reporting |
| Condition of MEWP | Good standard of MEWP maintenance | Personal monitoring technology could help |
| Visual appearance influences perceptions of condition | Shortage of maintenance engineers | Poor standard of MEWP maintenance |
| Maintenance standards | Maintain according to the Lifting Operations and Lifting Equipment Regulations (LOLER) | Competence of maintenance personnel |
| Variety of legislation worldwide | No defined rebuild cycle | Aftermarket parts |
| Charging for damage | Damage reporting | Off-hire condition |
| Site management & supervision | Operator checks | Unsafe condition & unsafe action reporting |
| Treatment of MEWP | Age of MEWP | Unauthorised modifications |
| Clarity of legend | Hall-effect joystick can fail due to cold and damp | Layout of controls |
| Position of MEWP | MEWP selection | Lift-load rocker can stick in winter |
| Site survey and requirements | Access | MEWP capabilities |
| MEWP used for secondary tasks | Hired on cost not suitability | Select on familiarity |
| Inappropriate over specification | Advice offered to clients but not always taken | Inappropriate planning |
| Hydraulics | Ground conditions | Inexperienced operators |
| Proximity of other vehicles | Overloading | Proximity to structures |
| Supervision | Management | Wind speed |
| Colour codes and arrows on base and controls | Incomplete information in manual | Awareness of position of emergency controls |
| Near misses and Incidents | Near misses are common | Fully movable control panels |
| Worker engagement | Lack of managed Method Statement | Lack of supervision |
| Human error | Poor maintenance | Lack of management competence |
| Incorrect control selection | Task selection | Incorrect MEWP selection |
| Lone working | Lack of training | Lack of supervision |
| Lack of willingness to change behaviour | Ground conditions | Unfamiliarity |
| Lack of awareness of environment | Lack of observation | Lack of awareness of ground conditions |
| Moving elevated | Supervision | Distractions |
| Consistency of control functions is a major issue | Manufacturer could design tamper-proof controls | Legal onus on employer re operators' familiarity with MEWP |
| Supervision could encourage daily checks | Professional recognition for MEWP drivers | Incentives could encourage daily checks |
| Technology exists for emergency lowering | Lateral loading can cause significant basket movement | Attitude towards hired equipment |
| Overriding safety lockout | All risk factors should be in | MEWPS used as cranes and |

| | | |
|---|---|---|
| controls | Risk Assessment process | forklifts |
| Management support | Consideration of MEWPs at planning phase | Variability in application of learning from training |
| Recording system for checks | Literacy levels | Management awareness of day-to-day pressures on MEWP operators, revenue flow pressure |
| Time and space to read Risk Assessments and discuss issues | Lack of knowledge of entrapment | Correct application of MEWP should be priority over harness wearing |

**APPENDIX 10**

SUBJECT MATTER EXPERTISE INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP



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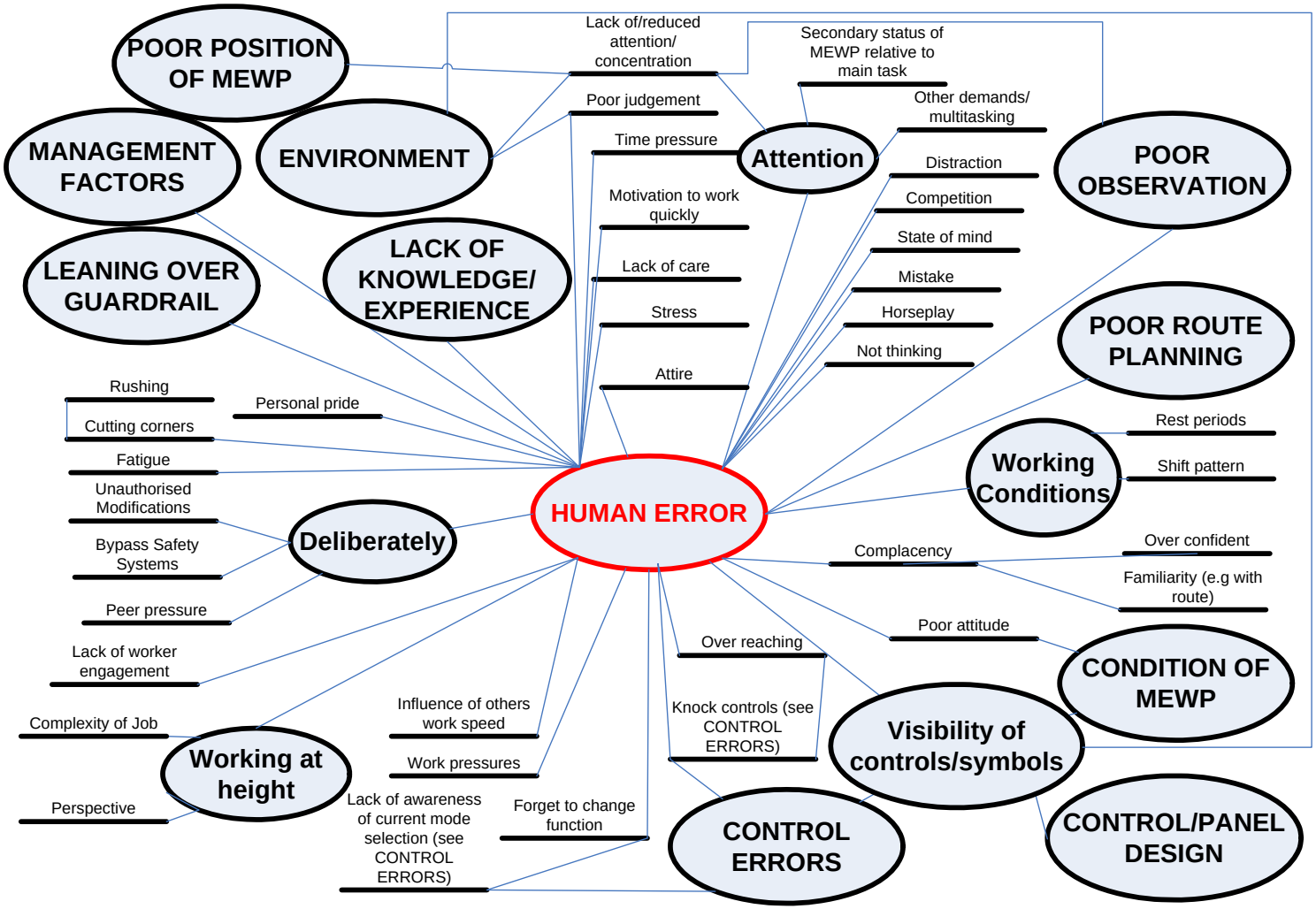

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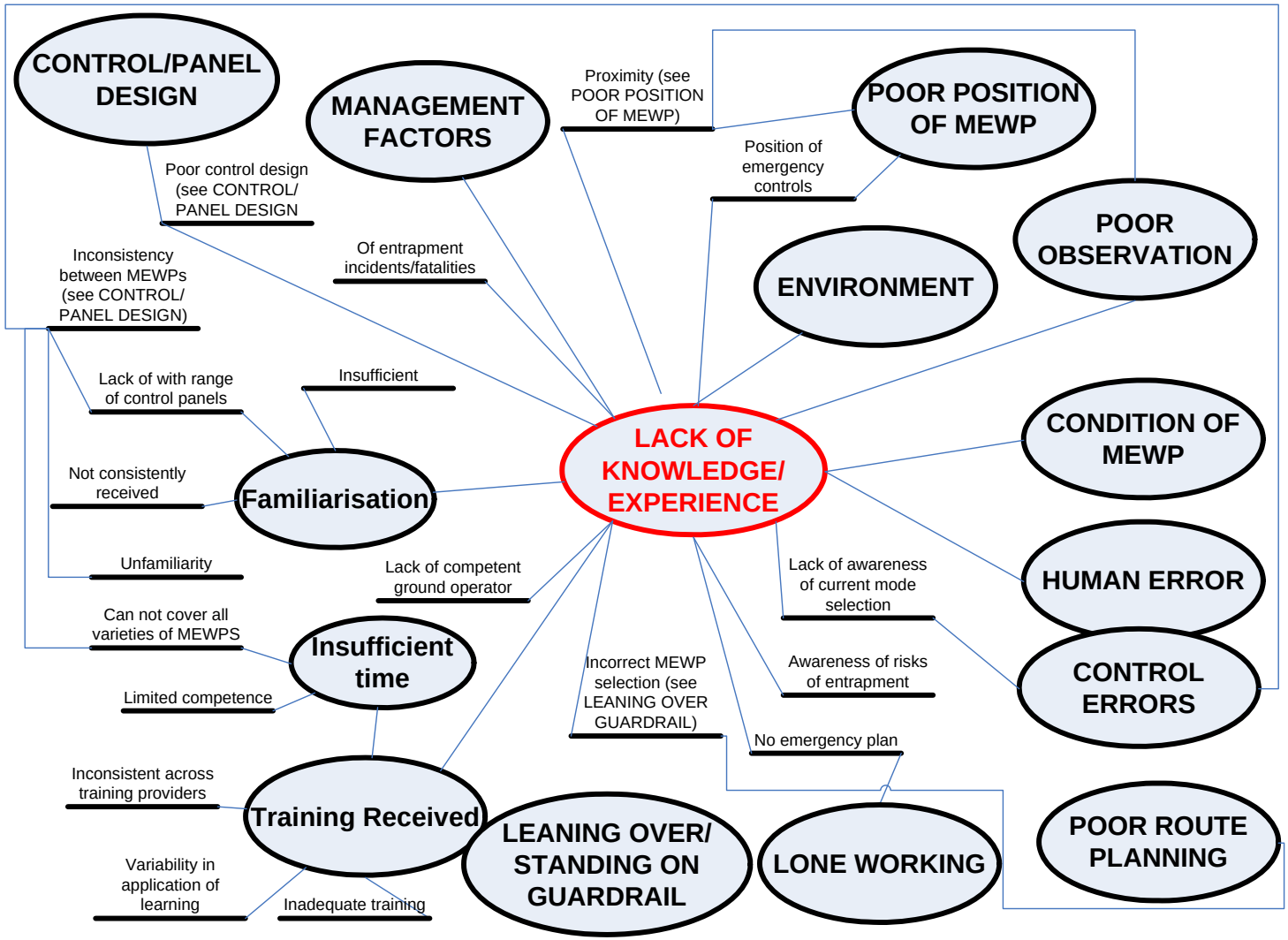

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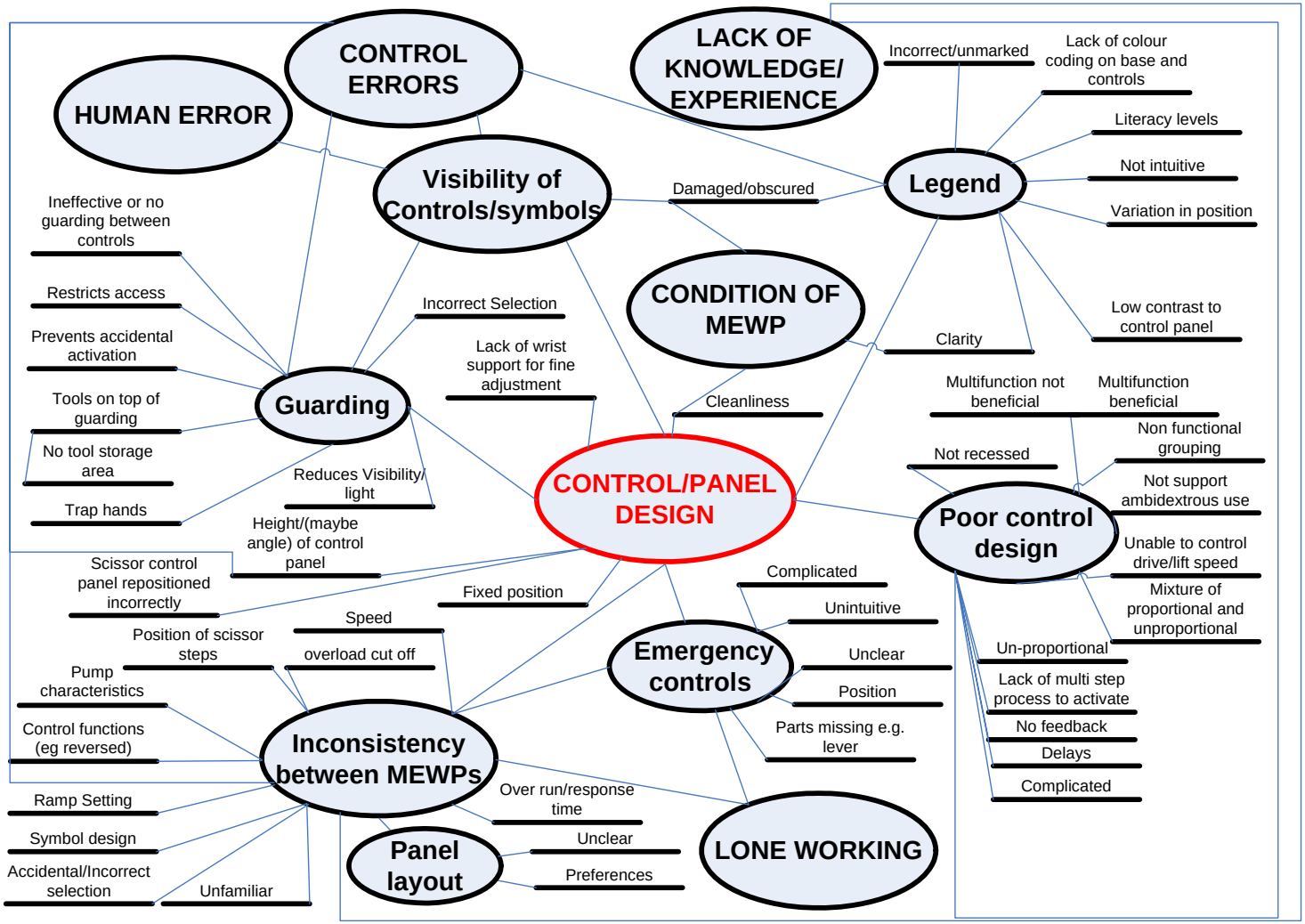

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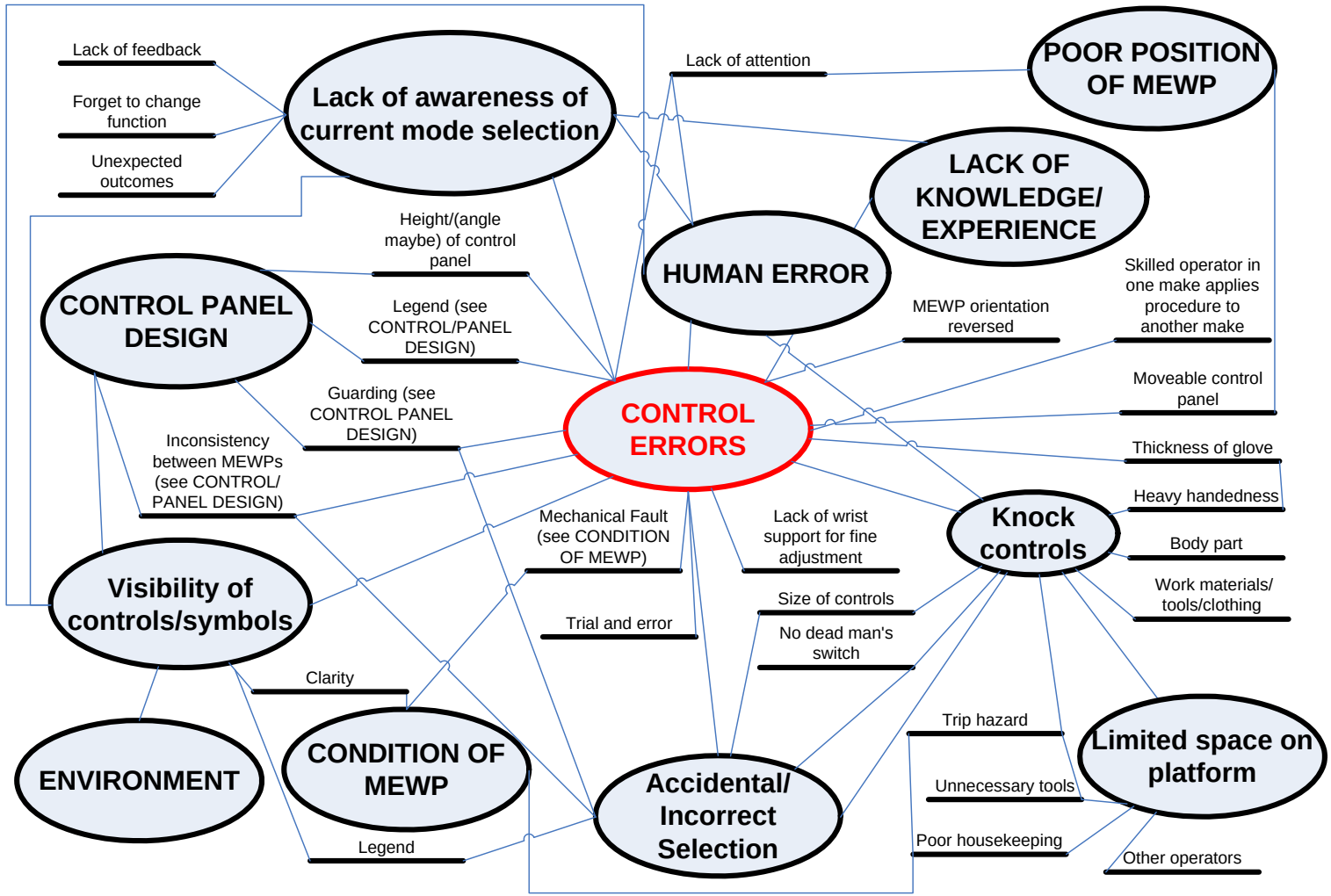

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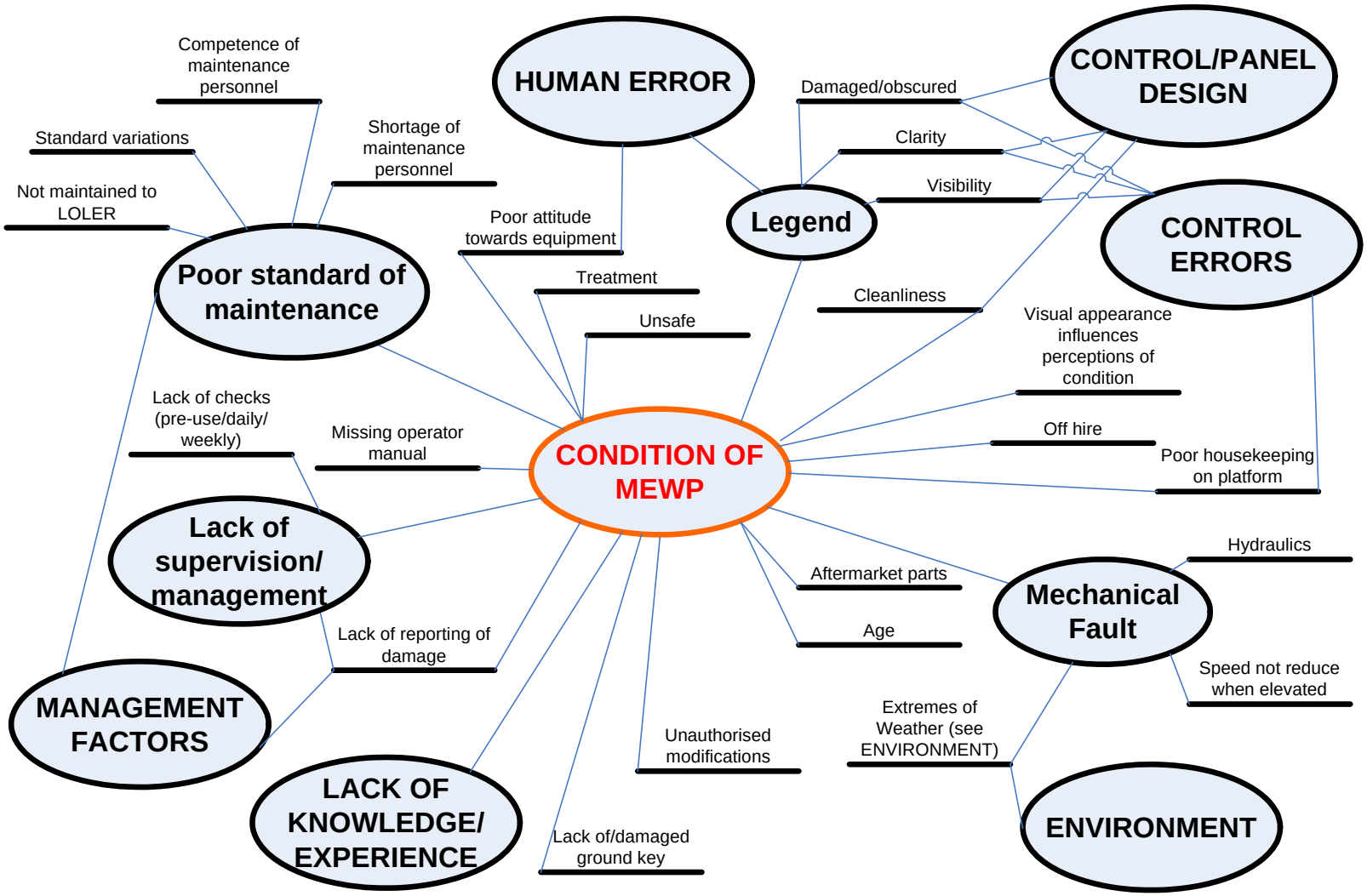

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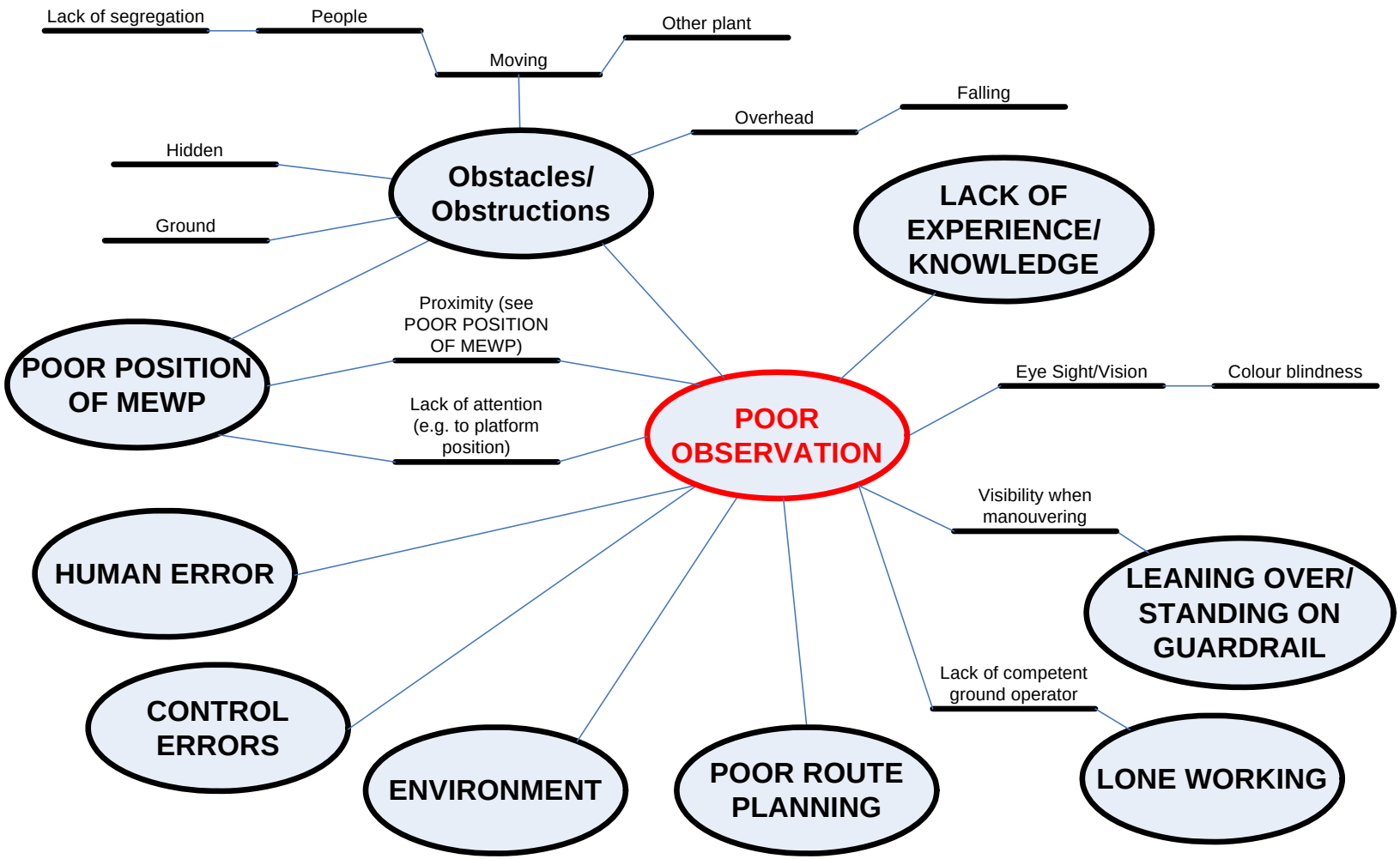

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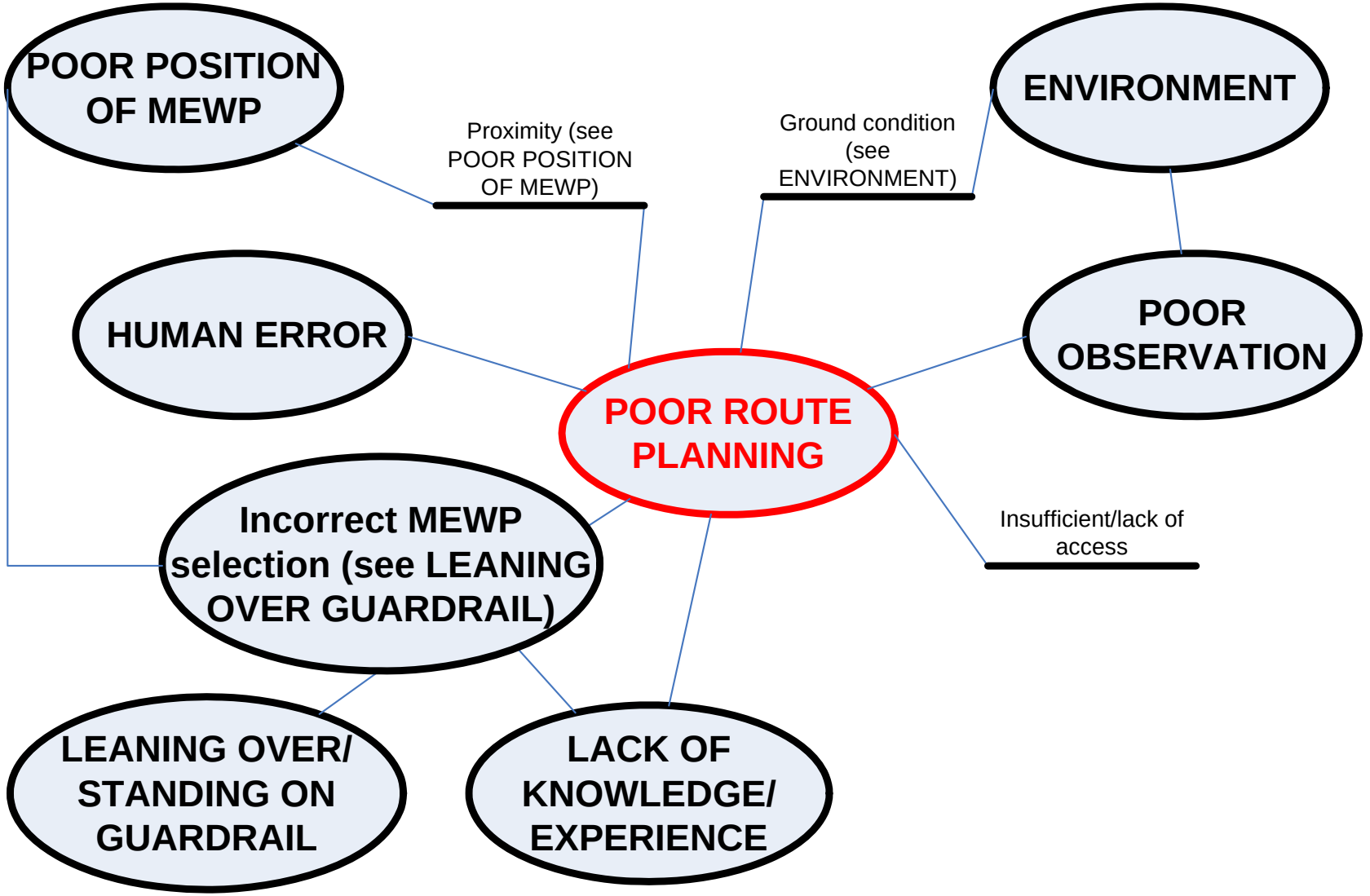

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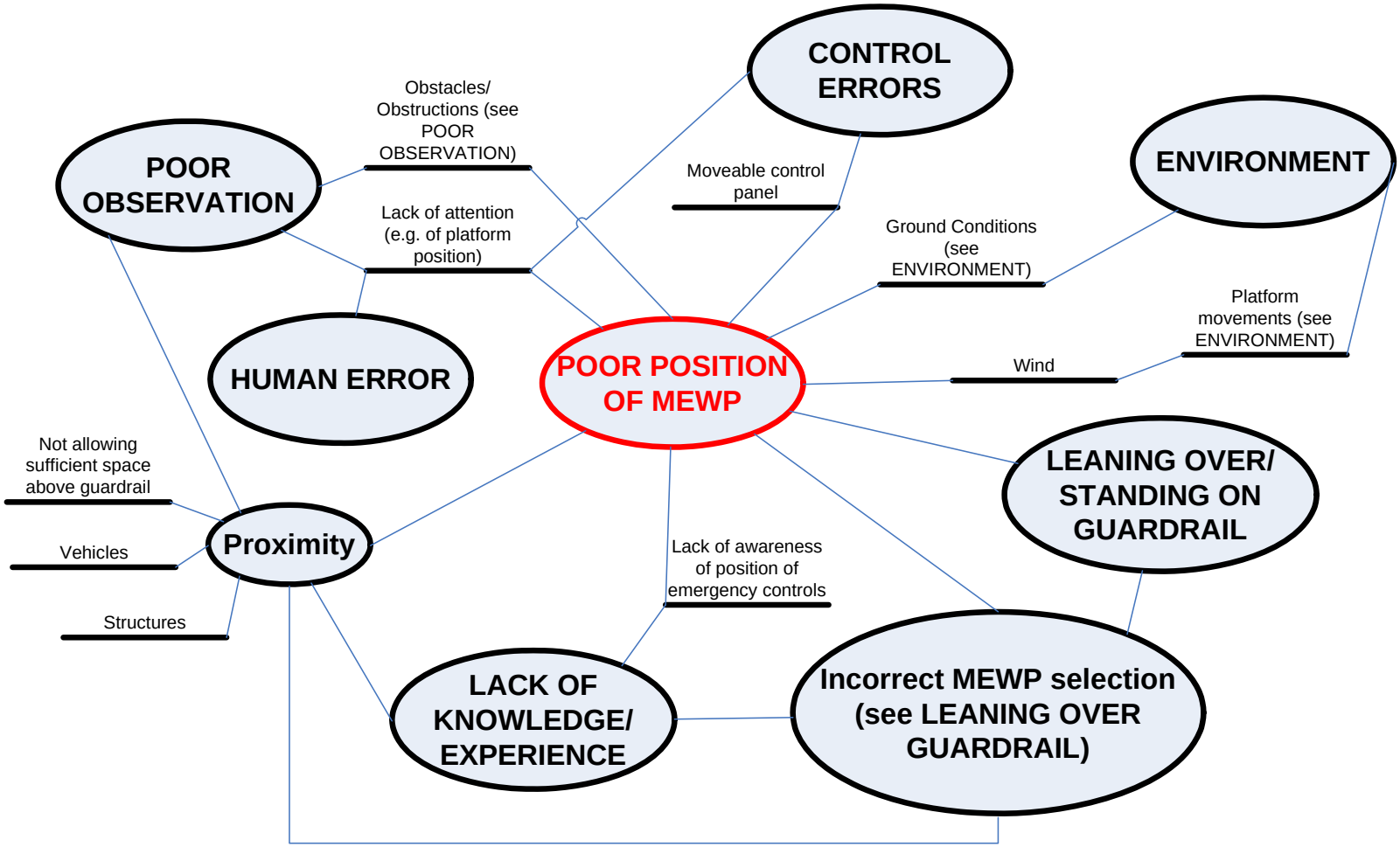

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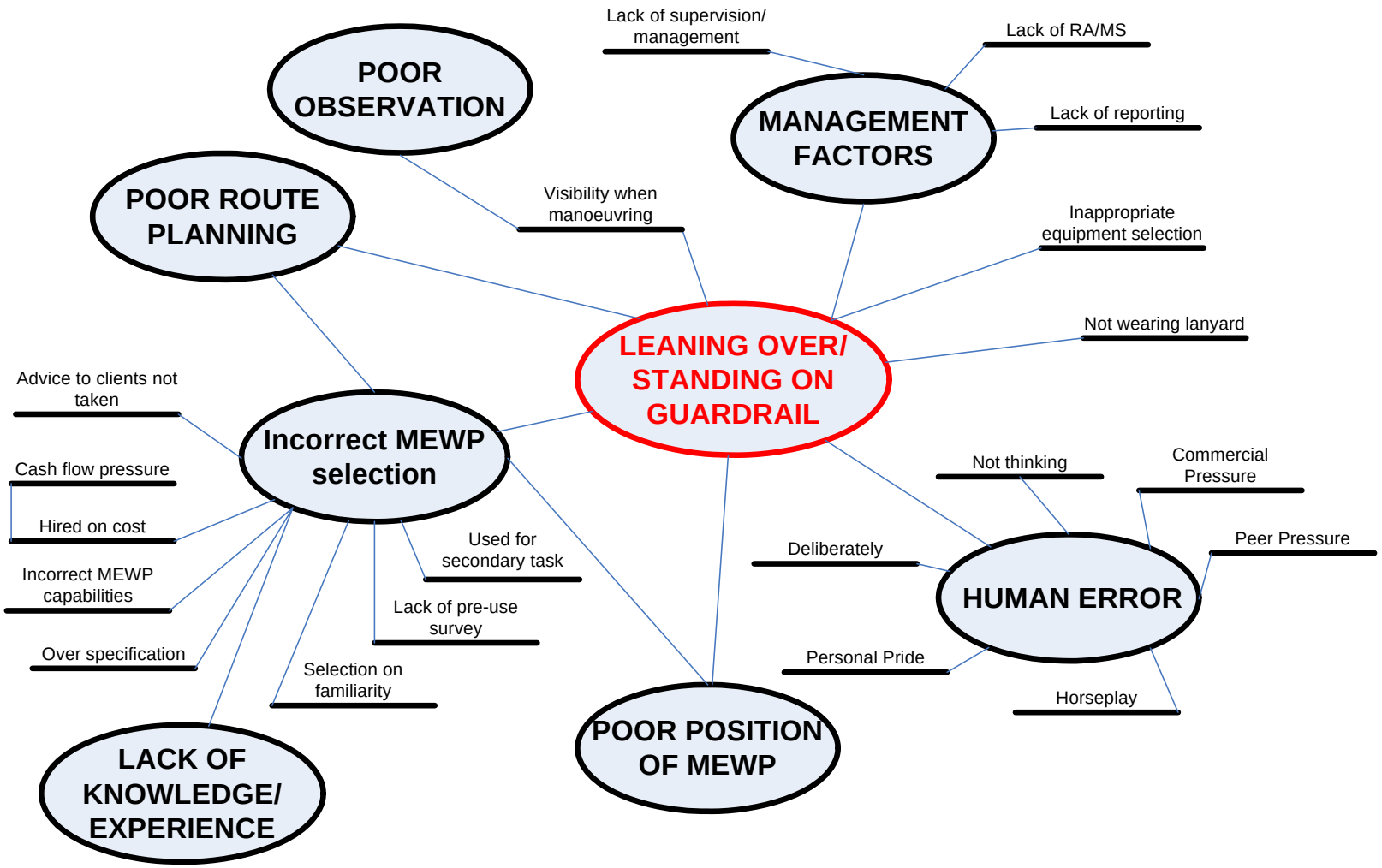

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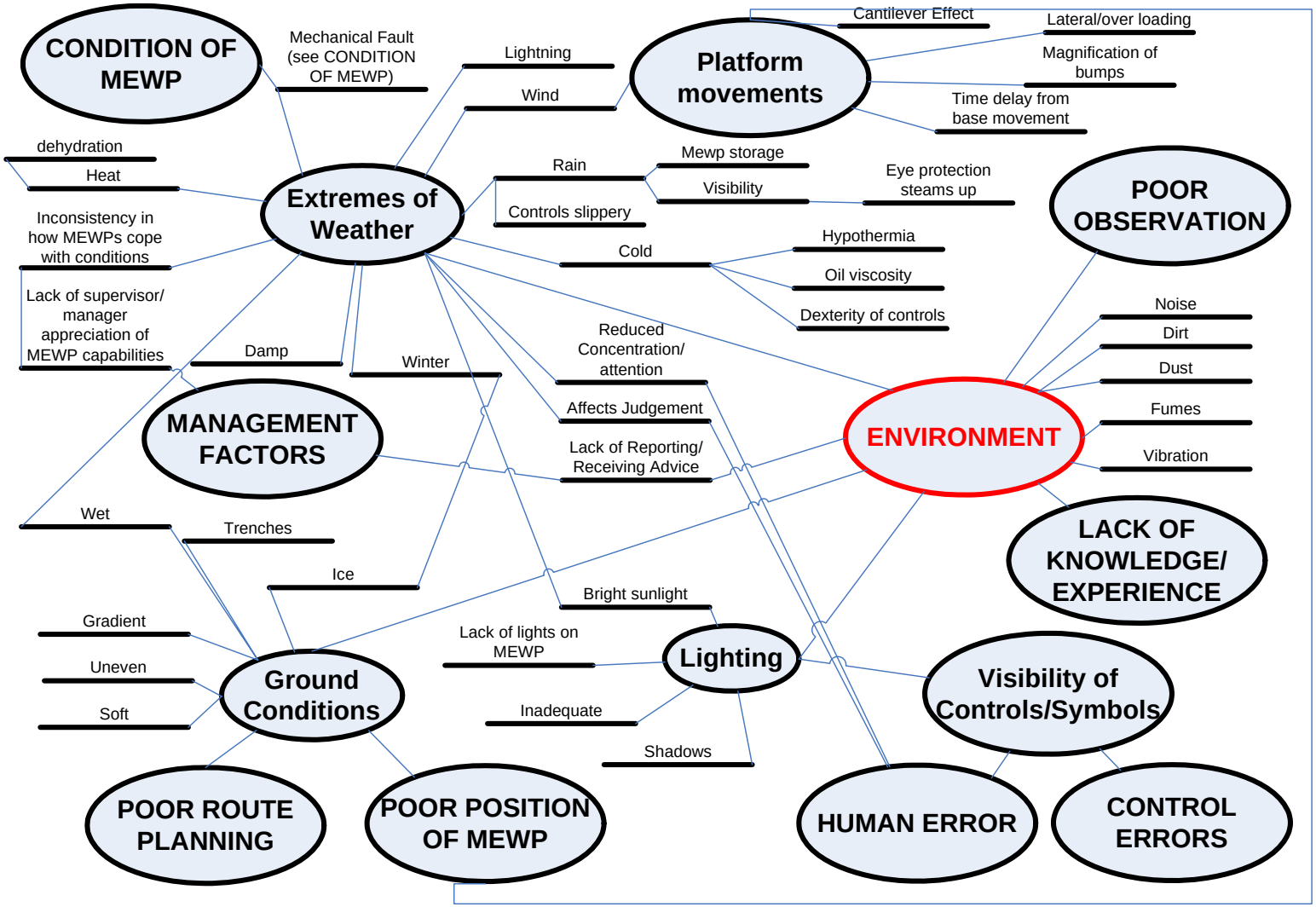

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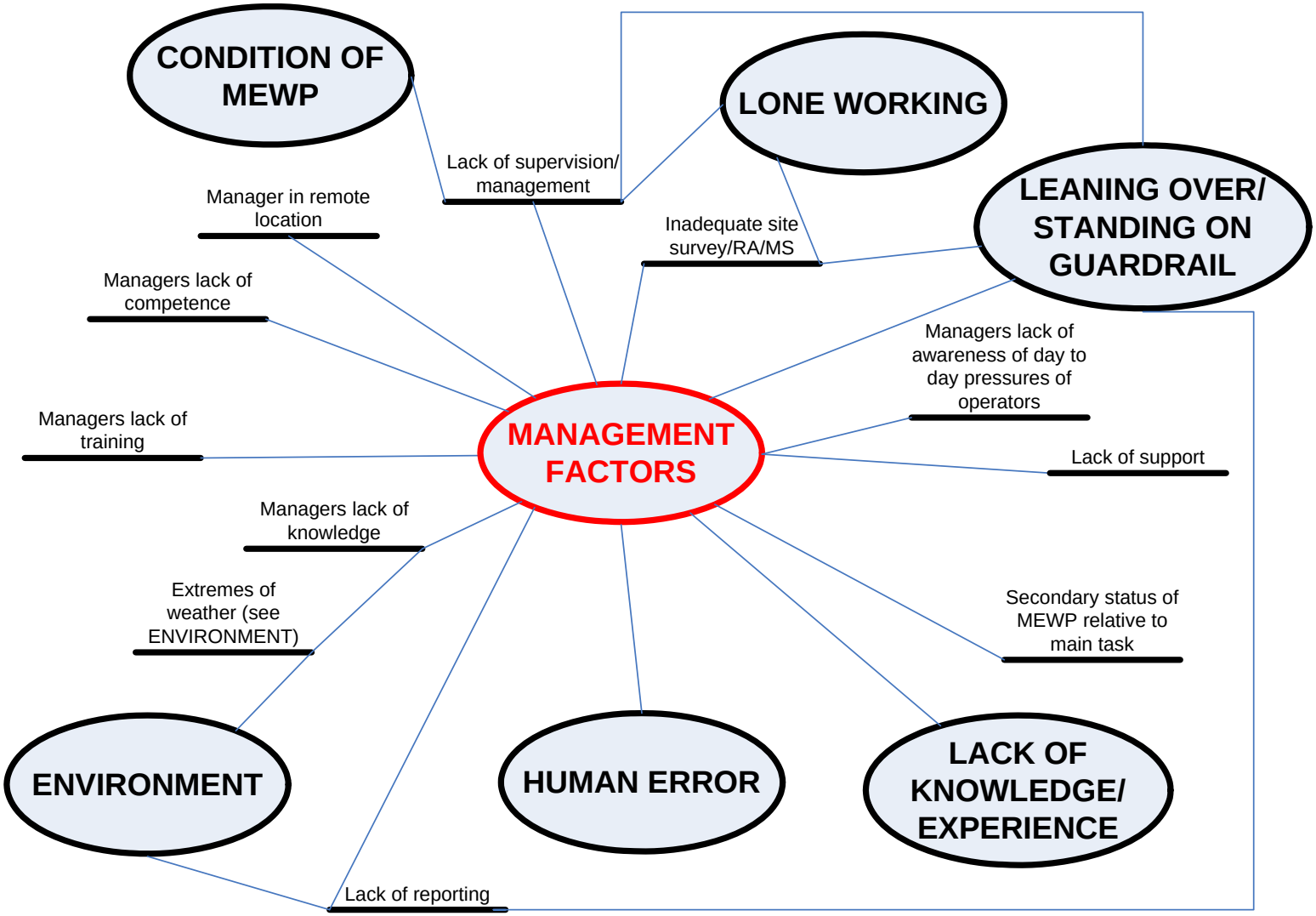

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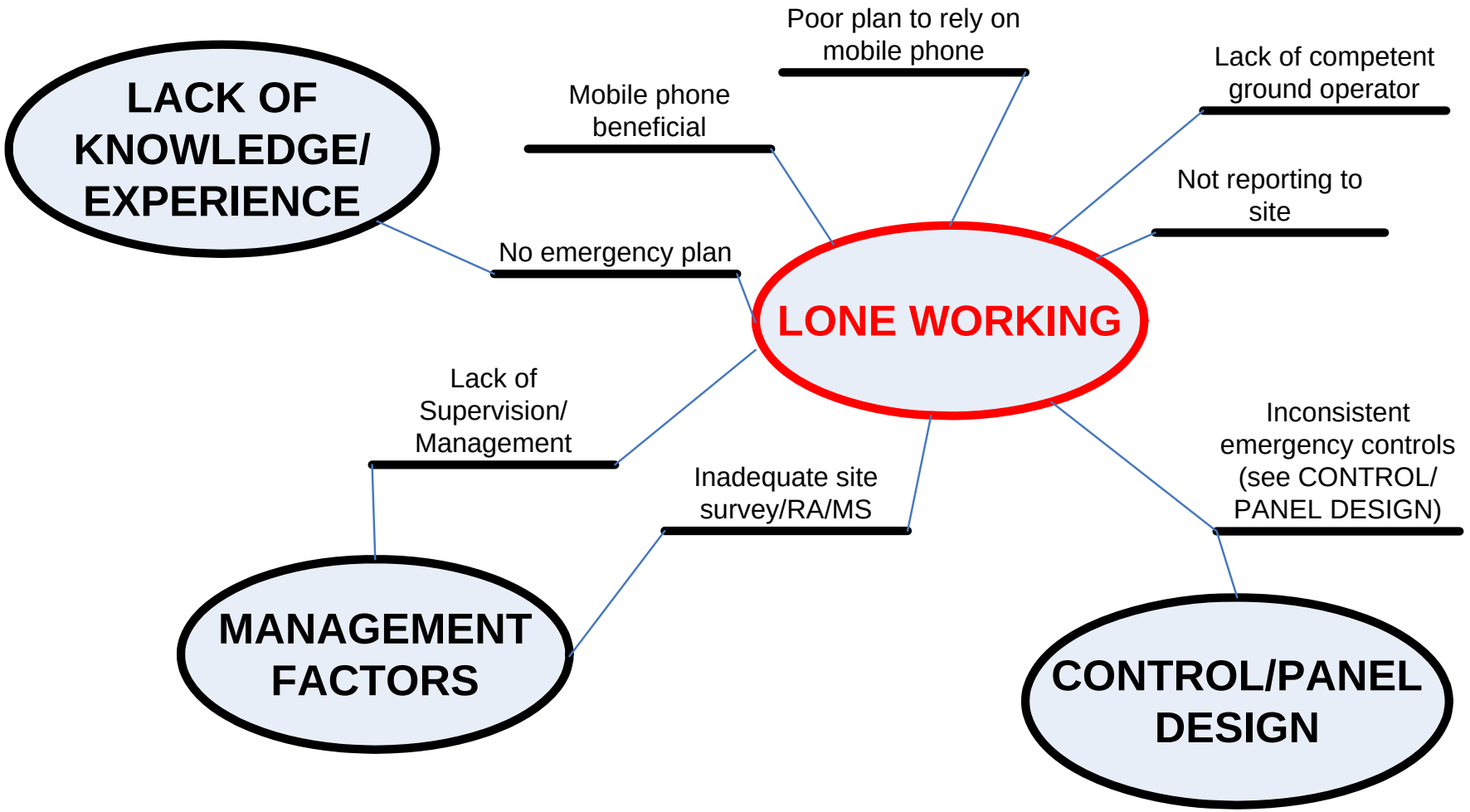

## APPENDIX 11

Risk reduction measures for entrapment suggested by the subject matter experts throughout the interviews are listed below.

- Standardised control panel layouts. Standardisation may help to combat user expectations and learned effects from one MEWP to another. Control errors may also be reduced. Other standardisation was suggested to include the following:
    - Factory settings should be standardised for example the overrun/ramping and tilt alarm. Consistencies between overload features for example what happens when the MEWP is overloaded;
    - Standardise symbols (as some are better than others);
    - Standardise control functions;
    - Standardise emergency controls and their position;
    - Ensure consistency of speed (e.g. reduced when elevated)

- It is suggested that work needs to be done in collaboration with end users to develop additional systems and functions for safer working, for example providing inverters to avoid trailing power leads, and having additional tool storage areas. This would help to avoid trip hazards that could potentially lead to an operator inadvertently knocking a control.

- Managers should attend the MEWPs for Managers course in order that the correct MEWP is selected for the task.

- *"Stop the machine going backwards when elevated."* This would reduce an operator needing to divide attention between observing the surroundings at ground and platform level whilst using a fixed control panel.

- *"Built in anemometers would help."* This would help enable the operators to know when the design wind speed maximum is exceeded and could cause instability.

- A suggestion was that the STOP control should be near the front of the control panel so that it is within easy reach.

- Written instructions should be suitable for those with reading difficulties.

- *"…Should be more requests to go to site to conduct familiarity exercises for each and every model even though operators are trained… a more pragmatic approach would be beneficial."*

- There needs to be a defined rebuild cycle (e.g. yearly) of control panels in the powered access industry. It was suggested that a new fascia to the control panel could be replaced so that the text/symbols do not become damaged/obscured overtime.

- A suggestion was to introduce mandatory eye tests. *"The ability to see a brick (on the ground) at 150ft would be a good test for operators." "Red and green eyesight*

*from 150ft is important to see markings on the base relating to (colour coded) directional controls*[1]*."*

- Investigation into those who instruct the instructors, *"need more consistency with machinery training"*.

- Training is a one-day course; this *"includes a limited set of competencies"* so more time is required for training to cover a wider range of machines. *"…Would prefer 2 days to cover everything more thoroughly particularly with the wide variety of MEWPS on the market."*

- Consider using devices that have the capacity to detect whether operators are mobile/static/upright for the protection of the lone worker.

- Charging for damage may help encourage operators to be more careful and reduce the proximity of the MEWP to structures etc.

- Encourage operators to report unsafe actions.

- *"Communication of changes/updates to machinery will help fill knowledge gaps and keep people abreast of developments that impact on the safe operation of MEWPs."*

- A regular manufacturers forum exists but not all manufactures are active members. Also, discussions are not focused on individual equipment and specifications and the difficulties of getting this information to operators, *"…it's communication and I think it is very very poor"*.

- *"The MEWP would benefit from a temperature display."* Being able to identify the temperature nearing significant levels could help combat the onset of thermal physiology issues, which in turn may affect an operator's judgement and manual dexterity.

[1] *The visual demands of the task require detailed consideration before an appropriate vision screening test can be suggested.*

**APPENDIX 12**

PAINTERS AND DECORATORS INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP

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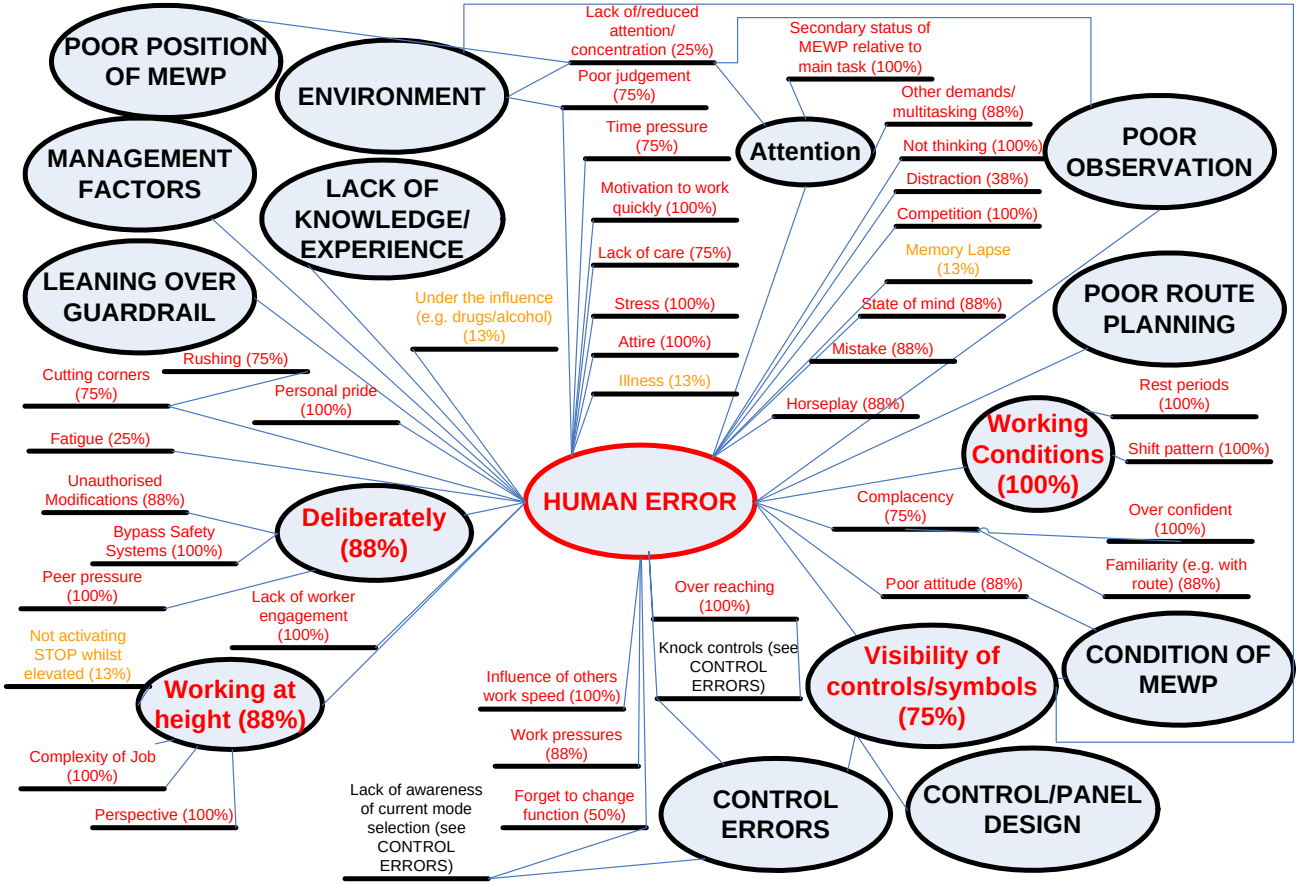


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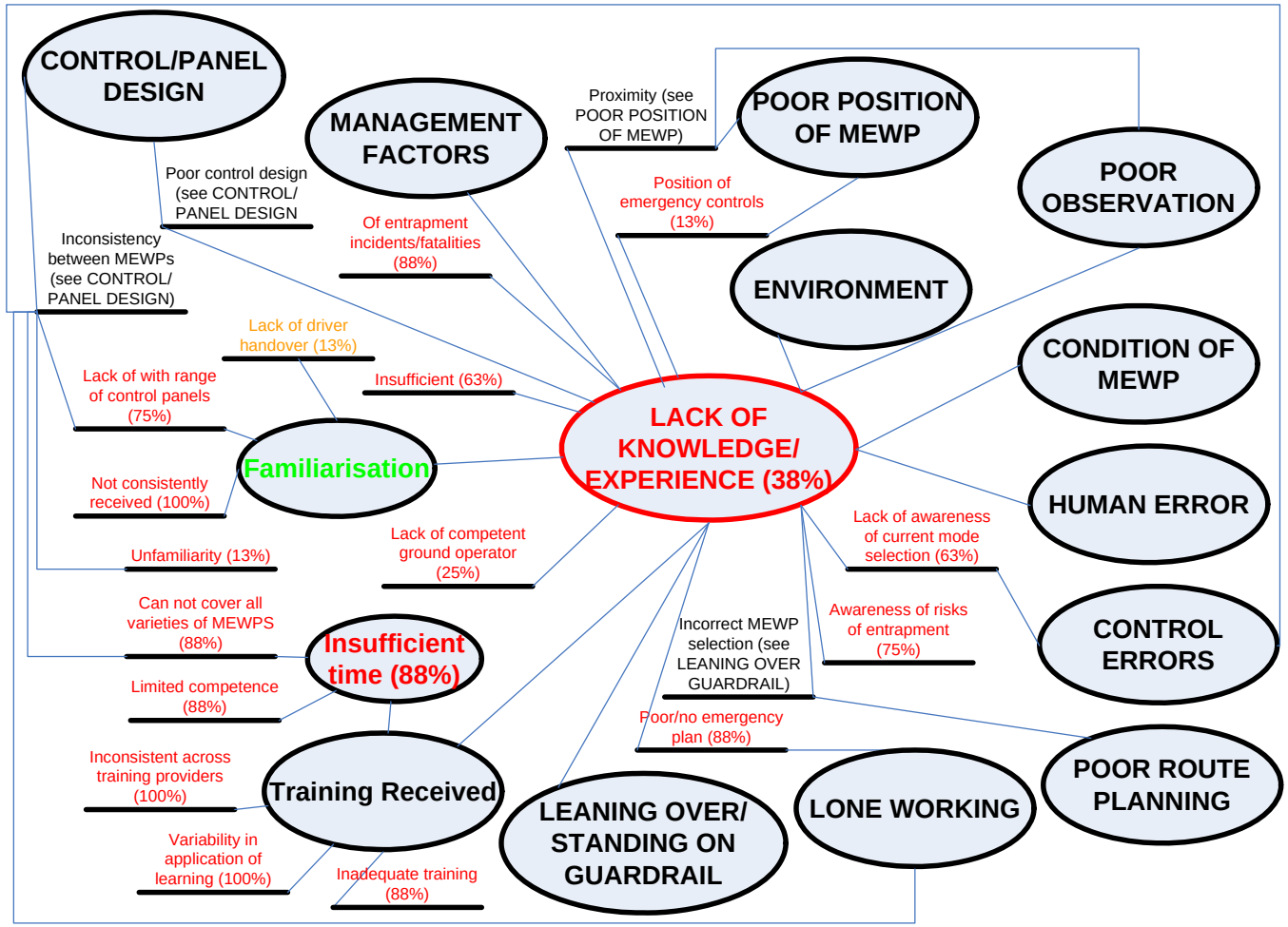


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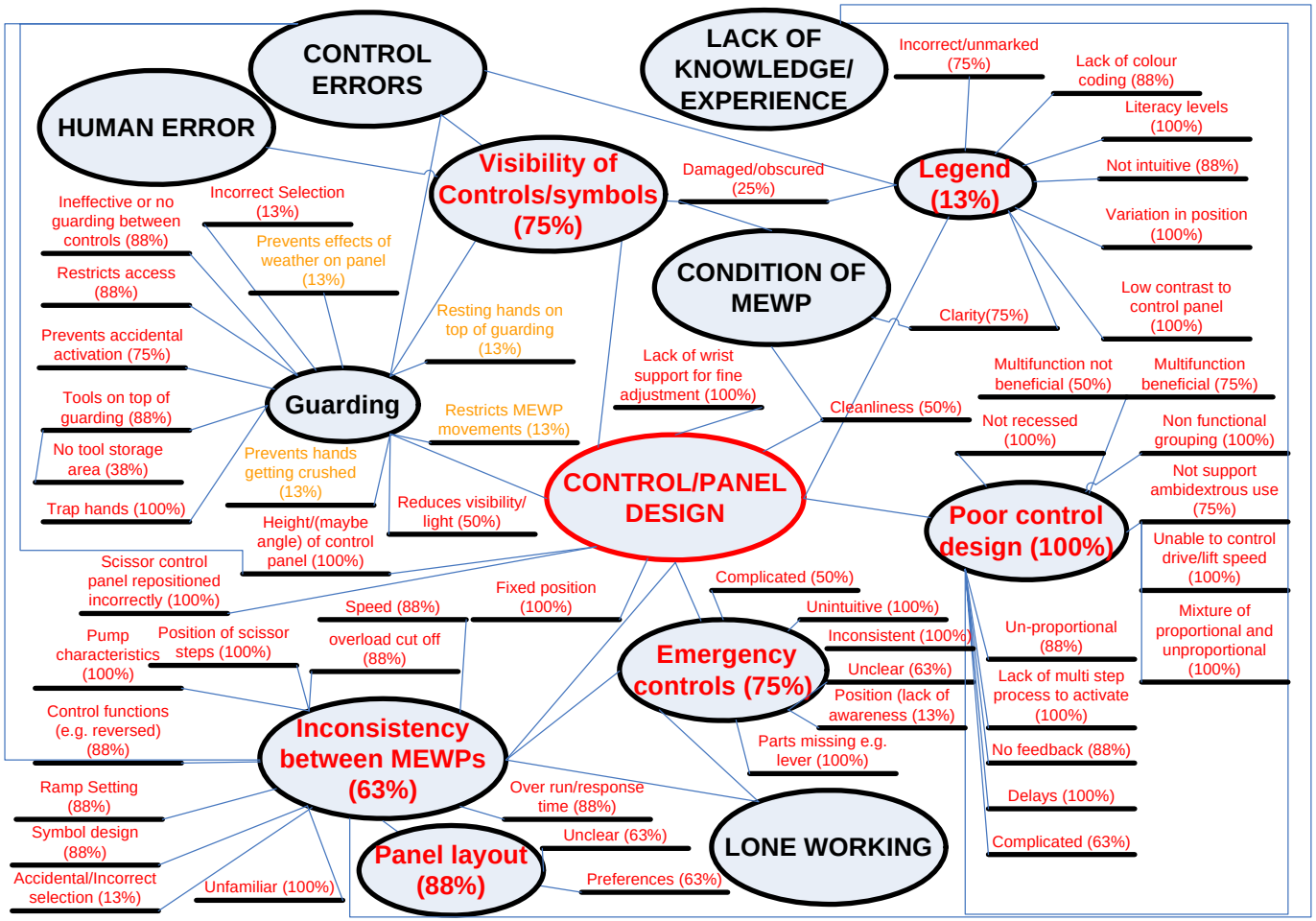


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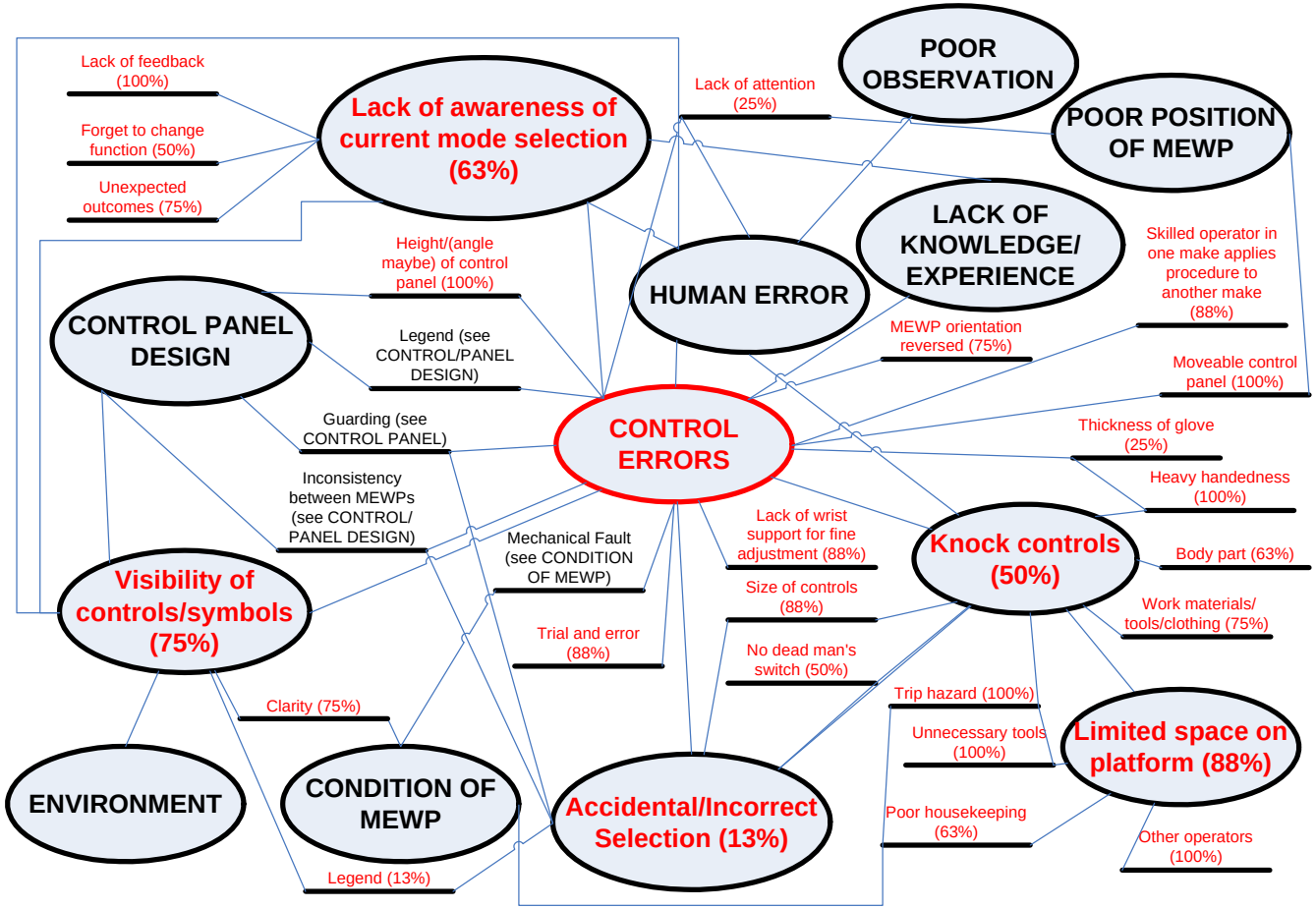


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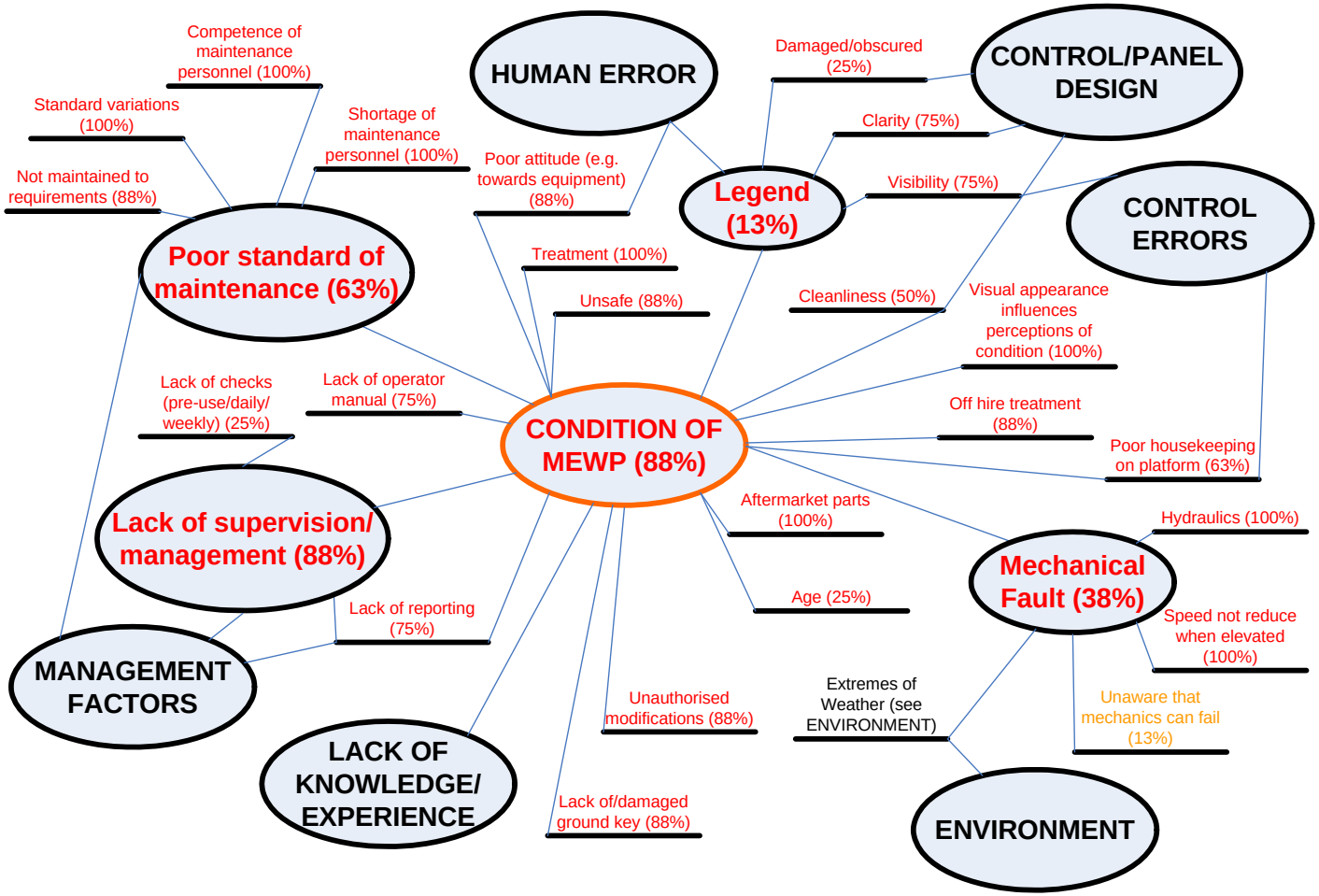


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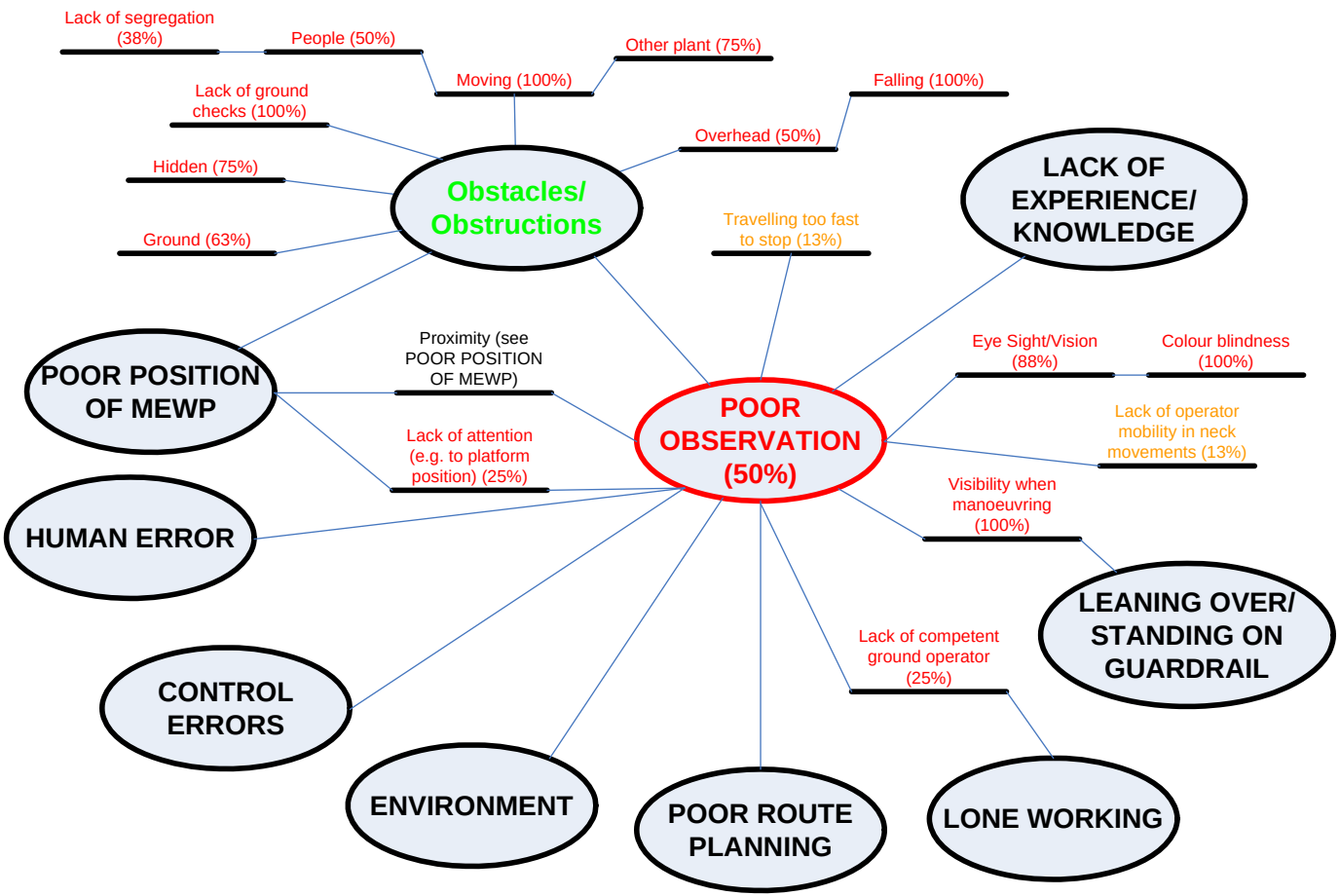


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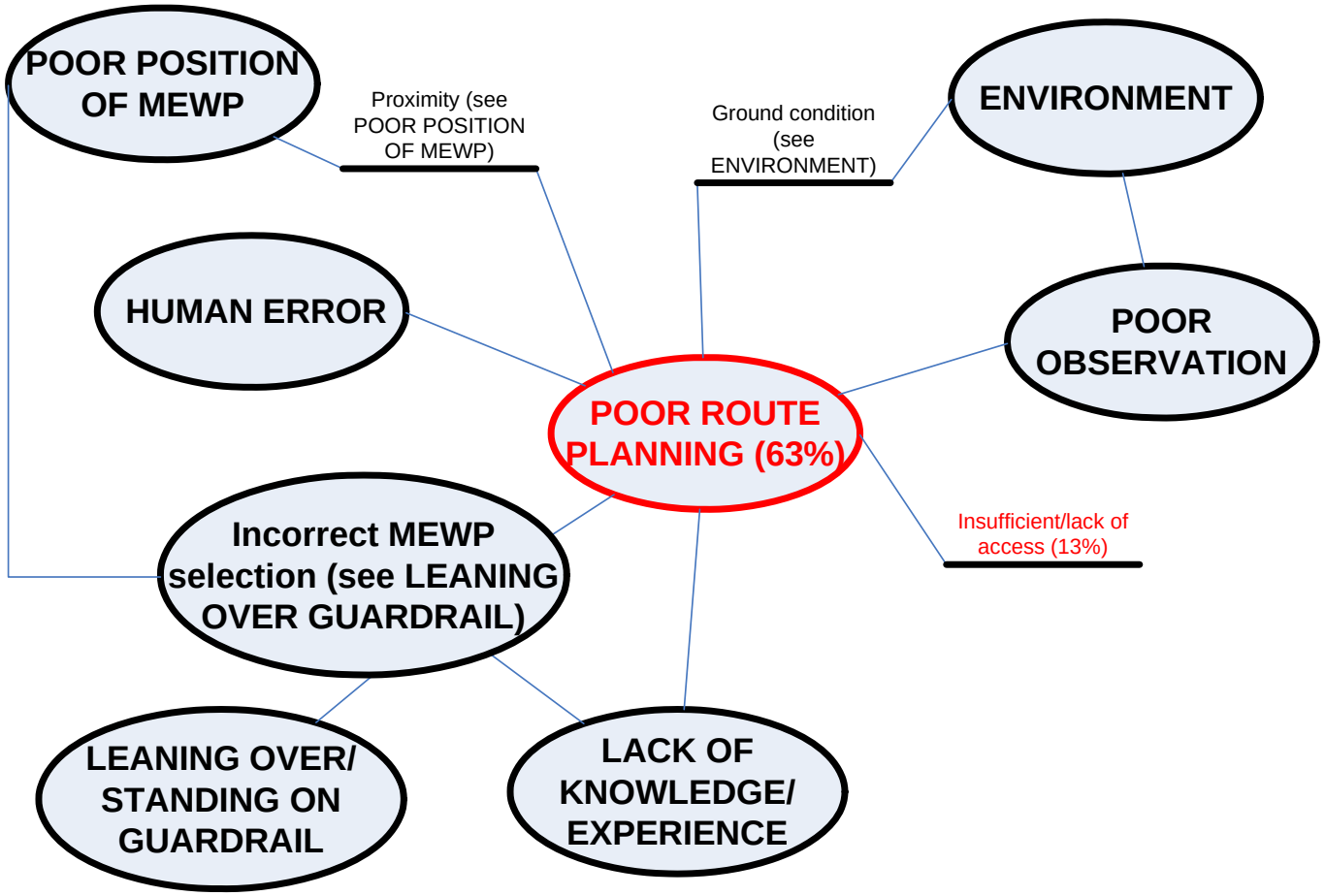


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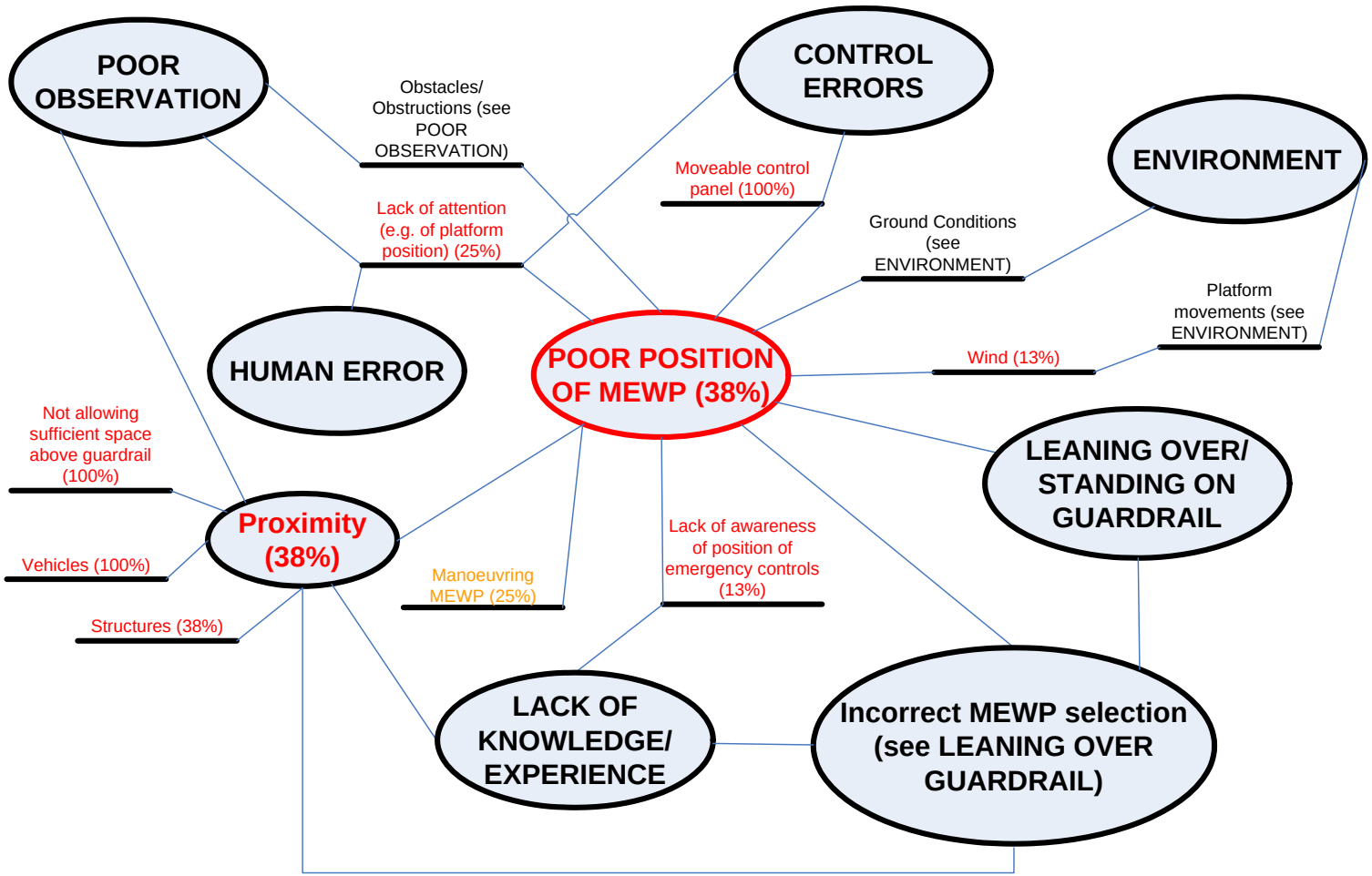


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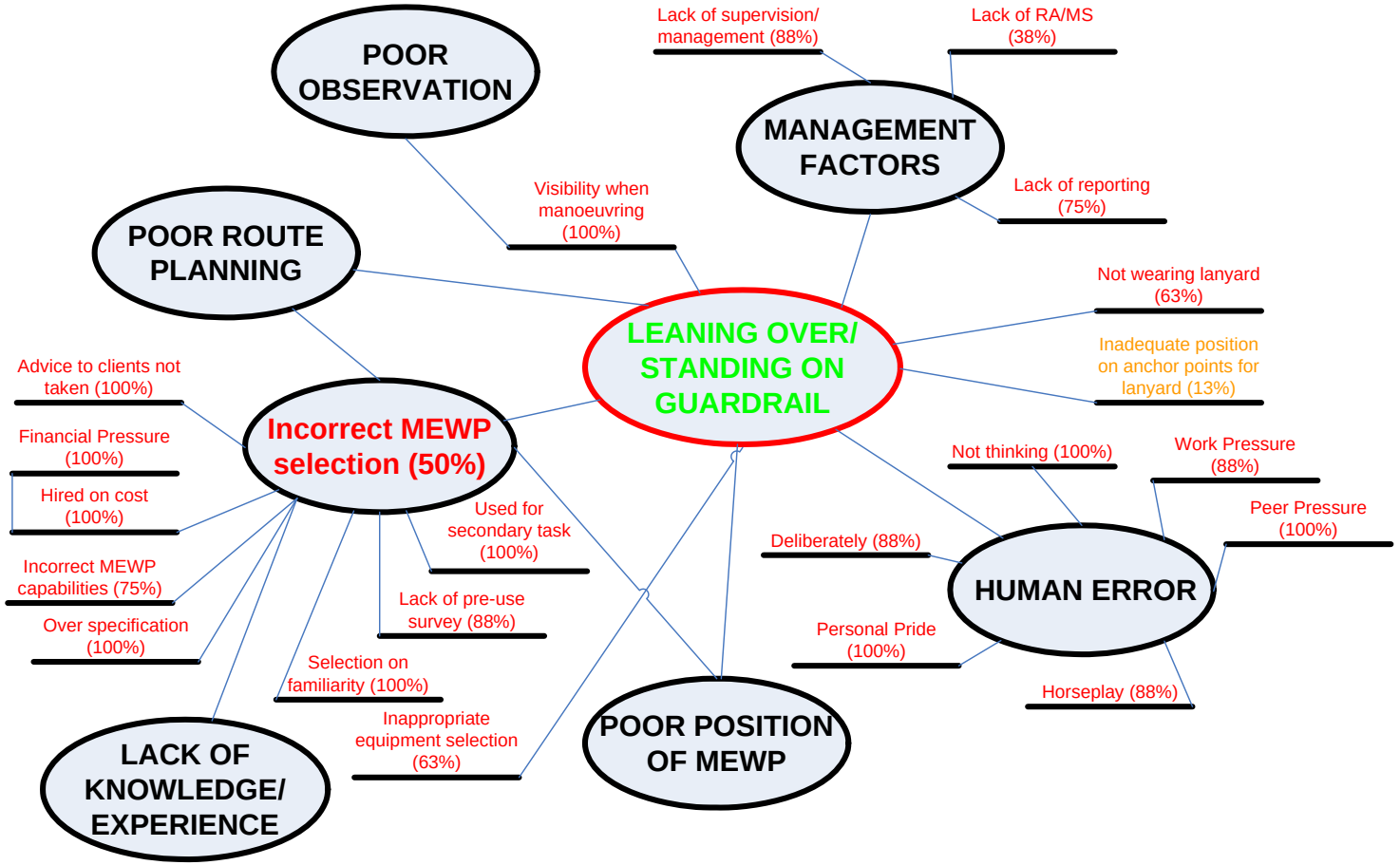


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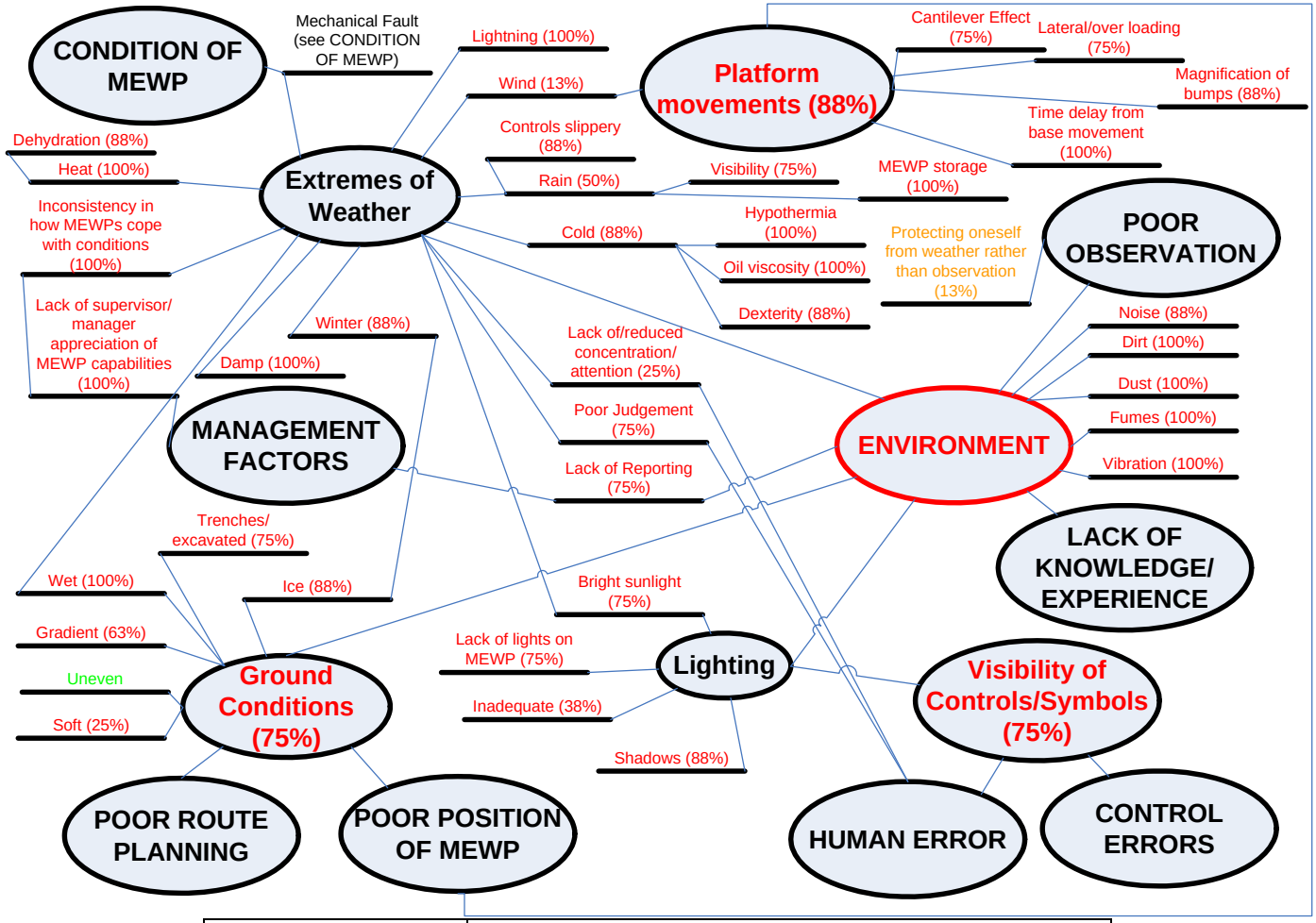


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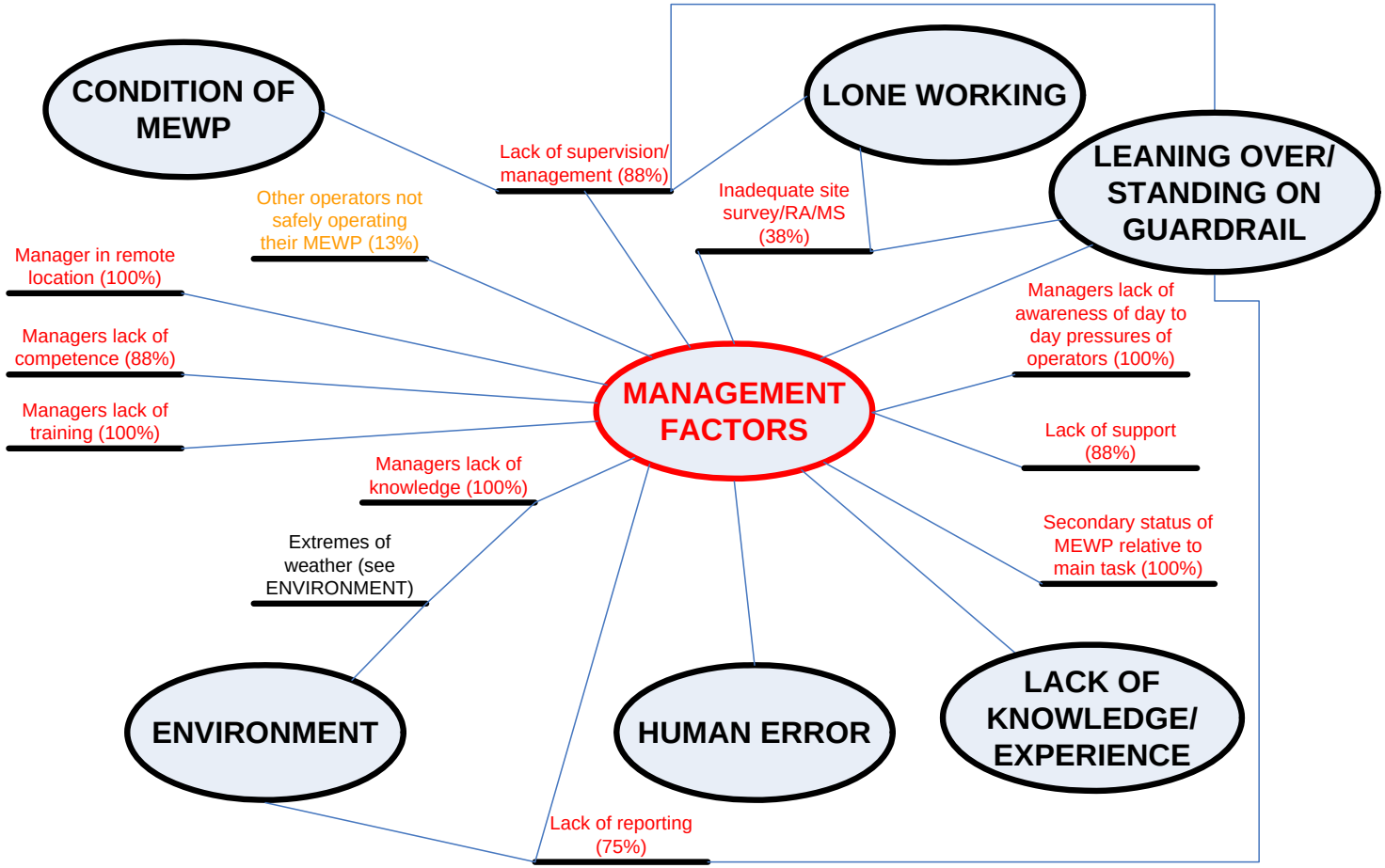


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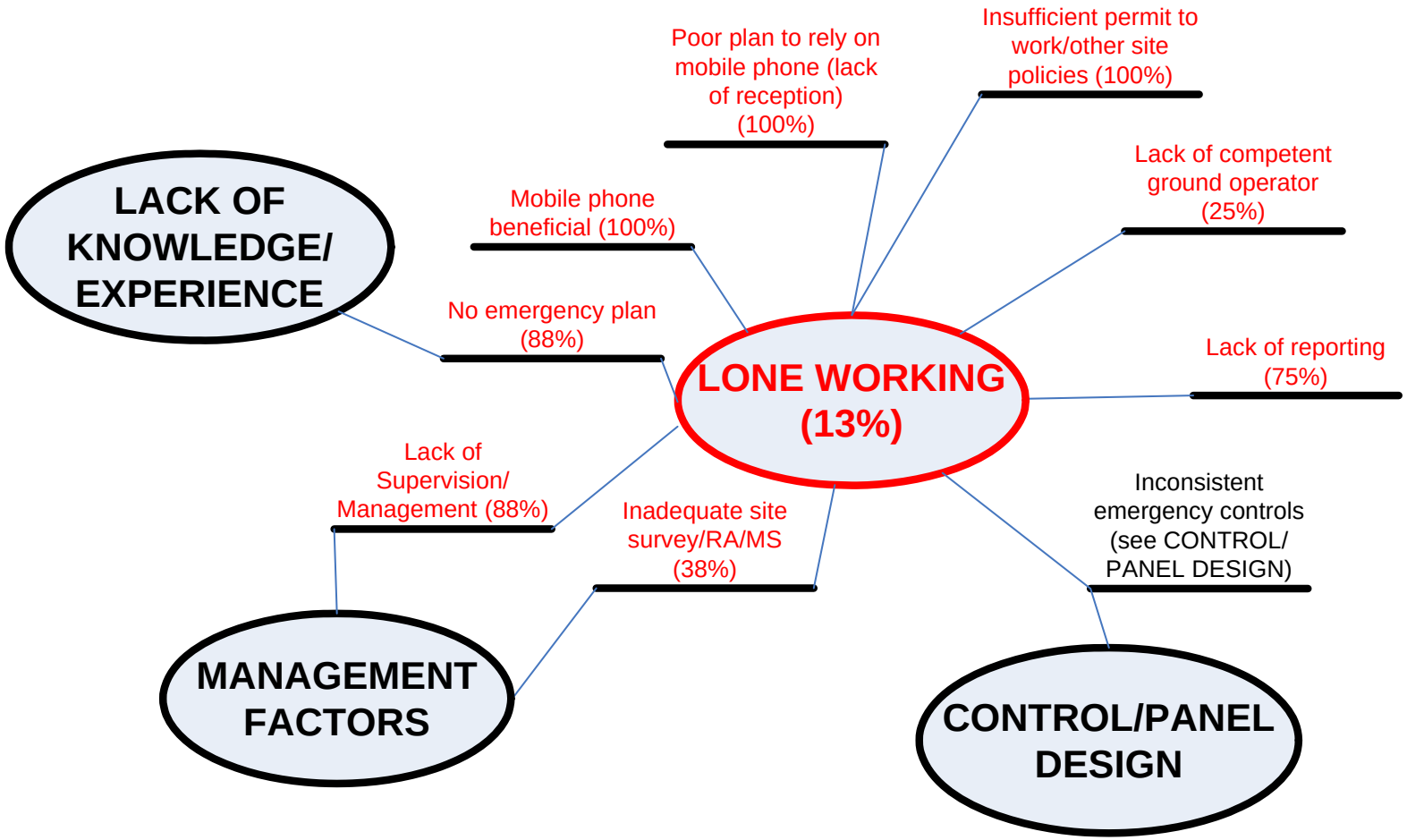


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## APPENDIX 13

Risk reduction measures for entrapment identified by the painters and decorators are detailed below:

- Anchor points should be better placed dependent upon lanyard used;
- Refresher courses should be completed for *occasional* users;
- MEWPs to be designed with solid sides around the platform (to prevent operators climbing the rails);
- Simplified control panel (to help reduce control errors);
- Standardised control functions (to help prevent the effects of learning on one make and model);
- Reduce distraction by confiscating the operator's mobile phone whilst in the platform;
- Proximity sensor and sounder on platform (to help reduce proximity to other structures/vehicles etc);
- Hydraulic levelling (although this may not be appropriate in all circumstances);
- Built in anemometer (so that an operator does not rely on what may be poor judgement);
- A steering wheel for drive;
- Improved tool storage area (to help prevent trip hazards/knocking controls);
- Better management of different trades at different times on site (to prevent proximity issues).

**APPENDIX 14**

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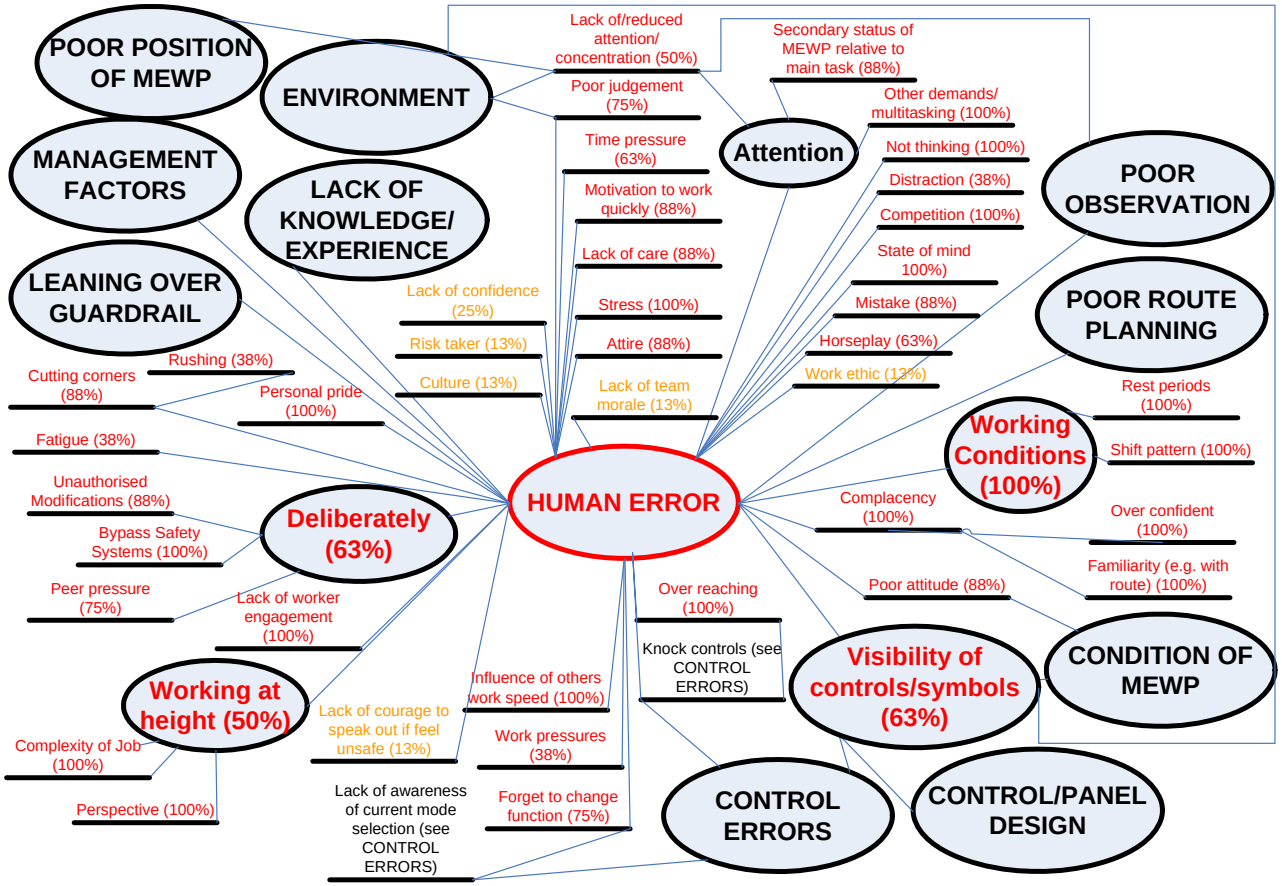


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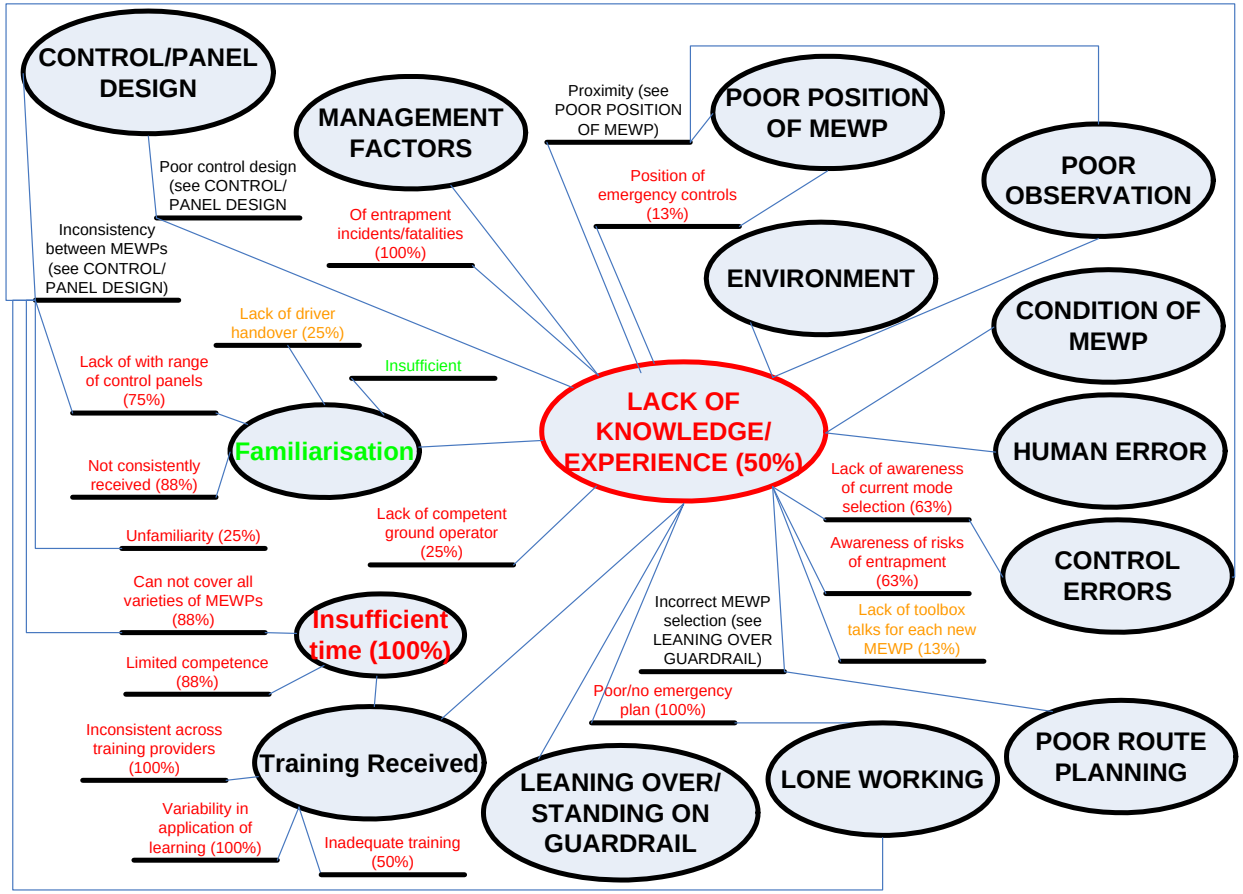


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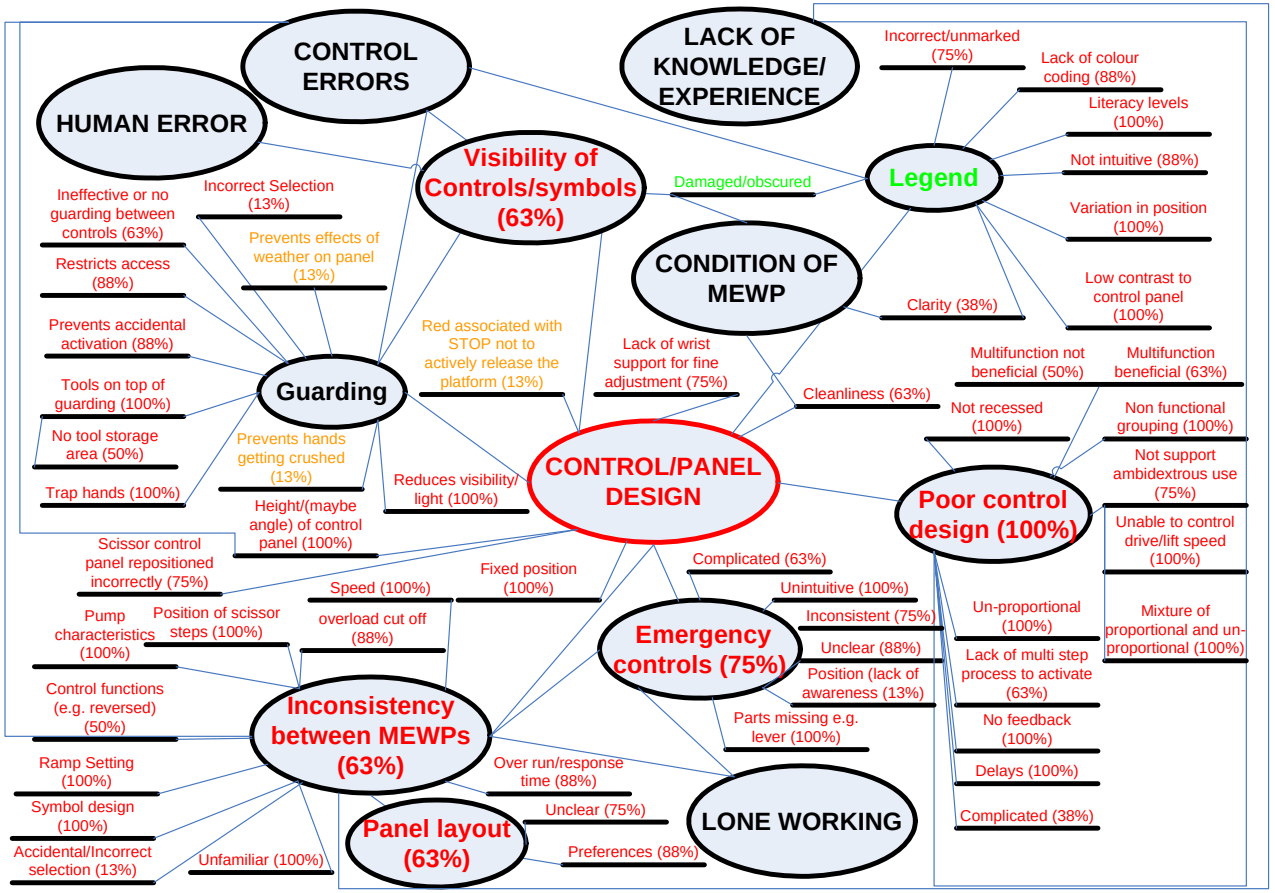


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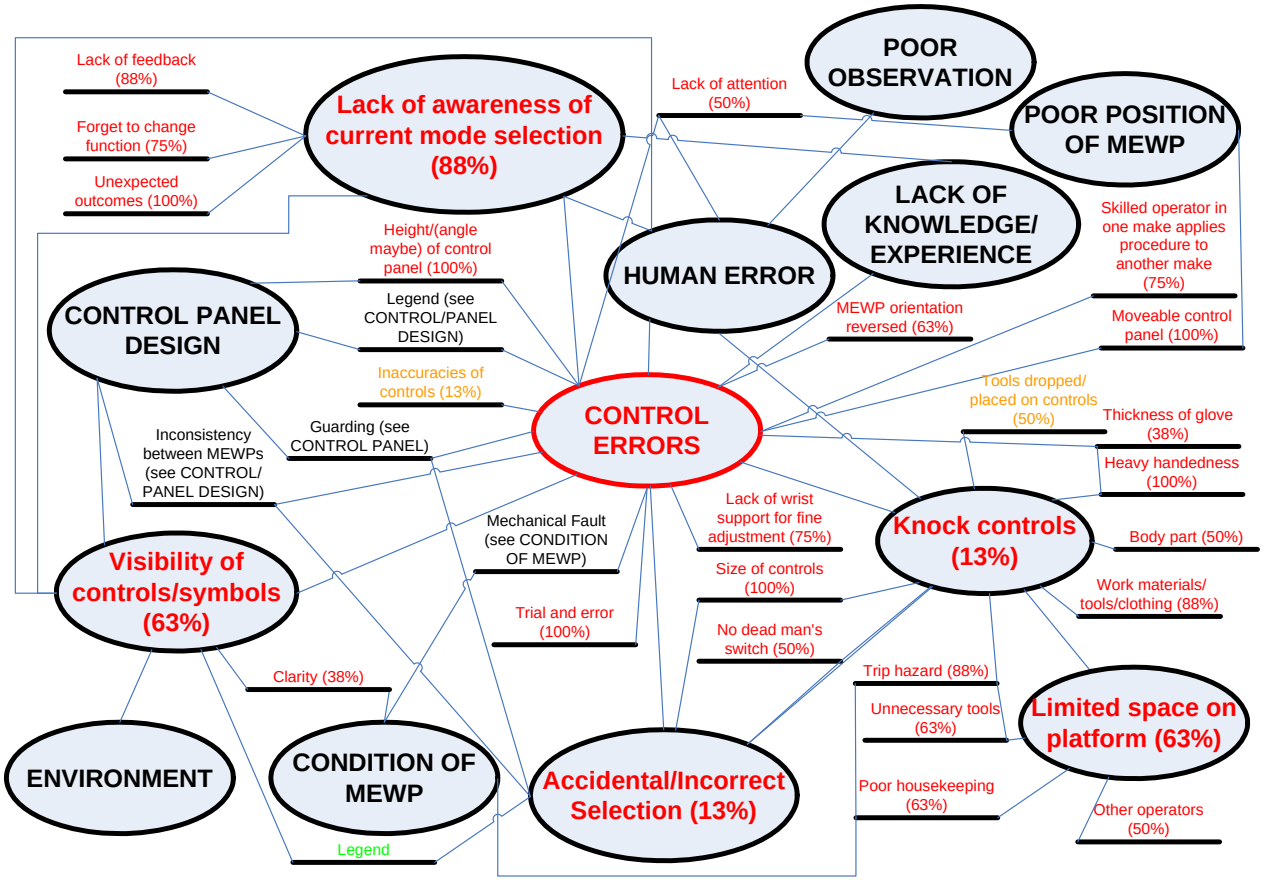


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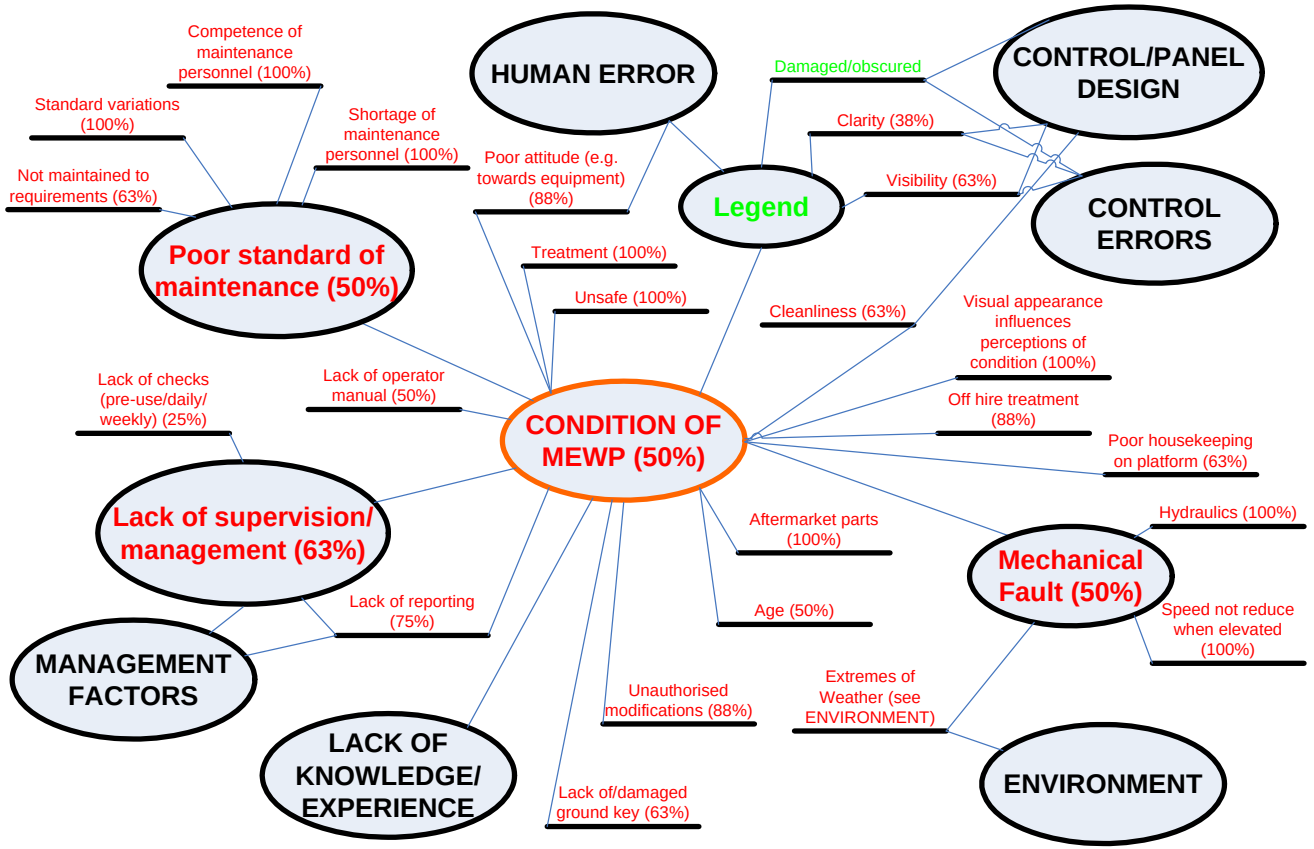


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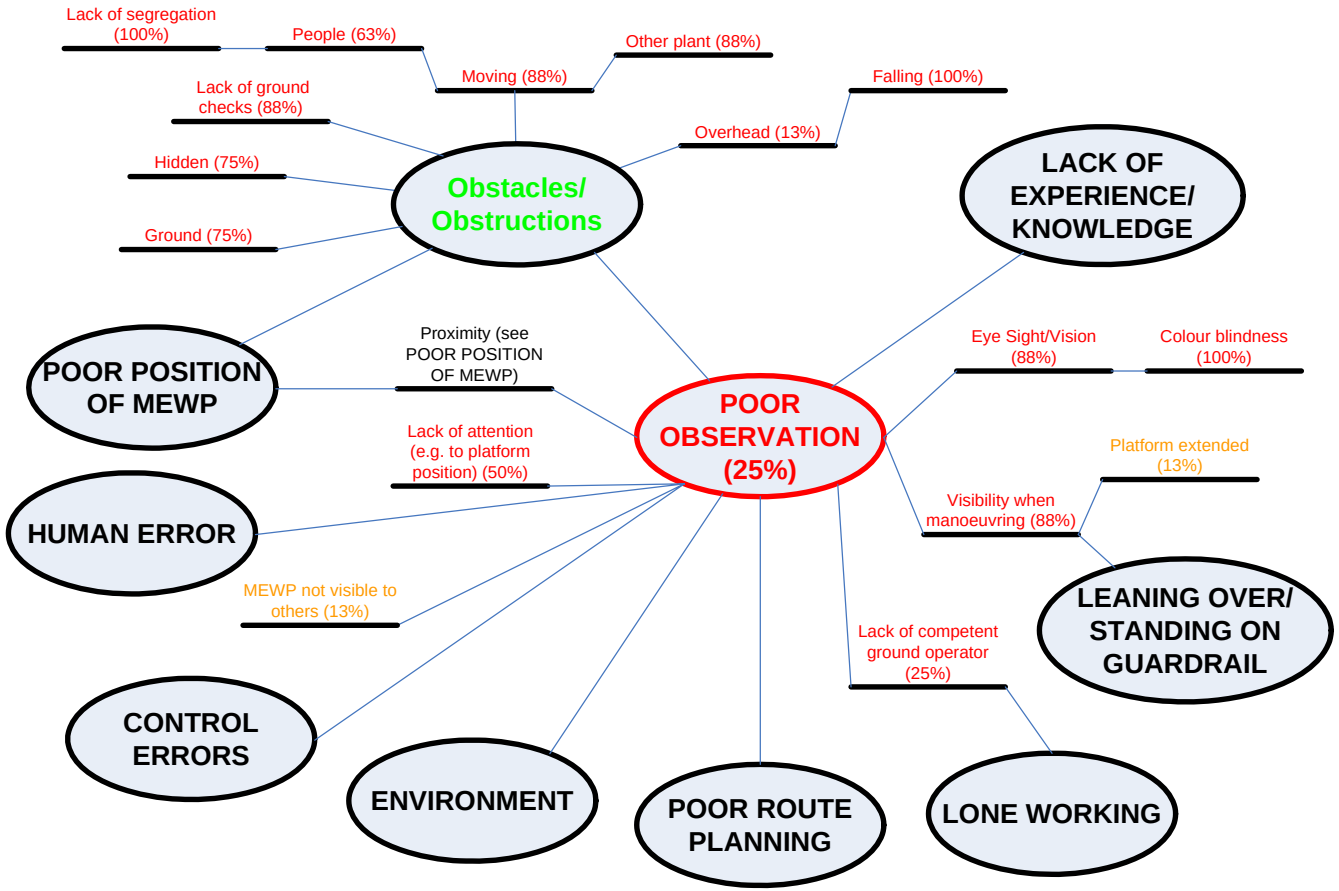


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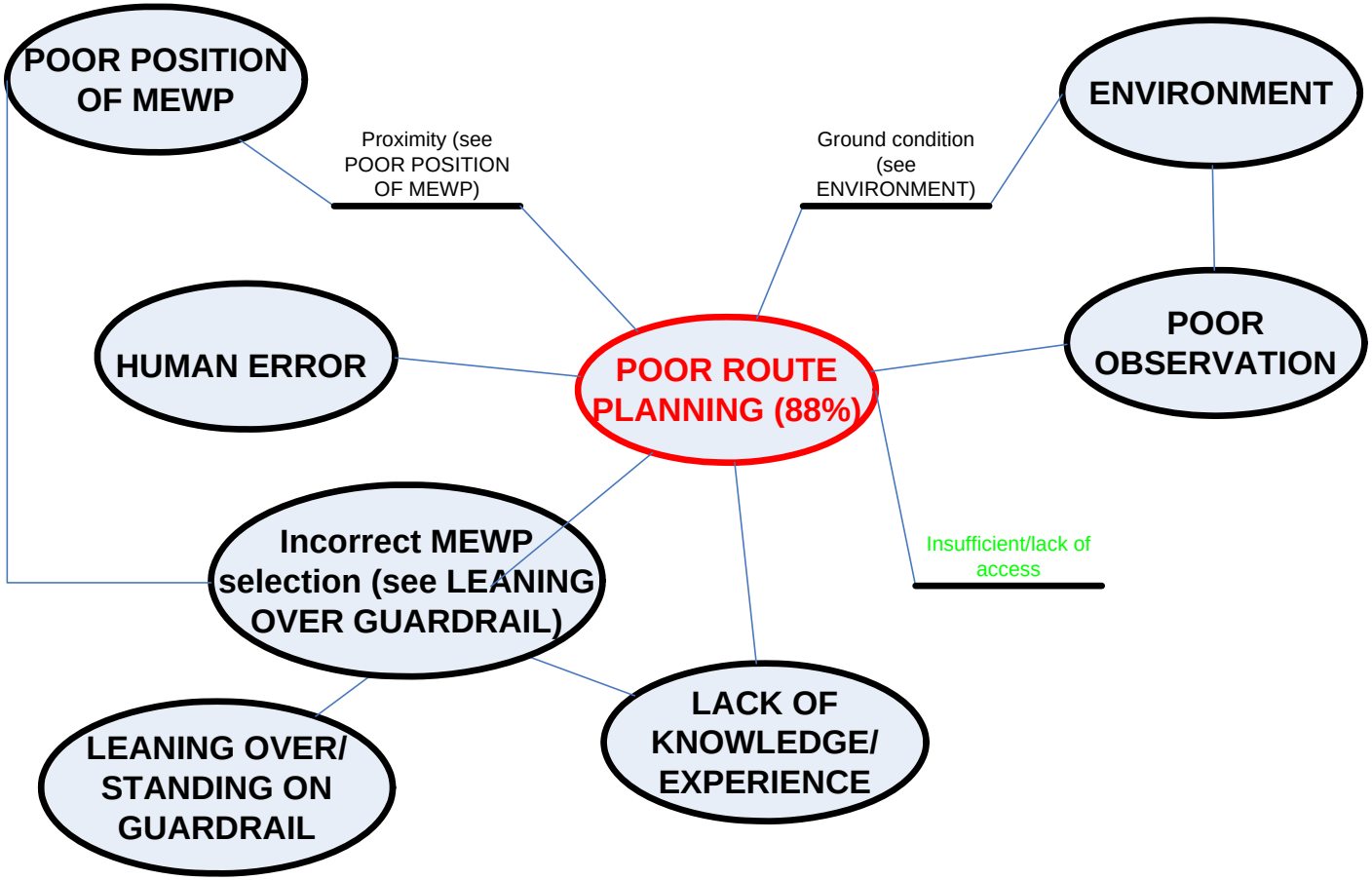


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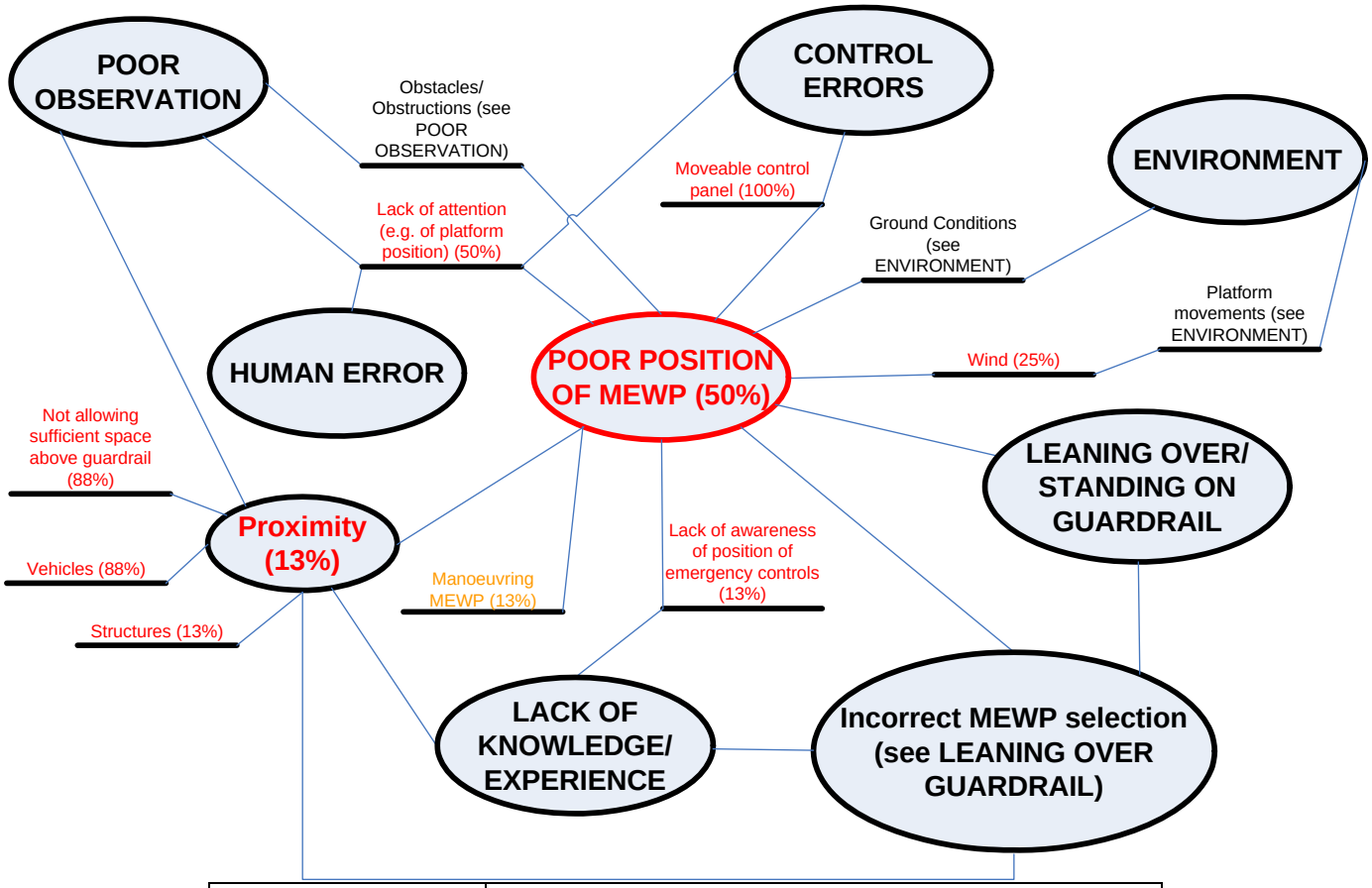


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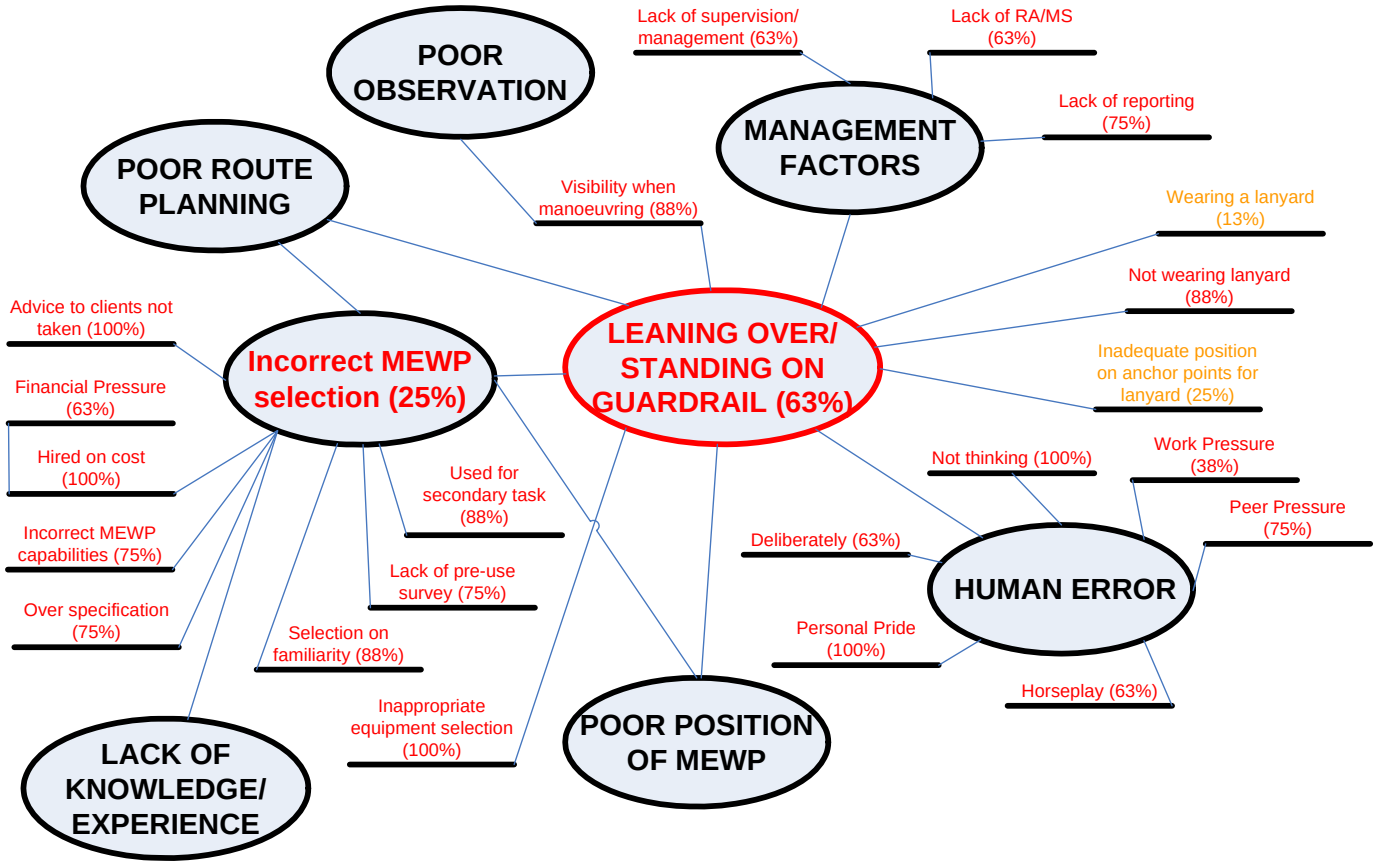


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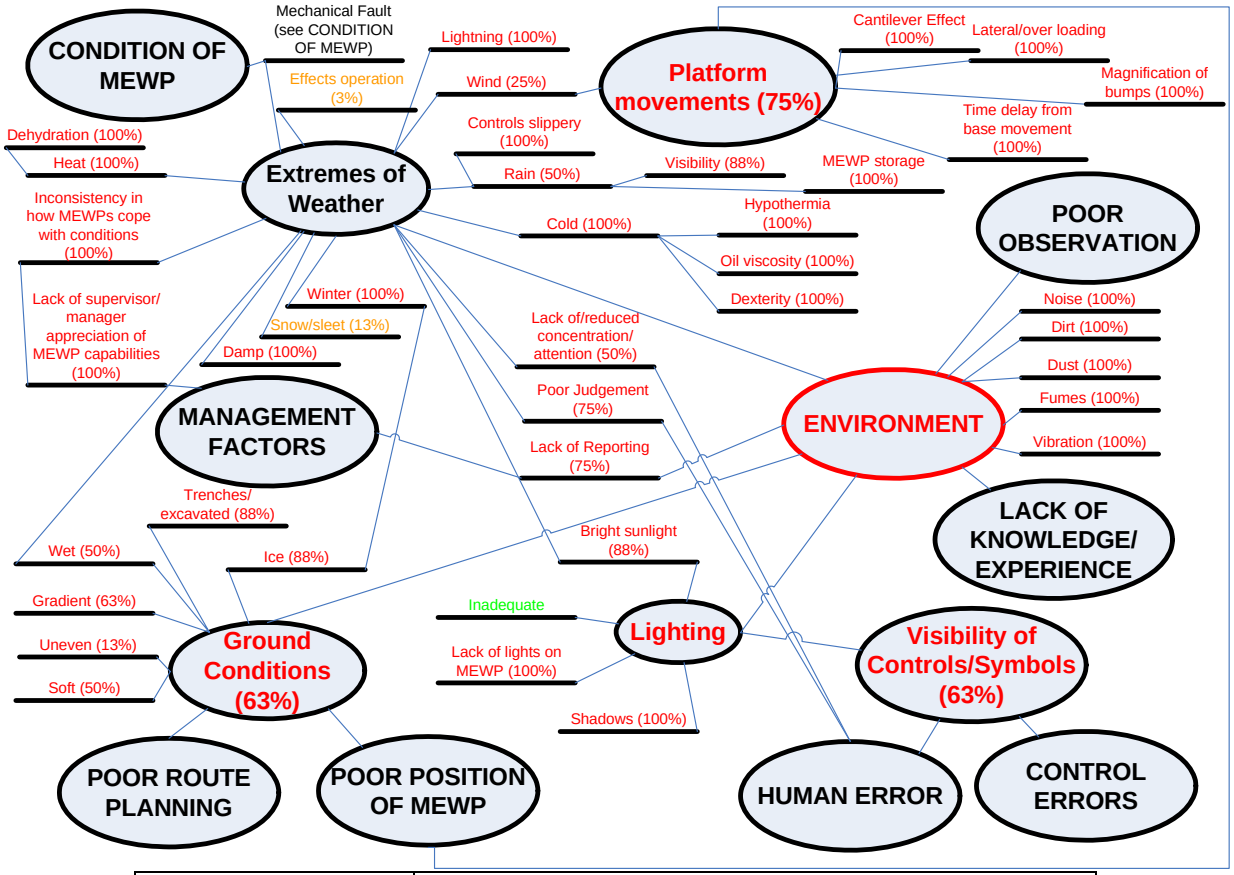
| Green text | All operators demonstrated knowledge |

**APPENDIX 14**

ELECTRICIANS INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP

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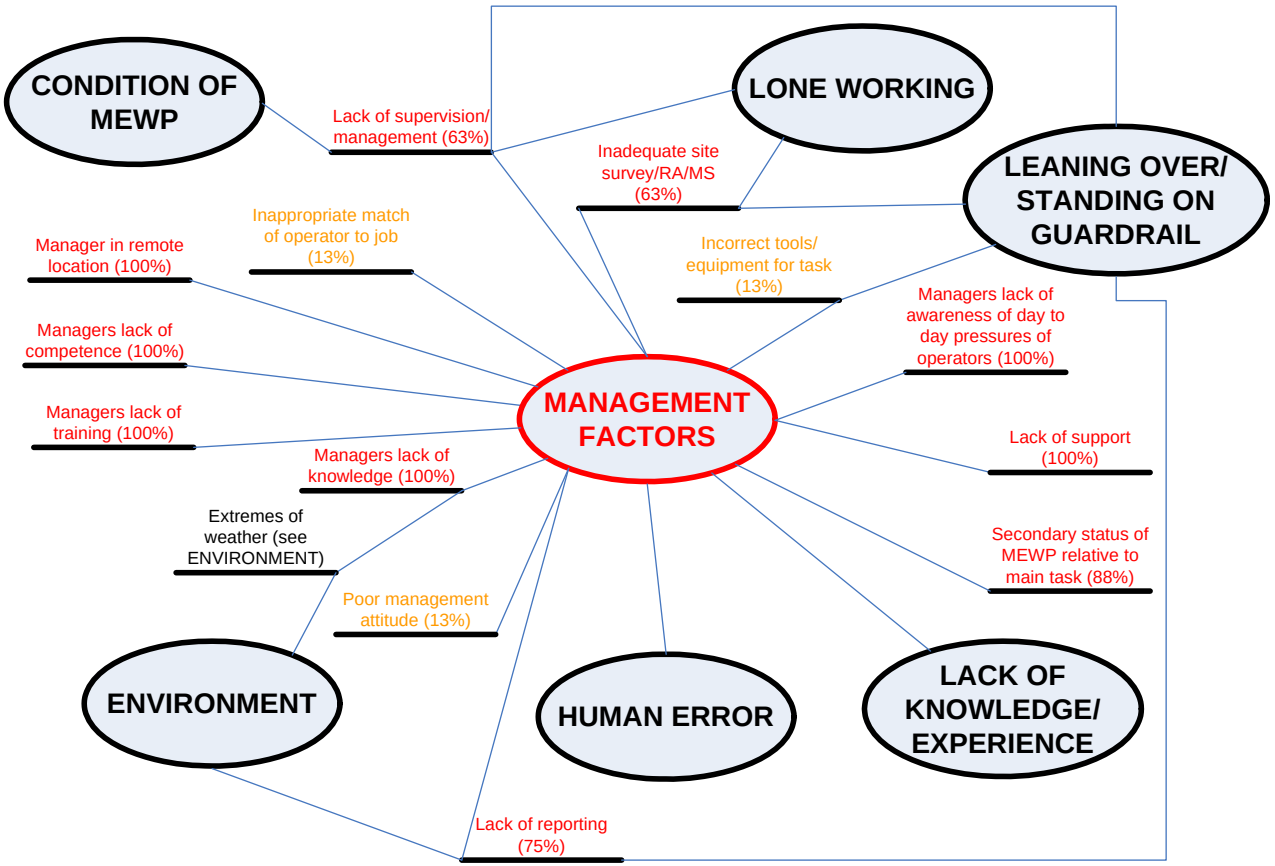


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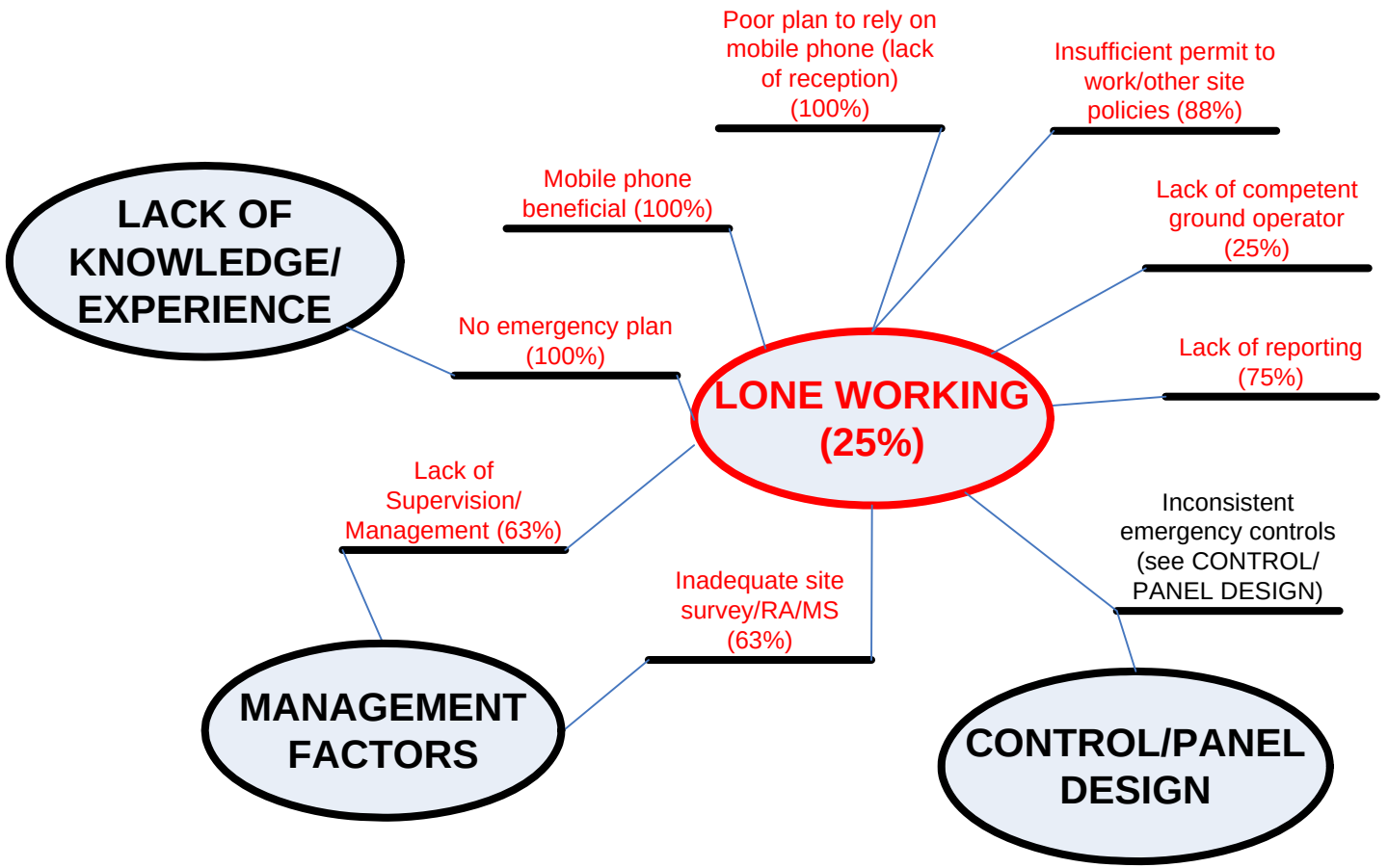


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| Red text and % | % Who did not demonstrate knowledge |
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## APPENDIX 15

Risk reduction measures for entrapment identified by the electricians are detailed below:

- Inbuilt light monitors (so that an operator does not rely on what may be poor judgement). However, it was highlighted that operators may deliberately counter this by shining a light on to it so that they can continue working;
- A second operator on the platform for improved observation (reduces the need for divided attention between task and driving). However it was noted that this may consequently mean that there is no ground operator due to resources and it could also cause increased distraction;
- A release function on the platform - at present if the overload alarm was activated, it would require a ground operator to lower the platform;
- To reduce uncertainty over which function the multi-function control is left in, there should be a requirement to re-press the required function before it will operate;
- Standardised emergency controls (to help reduce the effects of learning from one make and model and decrease time taken to activate controls);
- MEWPs should be fitted with additional lighting rather than the necessity to carry extra (reduce tripping hazards);
- Purpose-built tool storage area (to help prevent trip hazards/knocking controls);
- Emergency controls should be situated on more than one side (for example in circumstances where a vehicle may park and block access to one side of the MEWP);
- A cushioned top guardrail with sensor and alarm (would help to combat proximity to structures etc);
- Standardised control panels (to help prevent the effects of learning on one make and model and control errors).

**APPENDIX 16**

RACKING INSTALLERS INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP

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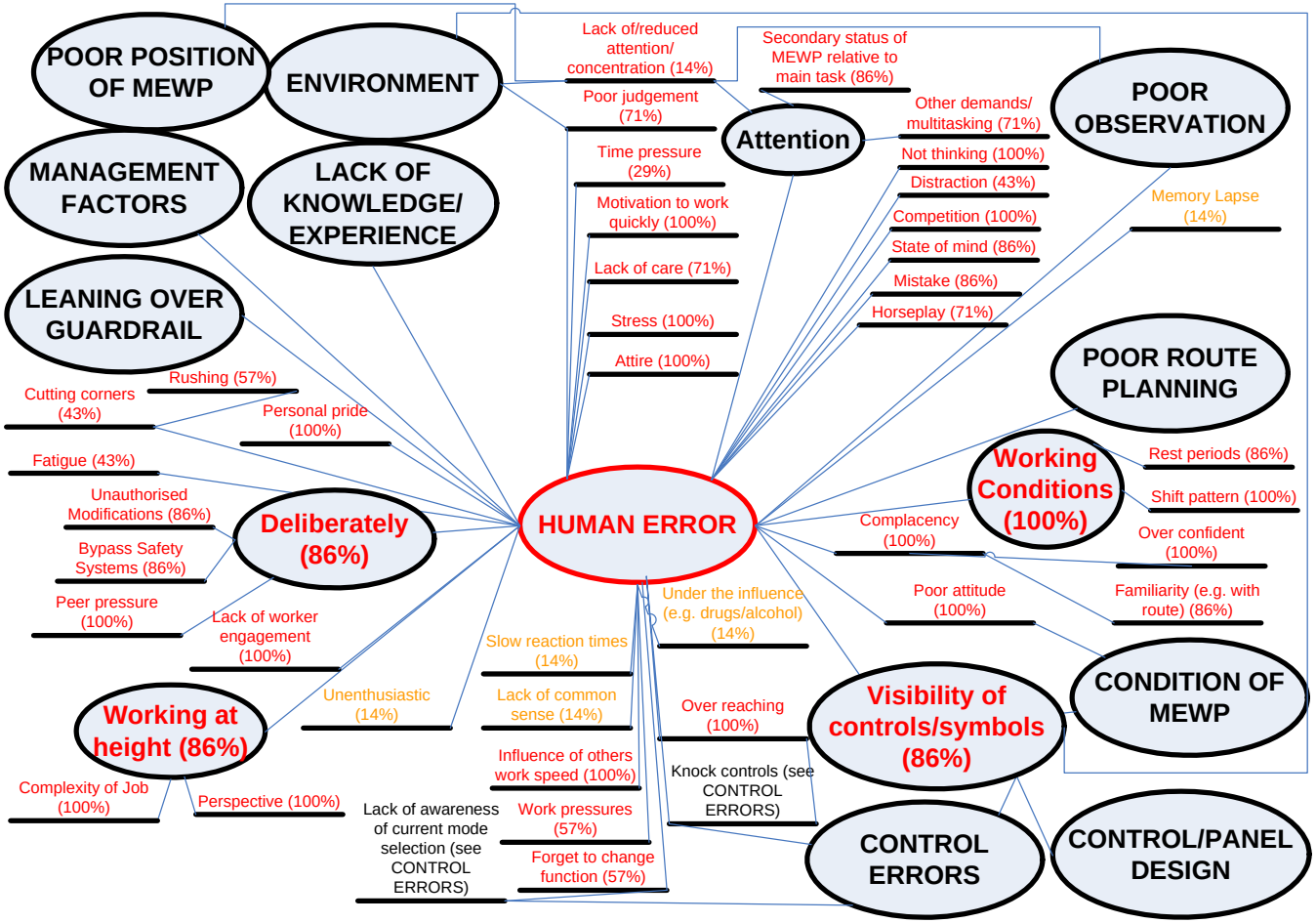


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| Red text and % | % Who did not demonstrate knowledge |
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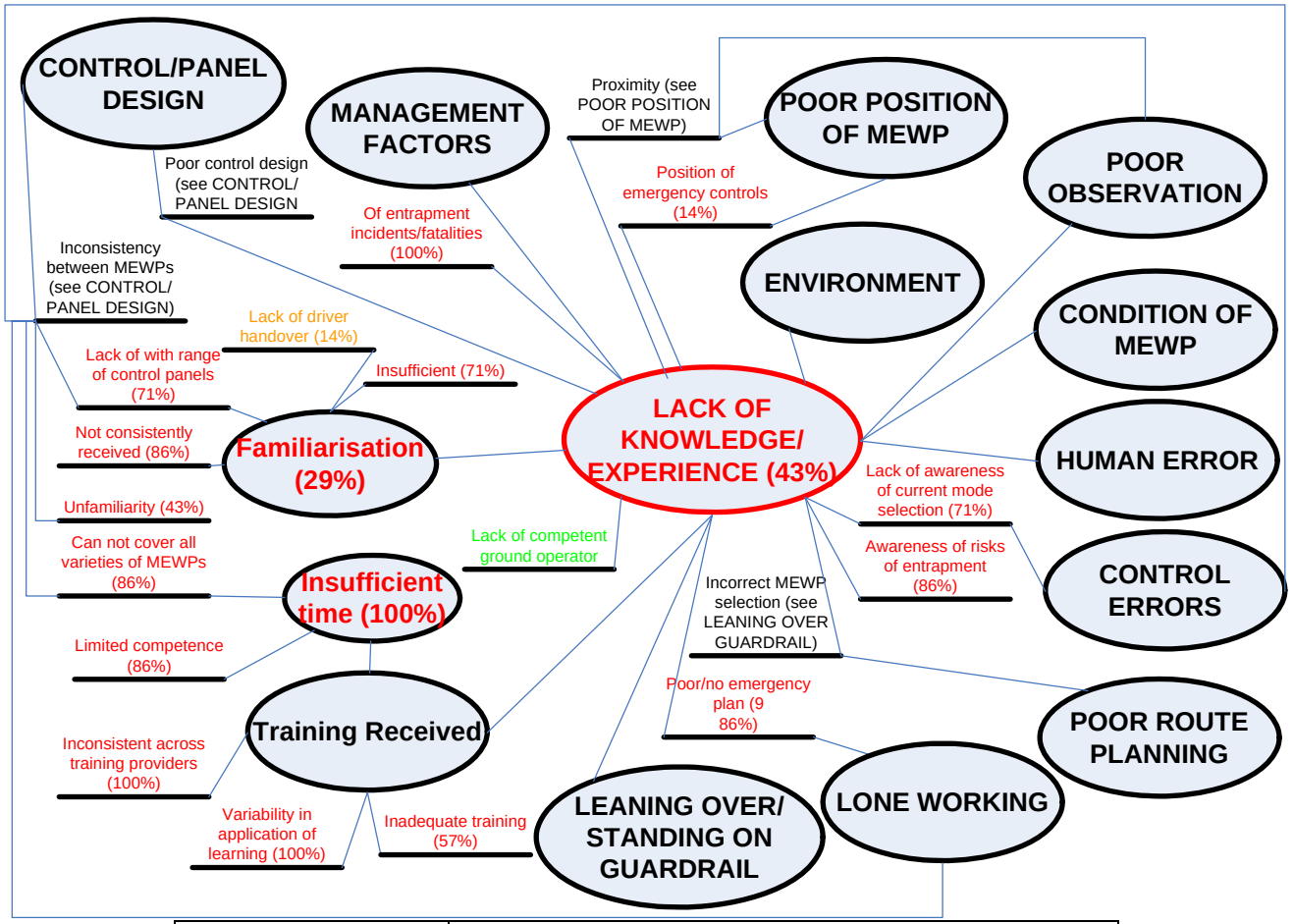


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| Red text and % | % Who did not demonstrate knowledge |
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RACKING INSTALLERS INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP


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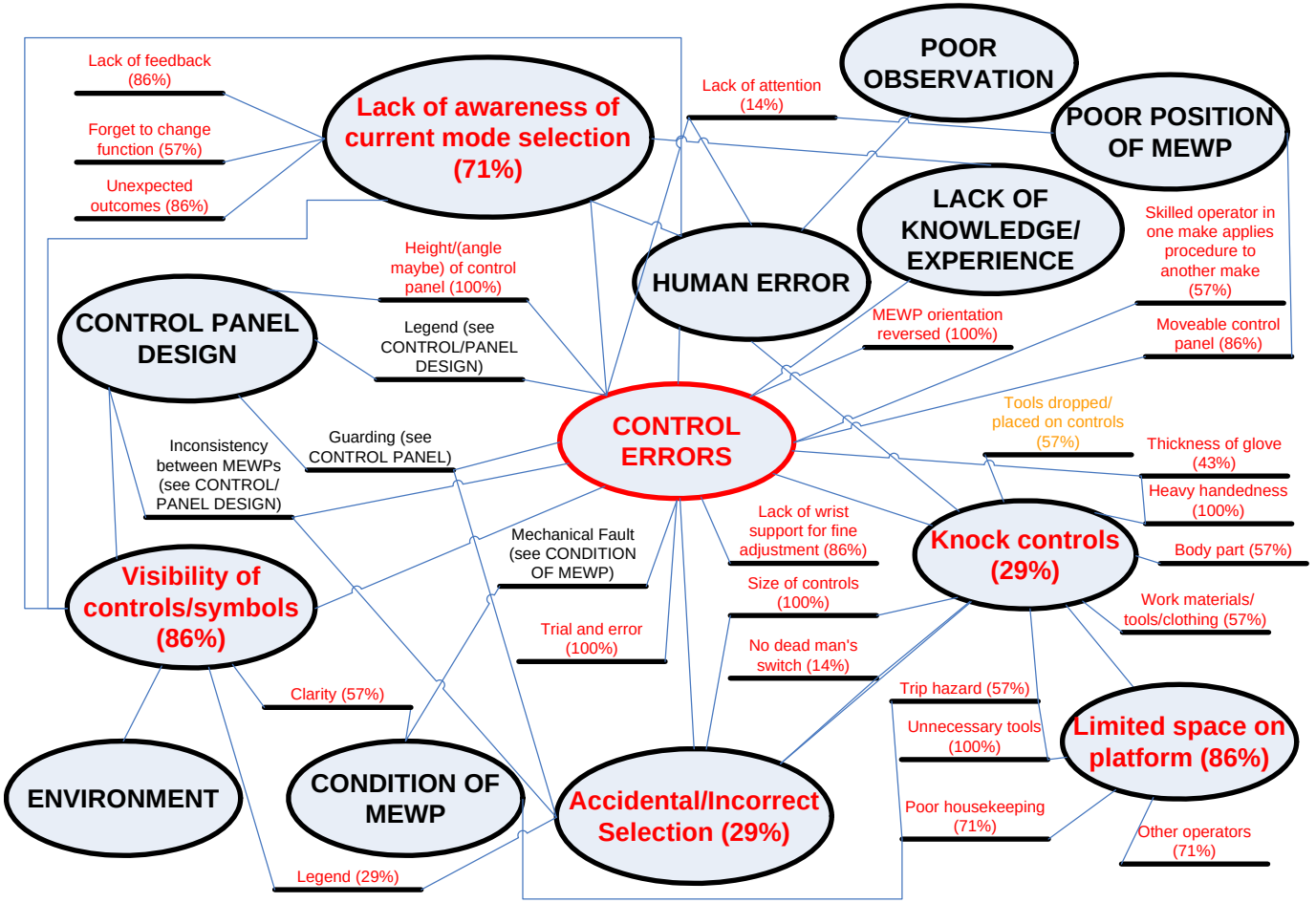


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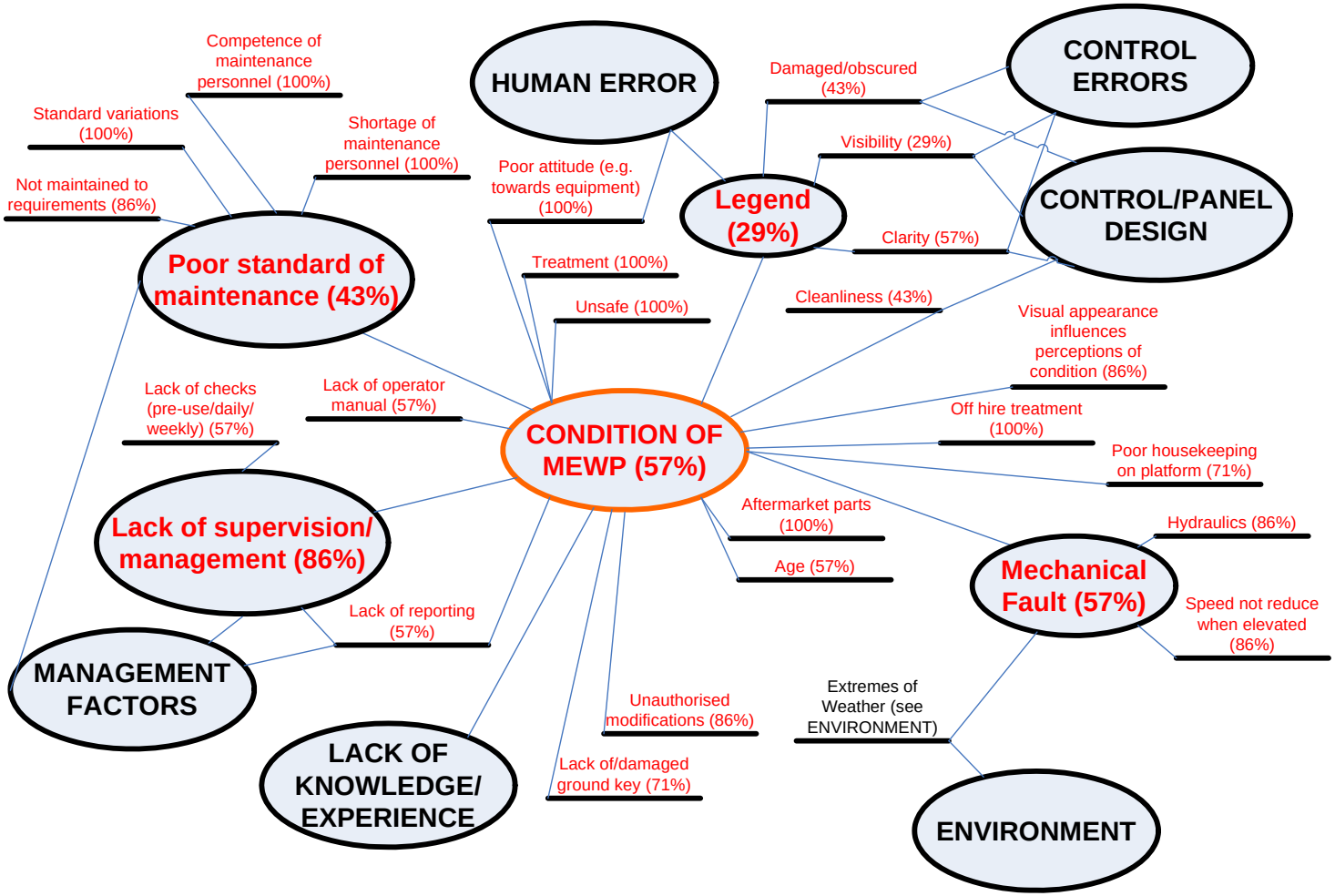


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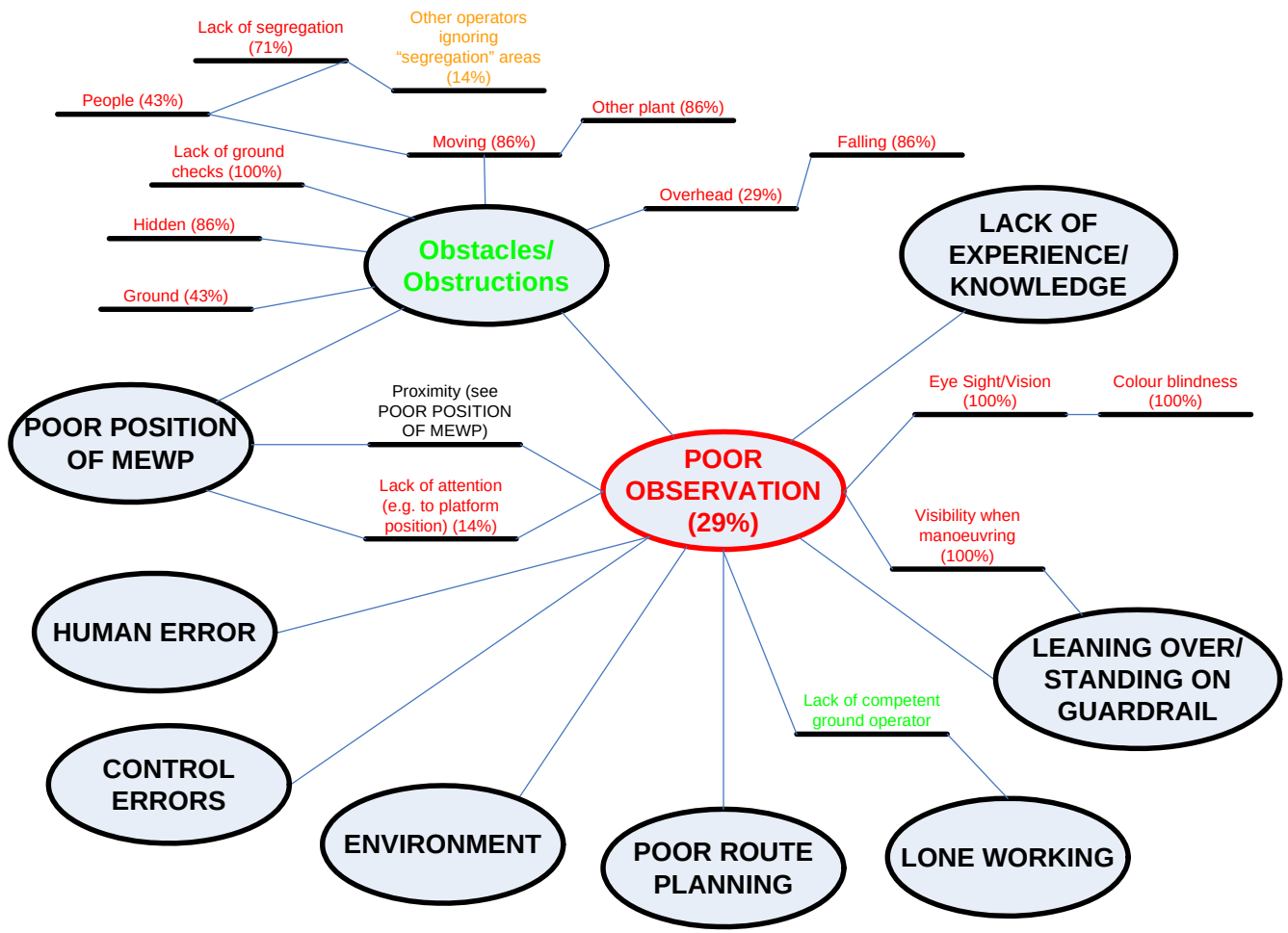


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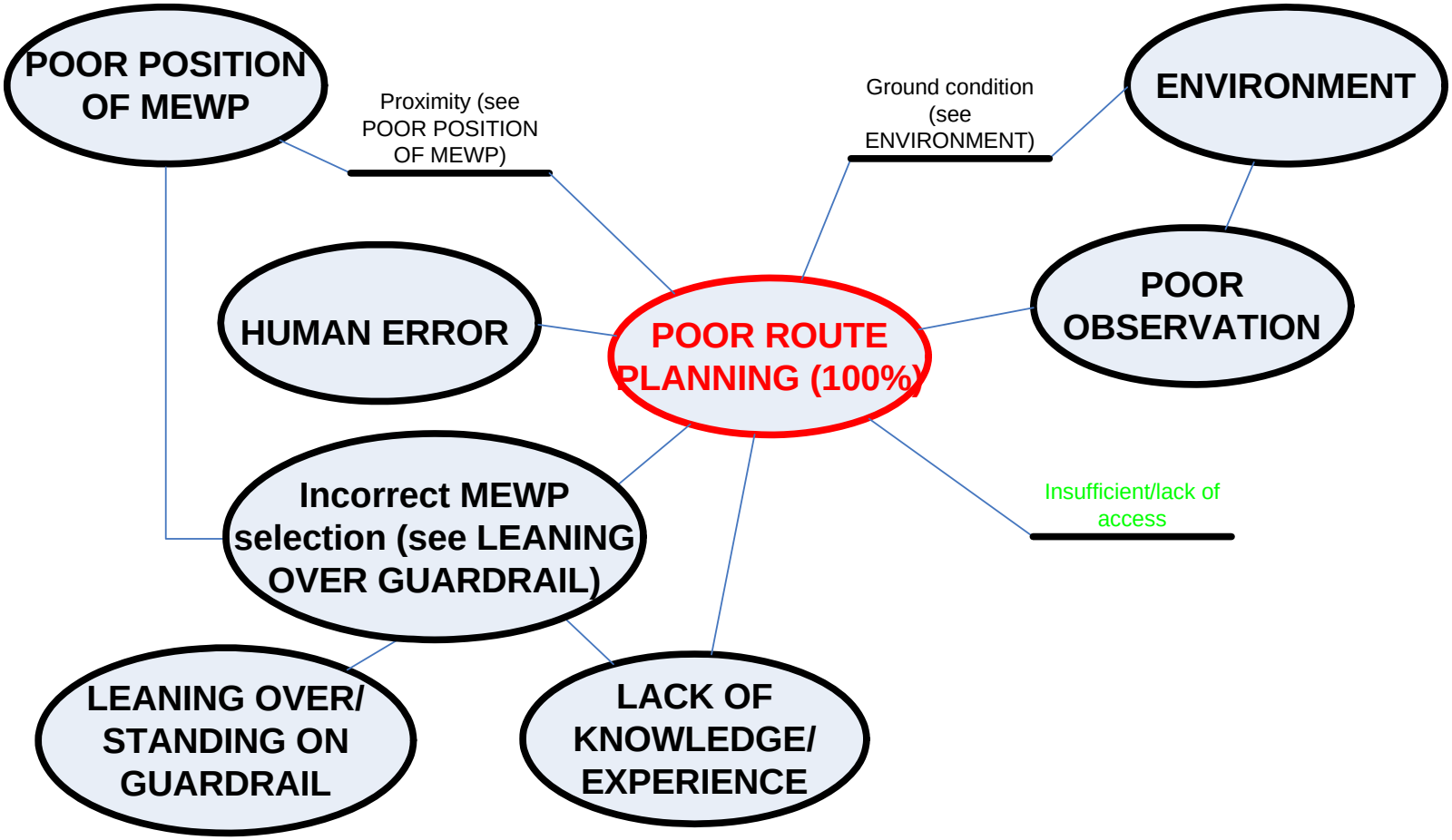


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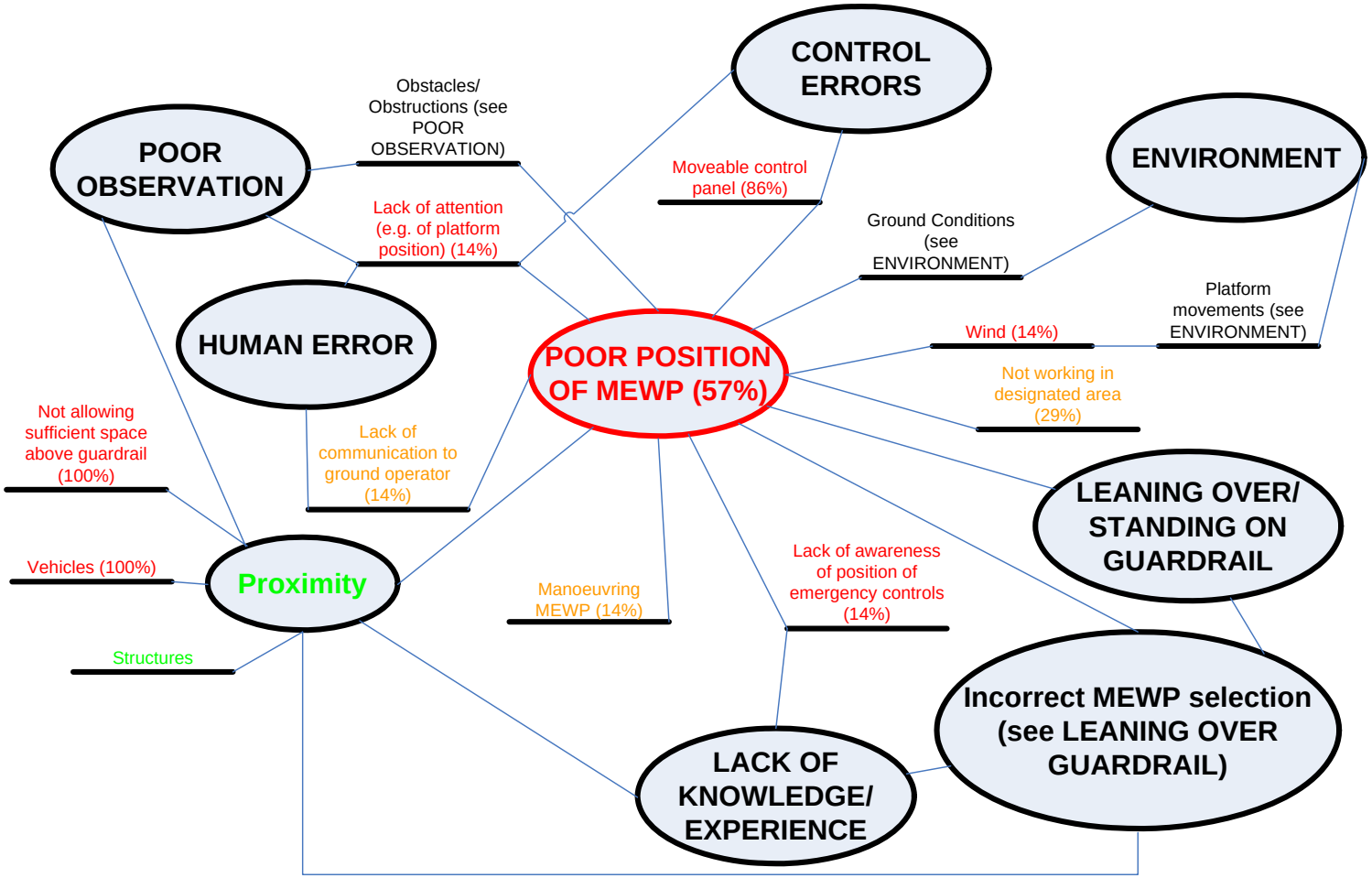


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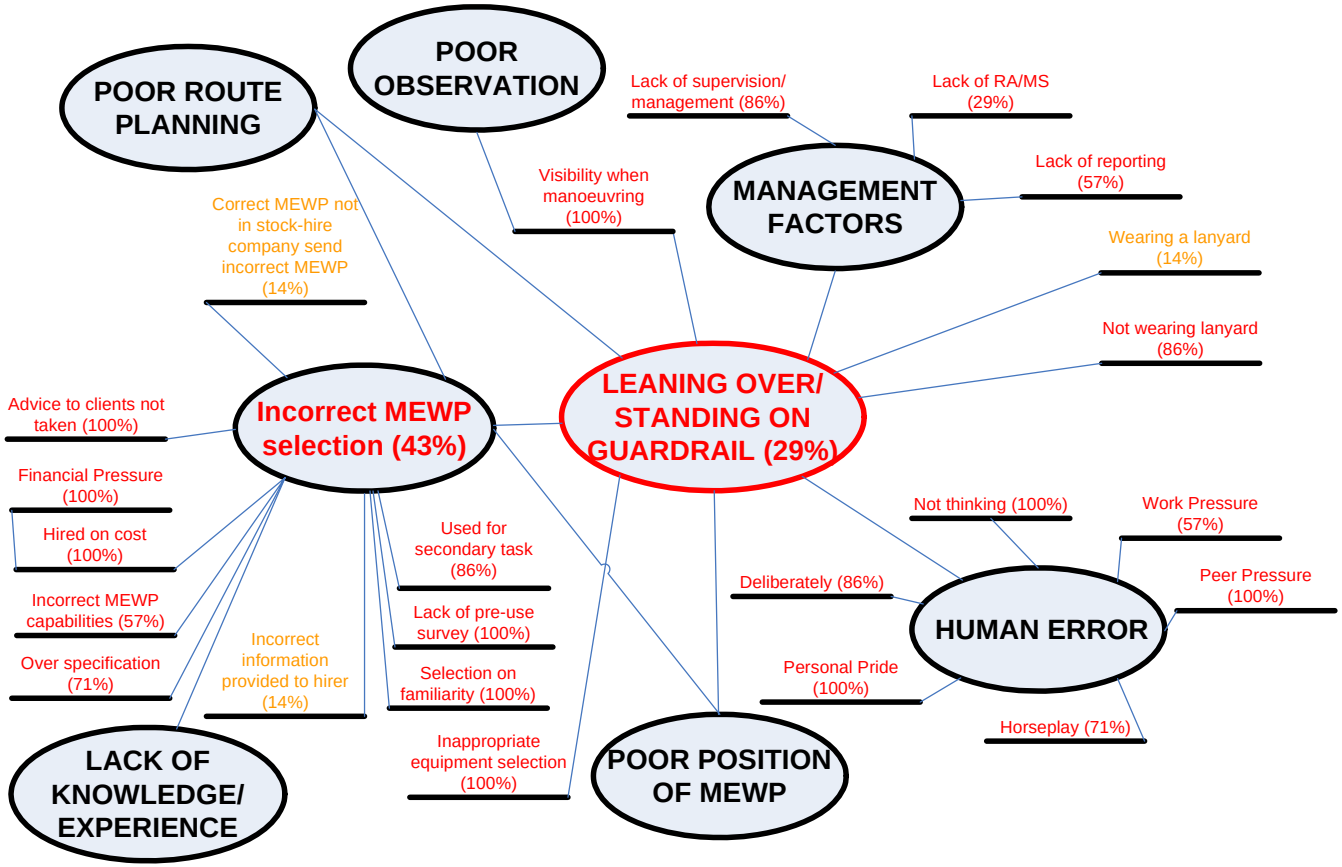


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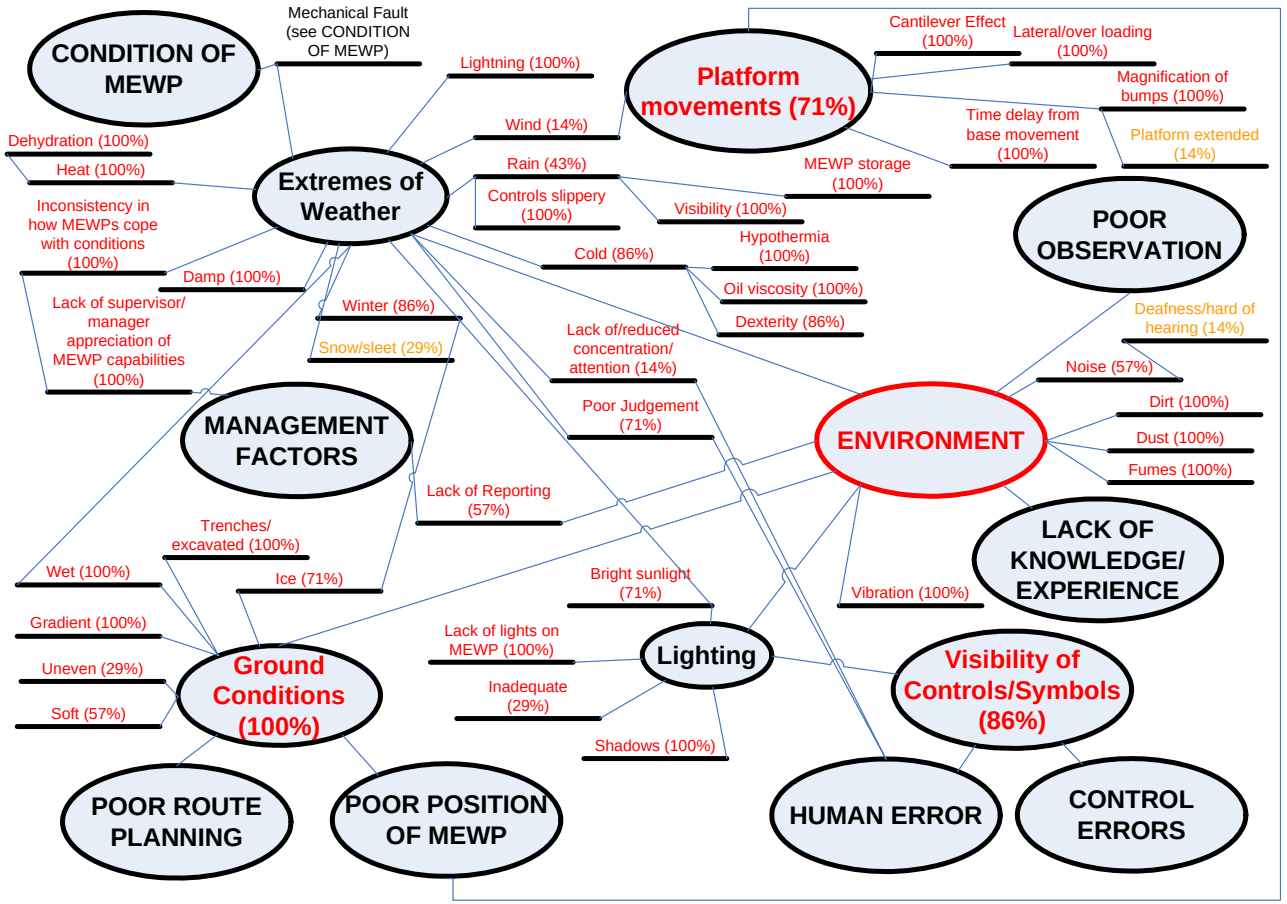


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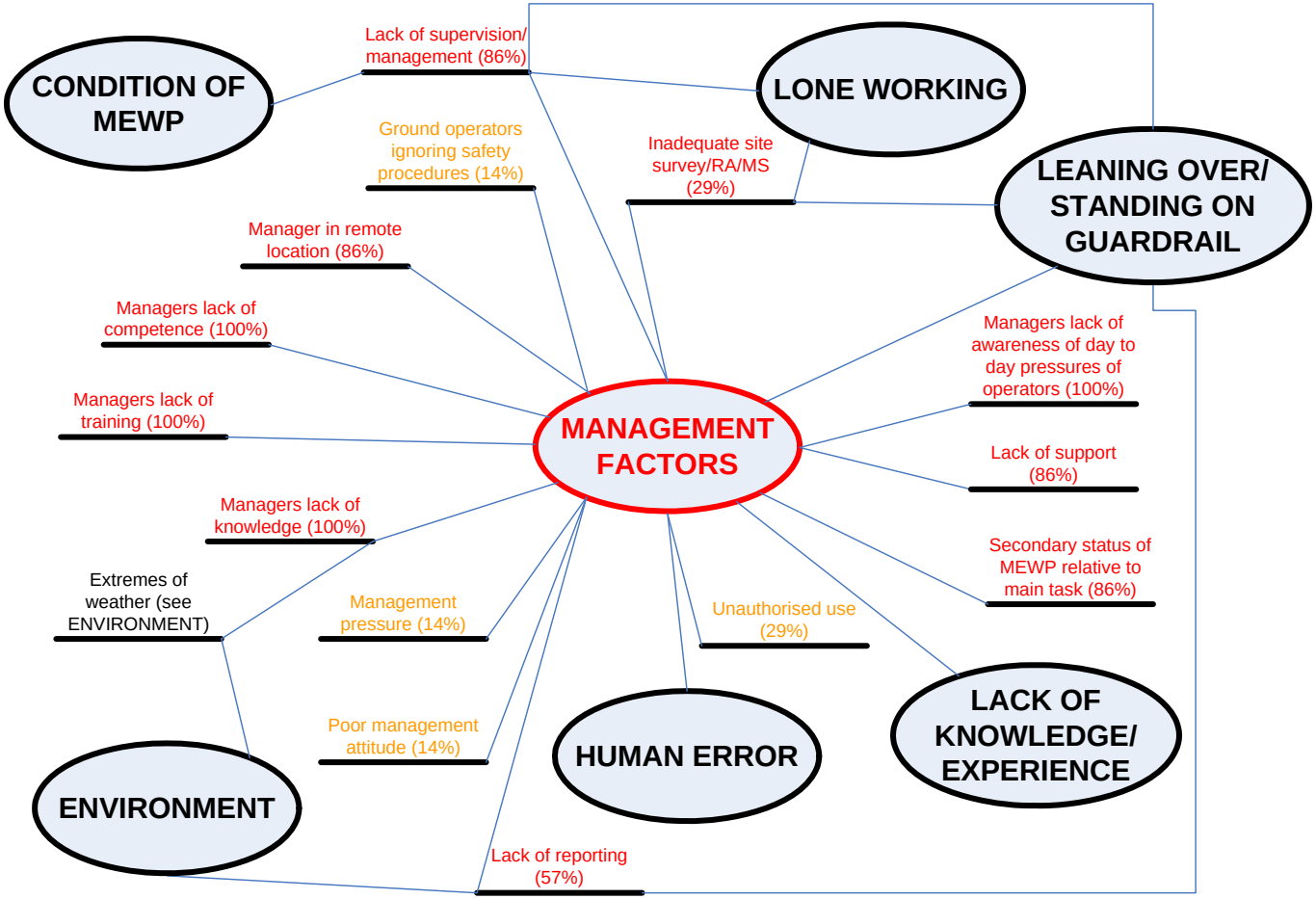


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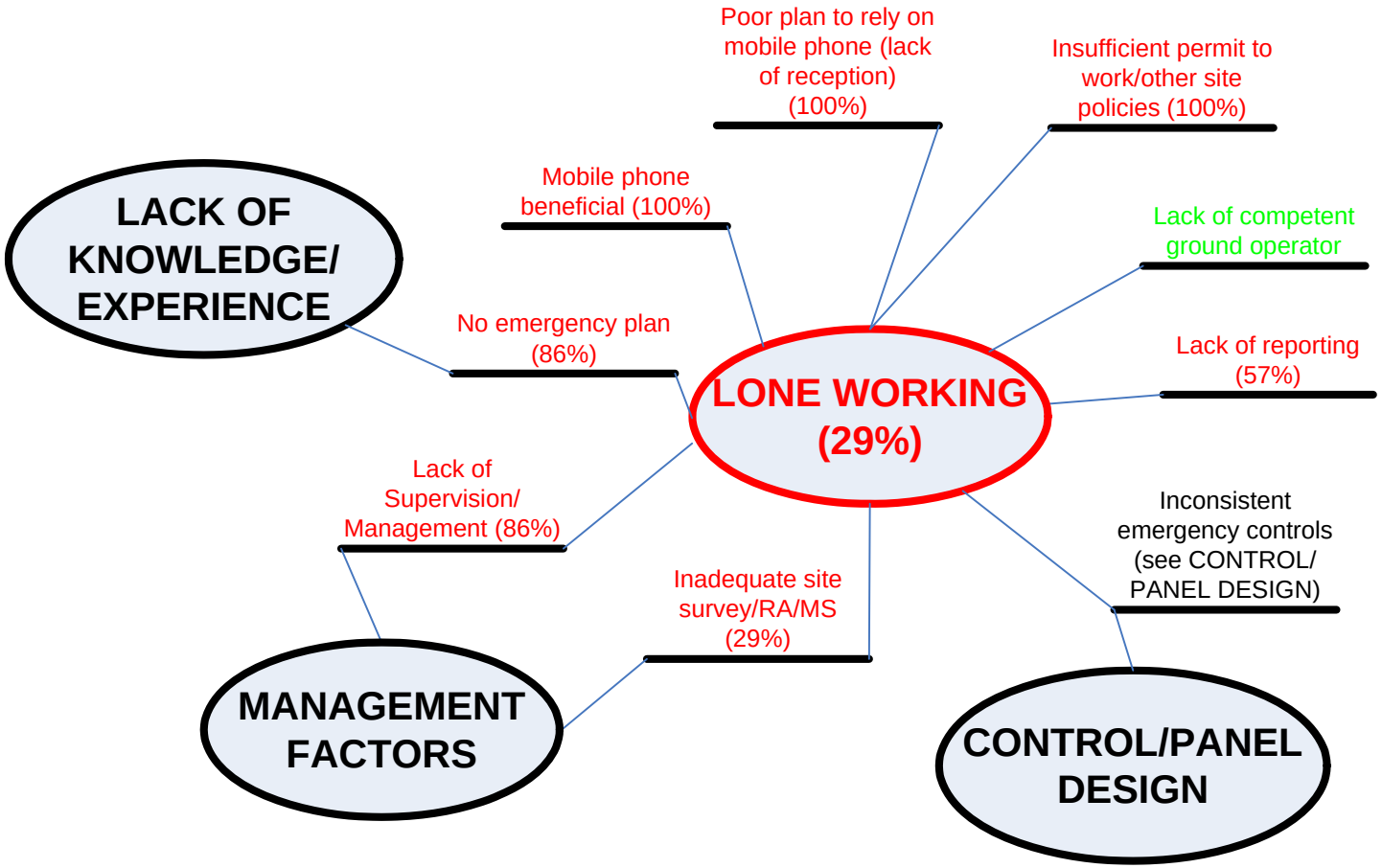


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| Red text and % | % Who did not demonstrate knowledge |
| Orange text and % | % Who identified this as a new risk factor |
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## APPENDIX 17

Risk reduction measures for entrapment identified by the racking installers are detailed below:

- Multi-function controls to be equipped with a time delay (e.g. 10 seconds) so that if no action is detected within the specified time, the operator is required to re-activate the function. (This would help to reduce the possibility of an operator forgetting which function the MEWP was left in, and inadvertently moving the MEWP with an unexpected outcome);

- Multi-function controls to provide more feedback e.g. noise *and* flashing light;

- Platform proximity sensors and cut-out;

- Improved tool storage area (to help prevent trip hazards/knocking controls);

- Emergency controls to be situated on more than one side (for example in circumstances where a structure/vehicle is blocking access to one side of the MEWP);

- Additional lighting to be provided on the MEWP;

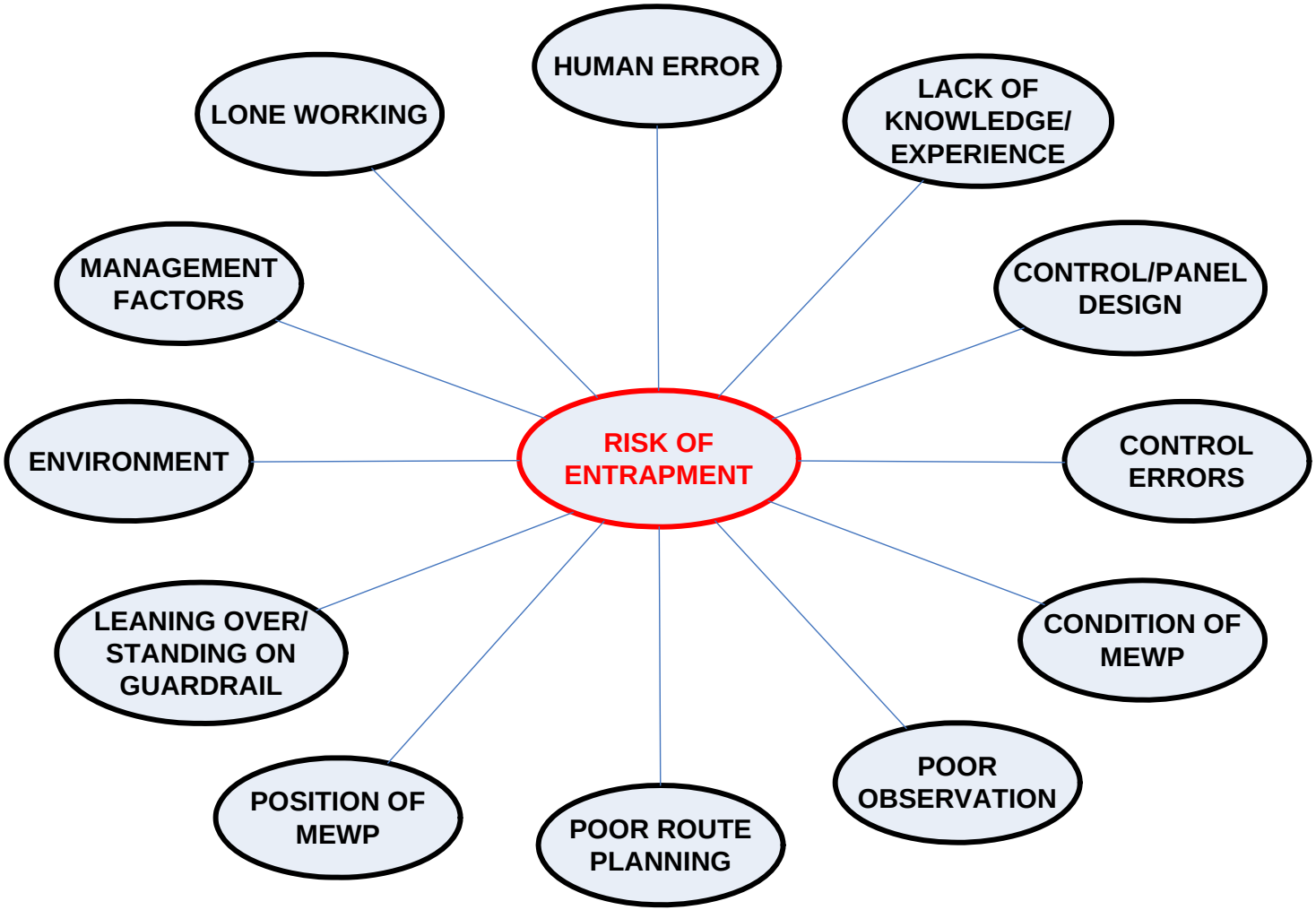
- Standardised control panels (to help prevent the effects of learning on one make and model and control errors);

- Control panel replaced/refurbished/reconditioned yearly (this would help to reduce the amount of MEWPs which have damaged/obscured legends which consequently could lead to control errors);

- If all operators were encouraged to be licensed for both scissors and booms, it would allow flexibility in man movements for a job. Additionally, in an emergency situation, operators would be familiar with both a boom and a scissor.

**APPENDIX 18**

STEEL ERECTORS INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP



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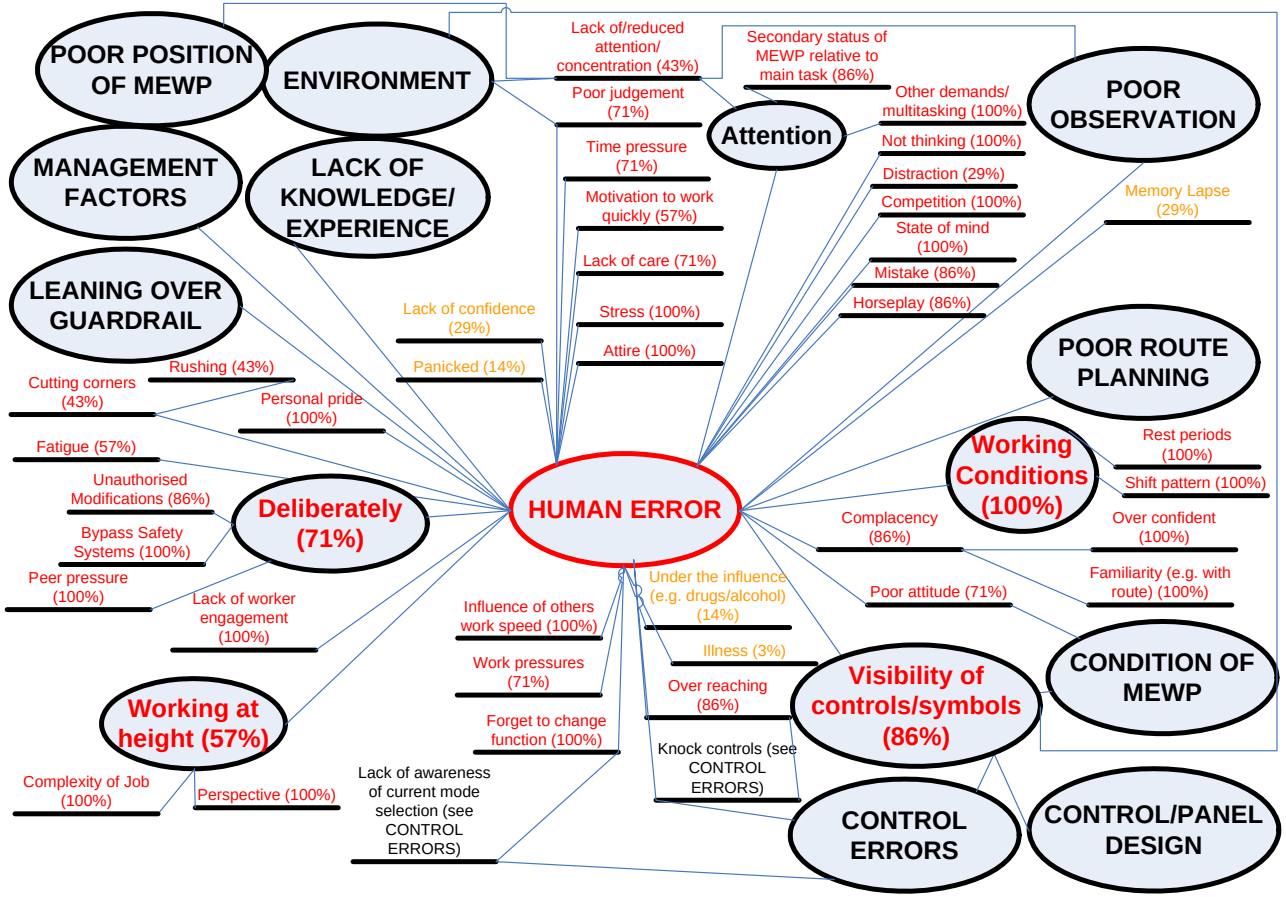


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| Red text and % | % Who did not demonstrate knowledge |
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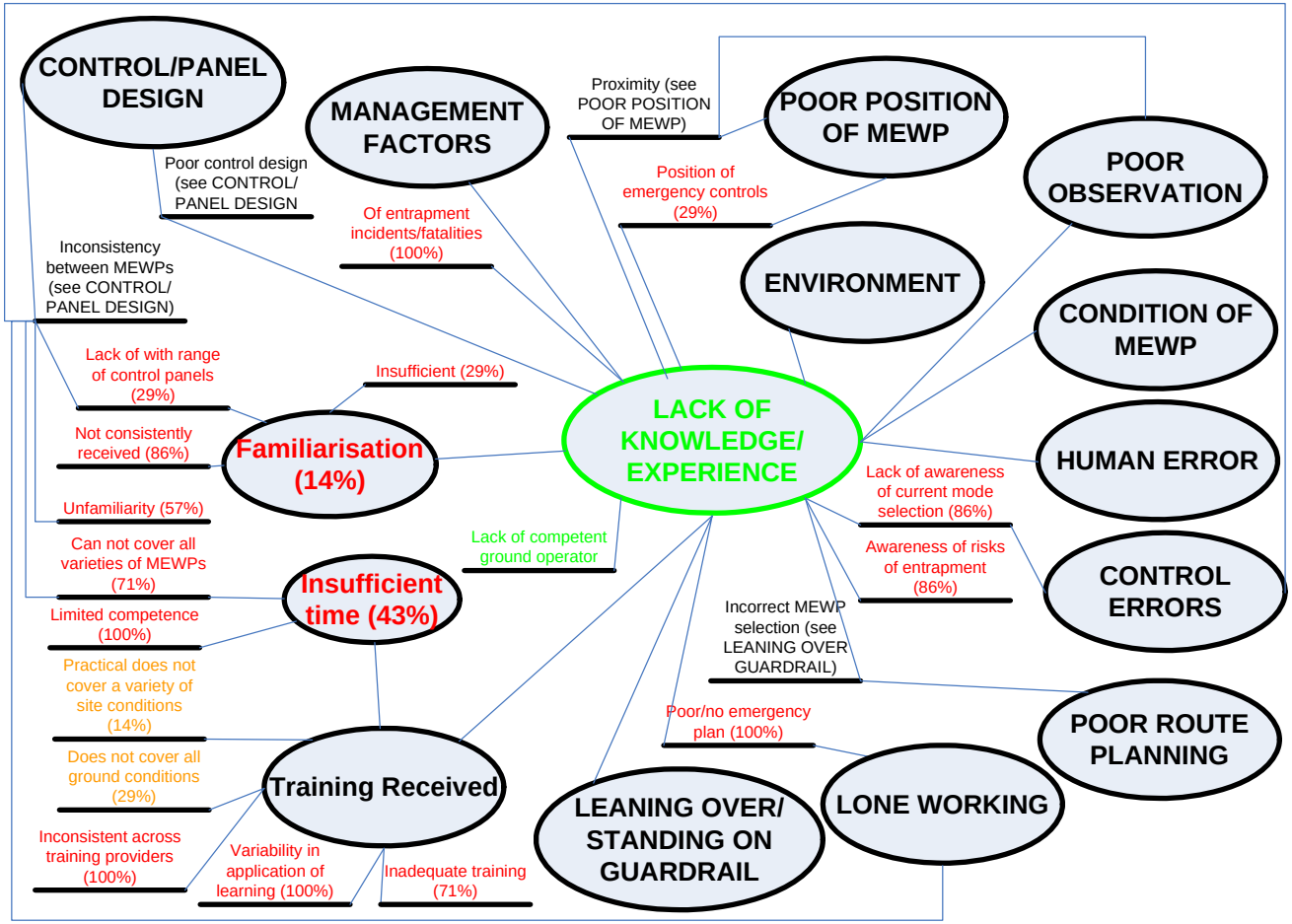


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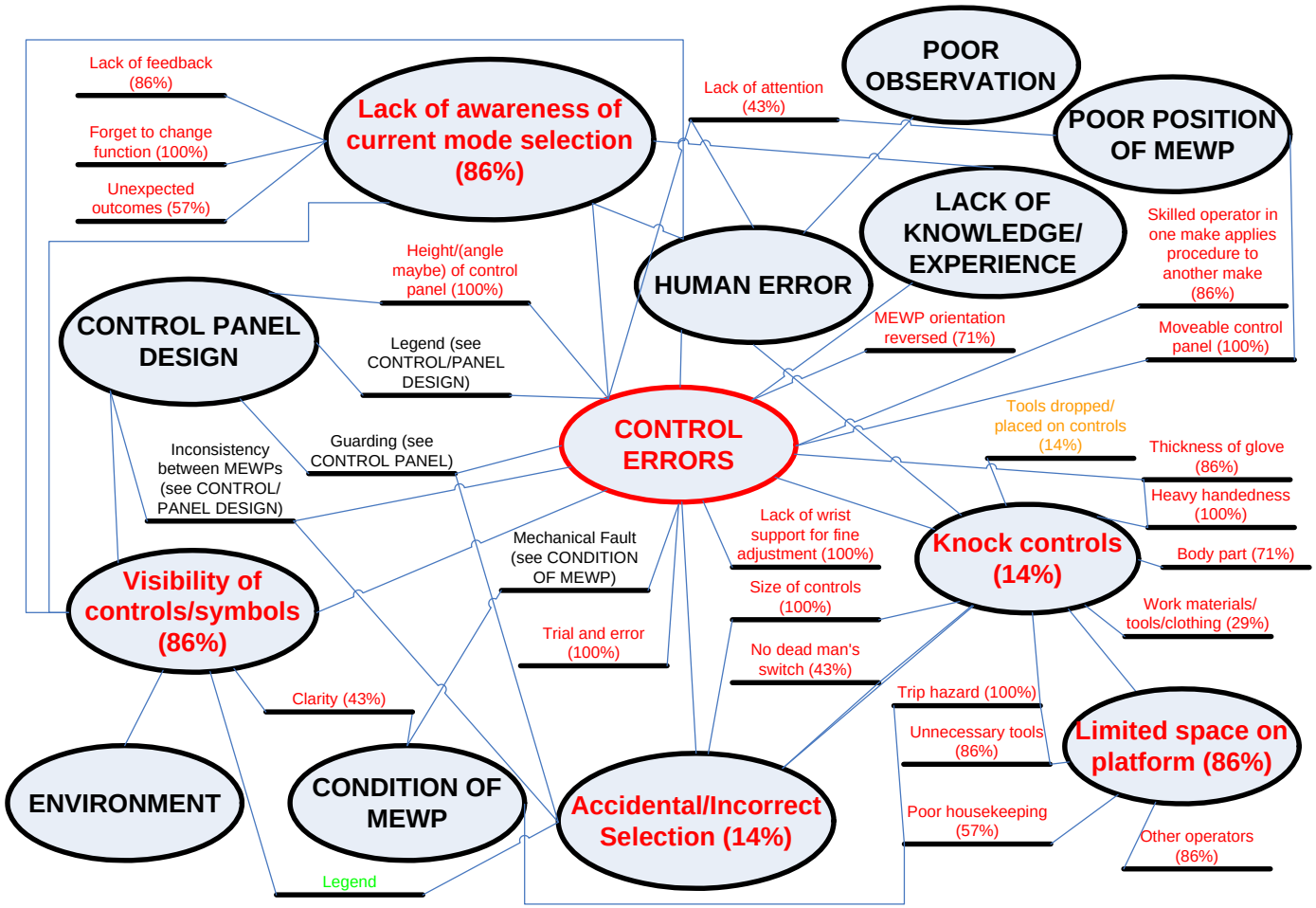


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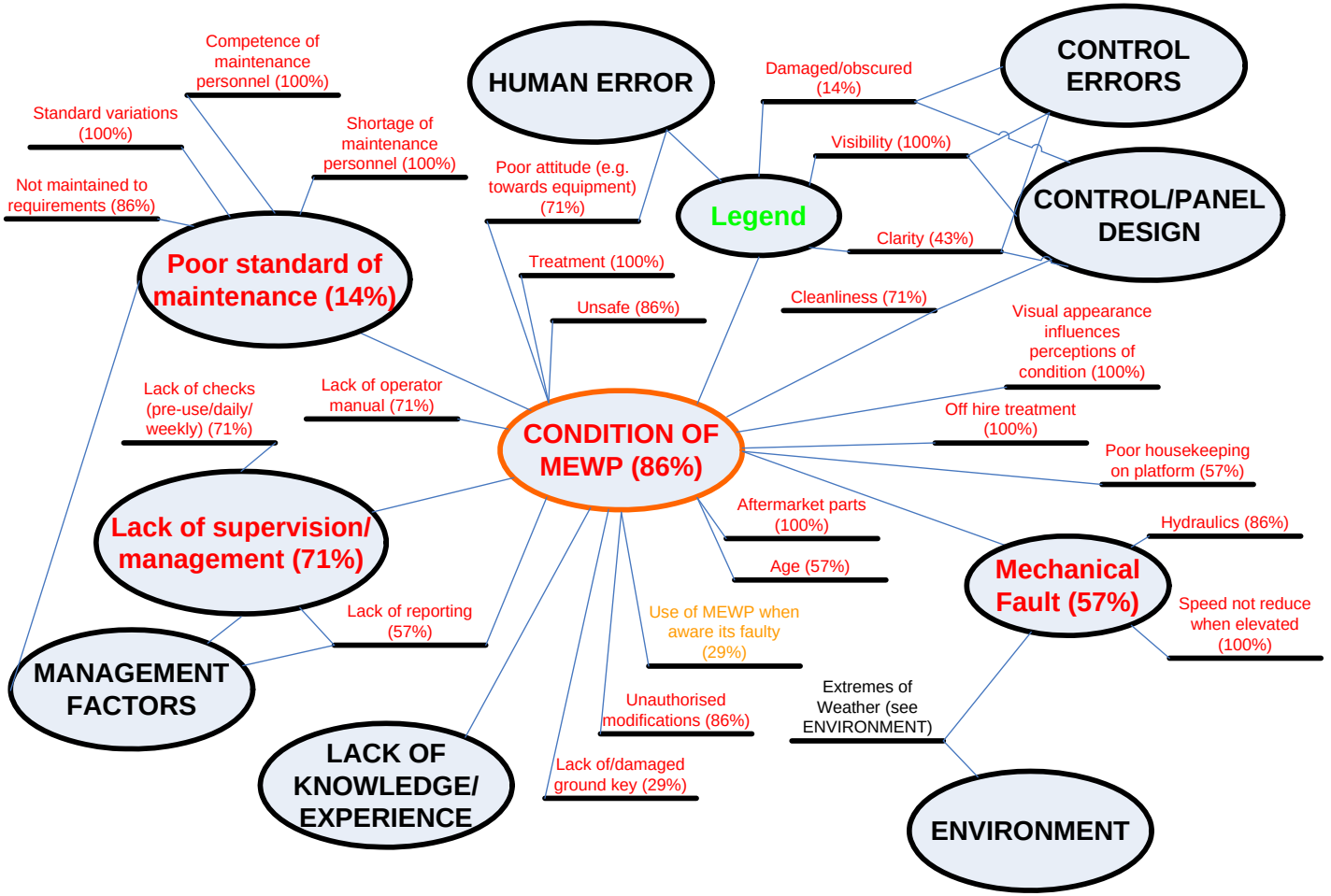


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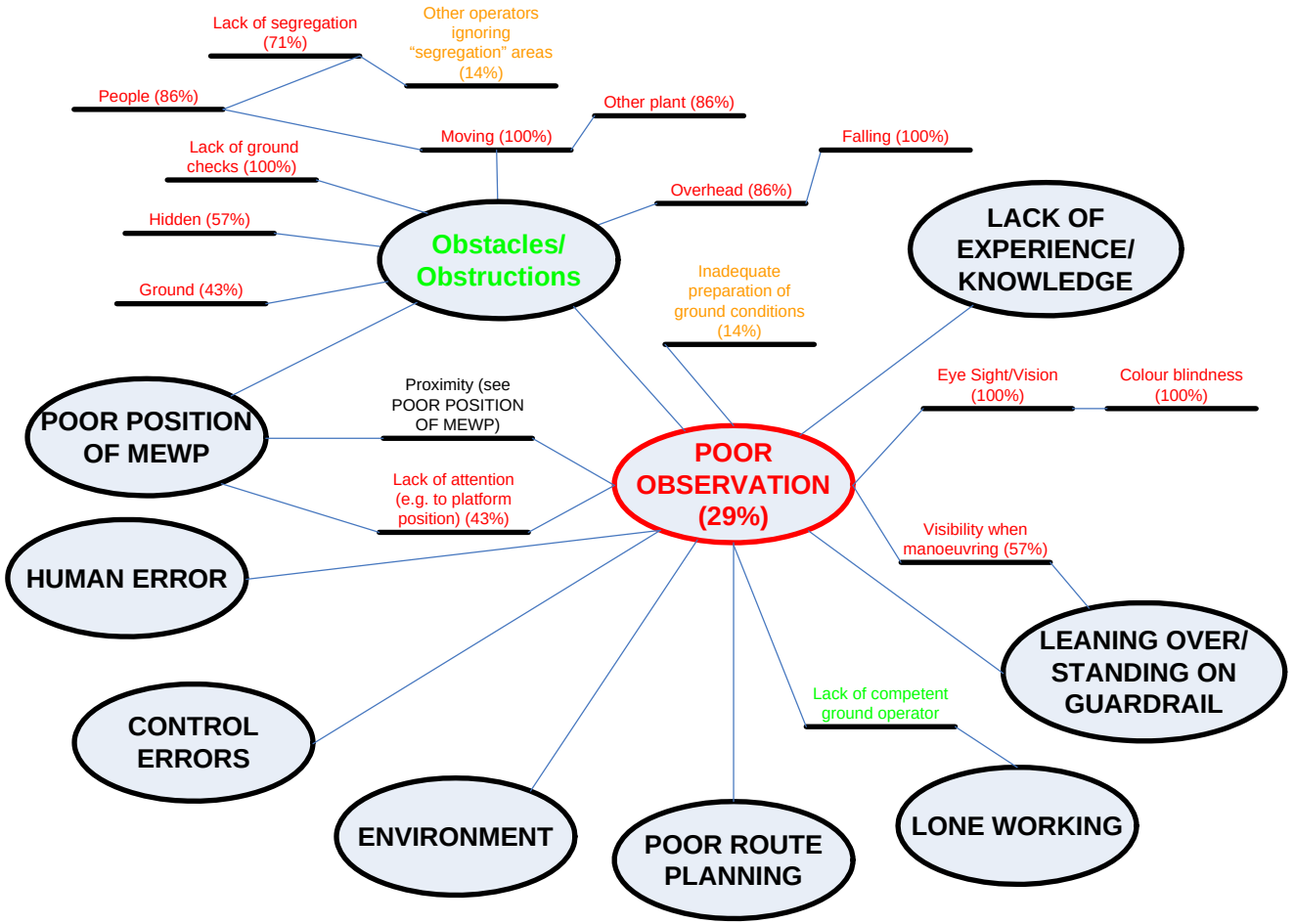


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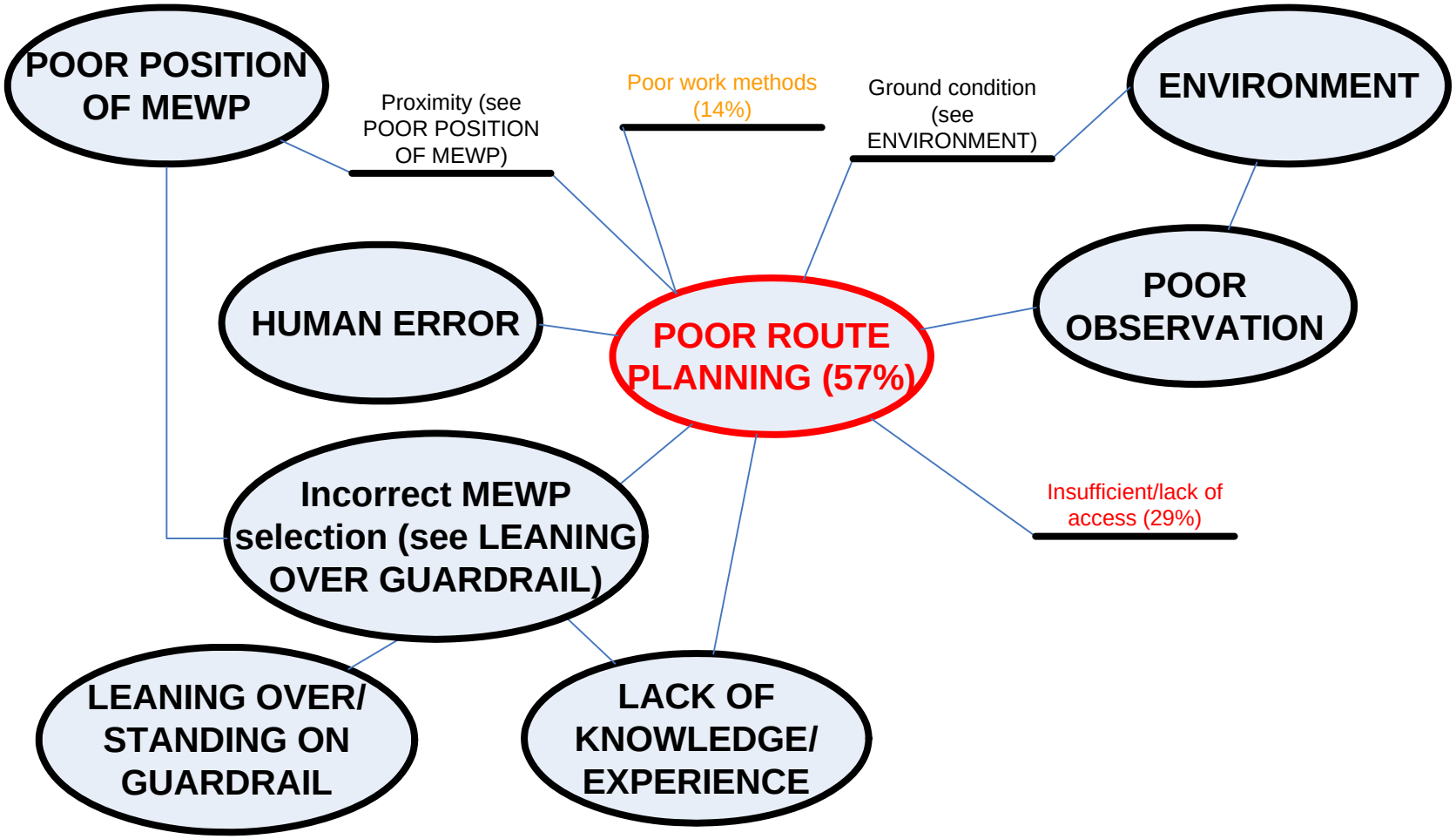


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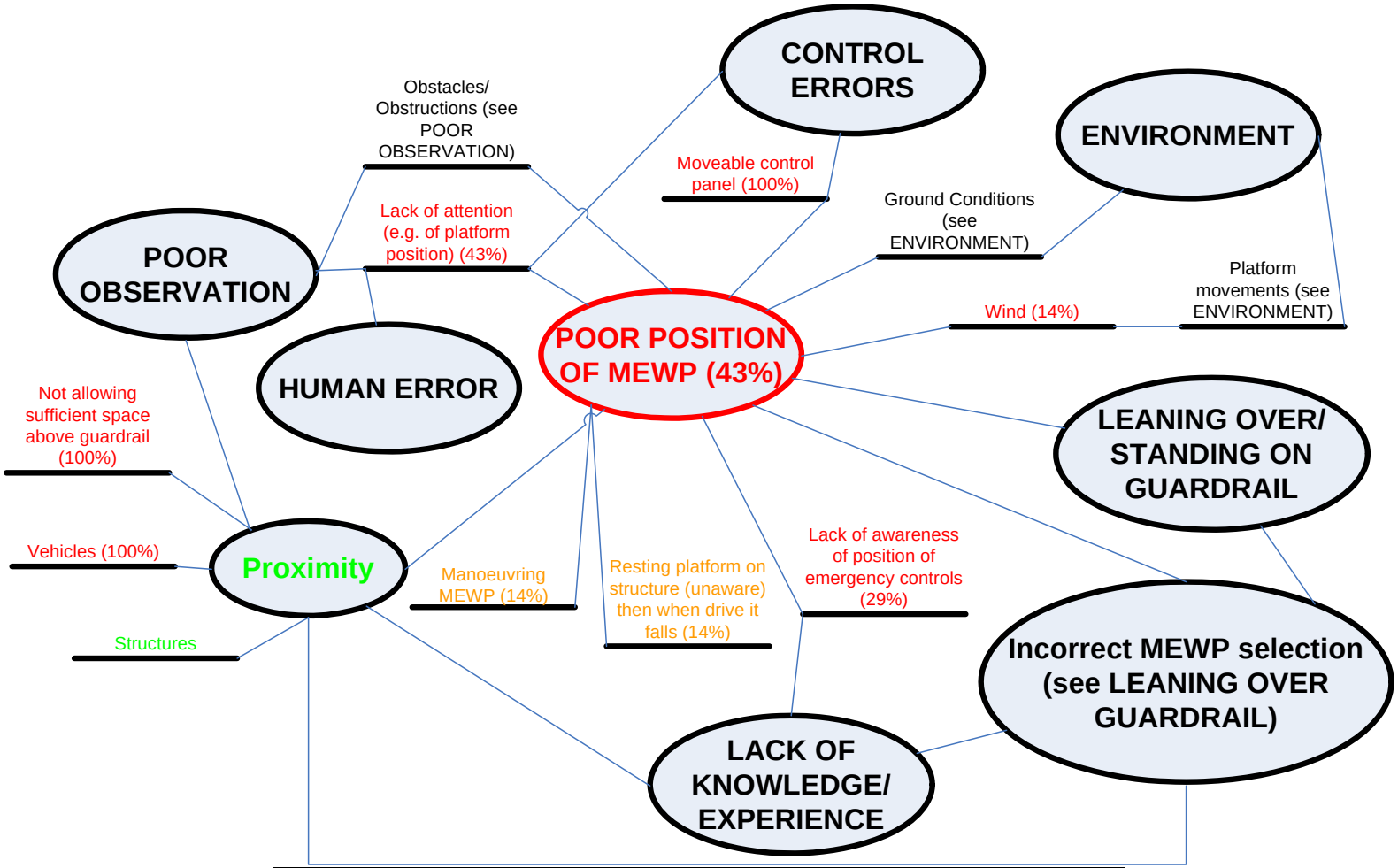


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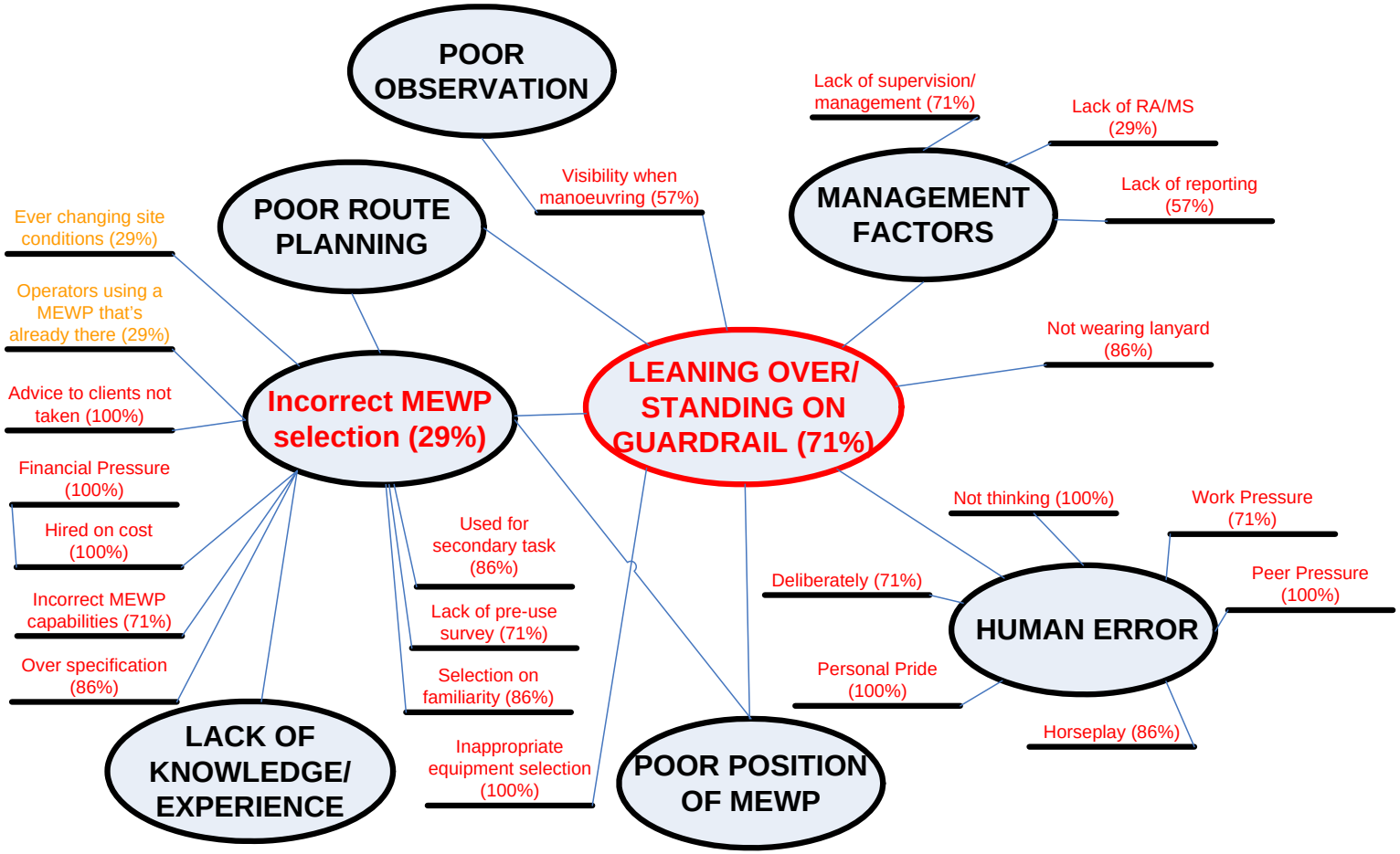


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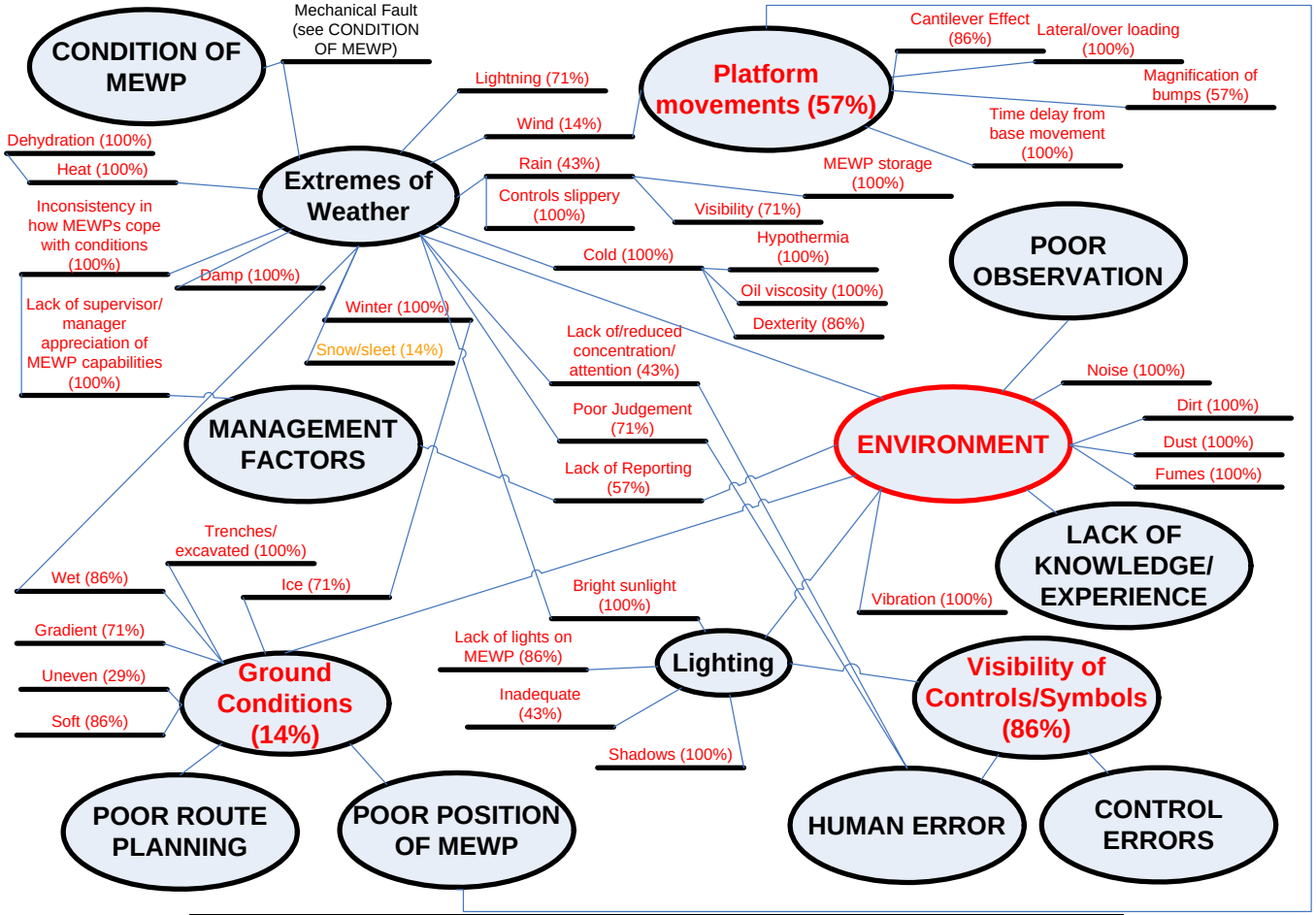


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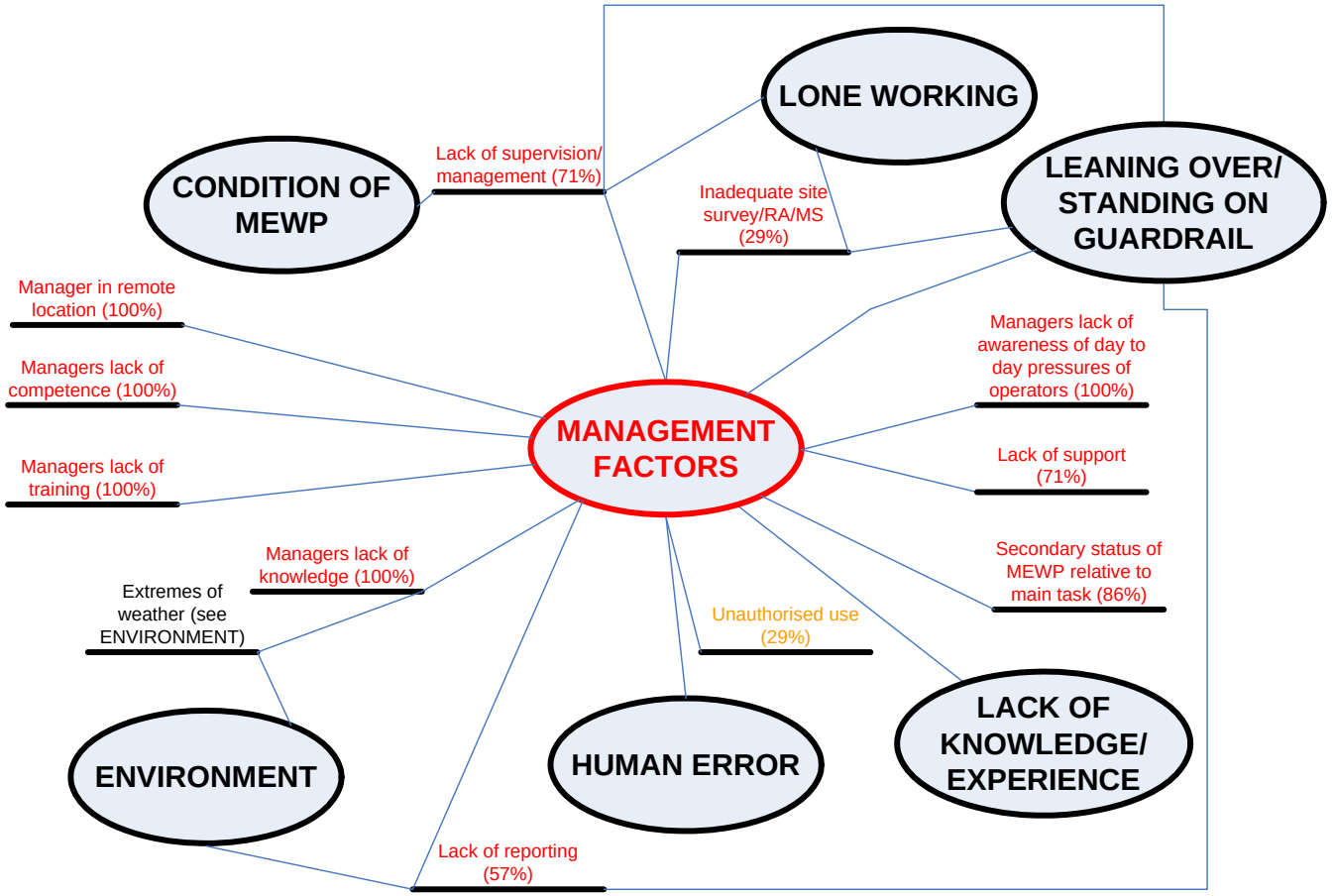


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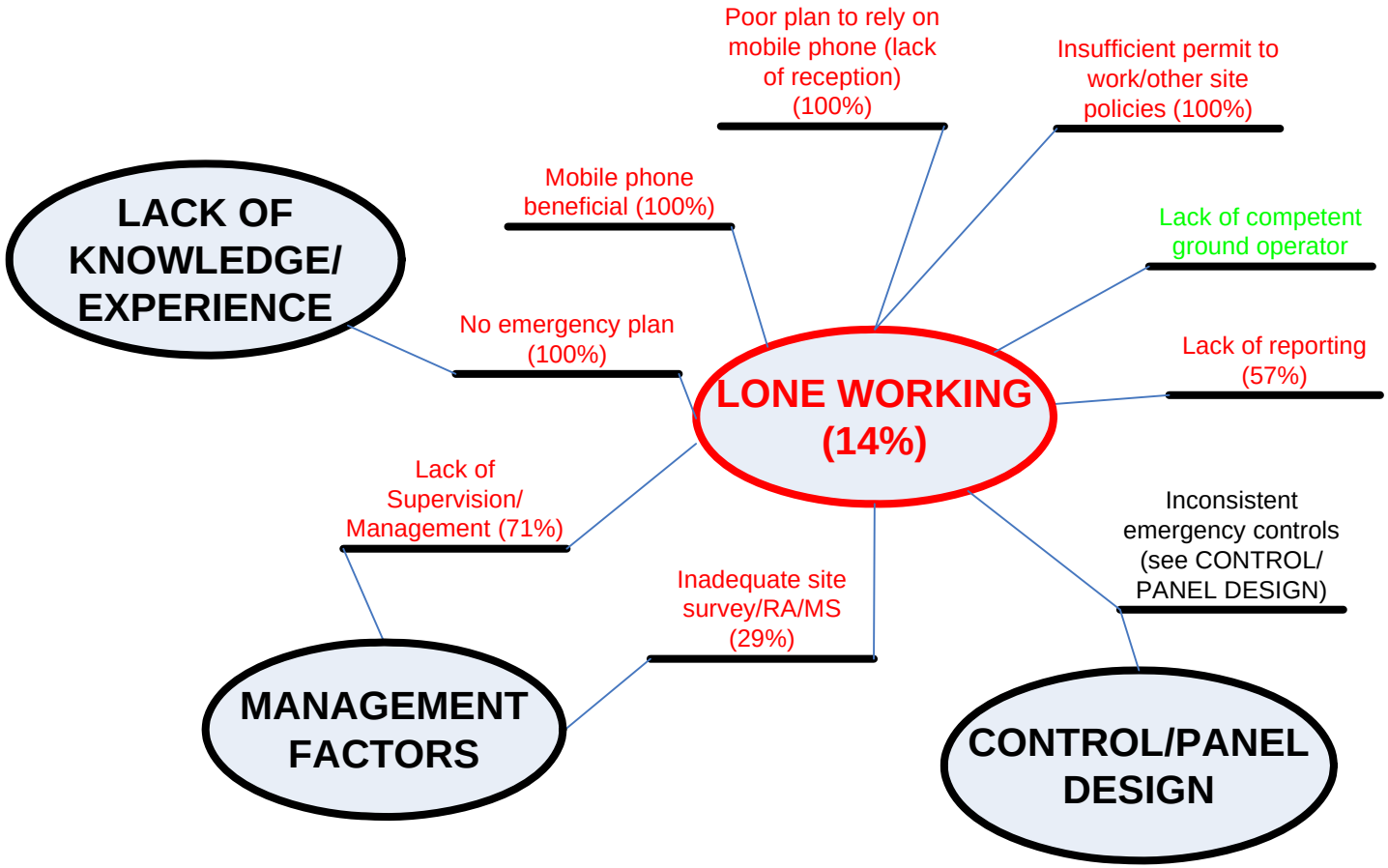


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| Red text and % | % Who did not demonstrate knowledge |
| Orange text and % | % Who identified this as a new risk factor |
| Green text | All operators demonstrated knowledge |

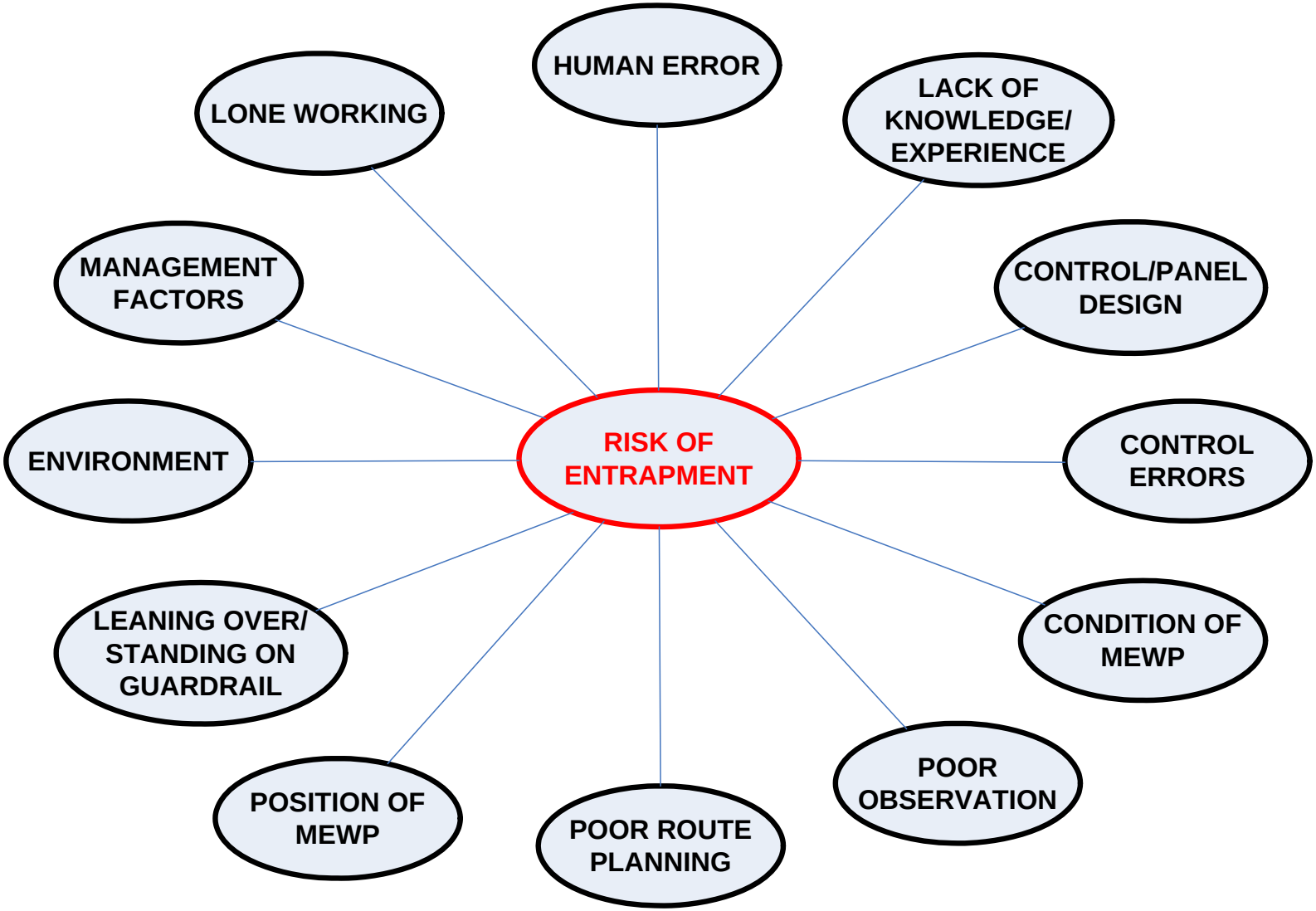
## APPENDIX 19

Risk reduction measures for entrapment identified by the steel erectors are detailed below:

- Provide additional lighting on the platform;
- Standardise control panels, *"…it'd be a lot easier if they were all the same"* (to help prevent the effects of learning on one make and model and control errors);
- Enhance MEWP training to more closely reflect the realities of site conditions;
- Standardise lone working procedures across the industry.

**APPENDIX 20**

COMBINED EXPERT AND END USER INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP



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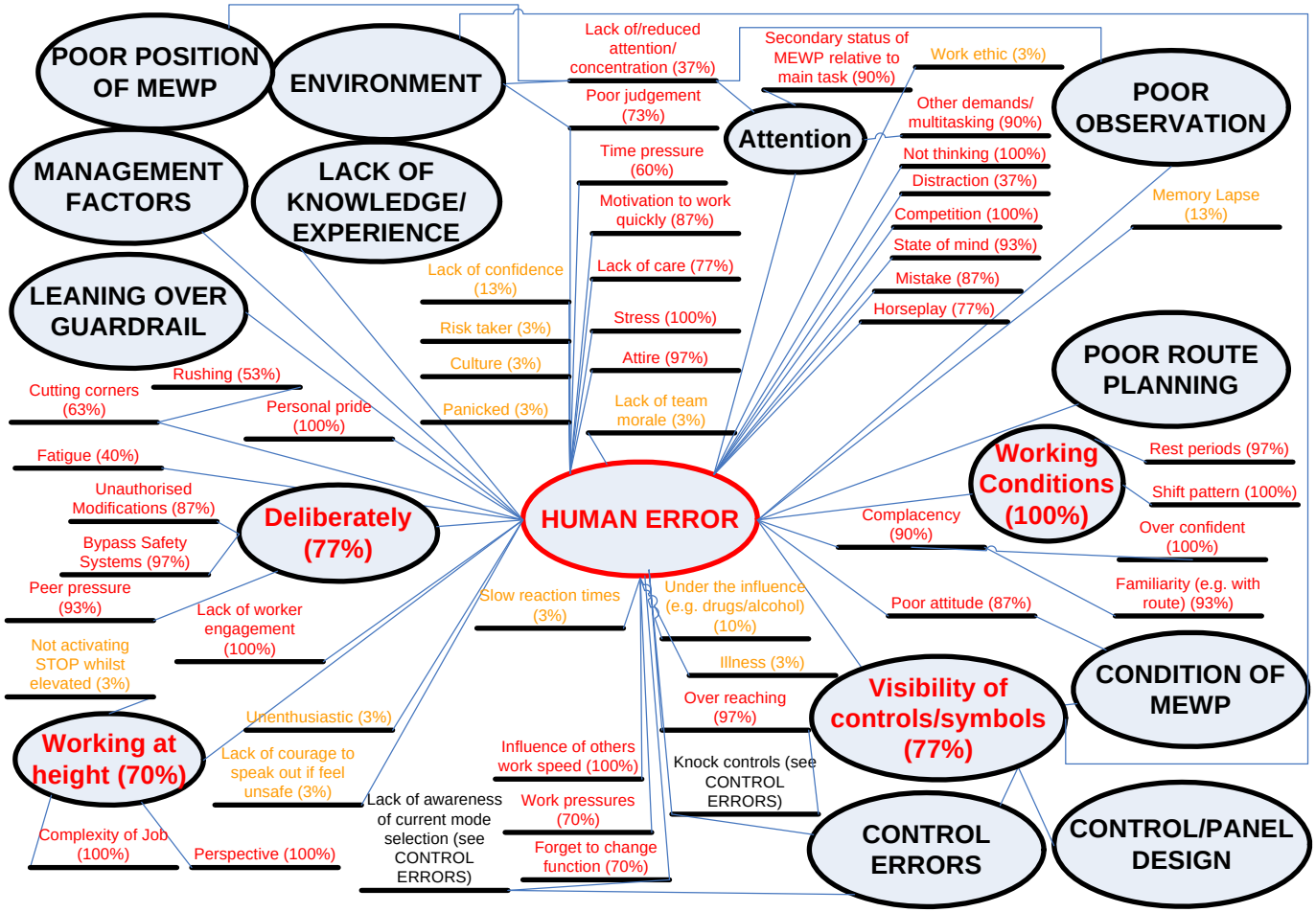


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| Red text and % | % Who did not demonstrate knowledge |
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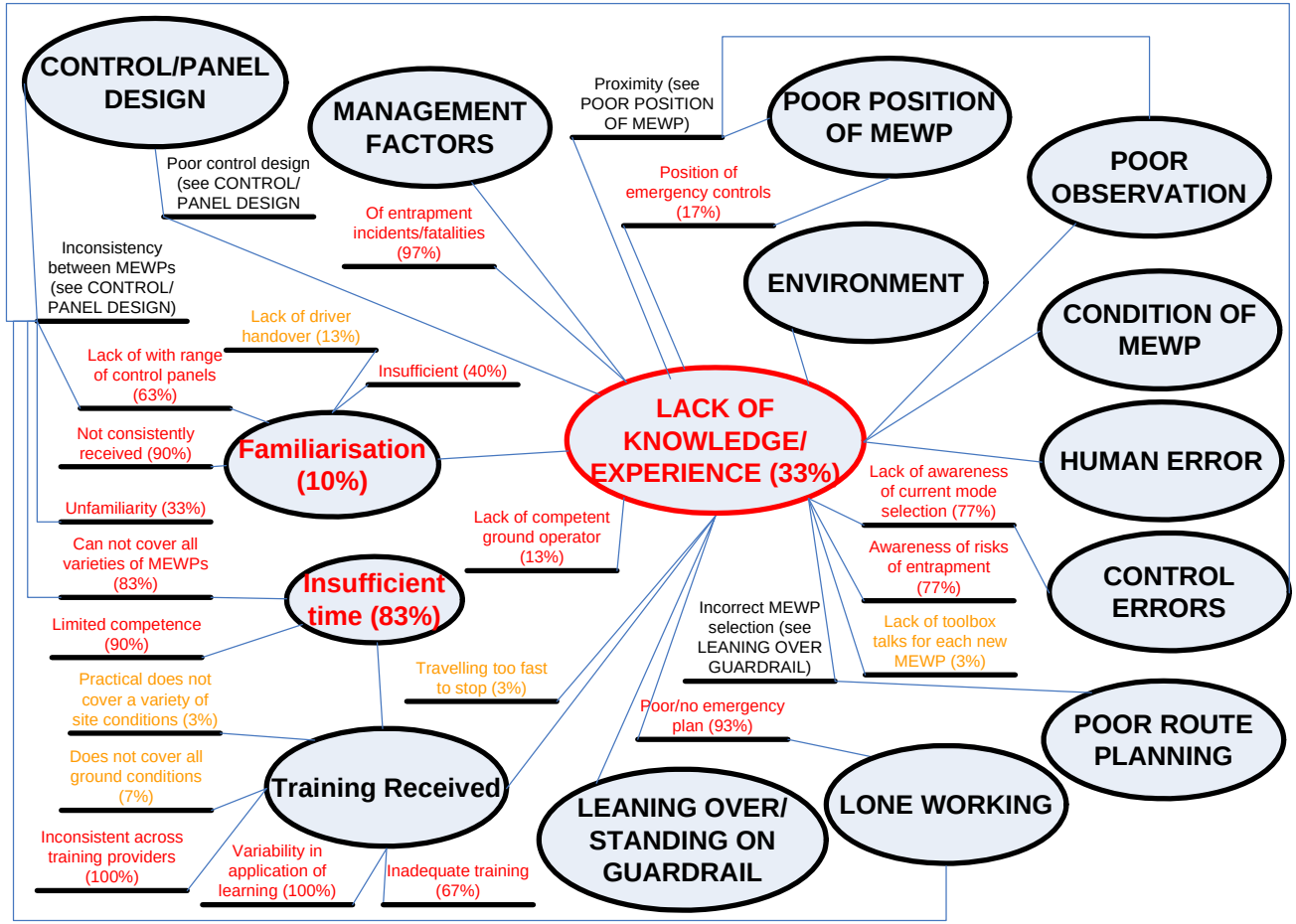
| Green text | All operators demonstrated knowledge |

**APPENDIX 20**

COMBINED EXPERT AND END USER INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP

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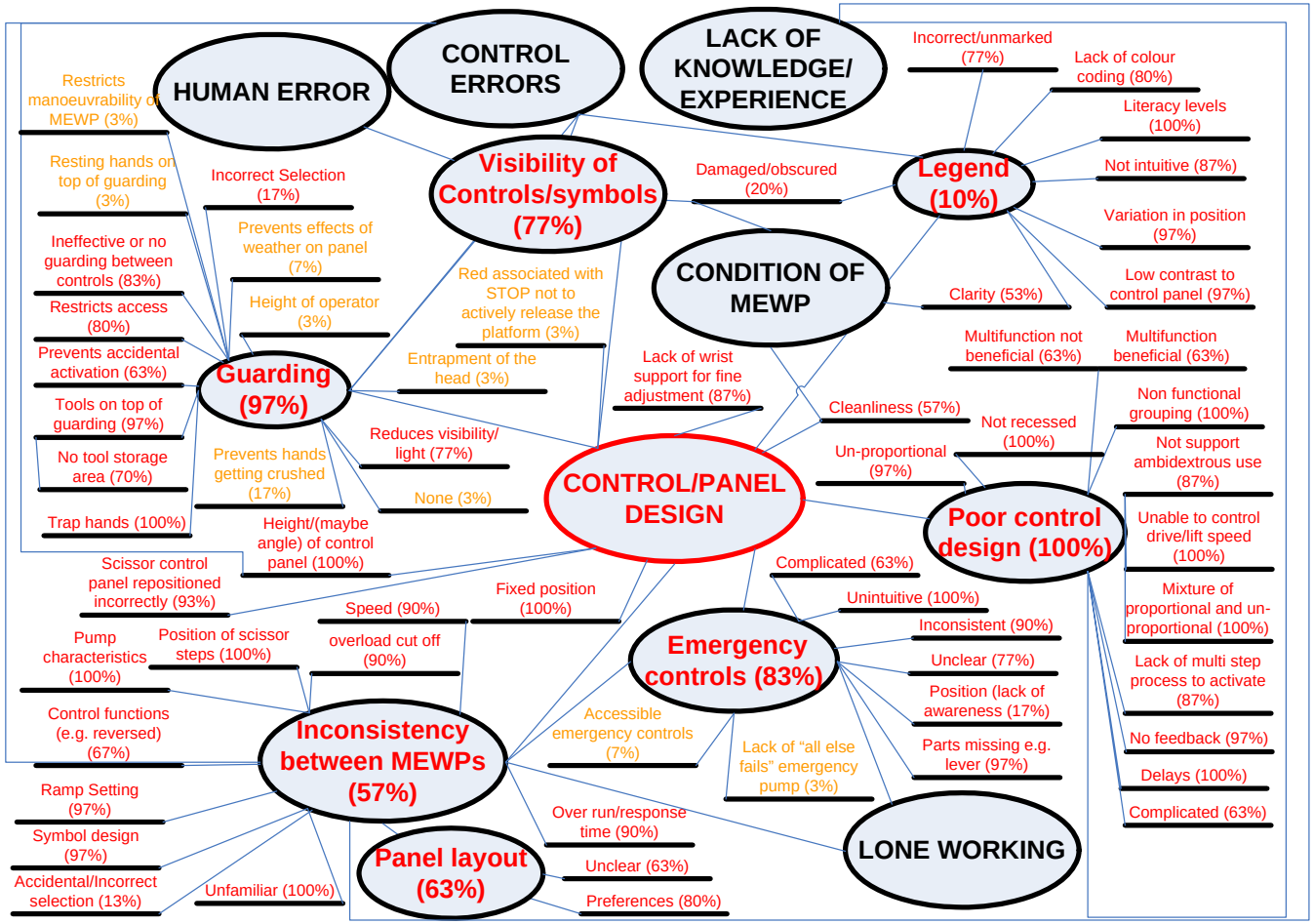


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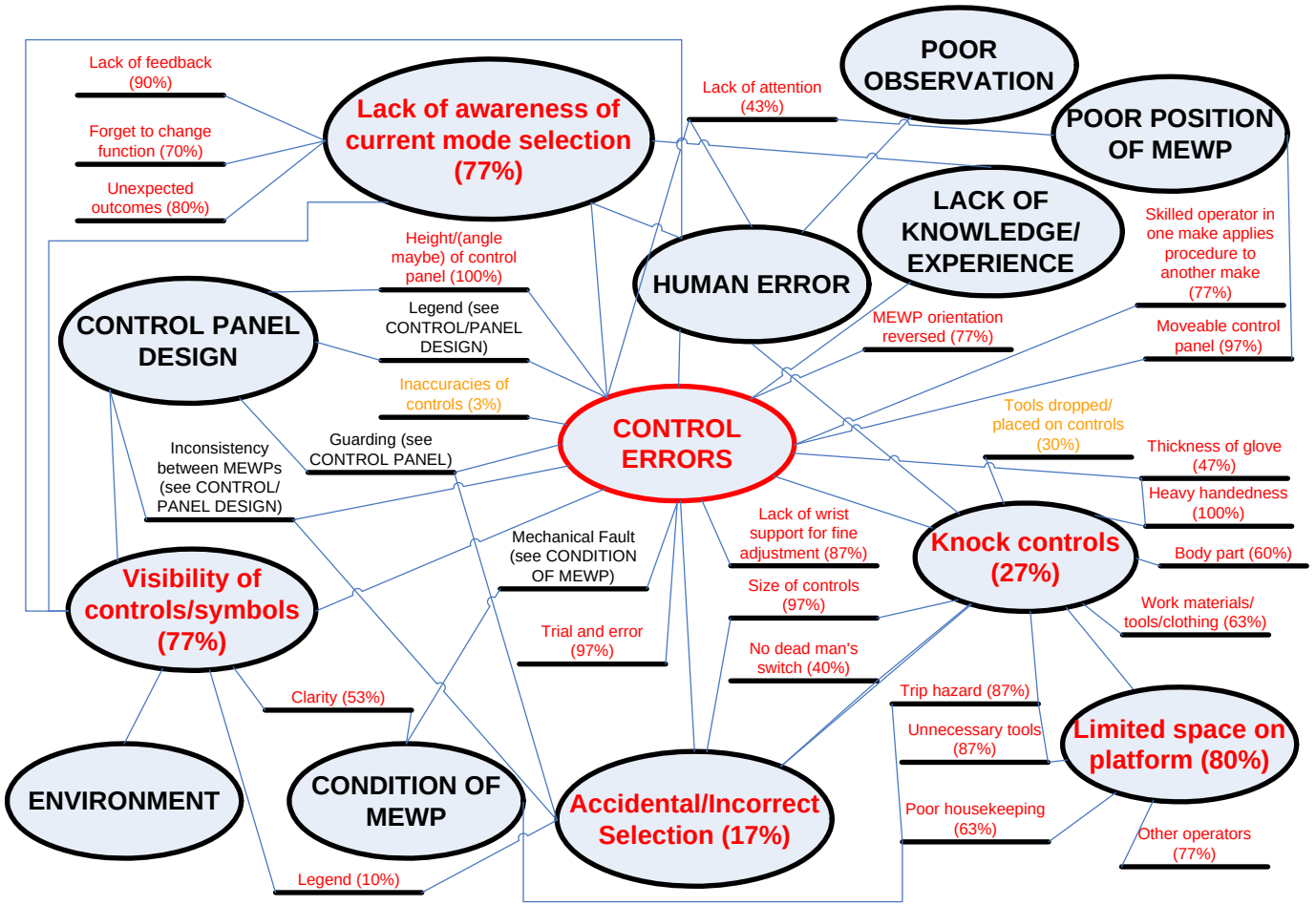


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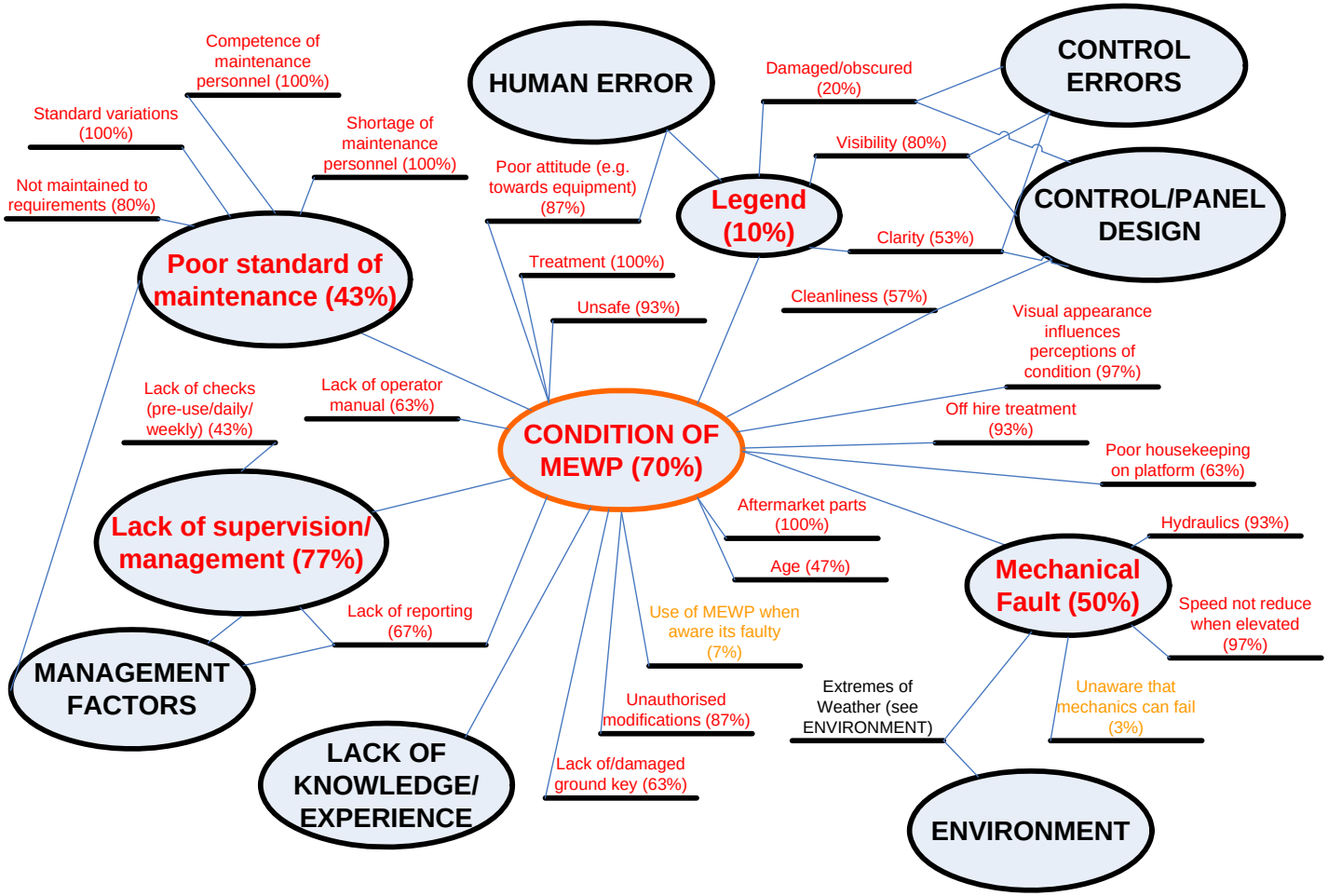


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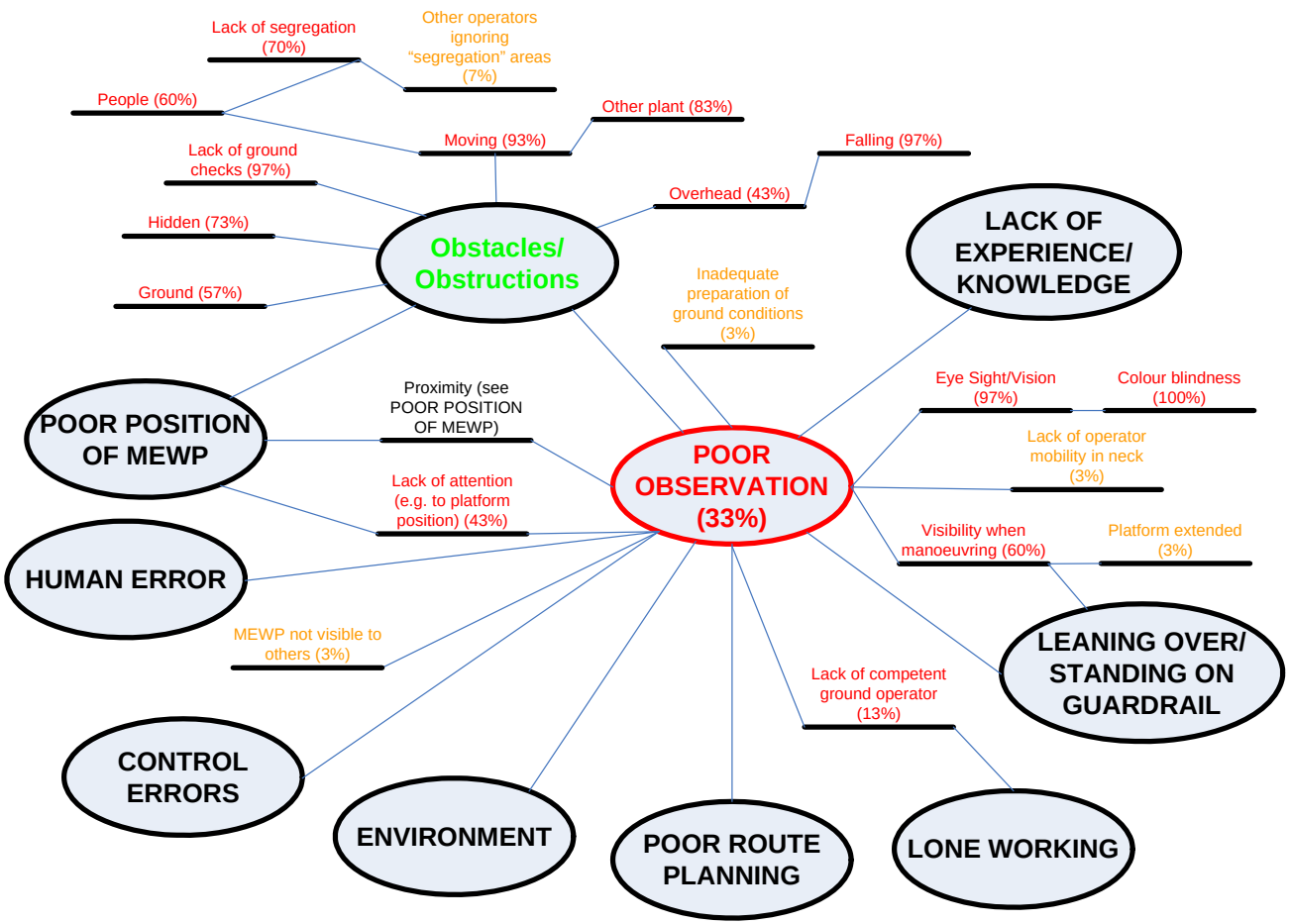
**APPENDIX 20**

COMBINED EXPERT AND END USER INFLUENCE DIAGRAM OF THE RISKS OF ENTRAPMENT WHEN USING A MEWP




| | |
|---|---|
| Red text and % | % Who did not demonstrate knowledge |
| Orange text and % | % Who identified this as a new risk factor |
| Green text | All operators demonstrated knowledge |

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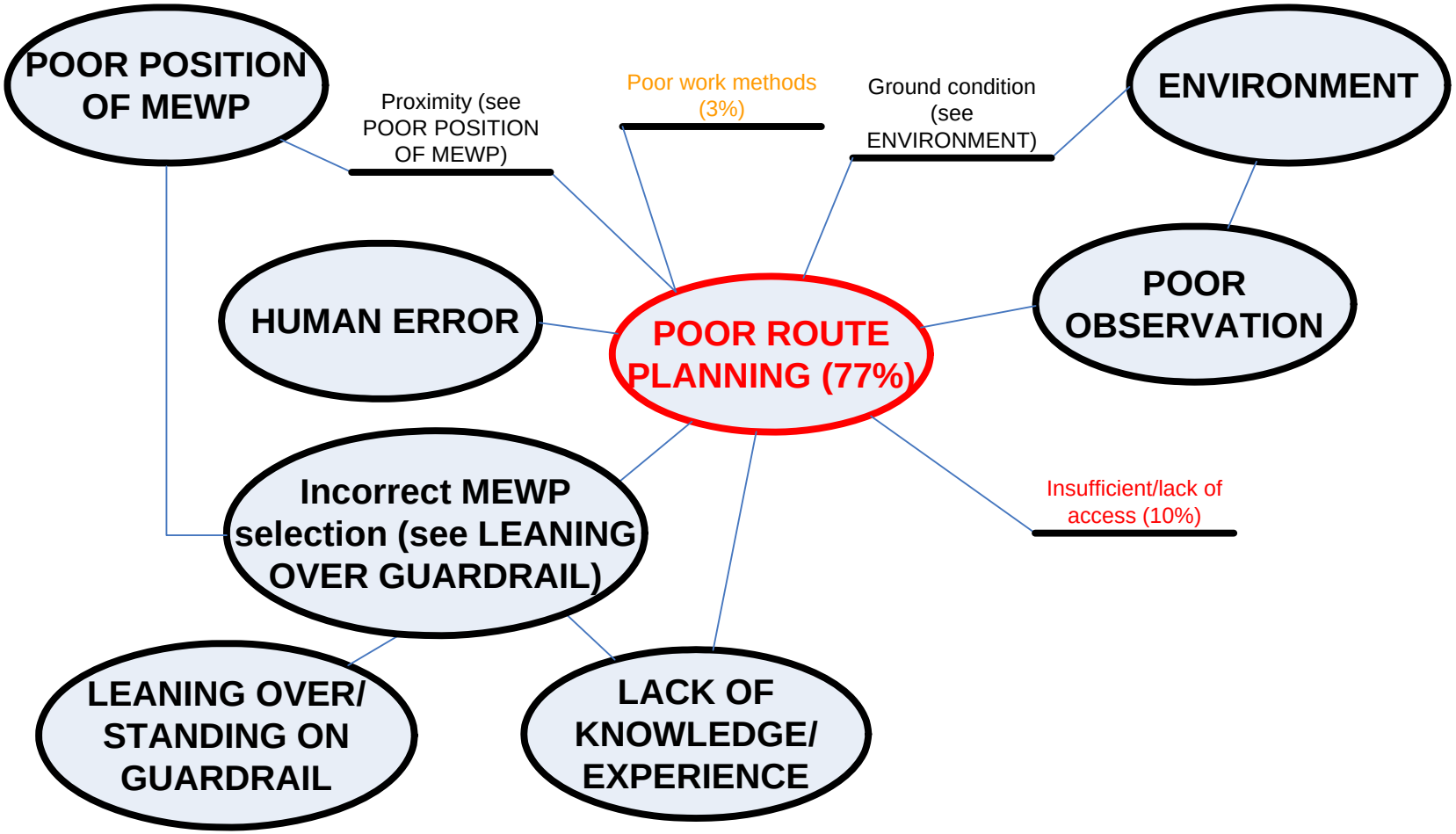


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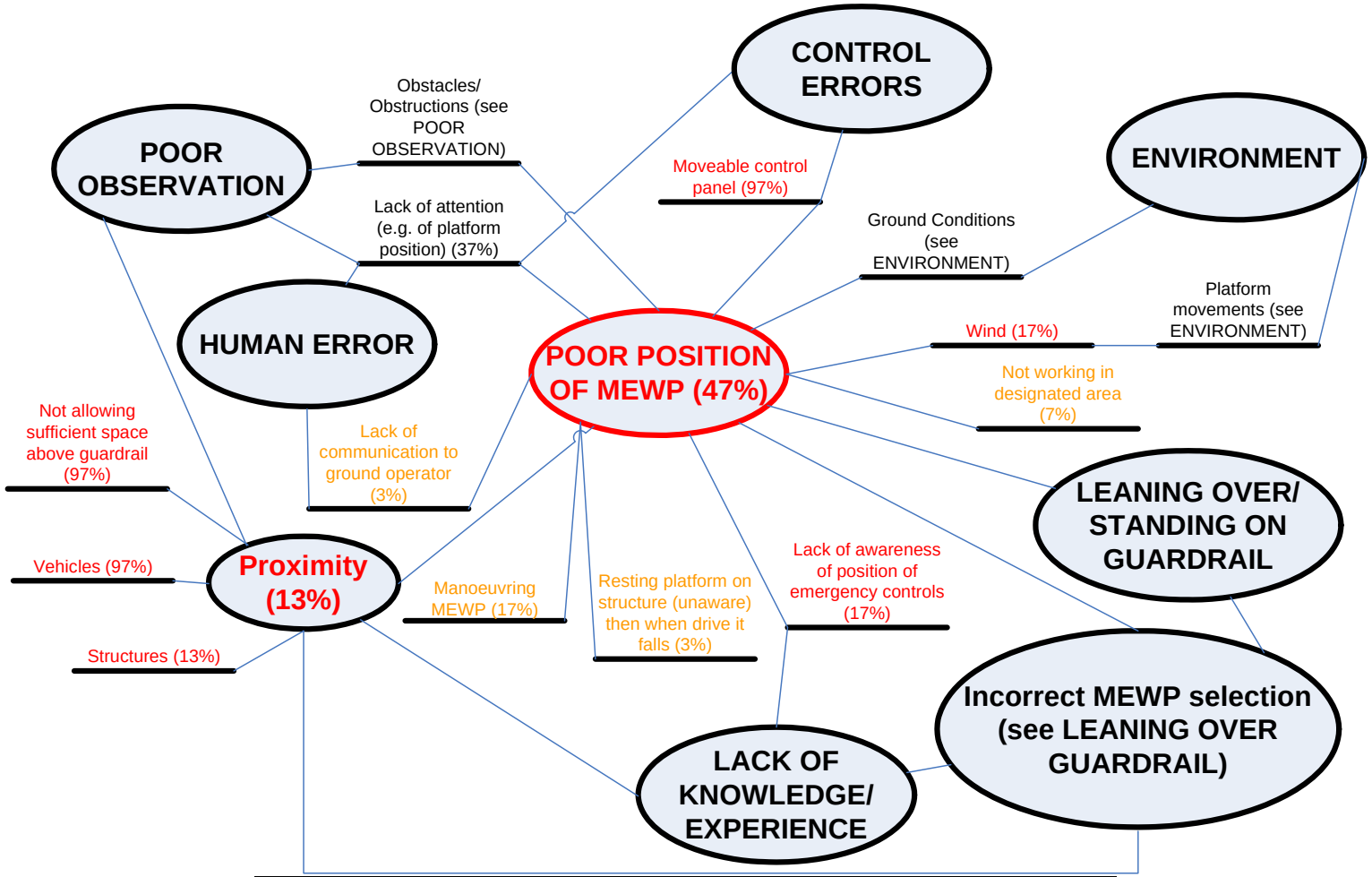


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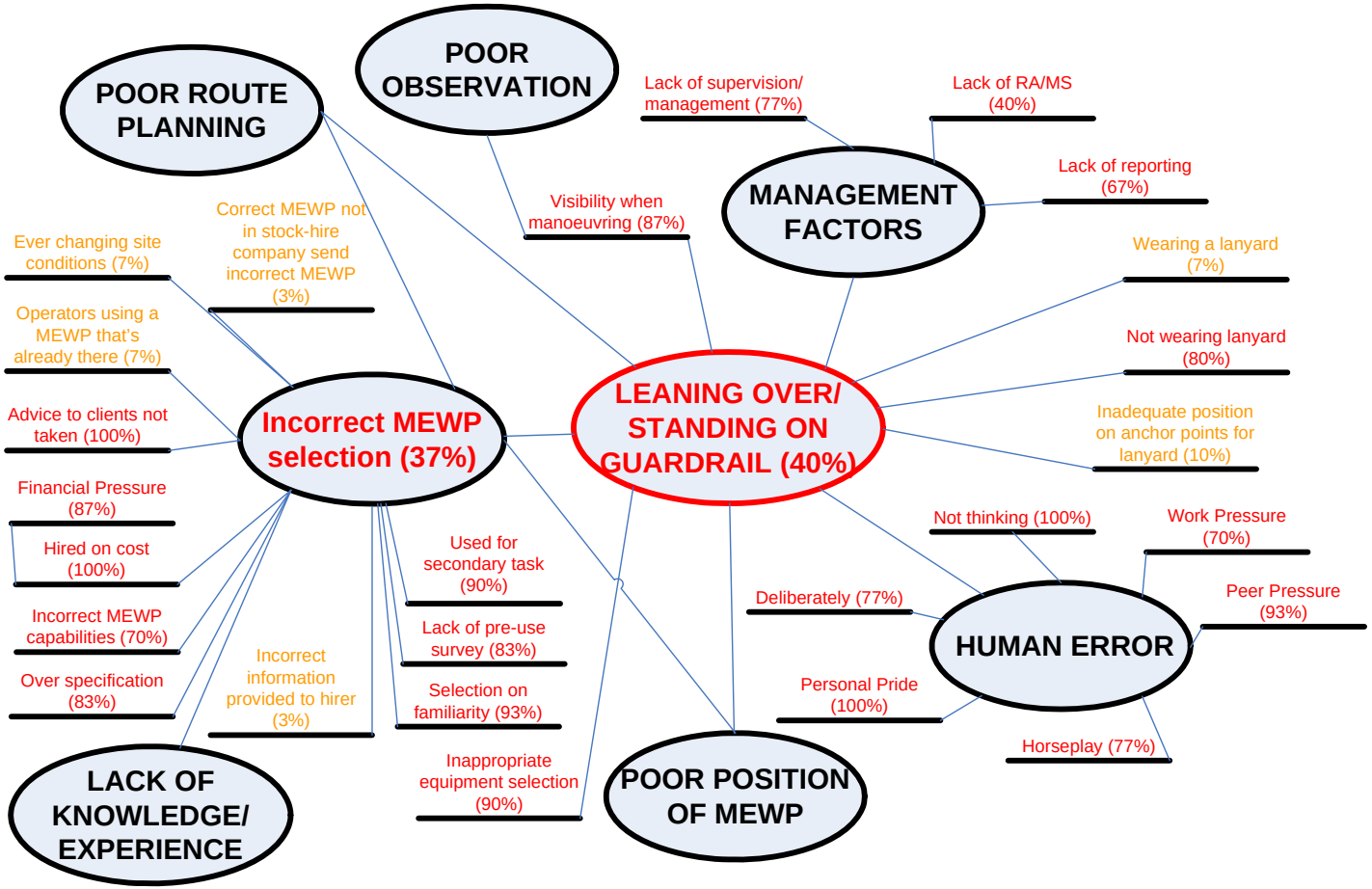


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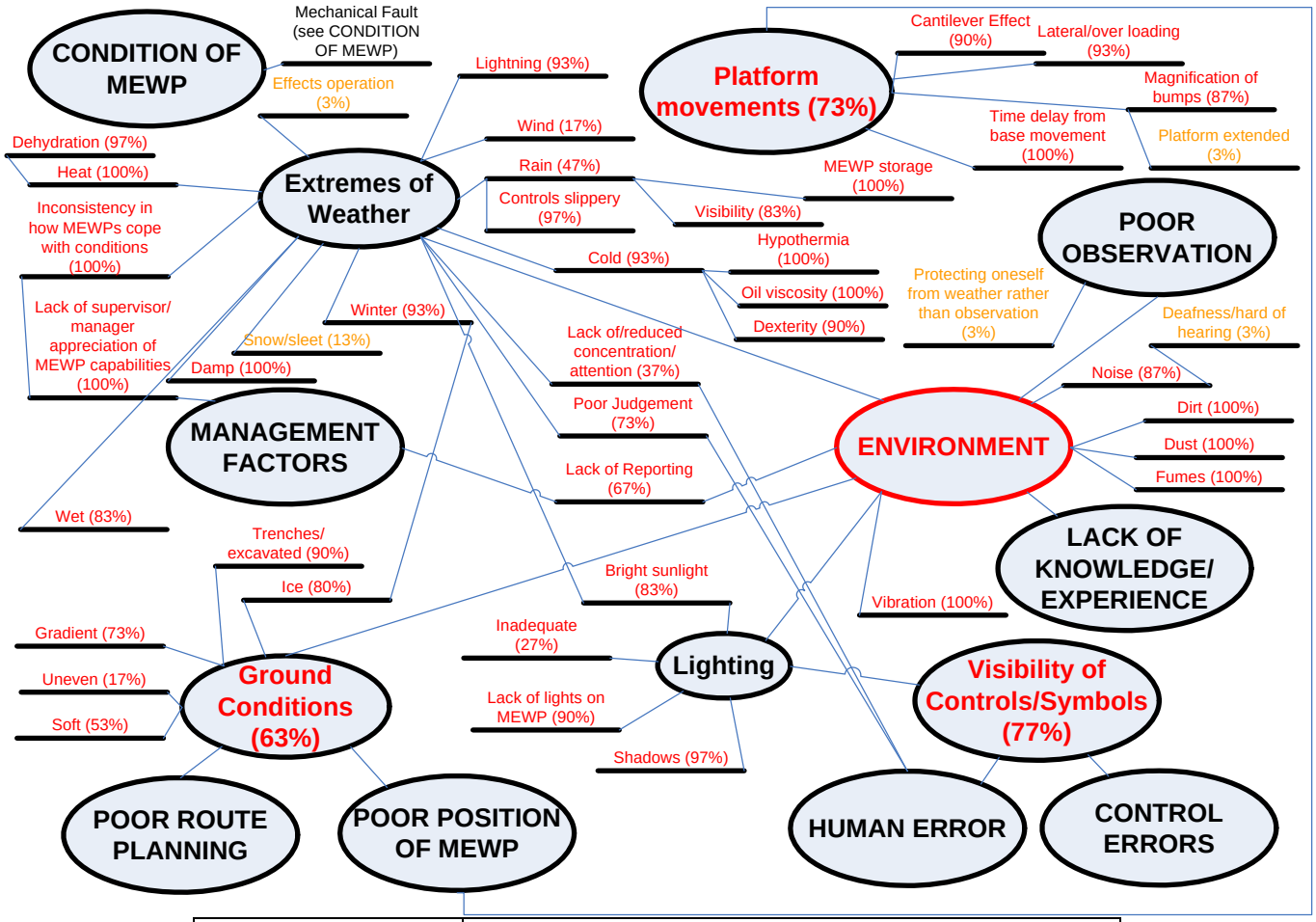


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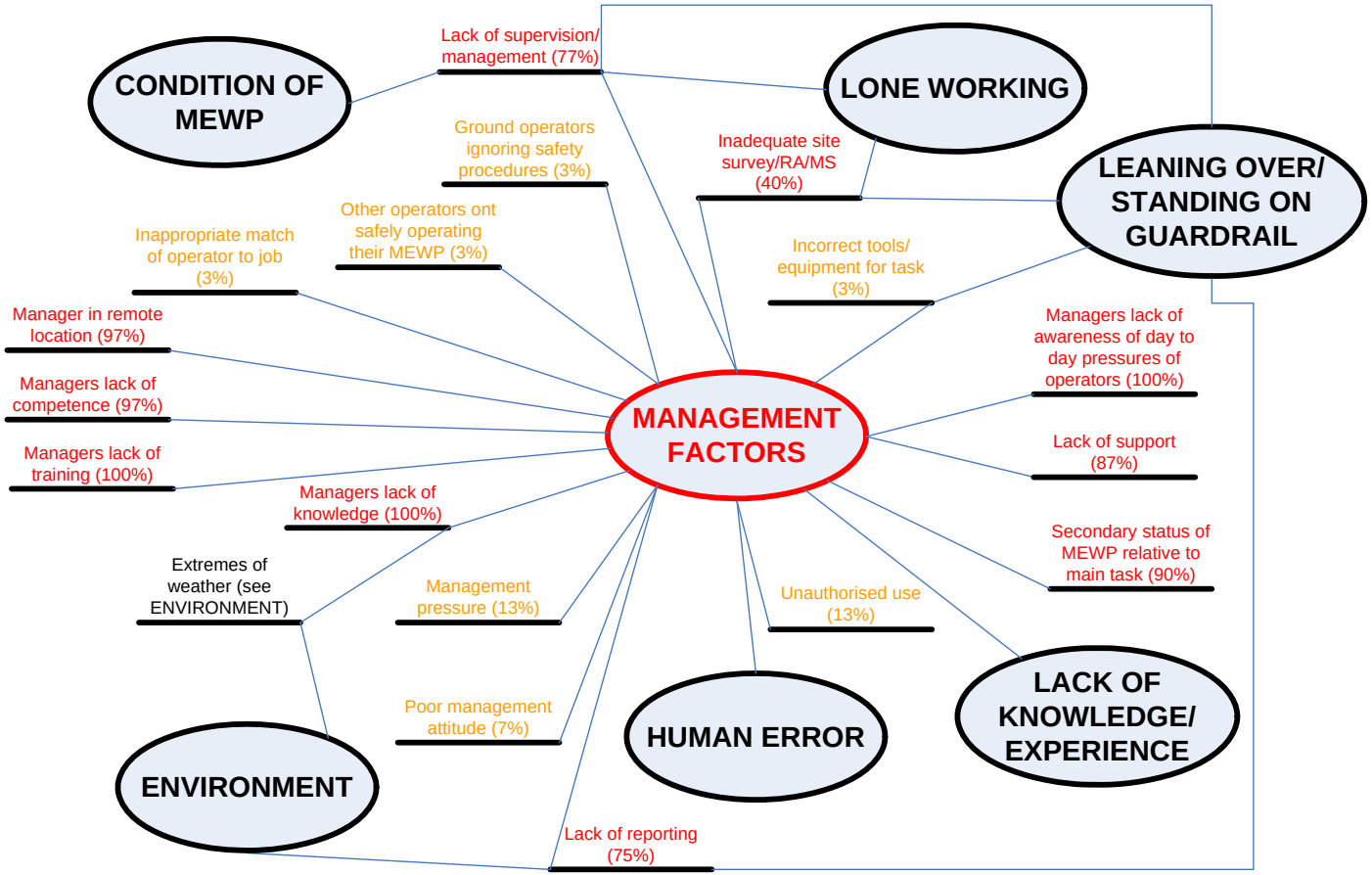


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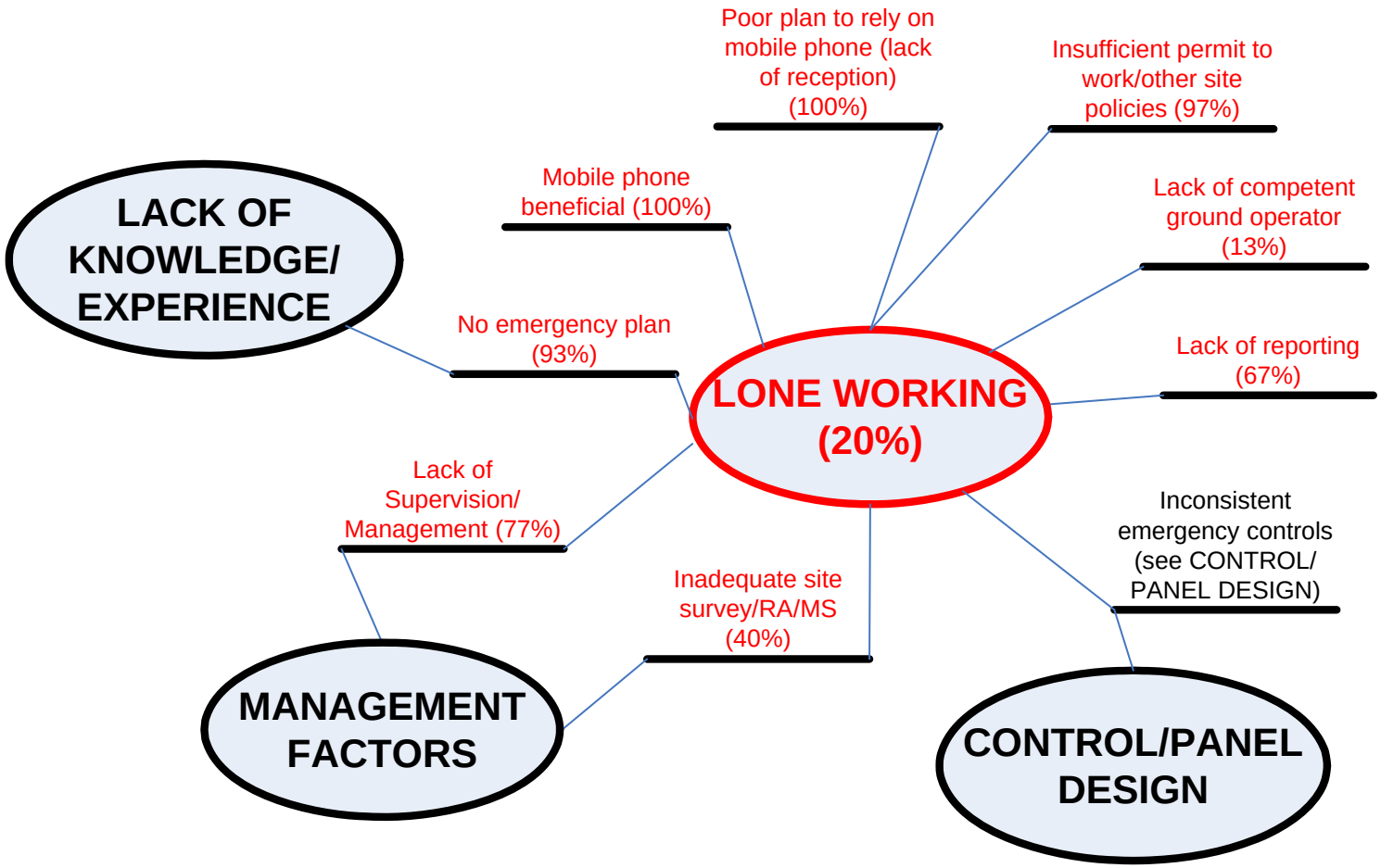


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## APPENDIX 21

The table below demonstrates the percentage of end users who demonstrated knowledge for a selected number of risk factors.

**Table 5** Percentage of end users who demonstrated knowledge for selected risk factors

| **Risk Factor** | **Percentage who demonstrate knowledge of the risk factor** |
|---|---|
| Height/angle of control panel | 0% |
| Stress | 0% |
| No feedback | 3% |
| Insufficient permit to work | 3% |
| Overloading | 7% |
| Inconsistent emergency controls | 10% |
| Lack of feedback | 10% |
| Sunlight | 17% |
| Visibility in rain | 17% |
| Ice | 20% |
| Lack of supervision/management | 23% |
| Lack of competent ground operator | 23% |
| Guarding reduces visibility/light onto control panel | 23% |
| Visibility of controls/symbols | 23% |
| Lack of awareness of current mode selection | 23% |
| Skilled operator in one make applies procedure to another make | 23% |
| Gradient | 27% |
| Poor judgement | 27% |
| Condition of MEWP | 30% |
| Forget to change function | 30% |
| Work pressures | 30% |
| Lack of reporting | 33% |
| Lack of/damaged ground key | 37% |
| Ground conditions | 37% |
| Complicated control panel design | 37% |
| Complicated time-consuming emergency controls | 37% |
| Poor housekeeping on platform | 37% |
| Time pressure | 40% |
| Inconsistencies between MEWPs | 43% |
| Soft (mud) | 47% |
| Age of MEWP | 53% |
| Rain | 53% |
| Poor position of MEWP | 53% |
| Lack of checks (pre-use/daily/weekly) | 57% |
| Poor standard of maintenance | 57% |
| Lack of attention | 57% |
| Inadequate site survey/RA/MS | 60% |
| Leaning over/standing on guard rail | 60% |

| Risk Factor | Percentage who demonstrate knowledge of the risk factor |
|---|---|
| Fatigue | 60% |
| Incorrect MEWP selection | 63% |
| Distractions | 63% |
| Poor observation | 67% |
| Lack of knowledge/experience | 67% |
| Inadequate lighting | 73% |
| Lone working | 80% |
| Legend is damaged/obscured | 80% |
| Uneven ground | 83% |
| Wind | 83% |
| Accidental/incorrect selection | 83% |
| Lack of awareness of position of emergency controls | 83% |
| MEWP orientation reversed | 87% |
| Proximity | 87% |
| Insufficient/lack of space | 90% |
| Obstacles | 100% |

## APPENDIX 22

The following dialogue has been extracted from the interviews to illustrate insights that have been gained from incidents or near misses that end users have directly experienced or witnessed or have good information about.

- Ground conditions

*"…One on soft ground, sunk down on one side and got clattered against the actual sheeting on side of wall, it were lucky that were there actually. I've heard of big wheels, wheels going down big pot holes, unseen sort of dangers if you know what I mean. I think that's a regular one actually…In an ideal world if you could come on and they'd already sorted out the groundwork out and everything because it doesn't all work hand in hand does, it, the development of places and sites".*

*"…Was going over rough ground too and the basket…and he had a beam above his neck".*

*"…The ground, the ground caved in under one wheel…it tipped over and he hit the steel and he severed his hand…ground conditions…a lot of rain the night before."*

- Overhead obstacles/moving plant

*"…I'm working in an area, I'm working up a column and somebody's boomed up above me, so I'm going up and they're already boomed up above me…So they're in my way, they're blocking my way straightaway".*

*"We've probably a couple of times been quite close to, when I say close, we've had to get where we needed to get to, to do the task but its been close to overhead obstructions. So there is extra care required. I mean a typical one would be for me its quite natural but if you're on the control and you just kneel down so your limiting the risks."*

*"I think this was a typical, a typical obviously taking it too high and obviously encountering whatever coming first, the roof structure or something else high up. You know we've had, we've experienced instances where your hard hat taps something.*

- Proximity to structures/Poor observation

*"…I was on a job last year and I'd gone home because I'd finished what we needed to do but the plumber was up in his lifter and he came down and he had the boom still out and he came right down on a row of lights and brought a whole row of lights down in the supermarket just as the shift change was going. So you had thirty odd people all leaving as this row of lights came crashing down and they were live. So all the tubes were smashing like bombs on the floor. Because obviously there's no sensor to say that you're coming down on something. Its not like you've got car sensors to say your getting close to something so you just came straight down on them, bang, brought everything down but that was probably human error".*

- Proximity to structures

*"…I'm working amongst services it got caught under a girder. It's the first time it's happened, I've been down there 5 months and the guys had to release the hydraulic switch…once it hits a girder or one of the services it actually cuts out and if you push*

*the emergency stop and activate the emergency stop and then push down, it still won't…I couldn't actually get down because I'd already gone up between all the ductwork and pipe work and I was actually up above everything so I just shouted down to one of the duct workers and he had to read* [the emergency instructions], *yeah, he found it"*

*"I've actually seen obviously somebody has got their hand trapped…he has actually been trapped on the control panel…the actual control panel is near the beams and he actually had his hand on top of that and he caught his hand and trapped it between the beams and the control panel…the proximity to the beams that's actually done that".*

- Poor attitude/Proximity

*"… A lot of people don't care, you know, you're supposed to keep a radius around each picker to keep away from each other because the back ends swing out so they could clash…"*

- Standing on the guardrail

*"I've witnessed it and I've seen it and I've seen the old guardrail one, standing on the guardrails, I've seen that as well numerous times, numerous."*

- Lack of concentration/poor observation

*"…The nearest ones are where you're not concentrating. Me, I've reversed or you've looked around, you're looking forward, you start reversing then you think, oh no I didn't see that. Because you tend to look down and around, you don't tend to look above you."*

- Lack of experience/poor observation/insufficient/lack of access

*"Yes. I've knocked through steelwork and this was at the start, but I put* [it] *down to inexperience and I … actually got my head caught here* [guarding]*…maybe confined space, full with steel and I was…how do you explain it, going up through it and your looking around you but I didn't see the small bit behind me...you have to cover the 360 degrees…and the beam caught me on the back of the head and pushed it forward".*

- Insufficient/lack of access

*"…I think he come down, got stuck and come down and I think his head was stuck…sometimes you have to sort of manoeuvre yourself into a tight space and then it must have gone down and got caught still"*

- Poor observation/MEWP secondary task

*"I think the closest I've come is like you swing the basket round and it hits a column at the side…and the basket protects me. But I mean if you had your fingers on the side of the basket then…I'd say just moving, probably not looking exactly where your going…because you've got, your eyes are set on your net, your safety netting, I'm looking at the nets up there, trying to move the control…yeah its easily done."*

*"…He was putting up nets and whatever happened he crossed between the basket and the steel beam above him and it just crushed him in the chest here and that was what killed him".*

- Poor observation

*"There was a guy...he hit his head on the basket and whatever happened he got his head caught between the basket and the beam. He must have been driving, he must have been driving back or forward or whatever way and he just didn't see what was behind him and he got his head kind of caught there. And if it wasn't for his hard hat like he would have been badly injured".*

*"…Was a guy reversing and I didn't see a beam behind him and it trapped him onto the controls."*

- Cutting corners/unauthorised modifications

*"…Because some people tape the buttons…and if I'm not wrong, I don't know whether the lad had got killed but he'd started going up and it carried on going up and squashed him…but yeah some people try to lock the buttons off…cutting corners…just wedge buttons in".*

*"…That's another, you can put it down as an experience, you know your cut off things for upraising, I mean they lift so much to such and such, so much to that and I've seen them disconnect that* [overload protection]*…it saves them coming back down and redoing it".*

- Unfamiliarity/unauthorised use/ground conditions

*"…He was trying to go places in the cherry picker he shouldn't have been…terrain…and he was unfamiliar with the machine, he was using a steel erectors machine, he shouldn't have been using the machine".*

- Unaware MEWP basket resting on structure

*"…Its where a guy was lowering himself, got stuck on a piece of steel, wasn't aware, moved forward and his basket dropped about six feet".*

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# Mobile elevated work platforms

## Phase 3

HSE has carried out a programme of research projects focused on MEWPs , in order to provide a better understanding of some of the issues involved and to help work towards their improved and safer design and operation.

An initial phase of work, reported in HSE Research Report RR961, examined the human factors involved in such accidents as a means of identifying possible solutions. The subsequent phase of work (to be published later in 2013) went on to critically evaluate MEWP control interfaces and platform environments.

The work detailed in this current report is the third phase of MEWPs research and has aimed to capture MEWP end users knowledge in relation to the key risk factors for entrapment/crushing whilst operating MEWPS, using insights gained from their experiences of near misses/incidents. Suggestions for how these might be addressed are also considered.

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RR960

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