

On Crossing A Drain – A Tutorial In Risk Management

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Most of us do many things every day without a second thought as to the dangers involved. Now that the Singapore Ministry of Manpower (MOM) is enforcing the Workplace Safety and Health Act vigorously, and requiring risk management (RM) - including Risk Assessment (RA) - at all workplaces, it is worthwhile to examine some of the basics of RM, particularly how to set up the risk assessment part.

Crossing a drain as a case study

A favourite example of the author's for a RA-RM tutorial is that of risks in crossing a drain. He has been using it in his lectures and also included it in his recent book (Ref.1).

The real-life importance of this 'classroom/textbook exercise' was vividly demonstrated when on 30 Jan. 2007 a 76-year old Singaporean who had been crossing a 1m wide, 2m deep drain as a short-cut many times, one day fell into it and died. (Fig. 1.)

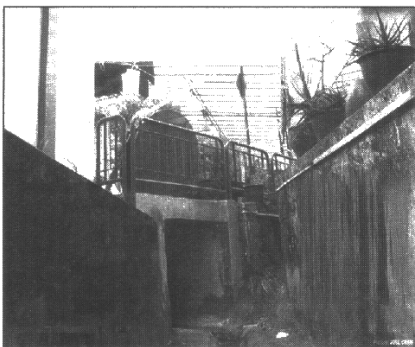


Fig. 1. Drain that the old man fell into

Consider a person pondering whether or not to cross a drain, of width w and depth d , as shown in Fig. 2. In real life, apart from the width and depth of drain, considerations like height and age of person, time of day, weather, etc. will also affect the outcome.

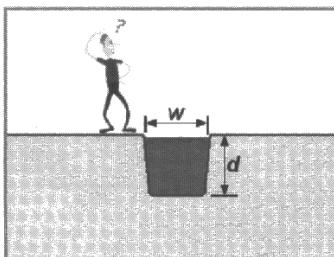


Fig. 2. Man at drain

However, to keep the discussion short and sweet, we shall restrict the analysis to attempted crossing by a normal healthy adult (not invalids or children); and to a normal day, not in very hot or rainy weather. (Male pronouns will apply to females unless otherwise noted.)

The RA-RM Procedure

We know that risk is (mainly) a function of the two independent factors:

- (a) Likelihood of the mishap occurring, and
- (b) Severity of the consequence of the mishap, if and when it occurs.

Steps in assessment and management of any hazard in a particular job, as popularised by MOM (Ref. 2) with reference to a 3 by 3 risk matrix (Fig.3) are:

1. Assess the hazard's likelihood and severity into one of three or more levels.
2. Combine likelihood and severity levels to assess the risk level by means of a risk matrix, whose cells are grouped into three or more risk categories.
3. Recommend safeguards for the risk category according to a certain hierarchy of controls.

Severity ↓	Likelihood		
	Low	Medium	High
High	Medium	High	High
Medium	Low	Medium	High
Low	Low	Low	Medium

Fig. 3. 3x3 matrix, 3 categories

These steps have now become fairly well known to practitioners. Author feels that the issue has now been reduced to what he calls 'The Scoping Problem', namely how to get the RA-RM process started, that is to say, how to formulate the likelihood and severity criteria to be considered for credible hazards while framing the risk matrix, and how to categorise the risk combinations.

Author has addressed this scoping problem in his earlier paper, (Ref. 3), by (i) selecting the feasible and applicable ('local') ranges of likelihood and severity of the mishap from within the bigger ('global') range of the entire spectrum of possibilities, and (ii) dividing them into three (or more) segments which may be designated (for example) as 'Low', 'Medium', 'High', etc.

Range and Levels of Likelihood of Occurrence

The likelihood of a fall into the drain will depend on the width w of the drain.

The range of widths that a normal adult male can cross may be taken as 0.5m to 2m. Below

0.5m the chances of falling are insignificant, and above 2m falling is almost certain - unless one is an Olympic athlete, facing the standing long jump record of 3.71m.

We will use three levels for likelihood as suggested by MOM (Ref. 2). We may choose, 0.5m, 1m, and 2m as the 'Low', 'Medium', and 'High' widths for consideration.

If the drain width w is:

- $w = 0.5m$: He can simply step across, with low likelihood of stepping into the drain.
- $w = 1m$: He may breathe deeply and take a long stride across it, with medium likelihood of missing the other edge.
- $w = 2m$: He must start a couple of steps behind the drain, take a running leap and jump across, with high likelihood of falling into it.

Range and Levels of Severity of Consequence

The severity of consequence of a fall into the drain will depend on the depth d of the drain.

We consider the feasible range of depths here as 50mm to 2m. Less than 50 mm will simply wet the shoe if drain is water-filled or barely make him stumble if it is dry. More than 2m will lead to a dire consequence: drowning if water-filled (for non-swimmers); major injury or death, if dry.

We will use three levels for severity, again as suggested by MOM (Ref. 2). We may choose 50mm, 1m, and 2m as the 'Low', 'Medium', and 'High' depths for consideration.

If the man steps or falls into the drain of depth d while trying to cross it, consequences will be as follows, for (a) water-filled, and (b) dry:

- $d = 50mm$: (a) Water will just wet his shoes, (b) toe stubbed, shoe scuffed; low severity.
- $d = 1m$: (a) Water will reach to his waist level, messy though not life threatening, (b) ankle twisted, bone fractured; medium severity.
- $d = 2m$: (a) Water will be over his head, fatal, (b) major injury, death; high severity.

Combination of Likelihood and Severity into Risk

Figure 4 depicts our man at the drain, now facing all nine possible combinations of three width options and three depth options. This table of combinations is the 'Risk Matrix'.

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Risk assessment of man planning to cross drain			
	Low Likelihood w = 500mm	Medium Likelihood w = 1m	High Likelihood w = 2m
High Severity d = 2m			
Medium Severity d = 1m			
Low Severity d = 500mm			

Fig. 4. Man planning to cross a drain

Decision to cross the drain or should be based on:

- Likelihood of his stepping into it while crossing, and,
- Severity of consequence if and when he steps into it.

The actual order of our assessment of likelihood and severity, and whether we denote one or the other by row or column in the matrix do not matter.

Risk Categories

The nine combinations are symbolically depicted in the 'qualitative' 3 by 3 risk matrix Fig. 4, as suggested in MOM Guidelines (Ref. 2). The cells in the risk matrix are then grouped for appropriate control into categories of risk.

For beginners and simple cases, it is adequate to group the nine cells into three categories of three cells each, the risks being designated 'Low', 'Medium', and 'High' as shown in Fig. 3.

Note that MOM's suggestion of three levels of likelihood and severity, and of three categories of risk, is not law or regulation. The RM team and management may decide to have more than three levels, and also unequal numbers of levels for likelihood and severity, as long as they can uniquely define the levels without gaps or overlaps.

Likewise, more than three categories of risk are also permissible, as long as unique controls can be defined for the different categories.

Author recommends that the number of categories should be not less than the smaller of the numbers of levels of likelihood and severity, as otherwise the effort spent in sorting out the basic levels would be partly wasted. Here three categories should be sufficient.

Fate of Our Man at the Drain

Let us say our 76-year old man in the news report is at the edge of a 1m wide and 2m deep drain, and debating whether he should try to cross it.

From Figs. 3 and 4, the 1m wide ('Medium' likelihood), 2m deep

('High' severity) drain is rated 'High' risk, meaning that our man should surely not try to cross it! But he did not analyse the obvious hazard scientifically like we have done here, and died possibly as a result.

It is natural to question how the man had been crossing that drain routinely earlier as reported - in spite of warnings from his family, one may add. The simple answer is that whenever he wanted to cross, he was able to (sub-consciously?) summon a strength beyond his normal capacity, and/or that he had just been lucky ... until that fatal day.

Let us however, go ahead and complete our analysis beyond this point.

Risk Control

Having categorised the risks we should decide upon the controls. Generally, the low, medium, and high risk categories are designated as 'Acceptable', 'Tolerable', and 'Unacceptable', and respectively disregarded, managed,

and avoided. Table 1 gives general actions recommended by MOM for the three risk categories, together with the author's 'mantra' (that is, slogan) for each.

Medium risks are those that would be left after the lowest and highest risks are eliminated from immediate consideration as acceptable and unacceptable respectively. These remaining risks are considered as tolerable risks which must be managed.

Usually, risk management follows a conventional hierarchy of controls (Ref.2) as follows:

1. Elimination (of the hazard)
2. Substitution (with a less hazardous product or process)
3. Engineering controls
4. Administrative controls
5. Personal Protective Equipment (PPE)

The first four apply to the entire workforce, but the last applies to individual workers, and mainly for this reason PPE is considered to be the least effective in the chain of safeguards.

How Our Man Could have been Saved

Our man, still thinking about crossing the drain, may be faced with one or more of the following risk control options - first four provided by the authorities or owners, and the last one utilised by himself, as depicted in Fig.5:

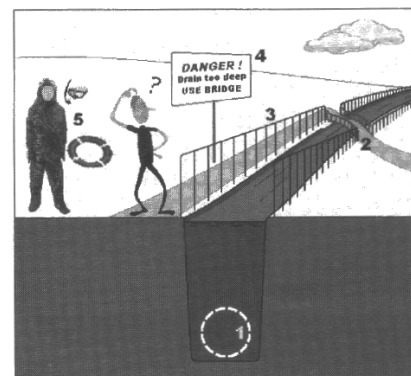


Fig. 5. Risk controls for crossing drain

Table 1. Risk controls for three categories

Risk category	Recommended actions
Low (Acceptable)	No additional risk control measures needed – But frequent monitoring needed to ensure that the risk level assigned does not worsen over time. [Don't worry!]
Medium (Tolerable)	Risks should be prioritised and managed so as to reduce risk levels to as low as practicable and maintain them there, within specified time periods – Interim risk control measures needed – Management attention and approval required. [Manage it!]
High (Unacceptable)	Job must not be started. If it is going on, must be stopped immediately – Eliminate or reduce to at least 'Medium' risk before commencing or resuming work – No interim control measures – Risk controls not to be too dependent on PPE. [Don't do it!]
[Phrases within square brackets in second column are author's mantras, i.e. slogans.]	

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1. **Elimination:** To eliminate the crossing hazard, the drain may be covered up, after embedding a pipe to carry the water. Or the man may ask someone else to do the task for him. Or he may just drop the plan to go out!
2. **Substitution:** A bridge would provide a much less dangerous alternative to jumping across the drain. Even with a bridge, some brave (or unthinking) souls, like the man in the news, would want to take a short-cut!

3. **Engineering controls:** Barriers along both sides of the drain; if drain is dry, some kind of cushion at the drain bottom, not shown.
4. **Administrative controls:** Funding for the other controls; warning signs; employment of a full-time guard.
5. **PPE:** If drain is water-filled, full body water immersion suit - complete with life belt, snorkel, etc. as shown. If dry, a full body harness anchored by lanyard to a lifeline stretching across the drain, not shown. (This is a feasible but impractical solution, offered more as a joke, intended to show how much extra effort will be needed with this option!)

References

1. Krishnamurthy, N., "Introduction to Risk Management", 88p, ISBN: 978-981-05-7924-1, 2007.
2. _____, *Workplace Safety and Health - Risk Management: Risk Assessment Guidelines*, Ministry of Manpower, Singapore, 2006.
3. Krishnamurthy, N., "On Changing a Light Bulb - A Tutorial", published in *Safety Matters*, Singapore Institution of Safety Officers, Issue 02, Second Quarter 2007, p. 12-16. Downloadable from author's website: www.profkrisna.com ♦