“For which one of you, when he wants to build a tower, does not first sit down and calculate the cost to see if he has enough to complete it? Otherwise, when he has laid a foundation and is not able to finish, all who observe it begin to ridicule him, saying, 'This man began to build and was not able to finish.'”

Luke 14:28-30 (New American Standard Bible)

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Enhancing Risk Identification Workshops: An Idea Generation Approach

by

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I dedicate this thesis to my wife. Without her lovely patience, understanding, and support this research work would not have been possible.

Abstract

Risk identification is the first step of risk management for construction projects. Project experts use many different methods to identify risk factors, such as decision trees, standard checklists, questionnaires and the Hazard and Operability procedure, but brainstorming sessions are among the most successful methods for identifying risks offering advantages not encountered in any of the others identification methods. Although the brainstorming technique is widespread in the construction industry, it typically is not used to its full capacity. This may be due to brainstorming literature ambiguity, variations in reporting technique usage in the literature, and lack of a methodology outlining the use of the brainstorming technique specifically for risk identification purposes. In this thesis, the merits, procedures, and appropriate applications of the brainstorming technique are outlined. Implications of the session, the session leader, the participants, and the output are explored, and best practices for risk identification brainstorming sessions are identified.

Acknowledgement

I would like to thank the God of the Bible for the opportunity to live in this generation and to do this research work. Many thanks are given to my advisor Dr. Simaan M. AbouRizk for his guidance throughout this research. Appreciation is extended to Dr. SangHyun Lee and Dr. Stanislav Karapetrovic for serving as members on my examining committee.

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1. Introduction

1.1. Problem statement

The construction industry deals with many different types of risks. Risk management is the effort of project managers to identify and mitigate risks so as to achieve the project objectives during the project lifecycle. The first step of the risk management process is the identification of risk, but while great attention has been paid to the risk analysis process, only limited research efforts have been directed to risk identification (Maytorena et al., 2007). Maytorena et al. (2007) also point out that risk identification is inconclusive unless it is addressed from a creative point of view.

Risks are currently identified using a variety of techniques, including decision trees, questionnaires, the Delphi Technique, HAZOP, comparison to other projects, brainstorming sessions, and a standard checklist (AbouRizk 2009). However, except for the brainstorming technique, none of the previous techniques incorporates the benefits of idea association in a group environment. Furthermore, no other technique focuses on the value on generating as many risks as possible, and no other technique treats risks as ideas.

Brainstorming is among the most popular risk identification techniques because it promotes interaction among project participants, allowing association of ideas. It also produces the most innovative ideas from project experts by giving them the opportunity to create as many ideas as possible,

relying on the principle that the more elaborated an idea, the higher the creative value. Brainstorming can be done individually or in a group; group brainstorming may be preferred by those who believe that groups of individuals produce better ideas than individuals, while individual brainstorming may be preferred by those wanting to share their ideas without group interaction.

Risks are usually identified in meetings held among project experts called workshops. If used during risk identification workshops, brainstorming techniques must be structured. A lack of structure compromises the creative essence of the brainstorming technique and creates deficiencies such as:

- "Rules of thumb" being used in the risk identification process because of the lack of a literature-documented approach.
- The lack of a scheme compiling the different aspects that make a risk identification workshop successful from a creative point of view.
- The lack of a methodology where risks are treated as ideas and managed from a cognitive perspective.

1.2. Research objectives

The expected contribution of this thesis is to provide a structured approach for risk identification workshops using brainstorming techniques to their full potential by making use of the association of ideas and the benefits of maximum idea creation during a brainstorming session. For example, project managers brainstorming about what risks could affect the excavation of a

tunnel would have the opportunity (using this methodology) to be guided through steps that would allow them to cover every possible aspect of the tunnel construction that could carry a risk factor. The project managers would be guided through minimization (what if something is smaller than expected), magnification (what if something is larger than expected), and many other factors which are essential parts of a brainstorming session. In other words, the objectives of this research are:

- To provide a clear methodology for risk identification workshops that deals with the deficiencies on the use of brainstorming techniques in the construction industry. Additionally the use of the brainstorming technique will be further justify as a way to identify risk by mapping the risk identification process onto the human cognitive process.
- To create a brainstorming framework in order to provide a systematic way to use brainstorming techniques for risk identification purposes by following the defined sequence of the idea generation process.
- To create a standardized method to prepare, perform, and evaluate risk identification workshops, making it easier to maintain uniformity and consistency in an environment where each workshop is unique. This standardised method will be accompanied by a list of recommendations to use brainstorming for risk identification workshops.

As a summary, this research focuses on improving the way brainstorming is used in risk identification workshops performed in the construction industry in order to ultimately improve the risk identification and management process.

This improvement will be achieved by dealing with the weaknesses of the way the brainstorming technique is used in risk identification workshops. The advantages presented in this work are those derived from the further utilization of experts' imaginations for identifying risks, the exploitation of the association of ideas and the systematic use of expert knowledge during risk identification workshops.

1.3. Methodology of the Solution

A structured brainstorming methodology that offers project managers the opportunity to carry out risk identification workshops at the full potential of the brainstorming technique is developed in this thesis by performing a qualitative research on the literature available on risk identification workshops performed in the construction industry and on the literature related to brainstorming techniques on its whole nature. For the purpose of this research work solely literature review will be applied utilizing a modified approach of the knowledge mining technique of Palaneeswaran and Kumaraswamy (2003). The reason of using solely literature review is due to the fact that the essence of the brainstorming technique is captured on existing literature and that integration between the knowledge available and the actual application of the brainstorming technique for risk identification workshops is the problem being addressed on this research work. In other words, the nature of this research is theoretical (non experimental), however experimental work such as holding brainstorming sessions for analytical purposes is mentioned as a recommendation for future research under Section 6.3.

1.3.1. Literature Review Strategy

Palaneeswaran and Kumaraswamy (2003) describe Knowledge Mining as a tool not only to “extract... knowledge from explicit documented sources, but also to ‘unearth’ and refine experiential and expert knowledge.” As a concept, knowledge mining is defined as the competence to receive knowledge from sources as well as the ability to transfer that knowledge (You et al., 2006). A modified knowledge mining approach is used as a literature review strategy on this thesis because of the capabilities of the knowledge mining technique to transfer knowledge among disciplines. This information transference is expected to happen between the knowledge available on psychology and behavioural sciences about brainstorming and the construction management area that we are addressing (risk identification). Figure 1 depicts the modified process used on this Thesis.

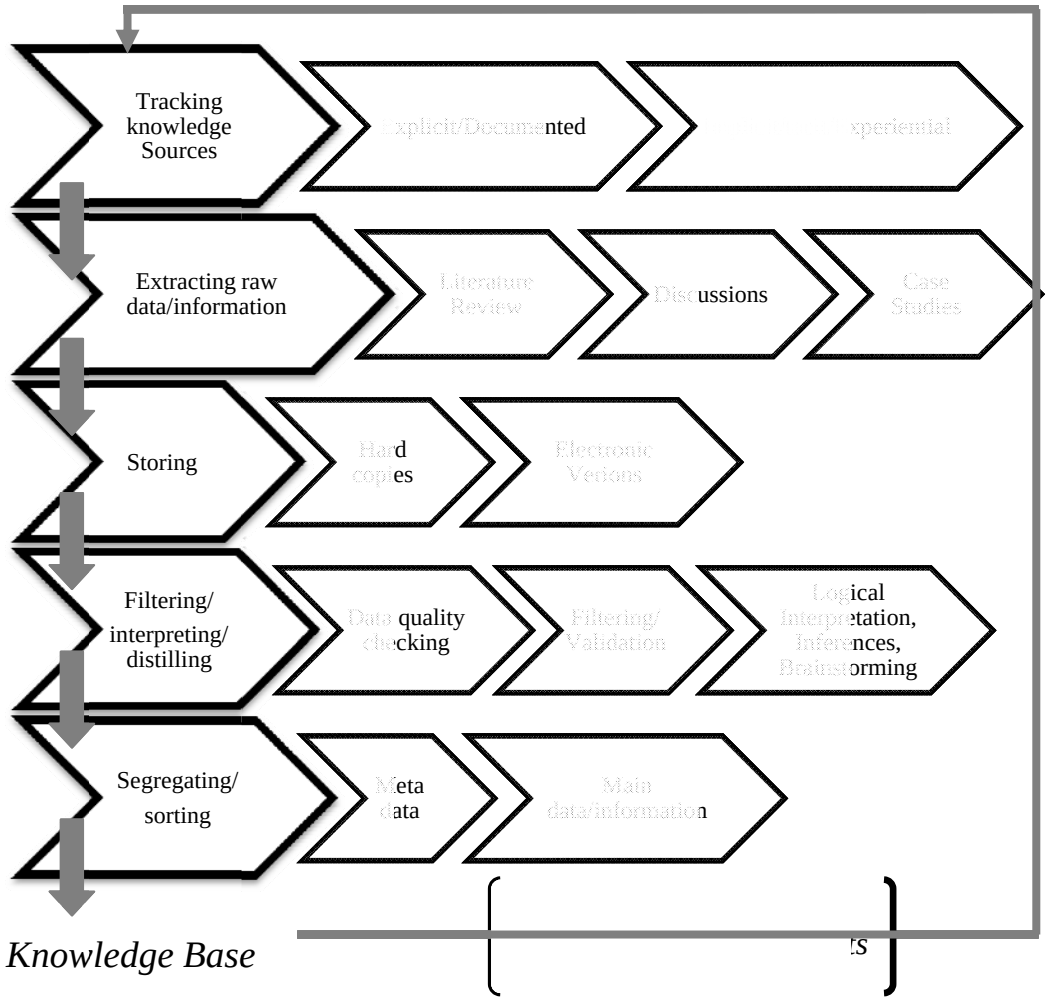

Figure 1: Knowledge Mining Framework used for the Enhanced Brainstorming Methodology for Risk Identification (Adapted from Palaneeswaran & Kumaraswamy (2003)).

1.3.2. Strategy to identify knowledge sources

Since the backbone of this enhanced methodology is the body of documents reviewed, it is important to define how those sources are selected. Traditional sources such as documents (journals, books and other documents), correspondence (letters and faxes), interviews, surveying methods and meetings and discussions were selected for this research because they have proven advantages such as availability, authenticity, reliability and ease of usage (Palaneeswaran & Kumaraswamy, 2003). The following source selection techniques were used:

- Searching the databases of the top 10 construction management journals as given by Wing (1997).
- Searching for sources related to Psychology and Behavioural Sciences using the ranking tool provided on the web site “Journal-Ranking.com” (Lim et al., 2007)
- Suggestions from colleagues.
- Catalogue review in databases and library visits.

1.4. Thesis Organization

This thesis is organized as follow:

Chapter 1: Introduction, objectives, research methodology, expected contributions and thesis organization.

Chapter 2: Literature review of brainstorming in construction related management research and alternative methods to the brainstorming technique.

Chapter 3: Literature Review on the Brainstorming technique from psychology and behavioural sciences.

Chapter 4: A revised risk identification process based on the thesis findings.

Chapter 5: Conclusion, highlighting contributions to the state of the art and recommendations for further research.

2. Literature review on brainstorming applications for risk identification

The literature in this first portion of this literature review comes from peer-reviewed journals of construction management as well as from alternative opinion-based research. The literature to be reviewed can be grouped into four categories: (1) evaluation of major risk identification techniques, (2) recommendations for brainstorming applications for risk identification in the construction industry, (3) explanations of other applications of the brainstorming technique in construction related areas, and (4) other techniques used for risk identification purposes. After reviewing the previous literature, the deficiencies reported for construction related brainstorming applications are reviewed; these provide the goals of this research work.

2.1. Evaluation of major risk identification techniques in the construction industry

Chapman (1998) provides an evaluation of three of the most used working group (workshop) techniques in the construction industry. He evaluates brainstorming, the Nominal Group and the Delphi technique against the framework provided by Handy (1981). Chapman's evaluation is based on the givens presented in the adaptation of the framework for working group effectiveness evaluation from Handy (1981).

According to Chapman (1998), the Nominal Group Technique requires much preparation; no changes are allowed during the meeting sessions, the participants need to behave in a predetermined way, and risks are "materialized" during the discussion of the information that comes up individually in the mind of the participants. The advantage reported is that members have the same chance of participation due to the individual collection of risks.

Chapman (1998) describes brainstorming as a technique very sensible to the characteristics of the participants (social needs, personalities, expertise, fears), the environment (ideas of the institution and status incongruities, "interpersonal underworlds," lack of personal appreciation of the problem), the existence of a group dynamic (manage disagreements, polarized discussions) and the characteristic of the group (size, existence of individual power); nevertheless the benefit of "social facilitation" is the prevailing advantage of this technique (the capability of triggering ideas from the ideas suggested by others).

Finally, Chapman (1998) describes the accuracy of the Delphi technique as depending on the clarity of the instructions and the usefulness of the documents presented to the participants. This technique could be affected by a lack of response or slow response rates, an unclear method of response to an anonymous author, and the lack of personal contact (it makes it less stimulating or attractive than the other techniques). Among the benefits of this method is the absence of the necessity of strong leadership and the opportunity

for the members to respond equally without inhibition due to their anonymity, even when their views contradict the organization's, as well as the benefit of a highly structured method.

2.2. Recommendations for brainstorming applications for risk identification in the construction industry

Establish the Classification Framework:

The methods used in the risk identification process are tools aimed at aiding the risk manager to identify risks of the project objectives. Mi and Nie (2008) argue that risk identification methods can be grouped into two main streams: analysis methods and expert survey methods. Figure 8 shows the most common known methods for each of these streams.

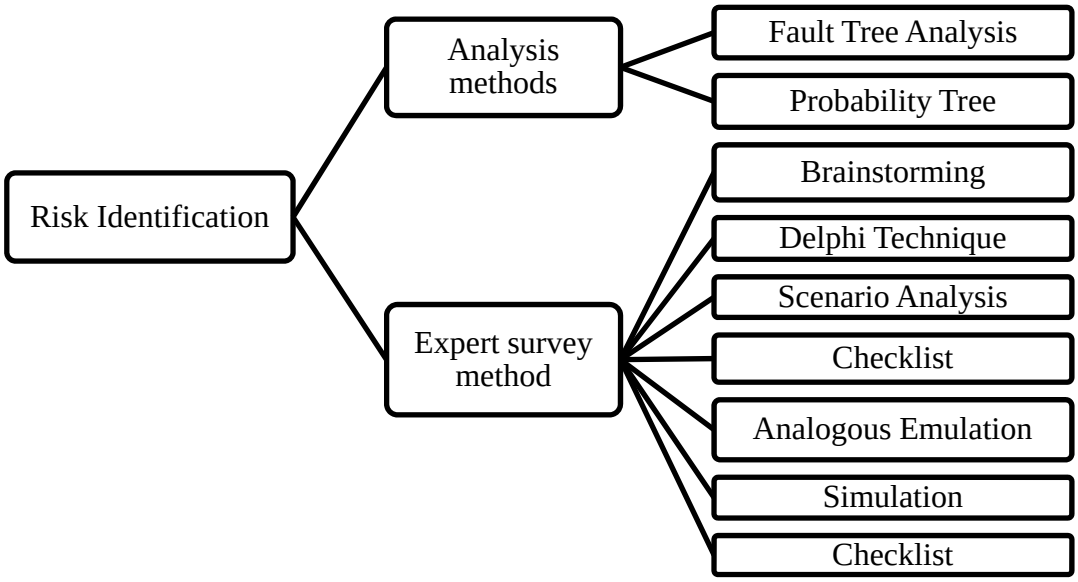

Figure 2: Risk Identification Methods according to Mi and Nie (2008)

Mi and Nie (2008) discuss the brainstorming procedure followed to identify risk in a “Procedure-Oriented Large-sized Mining Shaft Construction Project” by using brainstorming to confirm all the possible risk sources and the weights of risk assessment indicators. In this project, the brainstorming team was composed of the top managers of the company, the executive managers, experts of the field, and professors with related expertise to this specific construction activity. In addition, a face to face interview was performed between risk managers and the personnel related to the project in order to identify risks that are not easily identified. A semi-open questionnaire was used, as well as reference to checklists (Mi & Nie, 2008).

Mi and Nie (2008) recommend classifying and later identifying the risks factors as part of the risk identification process. This has the disadvantage of limiting the risk analyst’s understanding for a large number of risks, and making it easy to ignore risk factors that were not managed on previous projects. Similarly, it makes it harder to clearly communicate risk factors existing in different areas of the project at the same time (Mi & Nie, 2008).

Identify the Idea Triggers:

According to Mi and Nie (2008), “all risk factors may have different triggering sources and different severity of the consequences, there are lots of uncertainties in the successful implementation of the project.” Similarly, Perry (1986) comments that many different characteristics of the project can be the main causes of risk factors, such as the size, complexity, speed, and location of

the project, as well as the degree of familiarity of the owner and project manager with the project.

Mental position of avoiding overruns:

If a manager takes an “everything will be okay no matter what” position, many risks that could affect the project will not be identified. The manager should not have a defeatist attitude, but simply a position of avoiding overruns and ensuring that the project is one worthy of being done (Perry, 1986). Risk identification is not a pessimistic action; it is the task of foreseeing hindrances to the advancement of the project.

Use of Risk Breakdown Structure:

Chapman (2001) provides a wide acceptable Risk Breakdown Structure (RBS) in the “Project Risk Analysis & Management Process” (PRAM) by showing graphical subdivisions of the tasks needed in order to perform the risk analysis and management activities. In his risk breakdown structure, Chapman (2001) presents the risk analysis process as two sub-stages, confirmed by a qualitative and quantitative analysis.

2.3. Other techniques for risk identification

Many other techniques are used to identify risks besides brainstorming. These techniques differ from brainstorming in the nature of their application as well as in the final output.

2.3.1. Combinations of techniques

Risk identification can be accomplished via a combination of various techniques following a specific procedure. Among these techniques Barati and Mohammadi (2008) mention:

- Documentation review (analyzing the assumptions made in the project as well as all relevant documents, such as plans, that could lead to potential risks),
- Information gathering techniques (brainstorming, Delphi technique, interviewing, root case identification of previous risk events, SWOT – Strength, Weakness, Opportunities, and Threats analysis, and surveys),
- Checklist analysis from previous projects,
- Assumption analysis (identify risk from the failure of presented hypothesis),
- Diagramming Techniques (make possible to identify unveiled risks not possible to discover through verbal communication, among them: cause effect/fish bone diagrams, system or process flow charts, influence diagrams),
- Cross functional team,
- Join Application Development (JAD),
- Force field analysis (from strategic decision making), and
- Nominal group technique (aggregation of group judgement).

2.3.2. Checklists and HAZOP techniques

According to AbouRizk (2009) checklists are defined as lists aimed to aid the risk identifiers by reminding them of risks from other projects that could apply to the current one. The main function of the checklist is to trigger ideas which germinate potential risks relevant to the project on hand.

The Hazard and Operability procedure consists of developing a good understanding of the project (by reviewing project documentation), identifying a relevant set of nodes that will be analyzed, defining the design intent of that node, listing all logical derivations arising from systematically composing the primary and secondary key words for each node: primary words (the node) and secondary words incorporating the derivation (i.e., no, more, less, as well as, part of, reverse, other than). Once the derivations are completed the causes, consequences, and safeguards of each derivation are analyzed and recommendations and the responsibility to prevent its occurrence are given (AbouRizk, 2009).

2.3.3. Use of Cognitive Mapping and Active Information Search for Identifying Risks

Maytorena et al. (2007) define cognitive mapping as a tool used to analyze how decision makers reach a specific decision in a cluttered or difficult decision processes. Cognitive mapping can explore how individuals make sense of their experience to take a decision. The map has concepts and links, representing the nature of a problem.

According to Maytorena et al. (2007) in risk identification working with judgement under uncertainty is a fact, which can be dealt with by two different approaches (Maytorena et al., 2007):

- The prospect theory, in which a decision maker rationally evaluates alternatives against a final asset before taking a course of action. The problem with this approach is that it supposes rationality in the person who is making the decision at a certain point. The decision maker is full of biases and flawed points of view that could alter the decision being taken.
- Active information search (AIS) is an approach more close to reality where the decision maker needs to figure out the nature of the problem and assign pertinent weight to the data used for the decision to be made. This approach is highly recommended in risk identification problems due to the natural approach to modeling the decision maker's attitude in facing a problem in a given time.

The study performed by Maytorena et al. (2007) consists of a static analysis of the results from an active information search research project carried out in the United Kingdom with practicing managers. The active information search was carried out as an interview scheme consisting of an introduction and warm-up phase, an AIS exercise, a summary and a questionnaire. Afterwards the data was analyzed through data mapping (using cognitive mapping software Decision Explorer^{TM}) for a graphical representation of the data, data coding and statistical analysis.

Although the fundamental principle for successful risk management has been highlighted as the understanding of the project, how it is developed and the understanding of the sources of risks (everything relying upon the experience of the identifiers as the key of success), Maytorena et al. (2007) argue that to considered the experience of the identifiers as the key is an untested premise. Two hypotheses were tested: first, that there was "no association between a project manager's years of experience and their level of project risk identification performance"; second, that there was "no difference in the styles of information search used by project managers and their level of risk identification performance."

As a result of their experiment Maytorena et al. (2007) found that experience is not an indicator of a higher risk identification performance (a measurement of the average of the level of impact of the risk identified by the expert multiplied by the number of risks identified). However, the information acquisition style of the risk identifiers plays a great role in terms of risk identification performance. Finally, they concluded that risk identification performance is affected by the educational level, the use of feedback style and the existence of risk management training.

2.3.4. A tool relating the risks to the project attributes

Nelms et al. (2006) provide a risk management tool and test its effectiveness in a major building project. The need for a structured approach to risk identification and management at the time of providing a list of risk events and their properties over the life cycle of a project is explained.

According to Nelms et al. (2006), approaches using spreadsheet-based risk registers assist in risk management tasks, but do not relate the risks to the project attributes. Moreover, this type of application is defined as not dynamic and does not allow the user to update the information as the project progress. Another disadvantage to the use of paper-based, spreadsheet or database registers is the inability to update the register due to changes in the project scope. To keep an accurate and up-to-date risk register using this type of approach needs the constant intervention of the user of the system in order to make it accurate. An additional problem is the difficulty of navigation through the registry.

Nelms et al. (2006) present a way to address risk management in complex capital facilities projects with many interrelated dimensions. Among the advantages of using their approach Nelms et al. (2006) listed:

- Provides a standardized platform for risk terminology, reducing misinterpretation in the risk management process.
- Expresses the risk events as risk issues, which is easier to understand for stakeholders reading the risk registry.
- Allows tracking of changes in sources of the risks.
- Documents the assumptions and the causes of the risks.
- Allows sources of information to be cited, making useful references available to the risk managers.
- Documents assumptions, allowing the manager to check, update or even eliminate the assumptions made.

- Categorizes risks, making it possible for the risk manager to focus on, and to find specific mitigation options for, a specific type of risk.
- Associates risk factors with the time of the activity where they may or may not occur.
- Associates risk factors with the spatial location where they may or may not occur.
- Provides a master risk register for creating the actual risk register of the project. The user could modify the existing one or develop a new one in combination with the master risk register template.
- Provides customized reports collecting information from the physical and time dimensions at a user-defined level of detail.
- Integrates risk events with the environmental, physical, process and organizational or contractual dimensions of the project.

2.4. Deficiencies of brainstorming applications for construction-related risk identification

Problems reported in the area of construction related brainstorming techniques include the need to incorporate the full potential of the technique as described in the psychology literature, demonstrated by the lack of criteria selection and direction in problem solving, as well as an incomplete informational framework.

2.4.1. Need to incorporate the full potential of the brainstorming technique

The risk identification techniques currently used in the construction management field have a common origin. Most of the identification techniques originated in the fields of social psychology and the behavioural sciences; for example, the Nominal Group technique. Having said this, there is a need to incorporate creativity in the risk management process. Much classic literature in risk management suggests that risk management "should be viewed creatively and not be tied down to a set of rules" (Perry, 1986).

Problems reported in the area of brainstorming involve the selection of the experts participating in the workshops, how many of them should be involved in the process, how often they should be brought together during the project, the implications of this kind of thinking group, and the tendency to produce low impact risk by certain risk identifiers (Maytorena et al., 2007).

2.4.2. Incomplete informational framework

One of the current research challenges is drawing out information from project stakeholders to model project risks (Nelms et al. 2006). According to Al-Bahar and Crandall (1990) the available data in construction projects is "mainly subjective in nature and must be obtained through careful questioning of experts or persons with the relevant knowledge."

2.4.3. Lack of direction in problem solving

According to Mao et al. (2009) “one shortcoming of the brainstorming technique is the lack of direction in problem solving, and consequently the efficiency is low in generating innovative and useful ideas.”

In a similar way, Fan et al. (2007) enumerates the difficulties faced by current approaches for idea generation during Value Engineering workshops. Among them: shyness of public speaking, pressure to conform to the general idea presented, domination by a few individuals, idea blocking, and laziness of some members, relying on the provision of ideas by other members.

2.4.4. Analysis of the deficiencies reported from the state of the art

The deficiencies described in the literature are associated with four different elements of the brainstorming technique as it is currently applied: (1) the brainstorming workshop itself, (2) the participants, (3) the leader of the brainstorming session, and (4) the output of the brainstorming session.

Deficiencies related to the workshop:

These include problems related to the dynamic of the workshop as well as problems related to the workshop as a temporary organization of individuals following a set of rules in a given environment.

1. Is risk identification an idea generation process?
2. What findings on the idea generation process in the psychology literature could be applied to construction industry workshops?

3. Which principles govern the idea generation process that should be considered in the risk identification process?
4. What rules or boundaries are to be set in the risk identification process as an idea generation exercise?
5. Should specific brainstorming techniques be used for different ideation conditions?
6. Could different brainstorming techniques be combined to get the most from the different techniques?
7. If so, in what order should they be combined?
8. What are the most suitable places and times to perform risk identification workshops from an idea generation point of view?

Deficiencies related to the participants:

These are problems related to the attitude, number, capability, experience, motivation, needs, training and education of the participants.

1. How can affecting factors (diversity, education) of the participants be controlled or managed?
2. How can inhibitions provoked by emotional blocks be managed?
3. How can the participation of all members be regulated, regardless of their experience, while still providing the benefits of group cohesion?
4. How can the social categorization of the participants be prevented?
5. How can the participants be trained to participate in an idea generation process for risk identification purposes?

6. What can be done to motivate participants to express their ideas, even if they are contrary to the ideas of the organization?
7. How can we be assured that the participants are not looking for the acceptance or validation of others?
8. How can every participant understand the nature of the task?
9. How can the participants be persuaded of the importance of the ideation task?
10. If there is idea production outside the workshop, how can this idea generation be promoted among the participants?
11. How can the proper risk identification team be selected in order to avoid unidentified risks?
12. How can members be convinced of their specific importance in the idea generation process besides other participant's contributions?
13. How can the dominance of specific individuals be prevented?
14. How can the project participants be encouraged to generate a risk register, taking into account the limitations of risk registers of previous projects?
15. What is the best number of participants for the workshop and how often should the participants be rotated?

Deficiencies related to the leader:

These are problems related to the professional, psychological and managerial profile of the leader of the workshop, as well as the training and preparation of the leader for the workshop.

1. How can a leader be trained for idea generation purposes?
2. What tools can the leader use to start and further develop the ideation process?
3. How can the existence of a leader with a hidden agenda be prevented?
4. How can we ensure that the leader is not seeking to satisfy a social need with the workshop?
5. How can the quality (structure, suitability) of the material prepared by the leader for risk identification workshops be evaluated?
6. How can a workshop leader have the correct leader's profile, to provide strong leadership and powerful direction during the workshop?
7. What should a leader consider before running a workshop?
8. What can the leader do to reactivate idea production in the workshop?
9. What feedback method should the leader of the workshop use to ensure individual contribution?
10. How can the leader provide the proper environment and motivation?

Deficiencies related to the output:

These are problems related to the lack of methodology for assessing the usefulness of the output in quantitative as well as qualitative terms, as well as for post-workshop analysis of ideas.

1. What method can be used to "debug" the ideas generated and to categorize them as risk factors?
2. After the workshop, what procedure can be used to produce the final outcome of the workshop?

3. Which criteria should be used to select the relevant ideas?

3. Literature review on the brainstorming technique from psychology and behavioural sciences

For this second portion of literature review the focus will be on reviewing the literature on psychology and behavioural sciences, with a particular focus on correcting the deficiencies mentioned in Chapter 2. Construction-related ramifications of the literature will also be explored.

3.1. Literature review related to the workshop

3.1.1. Following the creative problem solving process:

According to Osborn (1953), the inventor of brainstorming, the creative problem-solving process is a three-step process composed of:

1. Fact finding: problem definition and preparation.

2. Idea finding: idea production (tentative ideas as idea leads) and development (selection of most likely ideas; also includes combining, modifying and adding selected ideas).

3. Solution finding: evaluating (verifying the solution) and adopting (deciding and implementing final solution).

The fact finding process itself is composed of four steps shown in Figure 3

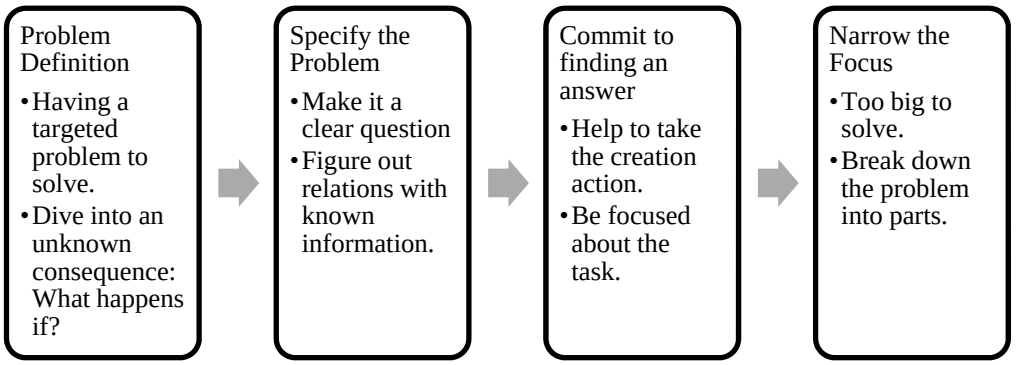

Figure 3: Fact Finding Process for Idea Generation

3.1.2. Making the brainstorming topic specific

Osborn (1953) recommends the brainstorming topic be specific rather than general. The leader of the brainstorming session deals with making the topic specific for the workshop. This enables the participants to attack a single element at a time. This technique is suitable just for problems considered to be merely solved by finding ideas. Problems that could be solved by choosing between a few alternatives (three or two alternatives) are not recommended to be solved using brainstorming exercises, and neither are problems requiring analytical judgement (pros and cons lists) (Osborn, 1953).

3.1.3. Making the principles clear and understandable

There are two basic principles of the brainstorming technique:

1. Deferment of judgement: Even when an idea does not seem useful it could be important because of the ideas that could be produced from it. Deferment of judgement used in individual ideation is reported to increase the number of good ideas generated by individuals by 90%;

when used in group brainstorming, an increase of 70% was reported compared to the individual ideation technique without deferment of judgement (Osborn, 1953).

2. Quantity breeds quality: Better ideas are reported to be produced in the second half of a brainstorming session. The concept that quantity breeds quality is important for idea generation and needs to be embraced in every brainstorming exercise (Osborn, 1953).

3.1.4. Establishing boundaries for the brainstorming session:

When approaching creative problems, imagination should always be given priority. Judgement should be reserved until all possible ideas have been expressed, and no merit should be given to any idea until the final selection of ideas takes place (Osborn, 1953).

A brainstorming session is a session conceived for individuals to be able to produce ideas in a free way without an inhibiting atmosphere. The underlying principle for brainstorming is the separation of the “ideation” thinking from the “critical” thinking. Free thinking can produce ideas that would never be produced in a constraining environment (Osborn, 1953).

The following rules should therefore be present in the brainstorming session and followed carefully:

- No criticism
- Acceptance of all kind of ideas related to the topic
- As many ideas as possible

- Improve, combine and mix ideas

3.1.5. Selecting the main brainstorming method to use during the workshop

Recommendations about which technique to use during specific environment and conditions are found in the literature and summarized here to provide risk managers (or whoever is in charge of the risk management process) with a framework to select the technique which will dominate the risk identification workshop.

Selecting Brainwriting:

Brainwriting is recommended when heterogonous participants with differing knowledge are part of the workshop. VanGundy (1984) states that brainstorming faces problems such as the necessity of a skilled leader, disruption provoked by problems among the participants, and the dominance of the group by isolated individuals, and concludes that brainstorming and brainwriting are supplemental techniques and should be applied depending on their suitability for an occasion.

In Heslin's (2009) approach brainwriting is considered more suitable for:

1. Persons with a previous bad experience in brainstorming sessions. Persons with a previous bad experience in brainstorming sessions tend to present a favourable attitude towards brainwriting. On the other hand, persons with good experiences in group brainstorming may feel constrained by the rules of brainwriting.

2. Persons with a "need for achievement." Persons with a need for achievement tend to prefer activities where they receive direct feedback about their achievements as happens with brainwriting

Heslin (2009) also explain that brainwriting is suitable when the resources (time, furniture) are available for brainwriting. The question of if consensus is necessary should be also considered.

Brainwriting's successful adoption depends on the culture of the organization, which must be identified to recognize if brainwriting is suitable for the organization (i.e., a collectivist culture avoids disruption of group harmony). Since brainwriting deals with anonymous contribution, there is another important question to consider: does the organization accept anonymous contributions more favourably than identifiable contributions (Heslin, 2009)?

As a summary, Table 5 shows the contextual boundary conditions for the use of brainwriting within organizations presented by Heslin (2009).

Table 1: Sample contextual boundary conditions for the use of brainwriting within organizations (adapted from Heslin, 2009)

Contextual Factors	**Illustrative potential moderators**
What does brainwriting yield?	• Criteria of "useful" ideas • Who evaluates usefulness • Group cohesion • Perceived usefulness and enjoyment
For whom is brainwriting suitable?	• Psychological reactance • Need for achievement and closure • Openness to experience • Social evaluation anxiety/neuroticism

	• Diversity of group composition • Group processes
When is brainwriting suitable?	• Time available • Importance of high-quality ideas • Uniqueness of participants' expertise • Innovation acceptance needed • Social interaction need satisfaction
Where is brainwriting likely to be successfully adopted?	• National culture of power distance and collectivism.
Why conduct brainwriting?	• Need for highly creative ideas • Importance of ancillary benefits, such as creating a 'status auction', building organizational wisdom, and impressing clients.

Selecting Electronic Brainstorming:

Electronic brainstorming is reported to reduce the traffic jams produced in group brainstorming, but problems do arise, such as: no assurance that the individuals are reading others' ideas, an overwhelming number of ideas, and the need for time after the session for individuals to be able to fully assimilate thoughts (Pinsonneault et al., 1999).

There is little evidence that electronic brainstorming is superior to both nominal and face to face brainstorming (Pinsonneault et al., 1999). Nominal groups are considered superior to electronic brainstorming as a result of comparing the process gain versus the process losses of both approaches. In Pinsonneault et al.'s research (1999), nominal brainstorming (individuals working alone) outperformed many different types of brainstorming processes (nominal, electronic – anonymous, electronic – non anonymous, and verbal).

Recommending individual brainstorming (nominal group technique):

Osborn (1953) states that the power of idea creation in individual is still necessary, despite the advance of collaborative idea creation. Brown and Paulus (2002) describe the benefits of writing as a mean of exchanging ideas and using both group and individual ideation (alternating between both techniques) as enhancers of group brainstorming.

Selecting group brainstorming:

Brainstorming means “using the brain to storm a problem” and it is defined as “nothing more than a creative conference for the sole purpose of producing a checklist of ideas” (Osborn, 1953). The benefit of brainstorming lies in producing more ideas in less time, compared to a normal conference. However, individuals with dispositional anxiety performed poorly when brainstorming in groups, but not during solitary brainstorming (Camacho & Paulus, 1995).

According to Kramer et al. (2001), although nominal groups have been found to produce more ideas than group brainstorming, the experimental design of those studies was questionable. Laboratory groups, artificial brainstorming situations as the subject of the work, no training and littler structure, are the main hindrances of the experiments showing the superiority of nominal groups over brainstorming. These experimental settings are considered too distant from real idea-generation settings.

In two experiments Kramer et al. (2001) demonstrate that with the provision of a trained facilitator as many ideas can be produced with face-to-face brainstorming as in the nominal group technique. The facilitator maintains the structure of the session and brings energy and enthusiasm to it. Facilitators were reported to be focused on following the rules, diminishing idea blockers, and promoting the generation of ideas while time was left. Motivational facilitators added to their role encouragement of participants and brought energy to the group.

Brown and Paulus (2002) state that creative groups need people with different sets of skills. The question of how groups could overcome the "inevitable liabilities" of group interaction to reach their creative potential is the main concern related to cognitive potential of brainstorming groups. In other words, the main benefit for group brainstorming is that "[p]eople believe that they come up with ideas in a group that they would not have thought of on their own. The potential for mutual stimulation of ideas is one of the reasons for the popularity of group brainstorming" (Brown & Paulus, 2002). Brown and Paulus also state as a useful approach enhancing group brainstorming to have a heterogeneous group.

A lack of internal and external validity is reported from the experiments condemning group brainstorming. Kramer et al. (2001) recommends researchers focus on improving face-to-face brainstorming for additional benefits. They describe the benefits related to group brainstorming as:

- Chain reaction by idea association: The outcome of this chain is ideas produced from ideas of other members of the brainstorming session.
- Social facilitation: more creative imagination was reported in individuals participating in groups than working alone as individuals.
- Competition: competition plays an important role because it increases the level of effort that the participants may be putting toward idea generation.
- Corroboration: psychological reinforcement consisting of receiving suggestions with an open and approving mind. Deferring judgement is seen as positive reinforcement.

3.1.6. Supplementing idea generation methods

"[T]he fact is that group brainstorming is recommended solely as a supplement to individual ideation" (Osborn, 1953). Individuals can brainstorm alone by personally "eliminating the external and internal standard of judgement, evaluation, and the proper use of checklist." Osborn (1953) reports that some people need group brainstorming to bring them to the point where they can produce a list of ideas, but others do not, although their participation may be helpful.

3.1.7. Establishing a sequence for the techniques selected

Since more than one technique is recommended for highly effective brainstorming exercises, a sequence for the techniques to be utilized needs to be determined. Brown and Paulus (2002) recommend using group

brainstorming before individual brainstorming, based on preliminary data from their experiments.

3.1.8. Promoting “afterthoughts” sessions

Some managers find it valuable to ask the participants of the workshop to keep the problem in their mind and to report any valuable ideas the day after the workshop (Osborn, 1953).

3.1.9. Managing the effort factor in the brainstorming session: the driving force of creativity

Rather than native talent, the effort factor is the driving force of creativity and the factor that varies the most from individual to individual. Effort is responsible for encouraging individuals to produce worthy ideas in times of war and necessity (Osborn, 1953).

3.1.10. Placing the workshop in the right place

The environment plays a very important role in idea generation. Because most individuals do not use imagination in their day-to-day lives, the use of imagination is seen as unusual. Modern life encourages quick solutions, not creativity. Because of this, creating an imaginative environment can be a real challenge.

Although creativity is actually needed for many different tasks in modern society, it seems to be considered as an ability only needed for art or perhaps science. A tendency towards criticism is also present in many societies, cramping creativity (Osborn, 1953).

3.1.11. Places for creative thinking

Osborn (1953) describes office places as inconvenient for brainstorming sessions. Working places usually promote judgemental behaviour; brainstorming must be done in places with no distractions and it is helpful if the location is a place not related to judgemental activities for any of the participants.

3.1.12. Timing the brainstorming exercise

The creator of the brainstorming procedure advocates 30 minutes as the duration of a brainstorming session, but reports many efficient teams brainstorming for 15 minutes, while others brainstorm until no more ideas are found. At most, 45 minutes is recommended. If it takes more time than this, the problem should be broken into smaller sections. If more than 45 minutes are needed, it is probably because the problem is too broad and only superficial ideas have been discussed (Osborn, 1953).

Osborn (1953) reported that some of the best sessions have been a “sandwich-luncheon” in the office. After sharing enjoyable food and setting the rules, the problem should be assigned and then the idea flow starts as they are recorded in some way. After the ideas are recorded, then the processing of ideas takes place.

3.1.13. Controlling the affecting factors through member participation

To increase the number and the quality of ideas in risk identification workshops, two factors should be controlled from an idea generation perspective: the diversity factor and the educational factor.

The diversity factor:

Faultlines are used for studying how diversity can affect the creativity of groups. In faultline theory, a faultline occurs when groups are divided into subgroups because of differences perceived by the members of the group among themselves. Subgroups are formed because of the tendency of alignment towards persons with similar attributes (Pearsall et al., 2008).This alignment affects the group by hindering the communication coordination, cohesion and trust of the group.

The educational factor:

Osborn states that “according to scientific tests for creative aptitude, there is little or no difference between college or non-college people of like ages” (Osborn, 1953). Therefore, to be more educated does not mean to be more innately creative. However, persons with graduate degrees related to the risk management disciplines tend to produce more ideas than those without this type of training (Maytorena et al., 2007). Although great ideas can certainly come from people outside a discipline, there is something to be said for knowing the environment in which a solution is needed. In other words, knowledge is not required to be creative, but in risk identification, awareness of the environment is useful.

3.2. Literature review related to the participants

3.2.1. Blocking the inhibitors

According to Osborn (1953), the two main problems to deal with regarding the participants of a brainstorming session are:

- Frustration: the factors that can induce frustration must be prevented, and self confidence induced instead.
- Functional fixation: is defined as the fixation of individuals on their functions (regular working tasks which are judgmental rather than creative) limiting them from fully engaging creative thinking. If followed faithfully, the “no judgement” and “acceptance” rules of the brainstorming session will triumph over this rigidity inducer called functional fixation.

In a similar manner Osborn (1953) states that common emotional blocks in the brainstorming technique are:

- The problem of self-discouragement.
- Conventionalism: fear of looking foolish to others.
- Timidity: sometimes reported as a hidden pride or the doubt of one’s creativity.
- Discouragement/self-discouragement.

3.2.2. Promoting participation through group cohesion

According to Pearsall et al. (2008), similarity-alignment prevention strategies need to be present among the participants as a strategy to avoid faultlines that could arise during the workshop. Pearsall et al. (2008) state: “Faultlines can arise from differences across a number of dimensions.”

Weaker faultlines have been found to be related to a higher group performance and behavioural integration. Weaker faultlines could be created by creating cross-cutting dimensions of diversity. Faultline activation is defined as the process of initiating social categorization; if the brainstorming group identifies as a subgroup, that defines the group and gives identity to the participants, but faultlines inside the group should be avoided to prevent fragmentation of the group (Pearsall et al., 2008).

3.2.3. Managing faultline triggers

The nature of the task will dictate the noticeability or salience of the faultline (Pearsall et al., 2008). Pearsall et al. (2008) relate the salience of social categories to the comparative fit, the normative fit, and the ease of access of the categorization to individuals (cognitive accessibility). The comparative fit is the level of individual difference (because of any categorization), the normative fit is the importance of this categorization for the individuals, and the cognitive accessibility describes how easily the members can realize this difference among the group (Pearsall et al., 2008).

3.2.4. Preparing participants through creative training

Osborn (1953) suggests training techniques that can be used to foster creativity in the participants of the workshop. Among them:

Reading as a source of imagination:

Reading provides opportunity for using the imagination. The results of reading could be either informational or enlightening depending on how much reading can foster the creative imagination.

Avoiding the sponge attitude:

Not functioning as a sponge while reading or doing any other type of creative work is crucial for exercising creative minds. Accordingly, for risk identification purposes there should be an emphasis not on just listening but on creating ideas in response to other ideas.

3.2.5. Convincing the participants to give their best

Effort

Creative thinking is a task requiring effort from the participants of a brainstorming session; ideas do not come easily (Osborn, 1953).

Concentration

Vividly defining goals can help participants to concentrate. Osborn (1953) explains “Whether self generated or not, an intense interest is needed fully to command the services of our imaginations.” Osborn (1953) adds “If we concentrate hard enough and persistently enough, the problem in hand can be

cogitated regardless of distraction." Osborn (1953) reported that thinking purposefully about something was a productive task from a creative point of view. Concentration allows lengthier imaginative production; it is this longer time that produces better ideas as part of a continuous effort (Osborn, 1953).

3.2.6. Allowing Incubation of ideas

The time between "divulging the problem" and the "decrease in rigidity in the solution effort" is important (Osborn, 1953). This span of time is called idea incubation; the main value of the process of incubation is called illumination, the arrival of "sudden" and "unpredicted" insights into a problem. Psychologists have ascribed this state of unconscious thinking to the work of the sub-conscious (Osborn, 1953).

A very useful explanation about illumination is that provided by Dr. Elliott Dunlap (cited by Osborn, 1953) describing the illumination as the recurring culmination and release of the tension produced by knowledge and clues over time. This inner tension is described as an unconscious effort to solve the problem (Osborn, 1953). Osborn (1953) also states that passive ways to induce illumination are reported as times where more thought on a problem is required to find a solution.

3.2.7. Making the creative time span longer

Beginning creativity tasks sooner allows for the maximum advantage of illumination, and can further reduce the functional fixation problems reported to hinder creativity (Osborn, 1953). Osborn (1953) also recommends that

during the period of incubation participants enjoy mental relaxation; tasks such as intense research are not recommended.

3.2.8. Output of illumination

Since illumination is a sudden occurrence of an idea, the idea should be written down immediately. Exposure to opportunities through perseverance and observation during incubation periods results in ideas that would otherwise not exist (Osborn, 1953). Mental freedom, without negative, threatening emotions, is also required to induce creativity and allow ideas to flow freely (Osborn, 1953).

3.2.9. Rotating the Participants

Choi and Thompson (2005) compared the ideas generated, as well as the variety of ideas, between open groups and closed groups. Open groups were defined as groups where the participants were rotated (changed) during a number of experiments, while closed groups were groups where the participants were the same all across the experiments. They found that open groups generate more ideas as well as more different ideas than closed groups.

"Newcomers" were also found to have a positive impact, showing a higher productivity. The creativity of the previous members of the open group was enhanced by introducing new, highly creative members into the group. This effect was related to the social interaction with the newcomers, demonstrating that the quality of the newcomer was a crucial part of the group success. However, Choi and Thompson (2005) caution that the newcomer was

permanently moved to the group and possessed a level of experience similar to the continuing members. Also, no distinction of the newcomer (as a person coming from other group) was made.

This study just dealt with short term interactions (10 weeks), and there is therefore no support for the existence of “long lasting positive impact.” While rotating participants, other aspects such as the characteristics of the group, the people involved in it, and the nature of the change (when, how often, as well as the group expectations) must also be considered (Choi & Thompson, 2005).

3.3. Literature review related to the leader:

3.3.1. Training the leader

Cognitive modeling with practice and reinforcement has been found to generate a higher self-efficacy than methods involving lecture and practice alone (Gist 1989). The number and variety of ideas was found to be higher in modeling training than in lecture and practice alone.

3.3.2. Starting the Ideation Process

Osborn (1953) states that starting the ideation process in a brainstorming session is one of the biggest problems when talking about idea creation. The generation of ideas must be fuelled by using different techniques, as follows:

3.3.3. Fuelling the generation of ideas

To perform creative tasks, a person should have creative experience and material from which to form ideas should be present in the mind. Experience is the mind's fuel for new ideas (Osborn, 1953). Osborn (1953) describes the experience possessed by the participant as "the very richest fuel" for creativity because of the ability of human beings to remember previous occurrences for generating ideas.

3.3.4. Establish a quota of ideas

Establishing a set number of ideas as the goal and giving a deadline provides motivation; participants put extra effort into brainstorming. In other words, self-commitment can empower idea creation. Osborn (1953) shares that a fixed

deadline will "'intensify' the emotional power by exposition to the fear of falling down."

3.3.5. Setting values of ideas

Osborn (1953) suggests valuing ideas in an increasing order. In this order, the later ideas in a brainstorming session would be the more valuable ideas of the session.

3.3.6. Setting the number of the participants

Osborn (1953) recommends having an odd number of participants to ensure a majority.

3.3.7. Reactivating the idea generation

Different methods can be used by the leader to reactivate idea production in the brainstorming session. Osborn (1953) recommends the following methods:

Gordon Method (William J. J. Gordon):

This method discusses all the aspects of the problem being solved in the brainstorming session. For example, if the transportation problem between two communities is the subject, first, all possible methods of transport should be discussed.

Attribute Listing (Professor Robert P. Crawford):

In this method the different aspects of the ideation object are described. Then, after listing the attributes, brainstorming takes place upon them. This is a very object oriented method where all aspects of an object can be seen and

brainstorming takes place upon the different parts of the object in a search for improvements.

Forced relationships (Charles S. Whiting):

This method looks for relationships between objects in order to produce new ideas or objects related to the previous analyzed. This method is also used with ideas, rather than just objects.

Morphological Analysis (Dr. Fritz Zwicky and Dr. Myron S. Allen):

This method is a combination of the attribute listing and the forced relationship method. It consists of thinking of ideas related to different areas of the project and then creating combinations between each aspect analyzed. With a number of ideas under each category, ideas can then be combined, elevating exponentially the number of ideas that could be created in the brainstorming process.

3.3.8. Searching for more/latest ideas

The leader of the workshop is responsible for extracting more ideas from the participants; in order to do this the leader can make use of the law of similarity and the law of contrast, as follows (Osborn 1953):

The Law of Similarity: A search for parallels

- Adaptation: Osborn (1953) explains how adaptation works in the creativity aspect of idea creation. When adapting, thinkers should look for answers to question such as: “What ideas does it suggest?,” “What is like this?,” “Do past offers parallel this?” In other words,

adaptation is questioning and applying the laws of similarity to direct one's imagination toward a new idea from a previous one.

- Modification: Modification deals with how something can become better through modification.
- Substitution: Substituting elements in ideas is a very good way to have new ideas from previous ones. Osborn, (1953) defines the substitution process as "a trial-and-error method which all of us can use in our everyday creativity." Questions such as "what other?," "who else?," and "where else?" can provide insights.
- The magnification categories: Magnification is mentioned by Osborn (1953) and it deals with questions such as: "What to add?," "Should it be stronger?," "Should it be bigger?," "What extra value?" Magnification categories are not built just in terms of size but also in terms of quantities, time, frequency, strength, components, features, and relations. In short, magnification is related to maximization.
- Maximization asks for increasing the amount of a feature to an exponential degree. The realm of exaggeration can provide insight into reality.
- Multiplication asks questions regarding what would happen if something is doubled, tripled, or multiplied by any factor in particular.

- The minimisation category: Minimisation is the opposite of magnification (Osborn, 1953). Questions like: "What would happen if something is smaller?," "What would happen if the amount is less?" are asked. Minimisation is also a creative feature when questions are asked about reducing attributes of the object. Minimizing attributes such as quantity, time, frequency, strength, components, and features is also a very good exercise to create more ideas from previous ones. Great advances have been made as a result of attempts to reduce aspects such as weight in engineering application fields.
- Omitting: Omitting or cutting off parts of products or projects can be translated into great savings; problems should also be identified that could occur because of omitting certain considerations. Eliminating objectionable features is another way to improve products.
- Subdivision: Some topics can be far too broad. In this case subdividing the topic can make the participants more productive and focused on the subtopic at hand.

The Law of Contrast:

- Rearrangement: Rearrangement calls for a change in order. Asking about the consequences if the order or arrangement of particular things is changed can bring new ideas to a brainstorming session.

Rearrangement of working schedules has demonstrated a creative way to improve productivity by inducing changes.

- Sequences: Sequence changes create new ideas from old ones. What happens if the sequence is changed? If this occurs before that? Along with the sequence technique, situations such as the cause and effect question, and the vice-versa or the opposite question can be very useful.
- The unexpected: Discussing the unexpected can help to foster creativity. Asking “What could surprise us?” can bring illuminating answers; asking “Why not?” can bring new pattern of ideations (Osborn, 1953).
- Combinations: A certain number of ideas can be combined, producing a larger number of ideas, which increases the probability of finding an answer for the ideation problem (Osborn, 1953).

3.3.9. Giving feedback to participants

Graham’s study on the effects on brainstorming performance of simulated biofeedback and monitoring (1977) provides evidence that incorporating physiological monitoring and simulated biofeedback conditions in the brainstorming exercise causes the participants to produce fewer ideas. However, human monitoring (interaction between a supervisor/facilitator and a person brainstorming on a specific topic) produces a larger number of ideas. Feedback conditions represent a condition where the participants had a reaction when idea production was not taking place. This feedback condition

and the human monitoring (both combined) produced the highest number of ideas generated.

3.3.10. Providing the Proper Environment

VanGundy (1984), discussing how to establish a creative climate in the work group, argues that the creativity in a group cannot be established in the same way as other working parameters in the organization. Ordering people to be more creative does not work; a development process by which the organization creates growth in its creativity potential is a must. This development process consists of providing the conditions necessary through managerial efforts.

VanGundy (1984) studied the different characteristics that make up a creative environment. Among them are the external environment, the internal creative climate, and interpersonal relationship characteristics. To keep a creative external environment, the following needs to be taken into consideration:

1. Freedom to perform and experiment without fear.
2. A moderate work pressure: not too high or too low.
3. Attainable goals.
4. A low level of supervision in the task to be performed.
5. The proper amount of tasks (delegating to keep the right amount of work).
6. Participation in administrative tasks and target setting.
7. Creative problem solving approaches for unstructured problems.
8. Timely feedback on the task being performed.

9. Proper resources for the task to be accomplished.

In terms of internal creativity climate within each individual, two aspects could be identified: people motivators and the individual internal creative climate. In terms of people motivations the aspects that should be taken into consideration according to VanGundy (1984) are:

1. Sharing ideas openly.
2. Accepting different or unpopular ideas and points of view.
3. Refining the ideas that were previously developed by individuals.
4. Promoting risks taken.
5. Providing time for people to think on their own.
6. Providing opportunities for professional growth and development.
7. Interacting with individuals outside the group for new ideas to be introduced.
8. Incorporating healthy competition among the group participants (though without losing sight of the ideation goal).
9. Giving merit for the value of good ideas.
10. Generating confidence in the participants by letting the participants know their creative potential.

According to VanGundy (1984) the components of an individual internal creativity are, among others:

1. Curiosity.
2. Independence.

3. Ability to defer judgement.
4. Willingness to test assumptions.
5. Optimism (things can be done/the problem can be solved).
6. Humour (a catalyst of subconscious creativity).
7. Self-confidence.
8. Openness to ideas (constantly vigilant for new ideas).
9. Persistence.
10. Concentration (ability to immerse themselves in a topic).
11. Tolerance of ambiguity (do not stereotype peoples or situations).
12. Self-awareness (knowledge of how you are perceiving things).
13. Commitment.
14. Flexibility (capability to develop new perspectives or different solutions).
15. Willingness to take risks (view the problem solved).
16. Discipline (capacity to stick with a task).
17. Ability to use imagery (produce mental images).
18. Ability to toy with problems and ideas.
19. Impulsiveness (remote association of the subconscious).

Addressing interpersonal relationships VanGundy (1984) expresses that relationships between the participants may be assessed based on the following characteristics:

1. Faith in the ability and skill of others (interpersonal trust).
2. Acceptance without criticism.

3. Verbal and nonverbal communication capacities (willingness to listen).
4. Friendliness between participants.
5. Cooperation (putting aside individual differences for accomplishing a task).
6. Motivation of expression of ideas (avoid long sessions of silence).
7. Ability to solve dormant conflicts with open confrontation of conflicts.
8. Ability to prevent hurting feelings (promote respect of feelings/benefit weighting).
9. Constructive reactions (lack of defensiveness/ability to turn good from bad, relevant from irrelevant and useful from useless).
10. Team mentality (awareness of roles and knowledge of expectations from each participant - getting every person fully involved).

3.3.11. Introducing external motivation

Osborn (1953) defines external motivation as every type of motivation that offers something that pulls somebody to work toward what is needed.

External motivations are referred as acquisitive motivation (the motivation to possess tangible goods) and vainer motivation (the motivation to have intangible goods such as recognition). The more those two aspects are in participant's life, the more motivated the participants feel to put effort for generating ideas. Forms of recognition are an example of an external motivation. Monetary incentives have been the all time most potent motivator

(Osborn, 1953). Encouragement and reinforcement are part of the “must haves” in a creative environment. Another type of motivator is necessity (Osborn, 1953).

In the short term, emotions such as love, hate, ambition, greed, and adversity are creativity activators. However, in the long term unemotional drives such as habit and curiosity drive the imaginative engines. Emotions are unstable and do not represent a reliable source of external motivation (Osborn, 1953).

3.3.12. Internal Motivation

As part of a study of the motivational and personality factors underlying the productivity of individual brainstorming, Hyams and Graham (1984) found that assigning goals improved brainstorming sessions. However, the individual initiative is the underlying motor of motivation that goal setting may affect. By using Ghiselli’s measure of initiative, Hyams and Graham (1984) found that persons with low initiative produce more ideas by having a goal set, but persons with a high initiative produce more ideas in a “do-best condition” (the mental attitude of getting the best possible output from the brainstorming exercise).

3.3.13. Avoiding performance matching

Studies indicate that performance levels in brainstorming groups are strongly affected by exposure to information about the performance of others (Paulus & Dzindolet, 1993). In other words, social matching of performance could be a

cause of productivity loss in brainstorming sessions if performance is matched to a lower-performing participant.

3.3.14. Producing the final outcome of the workshop

The day after the brainstorming session the incubation of ideas takes place and the leader or the leader's assistant for the brainstorming session should contact the participants to find out if there were any new ideas produced. The "afterthought session" is reported to produce even better ideas than the actual brainstorming session (Osborn, 1953).

Osborn (1953) also states that methods such as sending the minutes of the brainstorming session to all participants to add more ideas in the afterthought session may be used to methodologically gather all the ideas produced in the afterthought process.

For evaluating and selecting the ideas produced in a brainstorming session, Osborn (1953) suggested three main steps:

1. A list of all the ideas suggested must be available after the brainstorming workshop.

2. The ideas are edited to make them more clear and accurate and categorized depending on their characteristics. Individual ideas are placed under each of their categories.

3. The selection process consists of the selection of ideas that are relevant to the problem being solved according to a panel. The panel constituents are a

topic of some discussion; one suggestion is that the ideas should be evaluated by the team responsible for solving the problem, but criticism has been given to the fact that the persons generating the ideas may not evaluate them objectively (Osborn, 1953).

3.4. Literature review related to the output

As reported by Osborn (1953), the effectiveness of an ideation technique can be measured by counting the number of ideas per session. In terms of idea quality, ideas can be classified as excellent, good, or impractical at the moment (Osborn, 1953).

3.4.1. Selection of relevant ideas

Selecting relevant ideas from a brainstorming session is a very important aspect of the whole process of ideation. A criteria checklist has been reported to be helpful. Osborn (1953) reported a criteria checklist from the United States Navy containing questions that ask for the increase or improvement of aspects such as quality, efficiency, methods of operation, tools, machinery, safety or working conditions; the prevention of waste and unnecessary tasks; and the reduction of costs and ways of utilizing resources.

3.4.2. Presenting ideas to evaluation panels

According to Daymond Aitken (cited by Osborn, 1953), ideas should be presented to others for consideration in this way:

1. Showing the need (potential problems or opportunities) using visual means.

2. Stating recommendations for the problem linked to specific points of the need.

3. Re-stating the points in a more compact way recapitulating the needs that have been stated.

4. Guidelines and procedures for construction related risk identification brainstorming sessions based on literature review findings

This section is intended to provide specific guidelines for the rigorous implementation of the brainstorming technique for risk identification workshops, as well as the events that should be associated with a complete brainstorming exercise. For each of our four areas of concern (the workshop, the participants, the leader and the output) the steps are graphically illustrated and the recommendations from the literature reviewed are further summarized as a guideline. These steps must be understood and incorporated as part of the brainstorming exercise in order to recognize any deviation from these events when the brainstorming technique is applied, as well as to guide the proper use of the technique.

4.1. Guidelines and procedure from the literature review for workshops

The following guidelines and procedure are recommended for workshops conducted in the construction domain. The recommended order of events is shown in Figure 4.

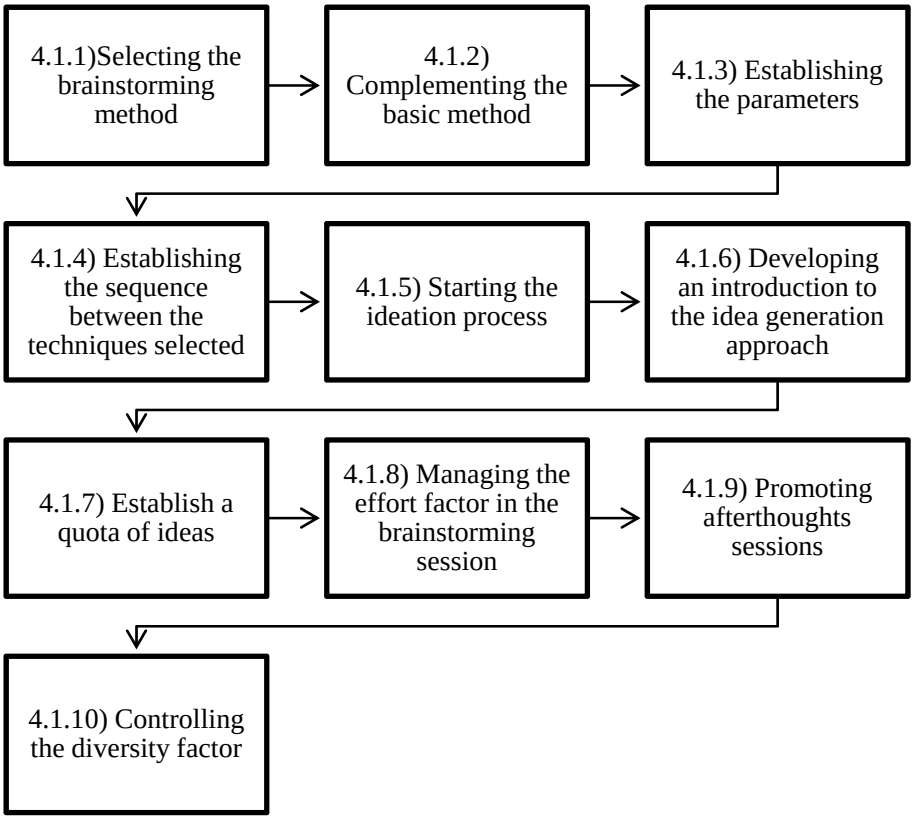

Figure 4: Guidelines for Construction-Related Risk Identification Workshops

The sequence of events in Figure 4 is determined by the input requirements of each activity as well literature recommendations. For example, before "Complementing the basic method" occurs, the brainstorming method must have been already selected.

4.1.1. StSelecting the basic brainstorming method

The basic form of idea generation needs to be determined. Three brainstorming streams could be considered: group brainstorming, nominal group technique (individual brainstorming) and brainwriting (silent group brainstorming)

(Kramer et al. 2001 and VanGundy 1984). The ideation selection process can be a participant-based methodology selection, an organization-based selection or a combination of the previous two.

Participant-based selection:

In selecting a brainstorming technique many different parameters should be evaluated: the existence of social anxiety in the participants, participants with a previous bad experience in brainstorming sessions, the presence of "need for achievement" in individuals, and the level of acceptance of the technique (Heslin 2009; Camacho & Paulus, 1995). From a participant's point of view, brainwriting is more suitable when psychological reactance (i.e., resistance to rules or regulations), a need for achievement and closure, openness to experience, social evaluation anxiety/neuroticism, and diversity of group composition and group processes exist among the participants (VanGundy 1984).

Organization-based selection:

For an organization-based selection, the values of the organizations should be analyzed. Aspects such as the organization's acceptance of anonymous rather than identifiable contributions, the avoidance of disruption of the harmony of groups, and the existence of status-stratified groups will guide which brainstorming method should be used. In the same way, it should be determined if the organization has time available, if high-quality ideas are important, the uniqueness of participants' expertise, the innovation acceptance needed and whether satisfaction from social interaction is valued (Heslin

2009). Factors such as the organizational culture (e. g. “market” vs. “clan”), industry (e.g. accounting vs. advertising), and the national culture (e.g. power distance, collectivism) must also be analyzed (Heslin 2009).

Maloney and Federle (1991) provide a useful framework to identify if the culture of the organization would value more group interaction of individual ideation. In this framework Maloney and Federle (1991) define four culture types for engineering-related companies: (1) Clan culture, (2) “Adhocracy” culture, (3) Hierarchy culture, and (4) Market culture. Identifying the culture of the organization doing risk identification using this framework informs the selection of a brainstorming technique.

4.1.2. Complementing the basic method

After the basic idea generation method has been chosen, a complementary method should be selected to take advantage of its differing strengths (Osborn, 1953). Even when the effectiveness of the selection of the initial methodology is very high, many different factors may interfere with the workshop as a temporary organization as well as with the individuals. Individual ideation should be added to group idea generation if group idea generation is selected as the basic idea generation method and vice versa. If brainwriting is selected as the basic idea generation method, the benefits of face-to-face group brainstorming should also be offered to the group as well (Osborn, 1953).

4.1.3. Establishing the workshop parameters

Parameters such as the place, time, and sequence of the techniques must be determined; ideally, the brainstorming workshop should be different from a day-to-day meeting. Participants must be at their best to generate ideas. Because of the variability of peak productivity from person to person, two approaches could be taken: the first is to define a time based on managers' knowledge of their team's energy levels. The second approach is to survey individuals on their typical levels of energy throughout the day and decide from those results.

4.1.4. Establishing the sequence between the techniques selected

Since more ideas are reported to be produced when individuals brainstorm in a group before brainstorming individually, the group brainstorming sessions should take place before the individual brainstorming session (Brown & Paulus, 2002).

4.1.5. Starting the ideation process

When starting the ideation process some kind of ideation "fuel" needs to be given in order to trigger the creation of ideas. Additionally, a deadline for idea generation must be clearly set (Osborn, 1953). This deadline needs to include the time available for the session as well as informing participants of any additional session to be performed in the future.

4.1.6. Developing an introduction to the idea generation approach

The first activity that should be incorporated in the workshop is the presentation of risks as ideas. This will show participants why the ideation approach is useful for risk identification purposes. In the author's experience, in the majority of risk identification sessions before starting the risk identification process a presentation explaining the risk identification process is given to the participants. The recommendation is therefore to incorporate as part of the presentation a section where risks are made equivalent to ideas and the reasons for doing so are given. Specifically it needs to be shown that ideas and risk share the same creation process and that both are a product of creative thinking (Osborn 1953).

After introducing risks as ideas, the brainstorming principles need to be made clear and understandable. An explanation of the two basic idea generation principles must be presented to the participants, which are the deferment of judgement and the "quantity breeds quality" principles (Osborn, 1953). The risk identification workshop must be presented as a time where no judgement will take place, and it must be impressed upon the participants that more ideas generated means a higher quality of ideas (i.e., more probable risks).

In order to keep the basic idea generation principles at the forefront of the minds of participants, rules should be displayed. These rules ensure the separation of ideation and analysis during the workshop: no criticism, acceptance of all kinds of ideas, as many ideas as possible, and improve, combine, and mix others' ideas (Osborn, 1953).

4.1.7. Establishing a quota of ideas

Establishing a set number of ideas expected from the ideation exercise motivates the participants (Osborn, 1953).

4.1.8. Managing the effort factor in the brainstorming session: the driving force of creativity

Incentive systems based on the number of risks identified by the participants should be implemented in order to motivate the participants to put effort toward idea generation; combined with explanations of how the effort put toward the generation of ideas is predicted to produce a successful workshop in terms of team effort, this will encourage participation (Osborn, 1953).

Maslow's five essential needs can be used to identify what type of incentive should be offered to promote effort. The organizations need to be aware of the needs and motivations of the individuals participating in the risk identification exercise. For example, if the risk identifiers are financially motivated, a monetary incentive would be a way of promoting effort towards the generation of ideas. More information about the motivation parameters are provided by Shoura and Singh (1998).

4.1.9. Promoting afterthoughts sessions

After the workshop, asking the participants to continue thinking about the topic (while taking notes about any new ideas) greatly improves idea generation (Osborn 1953); therefore, specific instructions to write down new ideas and

report them to the leader the day after the workshop should be given to the participants.

4.1.10. Controlling the diversity factor

Although in risk analysis workshops diversity is necessary to be able to gather all the experts of different areas of the projects in a same roof, the outcome of diversity needs to be a positive one. A positive application of diversity is needed because of the value of different opinions from different areas of the project (Osborn 1953, Maytorena et al. 2007). Because of the added value from the diversity of the members, the recommendation is that every area presented in the work breakdown structure of the project should be represented in the workshop.

However, it must be recognized that diversity can result in problems among members if faultlines are activated. Faultlines are defined as differences among members that split the group members into subgroups. The recommendation would therefore be to focus on the commonalities of the participants of the workshop (Pearsall et al., 2008).

4.2. Guidelines and procedure from the literature review for participants

After the workshop guidelines are considered, with the expectation of a successful and productive workshop (with a high level of ideation and member satisfaction), the participants of the workshop must be considered. Figure 5 shows the sequence of those considerations.

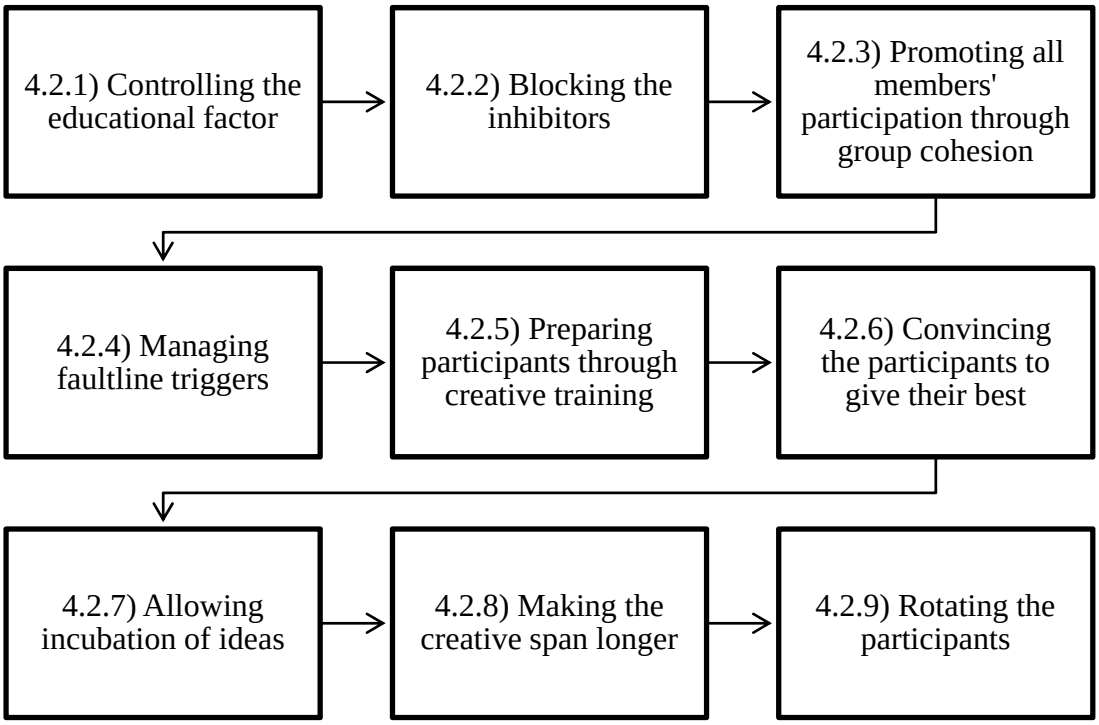

Figure 5: Guidelines for Construction-Related Risk Identification Workshop Participants

4.2.1. Controlling the educational factor

For idea generation purposes, to be more educated does not mean to be more creative. It must be understood that what matters is the knowledge of the person about the context in which the person is about to brainstorm, rather than the personal education of the participant (Osborn, 1953, Maytorena et al. 2007).

The leader of the organization and the leader of the workshop should select the project participants based on their involvement in the project and their knowledge about the specific area in which they are contributing to the project. However, it is reported that graduate degrees related to the risk management disciplines tend to produce more ideas than those without this type of training (Maytorena et al. 2007). For that reason, participation preference should be given to individuals previously involved in risk identification.

Different parameters can be used if a decision between two individuals needs to be made. Among these parameters:

- The knowledge the participant has about the project.
- The participant's area of expertise, and the necessity of the presence of an expert in that area in the workshop.
- The previous participation of the participant in risk identification workshops.
- The participant's possession of an academic degree related to risk management.

- The knowledge the participant has of the corporate, financial and managerial environment of the project.

4.2.2. Blocking the inhibitors

Two traits must be induced in the participants of the workshop. Self confidence is the first trait necessary for removing the inhibitors to contribution. With self confidence, participants are able to make contributions in their specific areas of expertise. The second trait that must be induced is "free-wheeling," by forbidding all judgement. By promoting free-wheeling, functional fixation will be eliminated Osborn (1953).

A list of suggested actions is presented, useful for blocking creativity inhibitors during risk identification workshops. This list could be used as a check list to follow and as a set of principles to be shared among the participants of the workshop to govern their behaviour (Osborn, 1953).

- Convince participants to keep trying, even with repeated failure
- Convince participants to make the most of their minds, regardless of other people's opinions
- Convince participants that their ideas are wanted
- Communicate that the more ideas generated, the better the organization works
- Communicate what is done with the ideas given and give feedback to the participants, telling them that their ideas are always welcome
- Convince the participants that they have the power to be creative

- Communicate that no perfectionism is required. A perfectionist point of view cramps creativity
- Provide an intimate climate to promote encouragement
- Communicate the existence of a stimulus plan for ideas (i.e. financial incentives, recognition of ideas shared by upper management)

This checklist could be used during the workshop or before the group or individual brainstorming. The previous recommendations are intended to help reduce self-discouragement, the fear of looking foolish to others, and timidity.

4.2.3. Promoting all members' participation through group cohesion

The main strategy used in this approach to promote group cohesion is to prevent similarity alignment. Similarity alignment prevention is a strategy meant to avoid faultline activations. This strategy is to be considered as part of the preparation of the workshop and exercised throughout it (Pearsall et al. 2008).

The strategy to prevent similarity alignment in the workshop can be summarized as (Pearsall et al., 2008):

Highlighting cross cutting dimensions of diversity: If a few members in the group are identified as having a great number of similar characteristics among them, faultline activation may take place. For that reason, it should be taken into consideration that the best group in terms of members' characteristics is a group where all the participants share similar dimensions of diversity among them, but without being able to categorize themselves as a sub-group.

Create a strong out-faultline: Rather than a faultline inside the group, a strong faultline outside the brainstorming group is highly desired to create and define the group identity. This could be achieved by specifying to the participants what differentiates the current brainstorming group from other, similar working groups. Focusing the group on the output that the group is seeking to achieve (a well defined set of risk factors for the current project) faultlines among the participants would not be relevant to the participants.

Prevent categorization: The faultline activation is defined as the process of initiating social categorization. Therefore, no classification that could end in the creation of a categorization should be found in the group.

4.2.4. Managing Faultline Triggers

When a faultline is inherited as part of the project for which risk factors would be identified (i.e. a risk identification brainstorming session for the construction of a library) the salience of the faultline will be dictated by how the task is managed by the team (Pearsall et al., 2008). In other words, the participants of the workshop could perceive a categorization of the participants who are part of the "library organization" because the brainstorming topic (risks for the library construction) focuses on the construction of the library. This categorization may induce a faultline between the Library participants and other participants of the brainstorming session. During brainstorming, managing the comparative fit can prevent the participants to be influenced by faultline triggers. In order to manage the comparative fit during risk identification the attention given to the difference among the individuals

(categorization) must be minimized. Categorization during risk identification includes (but is not limited to) categorization based on the discipline or expertise of personnel and the organization to which the participants belong, among others. The recommendation to minimize categorization is to intentionally incorporate activities where the participants need to interact with participants with different categories (i.e., different expertise, members of different organizations).

It should be noted that normative fit and social categorization can trigger faultlines as well, but are outside the scope of this research.

4.2.5. Preparing participants through creative training

Training in creativity enhances the ability to generate ideas (Osborn 1953). Creative training can be supplied by providing the participants with the opportunity to develop creative skills. This could be achieved by including a training agenda of exercises to develop creativity within the individuals. The training provided by the Creativity Education Foundation provides an option for creativity training that could be useful for the construction industry (CEF, 2010).

As part as the preparation for risk identification workshops the participants should be given a pre-workshop package to familiarize them with the project under study as well as with the process of risk analysis. This reading preparation is highly recommended as a source of imagination. Reading should be incorporated in the participant's activities to enhance the imagination.

Specific milestones can be established to foster the creativity of the individuals by encouraging the reading of material that will exercise their creative potential (Osborn 1953).

The right attitude towards creativity must also be established. For risk identification, an attitude of engagement and creation should be promoted. Rather than absorbing ideas, participants should be encouraged to engage with the idea and create a new one from it. Before the workshop, participants should set aside time to prepare themselves to create ideas (Osborn 1953).

4.2.6. Convincing the participants to give their best

Participants need to be convinced of important truths about creativity; this approach supplements creative training. Certain points or paradigms must be clarified; these points are general beliefs about creativity which impede the generation of ideas (Osborn, 1953).

As reported by Osborn (1953), the first paradigm is the effort paradigm, the general belief that no effort is necessary to produce ideas. To change this way of thinking, participants must be convinced that no idea comes easily before commencing the workshop; each participant must deliberately choose to think. The second one is the concentration paradigm, the belief that no concentration is needed to produce valuable ideas. Since fixed attention has a very important role in idea generation, persistent attention needs to be given to the brainstorming topic. This underlines the importance of a place for risk identification where no distractions could interrupt the ideation process.

4.2.7. Allowing incubation of ideas

After the brainstorming session, participants should devote time to incubate ideas from what was heard or shared during the workshop. As defined in chapter 3, incubation is a post-workshop phase where the participants digest the information produced or received (Osborn, 1953).

A summary of the workshop should be given to every participant, and the day after the workshop, relevant ideas from the incubation process should be collected and added to the general idea generation output.

4.2.8. Making the creative span longer

Early delivery of project information to the participants will allow the participants to produce a higher number of ideas. Therefore, individuals should be allowed as much time as possible between being given the brainstorming topic and the actual brainstorming exercise. For example, if a dam construction risk identification topic is given to any specific individual three months before the start of the actual identification exercise, more ideas will likely be collected from the participant because of the connection of the topic with day to day experiences made by the participant. If the topic is given a week before the ideation process starts, fewer connections will be made and therefore fewer ideas produced.

One subject of concern about the ideas generated during the incubation and pre-brainstorming period is the documentation of the actual ideas produced. In order to overcome this issue, the participants should use a reliable tool to

document the ideas produced during this period of time. These tools can vary from an electronic risk registry to manual documentation of risks to be shared during the workshop (Osborn, 1953).

4.2.9. Rotating the Participants

More than one workshop may be necessary to arrive at a feasible solution for the organization. Rotating the participants in a workshop offers several advantages. New participants should be included in different sessions of the risk identification exercise; however, the newcomer must fulfill a few requirements to be a successful match for the group (Choi & Thompson, 2005).

- Must qualify as a participant of the workshop by having related experience for the risk identification project. The framework provided by Hallowell and Gambatese (2010) provides a point system to evaluate qualifications of participants in a workshop related project management setting.
- Must be highly creative.
- Must show a higher productivity than the previous participants to promote performance matching.
- Must have the same amount of experience related to the project compared to the others members.
- Must be introduced as somebody belonging to the group (permanency).

- Must be categorized as a member; no classification as an outsider should ever be made.

4.3. Guidelines and procedure from the literature review for the leader

After the guidelines for participants are considered, the guidelines for effective selection and training of a leader should be followed. Figure 6 shows the sequence of those considerations.

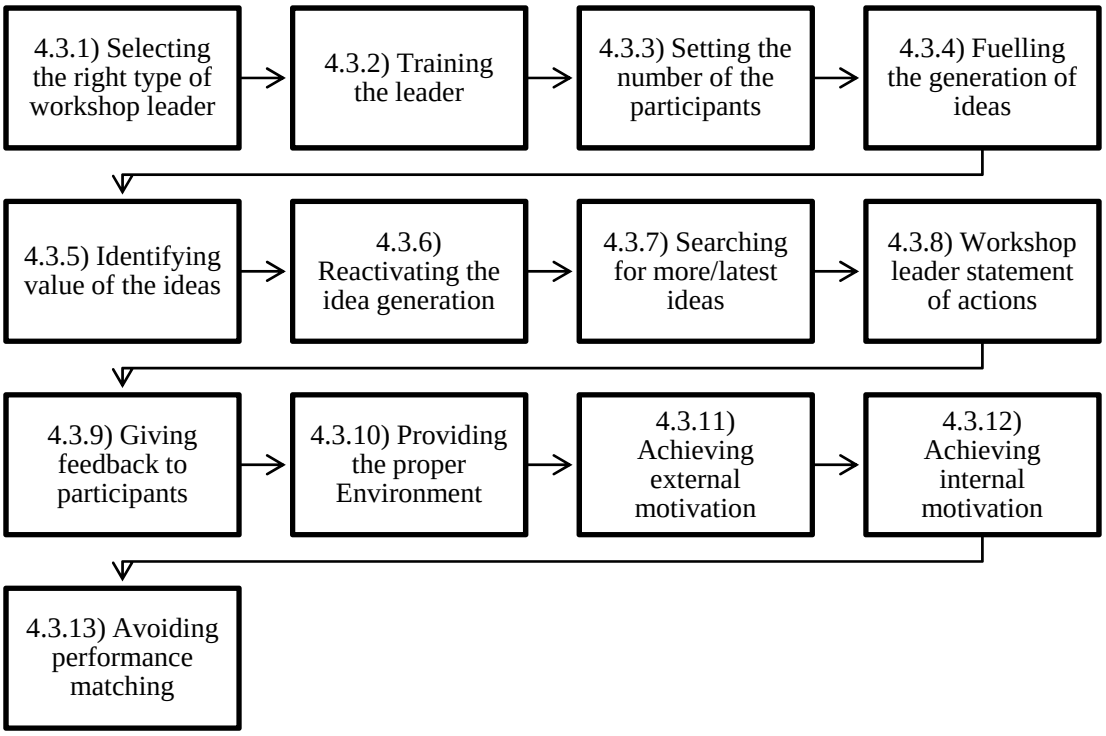

Figure 6: Guidelines for Construction-Related Risk Identification Workshop Leader

4.3.1. Selecting the right type of workshop leader

Choosing the correct profile of a workshop leader for risk identification purposes assures strong leadership if needed during the workshop and the capability for powerful direction.

Strong personality requirement:

As mentioned in the literature review section, the profile of a workshop leader should be strong enough to be able to give powerful direction. Psychological tests represent an important tool to identify the leader's personality type, allowing the prediction of the existence of the required behaviour. It should be taken into consideration the resources required to perform psychological tests as well as the proposed workshop leader's inclination to take the proper evaluations. The size of the project as well as the requirements of the owner will indicate the need to study the personality of the leader of the brainstorming session.

Firsthand experience

Since experience constitutes the fuel from which the mind creates new ideas, experience in related exercises of idea creation is an asset for risk identification. Firsthand experience can be easily identified by looking at the qualifications of the workshop leader (Osborn 1953).

Transformational Leadership

Sosik et al. (1998) refer to a transformational leader as a leader who provides intellectual stimulation through novel approaches, having an individual consideration of the members of the organization and providing motives to guide them to personal improvements. The presence of a transformational leader in the workshop will add intellectual stimulation and encouragement, and increase participant appreciation. Transformational leadership could be perceived or induced in the proposed leader. When the leader is not

transformational, training can be provided to foster the benefits of a transformational leadership within the workshop. In some cases, the leader could be an innate transformational leader.

4.3.2. Training the leader

Some training methods are more effective than others and should be encouraged for leaders of workshop sessions. Cognitive modeling training should be highly encouraged as the primary method of training the leader (Gist 1989). Training sessions should be arranged for the leader as an example of the actual activities that should occur during the workshop.

4.3.3. Setting the number of the participants

As reported in the literature review section, Osborn (1953) advocates between 6 to 10 participants. However, experienced workshop facilitators from a consulting construction company based in Edmonton, Alberta, recommend seven participants as a manageable group size for a single workshop leader (personal communication). In addition, Osborn (1953) does mention that an odd number of participants ensures a majority which is preferable for decision-making.

4.3.4. Fuelling the generation of ideas

The material that will be used to fuel idea generation should be selected by the leader of the workshop. Aside from their previous experience in similar projects, documentation that facilitates memory association must be provided to the participants by the leader. A initial set of risk factors has proven to be an

effective way to fuel the generation of risk while identifying risk factors. For example, in one study group brainstorming was carried out in order to identify risk factors for waste water supply and treatment in Alberta, Canada, and a list of risks previously identified by the workshop leader was provided in order to induce the production of ideas based on initial risk factors in a point form manner (refer to Table 5) (AbouRizk, 2009). The initial list of risk factors provides a set of issues that are intended to be used as idea triggers in order for the workshop participants be guided by the leader to produce final risk factors. For examples of risk factors as they would be stated in a final risk identification report refer to AbouRizk (2009).

Table 2: Sample initial risk factors

(Adopted from a pre-workshop package provided by SMA Consulting Ltd.).

Risk Factor Description
1. Unintended industrial discharge to North Saskatchewan River.
2. Underground contamination/remediation
3. Encountering endangered species
4. Lack of information on impacts of use of existing and future deep wells
5. Lack of public acceptability
6. Historic sites/ tribal lands
7. Terrorist attacks/sabotage/vandalism
8. Accidental release of toxic substances
9. Plant locations on private property
10. Treatment / reclamation technologies
11. Reclaimed water distribution
12. Liability allocation for wastewater/waste streams
13. Feasibility of deep well disposal of specific residual wastes (e.g. brine)
14. Unknown buried utilities

15. Unanticipated pipe corrosion
16. Ground shifting - settlement, earthquakes, sink holes etc
17. Industrial dump to reclamation facility
18. Process upset at reclamation facility
19. Basis of design wrong (flows, constituents - based on assumptions rather than hard data)

4.3.5. Tracking the value of the ideas

The level of development of a given idea should influence value; this should be part of the workshop documentation. For example, an idea worked by four different individuals where each individual added value to the first idea should have more value than an isolated idea given by an individual before the group turned their attention to another topic.

The recommendation is to pay special attention to ideas that have involved input from multiple participants.

4.3.6. Reactivating the idea generation

The leader must be aware of when the idea generation process needs reactivation by identifying periods where no ideas are flowing from the brainstorming exercise (Osborn 1953). As part of a pre-workshop documentation package the leader of the workshop would outline the use of the activation methods when required by giving examples of the Gordon method (developed by William J. J. Gordon), the attribute listing method (developed by Robert P. Crawford), the forced relationships method (developed by Charles S. Whiting), and the morphological analysis method (developed by Fritz Zwicky and Myron S. Allen) (Osborn, 1953).

4.3.7. Searching for more/latest ideas

In order to achieve the most valuable ideas, the leader of the workshop must be able to identify possible ideas that could come from an ideation pattern by applying different laws to the ideation process (Osborn, 1953).

The first law the leader should be able to apply successfully is the law of similarity, where the leader is looking for parallels to an already-existing idea. As described in chapter 3, the similarity could take the form of an adaptation, a modification, a substitution, a magnification, a minimization, an omission, or a division. The recommendation is that for every idea generated in the ideation process, all the forms of the law of similarity should be applied; the leader should ask questions related to the laws when an idea is identified in the brainstorming session.

In Table 6 the different forms of the law of similarity are presented and suggestions are given for questions to be asked by the leader to facilitate the generation of new risks from the participants.

Table 3: Table for association using the law of similarity

Primary idea generated	i.e. Encountering unexpected ground condition
Adaptation	*What ideas (other risks) does it suggest?* i.e. Encountering unexpected contaminants in the ground *What is this like?* i.e. Having a limited sample representation of the soil encountered in the area.
Modification	*How could this be worse?* i.e. Inaccuracy of soil investigation reports. *How can this be modified?* i.e. Existence of archaeological findings.
Substitution	*What, who, where else?* *What else?* i.e. The soil could not be removed by the excavation method being utilized.
Magnification	*What to add to the idea (risk factor)?* *How could the risk be stronger in some way?* *Should it be bigger?*
Multiplication	*What happen if the size is doubled?* What if there is twice the amount of dirt?
Minimization	*What could be done if something is smaller?* *What would happen is the amount is less?* *If attributes such as quantities, time, frequency, strength, components, features, are smaller how this would affect the project?*
Omitting	*Is there something that could be omitted and produce a new risk?*
Division	*Could this idea (risk) be divided into others?*

The leader needs to develop a table similar to Table 6 in order to make it suitable for the specific project where the leader is working. Different projects will need different numbers of questions, different types of questions and different applications of the forms of the law of similarity; however, the use of the law of similarity by the participants will center around the same concept of producing more ideas by associating existing ideas with others.

The second law of association is the law of contrast. It is used when the leader encourages participants to search for an idea with attributes or concepts opposite to the one being shown. The forms of the law of contrast are rearrangement (a change in order), re-sequence (a change in the sequence of processes), and the unexpected (what could happen as a surprise). Examples of the types of questions that could be asked by the leader to encourage further idea generation using the law of contrast are shown in Table 7.

Table 4: Table for association using the law of contrast

Primary idea generated	i.e. Encountering unexpected ground condition
Rearrangement	*What happens if some elements of the project are rearranged?*
Re-sequence	*What happens if any sequence is changed related to this idea (risk)?* i.e. if the risk factor would be "encountering unexpected ground condition while building entrance shaft", a new idea could be created related to encountering unexpected ground condition in the middle of the tunnel excavation.
Unexpected	*What could happen of a way of surprise?*
Combinations	*What ideas can be combined?* (This is dealing with the combination of risk factors that ultimately will produce a new idea).

4.3.8. Workshop leader's statement of actions

The workshop leader's statement of action constitutes a point form manner of the considerations for the leader to be carefully followed by the leader. Five main principles should be followed at all times by the leader of the workshop (Osborn 1953):

- Keep an informal environment.
- Warn or stop damagers of creative process.
- Identify participants not highly recommended for the ideation process.
- Encourage participants (especially introvert participants).
- Welcome every idea.

4.3.9. Giving feedback to participants

Human monitoring with feedback should be exercised while the participants are producing ideas (Graham 1977) by encouraging the leader of the workshop to provide constructive verbal feedback when ideas are received during the ideation progress.

4.3.10. Providing the proper environment

The characteristics that make up a creative environment are classified as characteristics related to the external environment, internal creative climate, and interpersonal relationships. For a proper external ideation environment the following characteristics should be present in the workshop (VanGundy 1984):

1. Freedom to perform and experiment without fear
2. Moderate work pressure according to what the individual can handle without encountering discomfort or stress.
3. Attainable goals
4. A low level of supervision in the task to be performed
5. The proper amount of tasks (delegating to keep the right amount of work)
6. Participation in administrative tasks and target setting
7. The use of creative problem solving approaches for unstructured problems
8. On time feedback on the task being performed
9. Proper resources for the task to be accomplished

It is highly encouraged that all the previous characteristics be present in the environment of the workshop.

The internal creative climate is assessed in terms of individuals' motivators and the individual internal creative climate. The aspects considered related to people's motivations are mentioned in the literature review section (success in this area is considered when 6 of the 10 are fulfilled). The previous aspects are aspects related to the capacity of the individual to motivate the open sharing of ideas, to accept ideas and point of views different than the communality of them, and to refine the ideas that were previously developed by individuals.

Internal creativity is defined by VanGundy (1984) based on different components of the personality (19 in total). These components are curiosity, independence, ability to defer judgement, willingness to test assumptions, among others. An accurate approach will be to have 10 of the 19 components perceived as integral components of the individual personality.

4.3.11. Achieving external motivation

To consider that external motivation exists in a workshop setting, at least two of the following must be present in the workshop (Osborn, 1953):

- Forms of recognition
- Monetary incentives
- Encouragement and reinforcement

4.3.12. Achieving internal motivation

Internal motivation is presented in two aspects depending on the initiative of the individual (Hyams & Graham 1984):

- Low-initiative persons produce more ideas by goal setting.
- High-initiative persons produce more ideas by being motivated to give their best in the brainstorming session.

4.3.13. Avoiding performance matching

The leader of the workshop should not disclose the performance of the participants in terms of idea production to prevent performance matching. Because of uncertainty whether performance matching will encourage or discourage the participants, a more considered approach is to encourage the participants to give their best (Paulus & Dzindolet, 1993).

4.4. Guidelines and procedure from the literature review for the output

After the leader is selected and trained, the guidelines for the output should be considered. Figure 7 shows the sequence of those considerations.

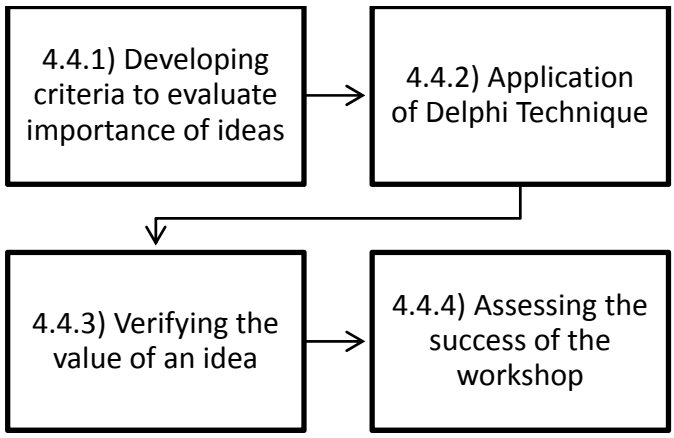

Figure 7: Guidelines for Construction-Related Risk Identification Workshop Output

4.4.1. Developing criteria to evaluate importance of ideas

Risks are relevant and useful ideas for the project team that reveal harmful or jeopardizing events for the successful project completion. A combination of checklists of criteria and group consensus evaluations should be exercised in the workshop for deciding which ideas will be part of the risk analysis exercise.

The ideas generated should be categorized according to their importance. In order for this to happen, the organization needs to make clear the parameters that will define the level of importance of an idea. In other words, a list containing the criteria of importance for the organization needs to be

developed in order to evaluate the level of importance of the ideas produced (Osborn 1953).

The leader must make sure not to confuse this step with the risk analysis exercise, where the severity of a risk factor is analysed. The criteria selection is for determining the relevancy of a risk factor to the project. The criteria will be used to develop the first list of risk factors that would be assessed in the analysis process.

4.4.2. Application of Delphi Technique

The present methodology for idea generation creates a large number of ideas to be analyzed, where not all of them represent useful ideas. For that reason, a technique to reach group consensus, for evaluating which ideas will be considered as risks, needs to be used (Hallowell & Gambatese, 2010). In other words, having a technique to select risk factors from the general list of risks allows the leader to analyse only the most suitable ideas (ideas that can be considered as actual risk events).

The Delphi technique is a well known technique for achieving group consensus. This technique evaluates a list of "parameters" by asking the participants of a workshop to consider them as not important, important, or very important. For more details of the application of the Delphi technique please refer to AbouRizk (2009).

As ideas could be generated individually, the presentation of all the ideas to the whole group needs to take place. A very important recommendation is that no

positivism or arrogance should be shown about any specific idea while presenting them to the participants.

4.4.3. Verifying the value of an idea

Verifying with persons involved in the practical areas of the problem to be solved is the most reliable way to confirm the value of an idea (Osborn 1953).

Before presenting ideas for others' consideration, the person responsible for the idea should consider the idea by itself. Presenting ideas graphically is recommended. One generally accepted method is to relate the risk events to the different dimensions of the project.

For this methodology the evaluation criteria for the ideas must be established by competent people related to the project (workshop participants and stakeholders), and every idea must be evaluated according to these criteria.

4.4.4. Assessing the success of the workshop

To assess the benefits of the workshop, factors such as enjoyment, improvement of initiative, personal development, and avoidance of fear of failure should be evaluated in the participants. For the organization, organizational savings and opportunity should be considered. A satisfaction scale survey, as in the satisfaction survey presented by Torbica and Stroh (2001), can be developed in order to assess risk identification workshops from a participant's perspective, giving participants an opportunity to provide feedback to the workshop leader, while a post-workshop analysis in the

organization can show the opportunities and savings provided by the technique to the organization.

5. Summary of revised risk identification procedure for using brainstorming in construction related areas

This is a comprehensive risk identification procedure incorporating and summarizing the four components of this idea generation approach. A schematization of the total process is presented in Figure 8 (due to the large size of the figure it was divided into two section Figure 8.1 and Figure 8.2 in order to meet format requirements).

The elements are sequentially organized based on their relationships, and the elements of the different group parameters explained in this section (workshop, leader, participants and output) are differentiated by providing the corresponding section numbers.

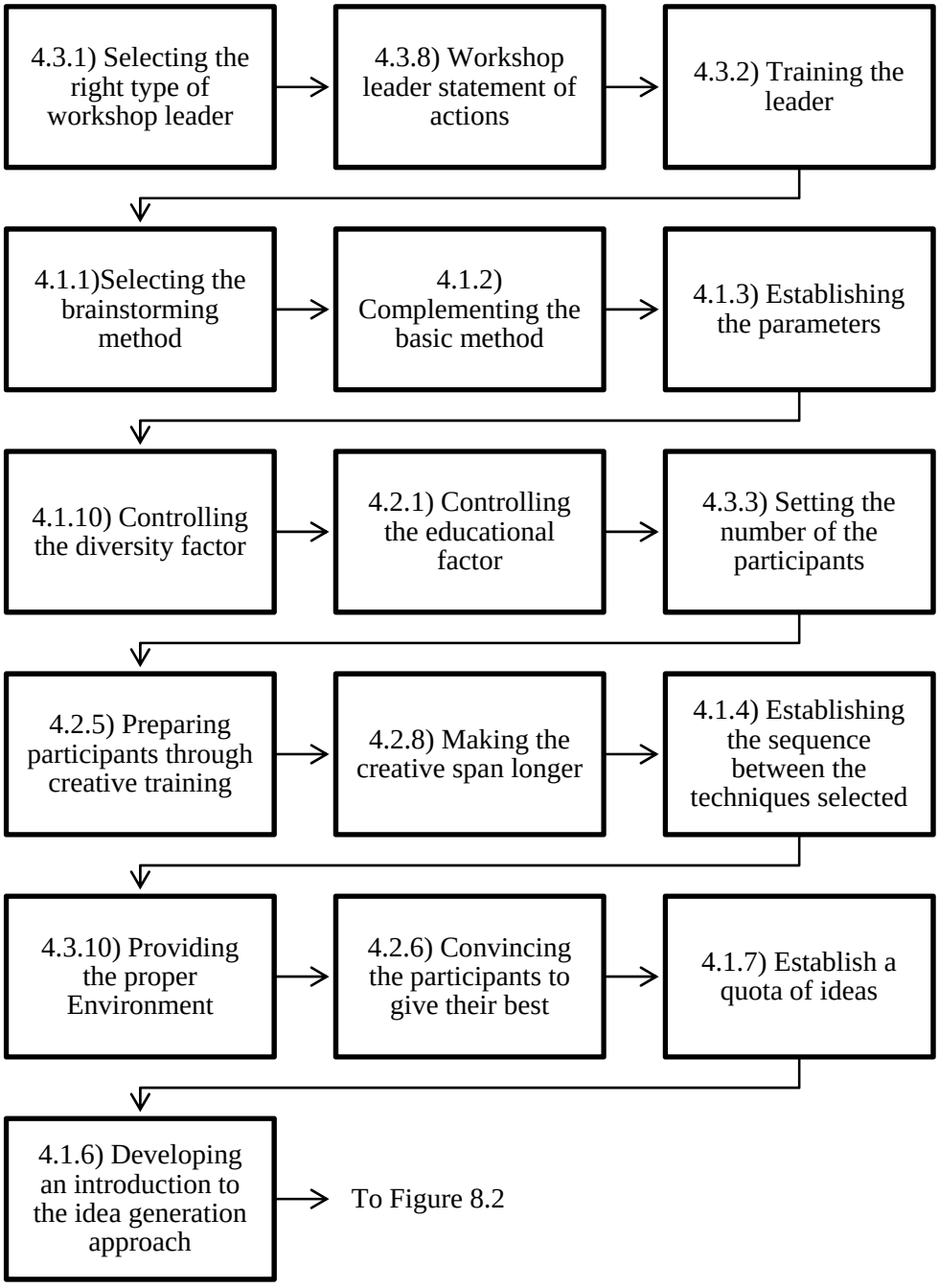

Figure 8.1: Summary of Revised Risk Identification Procedure for Using Brainstorming in Risk Identification Workshops (Part 1).

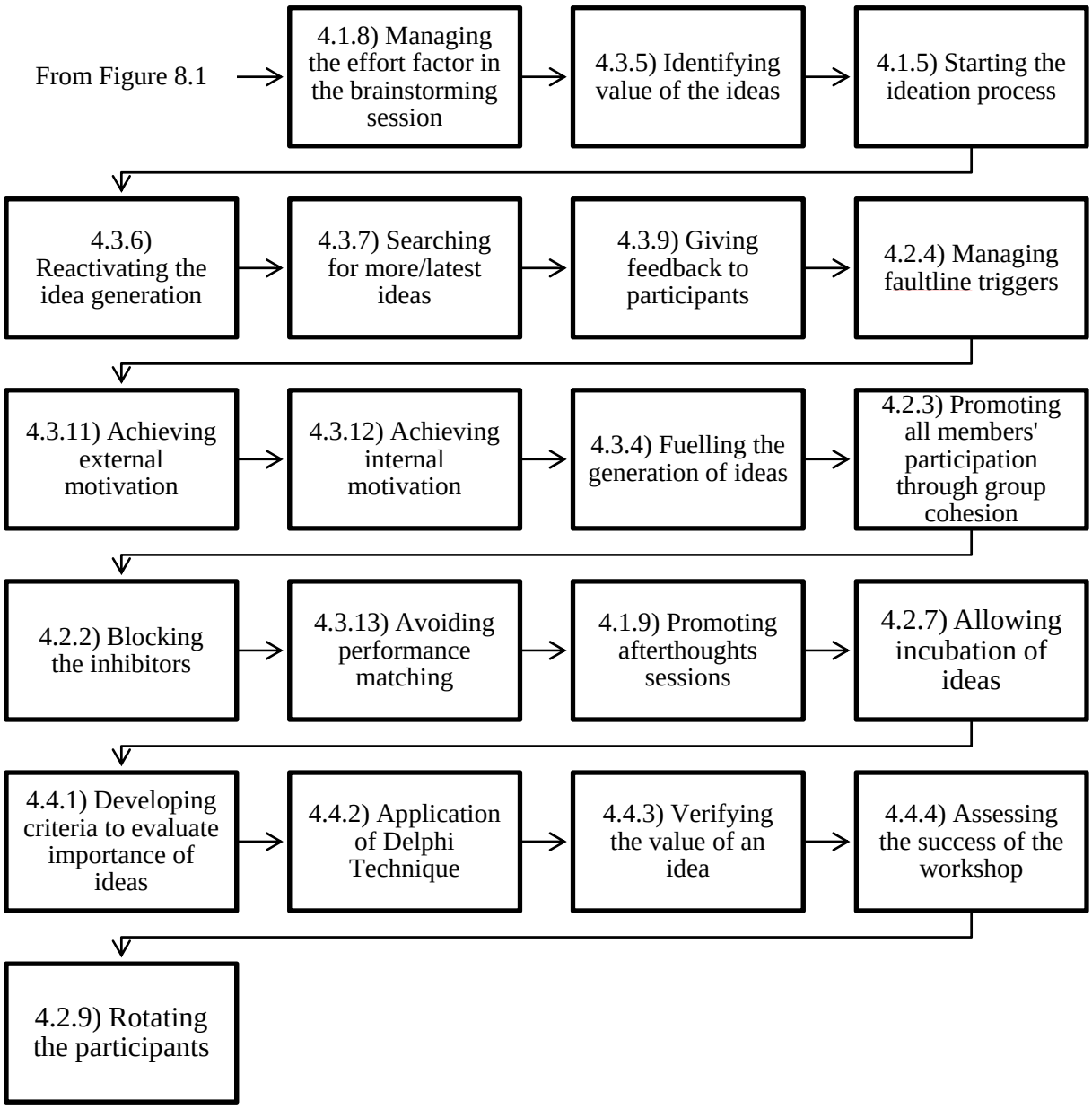

Figure 8.2: Summary of Revised Risk Identification Procedure for Using Brainstorming in Risk Identification Workshops (Part 2).

5.1. Definition of the revised procedure

Figure 8 describes the procedure to follow for risk identification workshops from an idea generation approach. The steps are summarised in Table 8. Note that the input of one step does not necessarily need to correspond to the output of the previous steps. The input of one step can be the output of a previous step modified by the environment of the workshop or by the implications of the nature of the brainstorming technique such as tiredness in individuals, lack of focus and the unique characteristics of a given working group.

Table 5: Summarisation of the risk identification workshop procedure: inputs and outputs.

Step. / Guideline	**Event**	**Input (s)**	**Output (s)**
1. / 4.3.1	Selecting the right type of workshop leader	Set of possible workshop leaders	Selected workshop leader
2. / 4.3.8	Workshop leader statement of actions	Selected workshop Leader (unaware of responsibilities)	Leader knowledgeable about required actions
3. / 4.3.2	Training the leader	Leader knowledgeable about required actions	Trained workshop leader
4. / 4.1.1	Selecting the brainstorming method	Participant and Organization information	Basic brainstorming method
5. / 4.1.2	Complementing the basic method	Basic brainstorming method	Method to complement basic brainstorming method
6. / 4.1.3	Establishing the parameters	Organization and individuals' culture	Parameters of the brainstorming session
7. / 4.1.10	Controlling the diversity factor	Potential participants	Participants selected based on diversity requirements
8. / 4.2.1	Controlling the	Potential	Participants

	educational factor	participants	selected based on education requirements
9. / 4.3.3	Setting the number of the participants	Potential participants	Selected number of final participants
10. / 4.2.5	Preparing participants through creative training	Selected number of participants	Participants trained in creativity thinking
11. / 4.2.8	Making the creative span longer (pre-workshop idea generation)	Preliminary set of risk factors	Increased number of risk factor due to further pre-workshop
12. / 4.1.4	Establishing the sequence between the techniques selected	Basic and complementing brainstorming techniques	Brainstorming techniques sorted for workshop
13. / 4.3.10	Providing the proper environment	Uncontrolled workshop environment	Workshop environment controlled by leader of the workshop
14. / 4.2.6	Convincing the participants to give their best	Average motivated participants	Highly motivated participants
15. / 4.1.7	Establish a quota of ideas	Participants without goal set	Participants focus on achieving set number of risk factors
16. / 4.1.6	Developing an introduction to the idea generation approach	Participants unclear about purpose of ideation	Participants convinced about effectiveness of ideation for risk identification
17. / 4.1.8	Managing the effort factor in the brainstorming session	Highly motivated participants	Participants highly motivated and able to commit to risk identification
18. / 4.3.5	Identifying value of the ideas	Participants without understanding value of association of ideas for elaborating ideas	Participants able to elaborate on somebody else's ideas (Knowledgeable participant)
19. / 4.1.5	Starting the ideation process	Trained leader, knowledgeable participants, proper environment, preliminary set of risk factors	Set of identified risk factors

20. / 4.3.6	Reactivating the idea generation	Set of identified risk factors (reactivation needed)	Further developed set of risk factors
21. / 4.3.7	Searching for more/latest ideas	Further developed set of risk factors (lack of ideation)	Highly further developed set of risk factors
22. / 4.3.9	Giving feedback to participants	Participants requiring feedback (questions)	Participant back on track
23. / 4.2.4	Managing faultline triggers	Participants aware of faultlines among the group	Participants incorporated as part of the group (team approach)
24. / 4.3.11	Achieving external motivation	Participants lacking external motivation to continue	Participants motivated by external factors
25. / 4.3.12	Achieving internal motivation	Participants lacking internal motivation to continue	Participants motivated by internal factors
26. / 4.3.4	Fuelling the generation of ideas	Highly further developed risk factors	Pre-final set of risk factors
27. / 4.2.3	Promoting all members participation through group cohesion	Participants lacking group cohesiveness	Participants working as a team
28. / 4.2.2	Blocking the inhibitors	Judgement appears in the ideation process	Idea generation has been further motivated
29. / 4.3.13	Avoiding performance matching	Participants are conforming to the idea production of other participants generating fewer ideas	Performance matching avoided participants producing as high ideas as possible,
30. / 4.1.9	Promoting afterthoughts sessions	Participants not considering to share inputs after workshops	Committed participants to share additional inputs after workshop
31. / 4.2.7	Allowing Incubation of ideas	Committed participants to share additional inputs after workshop	Final set of risk factors with additional risk factors from incubation
32. / 4.4.1	Developing criteria to evaluate importance of ideas	Organization criteria, Final set of risk factors	Criteria to evaluate relevant risk factors

33. / 4.4.2	Application of Delphi Technique	Expert panellists, final set of risk factors	Risk factors relevant to the organization
34. / 4.4.3	Verifying the value of an idea	Risk factors relevant to the organization	Final set of relevant risk factors
35. / 4.2.9	Rotating the Participants	Need of a second risk identification exercise, newcomers to the exercise (proper train for newcomers)	Final set of risk factors with additional inputs
36. /4.4.4	Assessing the success of the workshop	Survey, participants	Level of success of the risk identification workshop

5.2. Explanation of the proposed sequence for the procedure:

The first step is to select the workshop leader; after selecting the leader, the leader needs to be trained. Apart from the elements described in the literature review section for training the leader, the leader is trained with the inputs from the workshop leader's statement of actions.

After the leader is trained, the brainstorming method is selected, followed by the selection of a complementary brainstorming method. Then the parameters of the workshop are selected (while the educational and diversity factors are considered and controlled) and the number of participants is determined.

Participants are prepared by creative training; the topic for brainstorming should be revealed early to promote pre-workshop idea generation. While the participants are generating pre-workshop ideas the time and place of the

workshop need to be defined and the sequence of the brainstorming techniques established.

The leader of the workshop needs to arrange the proper environment. Participants are convinced to give their best and a quota of ideas is established.

Afterwards, an introduction to the ideation process needs to take place to ensure knowledgeable participants working with a clear purpose. Faultline triggers must be controlled to prevent the creation of subgroups among the participants. External and internal motivational frameworks are presented by the leader.

The formal risk identification session is started (Step 20) by presenting the motivation to the group. To “start the ideation process” in this methodology means participants start producing ideas The ideas must be fuelled by the concepts presented in the literature review section.

The effort factor must be clearly addressed and all members’ participation assured. Participants are encouraged to block the inhibitors of idea generation, while the leader promotes group cohesion, avoids performance matching, reactivates the ideation process if needed, promotes the acquisition of high value ideas, gives feedback to the participants, and searches for more ideas.

After the brainstorming exercise finishes, criteria for evaluating the importance of the ideas are brought up (though they could also be developed previously by the organization) and the Delphi technique applied (recommended in more than one round). Once the list of risk factors is prepared, the risk factors are

given to the participants and they are encouraged to produce more ideas the day after the workshop as an afterthought session. Finally, the workshop is assessed in terms of participant satisfaction and idea production. Rotation of participants is considered if other workshops are needed.

6. Validation and Conclusion

6.1. Verification & Validation

The thesis presented in here was verified using face validity ("subjective, non-statistical judgment that seeks the opinion of non-researchers regarding the validity of a particular study" Lucko & Rojas 2009), which was accomplished by collecting the positive appreciation of persons not involved in the research about the validity of the methodology. The components of this thesis were verified with a consulting firm in the city of Edmonton, Alberta, Canada, and risk analysis experts provided positive feedback on the guidelines presented as part of this work.

6.2. Conclusions

The inferences that could be made from this research work are:

- The most important factors needed for promoting ideation for brainstorming workshop used for risk identification have been addressed.
- Documentation of the psychological recommendations for brainstorming for risk identification has been made.
- A procedure for risk identification which includes the benefits of ideation reported in the state of the art has been developed.
- Risk events have been identified as product of the cognitive function of ideation and a precedence of using cognitive relative knowledge to enhance the production of ideas has been done.

6.3. Summary of Contributions

This research work claims the following as new knowledge:

- Development of the procedure for the ideation process that should take place for properly implementing the brainstorming technique in construction workshops for risk identification.
- Systematic steps for carrying out risk identification workshops, creating standardization for performing workshops consistently from an ideation perspective.
- Integration of the knowledge currently available related to the brainstorming technique in a construction related context.
- Documentation of the reason for supplementing a basic brainstorming method for completing the ideation process in a risk identification workshop.
- A brainstorming methodology suitable for construction related workshop and enhanced with the contributions from the literature, while highlighting and reincorporating missing elements in the current practice.

6.4. Future Research

The following topics are suggested for future research related to the presented methodology:

1. Developing a statistically valid method of testing the following hypotheses:

- A higher number of ideas (risk factors) are generated from an idea generation methodology applied in risk identification workshop, compared to the normal (current) use of idea generation techniques for risk identification.
- A higher quality of ideas (risks with higher severity) are generated if an idea generation methodology is follow, compared to the normal (current) use of idea generation techniques for risk identification.

2. Creating a simulation model to model the dynamic of brainstorming exercises by:

- Modeling the social, psychological, and environmental parameters that affect the performance (number and quality of ideas) of risk identification workshops.
- Modeling the variability of idea generation as a function of the likelihood of a thinker to change ideation parameters that may affect the idea production.

3. Developing a Group Decision Support System for risk identification exercise based on this creative methodology.

4. Adapting the present methodology for use in other areas of the construction industry dealing with brainstorming as the base of their idea production, i.e. for value engineering purposes.

5. Developing construction related evaluation measures for the parameters of the workshop, leader, participants and output, taking into consideration the psychological nature of the matters.

6. Creating a numeric index for evaluating the workshop from an ideation perspective dealing with:

- The paradigms for idea generation topics used by the participants.
- The evaluation of the incubation process performed by the participants.
- The workshop, the leader, the participants and the output, constituting the numeric category values of the index.
- The condition of the workshop environment, tracked and evaluated based on the parameters explained herein.

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