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# The factor structure of a safety leadership assessment tool for the mining industry

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**Abstract**

Research has established that an organisation's safety culture plays an important role in its safety performance and that developing safety leadership is one of the key elements of an optimal safety culture. The assessment of safety leadership behaviours forms the basis of safety leadership development strategies. Although several instruments are available to assess leadership behaviours only one measuring instrument was found specifically designed to assess safety leadership.

The main aim of this article is to describe how exploratory factor analysis was applied to establish whether the Leadership Assessment Tool is a valid and reliable instrument for the assessment of safety leadership. The second aim was to determine if a leadership assessment measure also indicates any progress achieved as a result of development actions. The study was conducted in an organisation in the South African mining industry.

The purposive sample (n = 54) consisted of management, employees, and health and safety representatives. The study followed a pre-test post-test design and data was collected by means of a 360-degree type survey. The data was analysed by means of factor analysis and Cronbach's coefficient Alpha.

Results indicated that the Leadership Assessment Tool is a valid and reliable measure to assess safety leadership.

***Key phrases***

*leadership assessment; leadership development; mining industry; safety leadership model*

# 1. INTRODUCTION

In South Africa, as in many other countries, employers have a moral as well as legal obligation to provide a healthy and safe working environment (Alli 2001:8; Esterhuizen & Martins 2015:428). Many organisations have started to place a higher priority on the prevention of occupational injury and disease and have adapted their health and safety policies to be in line with legislation and international standards (ILO 2011:1).

However, every year millions of workers worldwide still suffer, lose their ability to earn a livelihood and even die because of occupational injuries and diseases (Alli 2001:9; Esterhuizen & Martins 2015:428; ILO 2011:1). In the South African mining industry the situation is much the same and the industry continues to report unacceptably high injury rates and fatalities (Esterhuizen & Martins 2015:428; Jansen & Brent 2005:719; Pyoos 2008:5; Shabangu 2012:3).

Research has established that an organisation's safety culture plays an important role in its safety performance (Guldenmund 2006:i; Wiegmann, Von Thaden & Gibbons 2007:1) and that leadership and management commitment to safety is one of the key elements of creating an optimal safety culture (Keil Centre 2000:13; Krause 2004:1). Studies on the factors that distinguish organisations that are successful with their safety improvement initiatives from those that are less successful or that have failed have shown that *quality of leadership* is the most important distinguishing factor (Esterhuizen & Martins 2015:428; Flynn & Shaw 2009:31; Krause 2004:1). Thus, organisations that are interested in establishing a safety culture to improve safety as well as business performance would do well to develop the quality of their safety leadership (Boyd 2008:1; Clark 2002:211; Cooper 2001:iv; Dunlap 2011:42; Flynn & Shaw 2011:31; Krause 2004:11; Krause 2007:24; Krause & Weekley 2005:34; Pater 2012:28).

# 2. SAFETY LEADERSHIP

Leadership, at its most basic, can be defined as a "social process of influencing people to work voluntarily, enthusiastically and persistently towards a purposeful group or organisational goal" (Werner 2007:288). Leaders focus on developing long-term strategies to achieve organisational goals; they create a vision and inspire people to achieve that vision (Werner 2007:288). In short, a leader is someone who influences other people's behaviour to achieve certain goals. In terms of safety, the goals that need to be achieved are the prevention of incidents and the reduction of injuries and this is commonly referred to as safety performance improvement (Jones 2006:82; Petersen 2004:29). Essentially, safety leadership is the interpersonal influence that a leader exercises in order to achieve the organisation's safety performance goals (Petersen 2004:29).

Researchers have identified several elements that contribute to effective safety leadership such as personal attributes and values, knowledge and experience, safety management, leadership style and leadership behaviours (Carrillo 2002:41; Cooper 2001:30; Flynn & Shaw 2009:32; Geller 2000:41; Krause 2004:7; Krause 2007:24; Krause & Weekley 2005:35). Safety leadership behaviours include credibility, accountability, collaboration, learning orientation, business integration, action orientation, feedback and recognition, and vision and values (Carrillo 2002:41; Dunlap 2011:42; Flynn & Shaw 2009:33; Krause 2004:7). Esterhuizen (2014:96) and Esterhuizen and Martins (2015:429) developed an integrated safety leadership model that explains the interrelated working of the elements of safety leadership as illustrated in figure 1.


**FIGURE 1: Integrated safety leadership model**

Source: Esterhuizen 2014:96

The first step in developing safety leadership is to assess leaders on the different elements of safety leadership (Cacioppe 1998:48; Carrillo 2002:44; Locke & Tarantino 2006:54; Pater 2012:28). The assessment method employed will depend on which element is measured. Many different assessment instruments are available for assessing personal attributes and values and leadership style. Knowledge, experience and safety management can be assessed by collecting biographical data such as training records and work experience. Information on safety leadership behaviours are often collected by getting input from others in the form of a 360-degree survey (Carrillo 2002:44). The survey is one of the most frequently used methods in organisational research to assess phenomena that are not directly observable such as behaviours (Bartlett 2005:98; Rosenfeld, Edwards & Thomas 1995:548).

According to Cacioppe (1998:48) leadership assessments must capture the current level of leadership competence in the focus area, provide information for individual development actions, and measure improvement as the development programme progresses. The only measuring instrument that could be found in the literature specifically designed to measure safety leadership behaviours was the Leadership Assessment Tool (LAT). However, no information on the reliability or validity of the LAT is available.

## 3. AIM OF THE RESEARCH

This article is the second research paper based on research that investigates safety leadership in the South African mining industry. The first paper focused on the nested mixed methodology that was followed to evaluate the impact of a coaching programme on safety leadership and was presented at a conference in Malta (Esterhuizen & Martins 2015:430). The LAT was central to the quantitative part of this mixed methods study.

The main aim of this article is to describe how factor analysis was applied to validate the LAT. Specific aims are to establish the validity (measurement, content and construct) of the LAT and assess the adequacy of internal consistency estimates of the measure. The final part of the validation consisted of determining if this leadership assessment measure is able to indicate the progress achieved as a result of development actions.

The process followed to achieve these aims is depicted in figure 2.

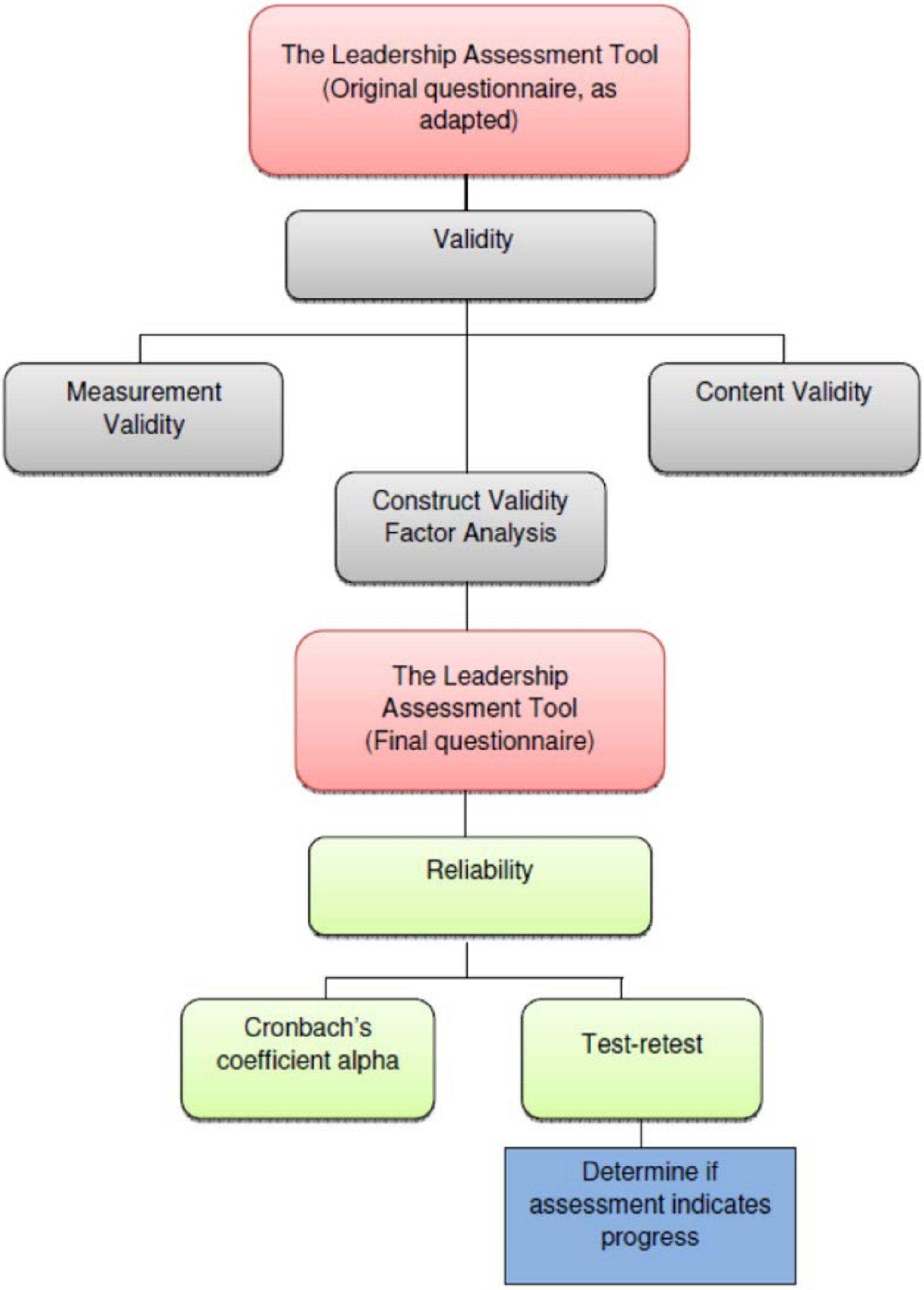


**Figure 2: The validation process**

Source: Author's own work

The original LAT was adapted for the purpose of the study and the subsequent validation of the measure consisted of establishing measurement validity, content validity, and construct validity by means of factor analysis as well as conducting reliability measures including Cronbach's coefficient alpha and test-retest reliability. Finally, pre-test and post-test results were compared to establish whether the assessment tool was able to indicate any progress achieved as a result of development actions.

## 4. DEFINING THE FACTOR ANALYSIS FRAMEWORK

The overall aim of the article is to describe how factor analysis was applied to validate the LAT. Thus, it is necessary to define factor analysis and consider a theoretical framework that guides the process.

Factor analysis is a useful statistical tool to determine construct validity and to develop and validate measurement instruments (Yang 2005:182). Factor analysis explains "correlations among a large number of observable variables by identifying or confirming underlying factors that explain these correlations" (Yang 2005:183). It is a method to reduce or summarise data into a smaller set of variables or factors with minimal loss of information (Hair, Black, Babin & Anderson 2010:96; Tredoux & Pretorius 1999:362). Data summarisation provides a structure for individual variables to be grouped together in terms of a concept that they represent collectively (Hair *et al*. 2010:98).

### 4.1 Theoretical framework

Factor analysis involves the making of a number of decisions and the Factor Analysis Decision Diagram (FADD), as proposed by Hair *et al*. (2010:97), was applied as a theoretical framework to guide the process. As illustrated in figure 3, Stage 1 to Stage 3 of the model involves making decisions about the factor model and whether the data complies with the requirements of factor analysis.

**Stage 1** involves deciding whether the purpose of the factor analysis is exploratory or confirmatory (or both) based on the research problem and the objective of the factor analysis. Exploratory factor analysis is appropriate when the objective of performing the factor analysis is to achieve data reduction into a smaller number of components and identify the structure among the set of variables (Hair *et al*. 2010:97).

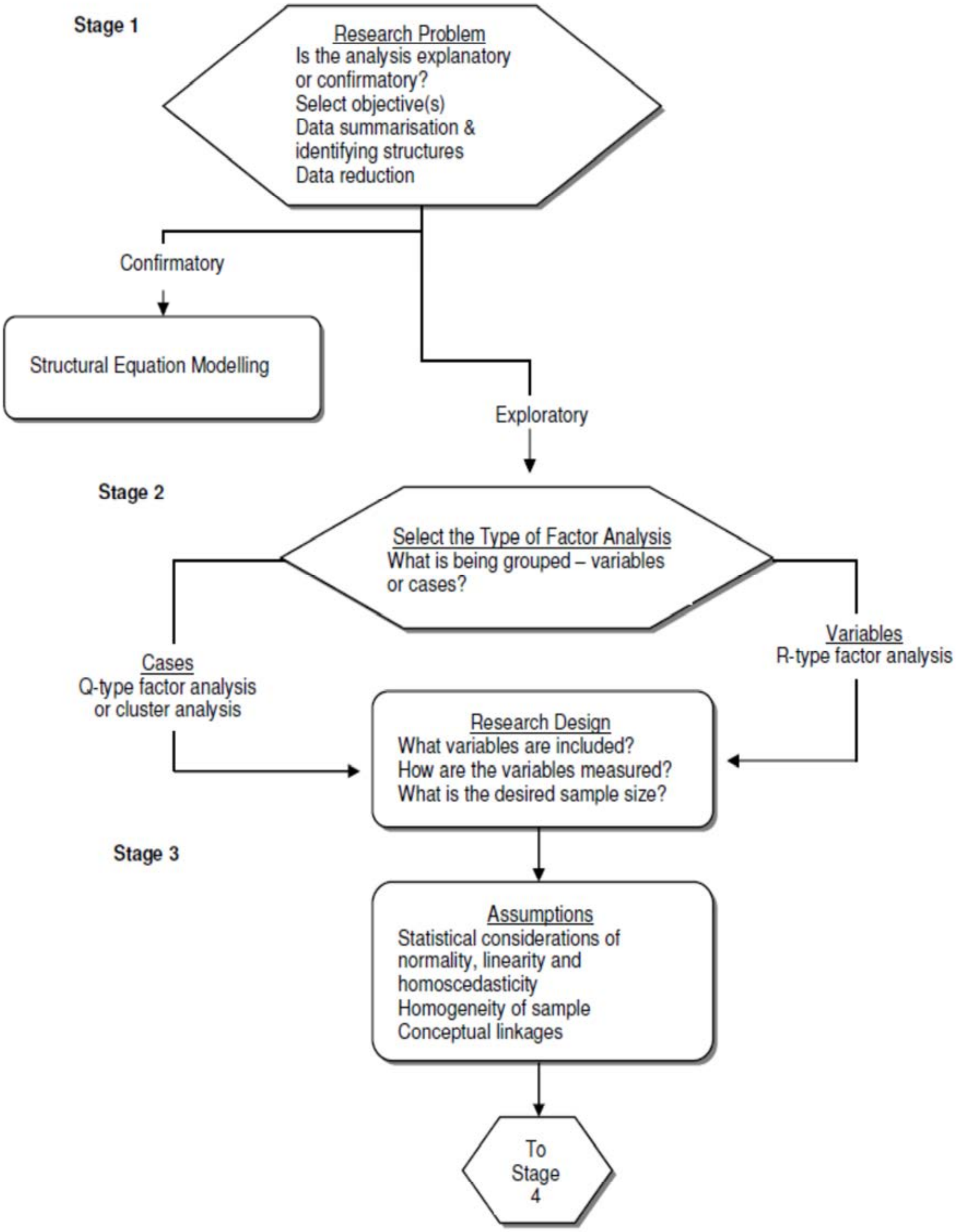


**FIGURE 3: Stages 1-3 in the factor analysis decision diagram**

Source: Hair *et al*. 2010:93

It is also appropriate when the main purpose is to explore underlying factors and how items load on factors that have not been clearly revealed (Yang 2005:184). Confirmatory factor analysis, however, is preferable to confirm or disconfirm the relationship between variables and factors in a hypothesised factor structure such as when evaluating existing instruments (Hair *et al*. 2010:693; Yang 2005:184).

In **stage 2** the researcher must make decisions about the type and design of the factor analysis. This includes considering aspects such as what is going to be grouped (variables or cases), and selecting an adequate sample size from the target population. If cases are grouped, then Q-type factor or cluster analysis is performed, and when variables are grouped, R-type factor analysis is conducted. Although there is some debate around what constitutes an adequate sample size for factor analysis, the general rules of thumb for sample size are that the sample should be 100 or larger and that there should be five times as many observations as the number of variables being analysed (Hair *et al*. 2010:102; Yang 2005:185).

**Stage 3** involves complying with the conceptual and statistical assumptions of factor analysis. Firstly, the researcher must ensure that observed patterns are conceptually valid and appropriate to be analysed with factor analysis in that some underlying structure (based on theory) must actually exist in the set of variables (Hair *et al*. 2010:103). Secondly, to comply with the statistical requirements in factor analysis of sampling adequacy and sufficient correlation, the Kaiser-Mayer-Olkin measure of sampling adequacy and Bartlett's test of sphericity can be utilised (Hair *et al*. 2010:104).

The next two stages, namely stage 4 and stage 5, in the Factor Analysis Decision Diagram of Hair *et al*. (2010:97) are depicted in Figure 4.

**Stage 4** consists of two parts: Firstly, a factor extraction method is selected, for example principal component analysis or common factor analysis, and secondly the factor matrix is specified by determining the number of factors to be retained.

Principal component analysis is generally selected when the objective of the research is data reduction, i.e. reducing many variables into a smaller set of components (Hair *et al*. 2010:107; Yang 2005:188). Common factor analysis is usually selected when the purpose is to identify underlying variables that contribute to the common variance of the variables (Hair *et al.* 2010: 107; Yang 2005:188).

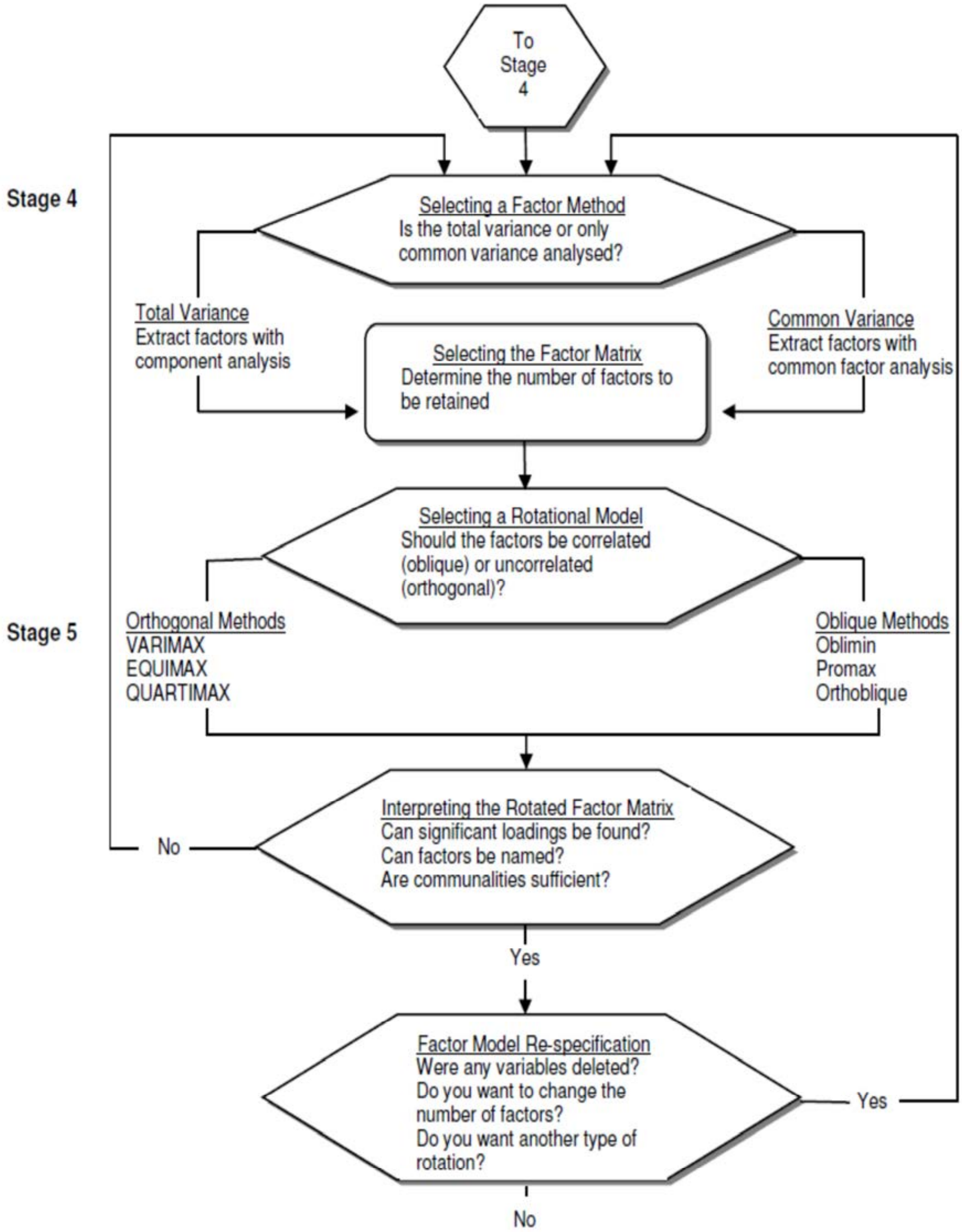


**FIGURE 4: Stages 4 and 5 in the Factor Analysis Decision Diagram**

Source: Hair *et al.* 2010:106

The second part of stage 4 involves deciding how many factors to retain. In determining the number of factors, the researcher must combine a conceptual foundation, i.e. how many factors should be in the structure with some empirical evidence that shows how many factors can be reasonably supported (Hair *et al*. 2010:109). Empirical evidence to determine the number of factors includes latent roots or eigenvalues greater than one as well as the percentage of total variance criterion of 60% or more (Hair *et al*. 2010:109; Tredoux & Pretorius 1999:363; Yang 2005:190).

In **stage 5** the researcher must select a rotational method and interpret the rotated factor matrix. A rotational method is selected based on whether the factors are expected to be correlated (oblique) or uncorrelated (orthogonal).

The VARIMAX method has proved successful as an analytic approach to obtain an orthogonal rotation of factors (Hair *et al*. 2010:115). Interpreting the rotated factor matrix involves five steps, namely to examine the factor loadings, determine whether significant loadings exist, determine whether communalities are sufficient, re-specifying the factor model if needed and naming the factors.

Hair *et al*. (2010:122) identified two additional stages of the FADD.

**Stage 6** of the FADD involves validating the model, and the most direct method is to adopt a confirmatory approach to assess the replicability (reliability) of the results with split halves or another, preferably independent, sample (Hair *et al*. 2010:122; Hinkin 2005:175).

**Stage 7** involves making the decision to further engage in other methods of data reduction or, if the objective of the research was achieved, to suffice with factor analysis.

## 4.2 Research design

A one-group pre-test post-test design was followed for this study. This design involves the collection of data before and after an intervention in order to determine the impact of the intervention on the variables being studied (Bartlett 2005:102).

This design is commonly applied to evaluate improvement as a result of development actions as well as to establish the validity of factor analysis and the reliability of a measure (Hair *et al*. 2010:122; Hinkin 2005:175).

## 4.3 Research method

### *4.3.1 Sample*

The case organisation is a small mining operation with approximately 480 employees. The purposive sample (N = 54) consisted of senior management and other managers, their superiors and some subordinates as well as the organisation's health and safety representatives. These groups rated themselves and each other in their various capacities as peers, subordinates and superiors and a total of 215 questionnaires were completed.

### *4.3.2 Measuring instrument*

The LAT was developed by the Mine Health and Safety Council (MHSC) in 2011 to enable mining companies to assess the quality of their safety leadership. This 360-degree type survey is based on the internationally recognised work of Behavior Safety Technologies (BST) and the International Council for Minerals and Metals (ICMM).

The original questionnaire consisted of nine main statements that described the required safety leadership behaviours. Seven of the main statements each had between one and five sub-statements numbered a) to e). Two of the main statements did not have any sub-statements. The questionnaire asked for participants' responses to statements about safety leadership performance along a 5-point Likert type scale ranging from strongly disagree (1) to strongly agree (5). After each set of statements, a space to record comments was provided.

In order to utilise this questionnaire for the purpose of the study, three aspects needed to be addressed. Firstly, the original questionnaire did not include the recording of any demographic data to be able to make comparisons between the responses of different groups. Secondly, the name of the person being assessed is not recorded which makes it impossible to collect the individual performance data required for development actions. Thirdly, some of the statements are compound questions in the sense that a statement asks for one response but includes two aspects, for example challenges *and* inspires.

Thus, the questionnaire was adapted to provide for the recording of participants' demographic data, namely gender, race, position and age group. The person that must be evaluated was also indicated for the respondent. In addition, participants had to indicate in what capacity, in relation to the person being evaluated, they were completing the questionnaire, i.e. as self, peer, subordinate, superior or health and safety representative.

The statements were reviewed and all compound questions were split into two separate questions and the adapted questionnaire consisted of 44 statements. No headings were included but the statements were kept in the same order and grouping according to the nine main statements as in the original questionnaire. The space for comments was omitted because the focus was on a quantitative analysis.

### *4.3.3 Data collection method and procedure*

A session for each level of participants was conducted separately. During the sessions the purpose and aims of the research project were explained. The 360-degree survey process was explained and participants were given basic training on the pitfalls to avoid when rating. Confidentiality arrangements were explained, namely that the questionnaires were to be completed anonymously and that any feedback of the results would only be given in group context.

Hard copies of the original questionnaire, as adapted, were handed out to participants. The researcher explained the different sections of the questionnaire and also read through each statement and dealt with any questions regarding the meaning of words. Thereafter, the participants were given the opportunity to complete the questionnaire and put their completed surveys in a slotted box. A total of 215 questionnaires were completed.

The pre-test results reflected the current level of safety leadership competencies and provided information for individual development actions. Based on this, development areas for managers were identified and development strategies were implemented as part of an executive coaching programme.

The post-test assessment was conducted after completion of the executive coaching programme to improve safety leadership and approximately eight months elapsed between the pre- and post-test. For the post-test survey, the above process was repeated. All information was repeated for refresher purposes and the same procedure was followed. Exactly the same group of people participated in the post survey and thus a total of 215 questionnaires were completed again.

## 4.4 Data analysis

The statistical analysis of the data was conducted with the Word version of the Statistical Package for Social Sciences (SPSS). Frequency distributions were generated to provide descriptive statistics of the sample. Statistics generated for the factor analysis included the Kaiser-Mayer-Olkin measure of sampling adequacy, Bartlett's test of sphericity, communalities, total variances explained, the factor matrix, and the rotated component matrix. In terms of reliability estimates, Cronbach's coefficient alpha was calculated.

## 4.5 Results

### *4.5.1 Demographics of the sample*

The majority of the questionnaires (n = 215) were completed by males (82%) and 18% by females. The majority of the sample consisted of Africans (79%) and whites constituted 21%. Indians and coloureds were not represented in the sample as they are not represented in the population either. Participants were grouped into six main job categories or levels, namely senior management, management, supervisor, foreman, employee, and health and safety (H&S) representatives. Most of the questionnaires were completed by H&S representatives (38%) and employees (27%), followed by foremen (14%), management (11%), senior management (7%), and supervisors (3%). The age distribution varied across five categories and the majority of participants were between the ages of 31 and 40 years (61%). Seventeen (17) per cent were between 41 and 50 years, 14% were between 21 to 30 years and 8% between 51 and 60 years.

### *4.5.2 Measurement validity*

Measurement validity is ensured when the measuring instrument is suited to the purpose for which it is applied (Durrheim 1999:83). Measurement validity was established because the measuring instrument was designed to measure safety leadership behaviour and it was applied for that purpose.

### *4.5.3 Content validity*

Content validity is established if the items on the instrument are representative of what is being measured (Durrheim 1999:85). The content validity of the statements in the questionnaire was established in a logical manner by subject matter experts by means of comparing it with the descriptions of safety leadership behaviours as described in the literature. It was confirmed that the statements reflected the content of the domain that was being studied.

### *4.5.4 Construct validity*

A construct is a phenomenon (an attitude, behaviour or other characteristic) that is difficult to observe or measure directly, for example motivation or job commitment (Holton & Burnett 2005:33; Rosenfeld *et al.* 1995:548). Establishing the construct validity of a measure involves the task of "determining the degree to which a measure of a construct is empirically related to other measures with which it is theoretically associated" (Durrheim 1999:87). Construct validity was established with factor analysis as reported in the next section.

### *4.5.5 Factor analysis*

The analysis was considered exploratory as the objective of performing the factor analysis was to achieve data reduction into a smaller number of components and identify the structure among the set of variables. Variables and not cases were grouped thus resulting in R-type factor analysis (Hair *et al*. 2010:97-98). In this study there were 44 variables and 215 observations complying with the general rule of thumb of a ratio of 1:5 (Hair *et al*. 2010:102; Yang 2005:185).

The variables were based on the safety leadership behaviours identified in the literature and structured around nine main statements concerning required safety leadership behaviours thus complying with the conceptual requirement of factor analysis. In order to comply with the statistical requirements of factor analysis the researcher must ensure sampling adequacy and that sufficient correlation exists in the data. According to Field (2009:877), Kaiser-Myer-Olkin values between 0.5 and 0.7 are average, between 0.7 and 0.8 are good, and above 0.9 are excellent.

As displayed in Table 1, the Kaiser-Myer-Olkin value was 0.925 thus confirming sampling adequacy. A statistically significant Bartlett's test of sphericity (sig. $< 0.0$) indicates that sufficient correlations exist among the variables to proceed with factor analysis (Hair *et al*. 2010:104). As is also reflected in Table 1, Bartlett's test of sphericity reached statistical significance ($p=0.000$) supporting the factorability of the correlation matrix.

### TABLE 1: Kaiser-Meyer-Olkin and Bartlett's Test

| Kaiser-Meyer-Olkin measure of sampling adequacy | | 0.925 |
|---|---|---|
| Bartlett's Test of Sphericity | Approx. Chi-square | 7970.286 |
| | Degrees of freedom | 946 |
| | Significance. | 0.000 |

Source: Calculated from research results

Thus, eight factors were retained, all with eigenvalues greater than one and explaining 70.2% of the variance, as reflected in Table 2.

### TABLE 2: Factor analysis

| Total variance explained | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Component | Initial Eigenvalues | | | Extraction sums of squared loadings | | | Rotation sums of squared loadings | | |
| | Total | % of variance | Cumulative % | Total | % of variance | Cumulative % | Total | % of variance | Cumulative % |
| 1 | 20.466 | 46.513 | 46.513 | 20.466 | 46.513 | 46.513 | 5.095 | 11.579 | 11.579 |
| 2 | 2.299 | 5.226 | 51.739 | 2.299 | 5.226 | 51.739 | 4.489 | 10.203 | 21.782 |
| 3 | 1.698 | 3.858 | 55.597 | 1.698 | 3.858 | 55.597 | 4.243 | 9.642 | 31.425 |
| 4 | 1.563 | 3.552 | 59.150 | 1.563 | 3.552 | 59.150 | 3.540 | 8.046 | 39.470 |
| 5 | 1.431 | 3.251 | 62.401 | 1.431 | 3.251 | 62.401 | 3.525 | 8.012 | 47.483 |
| 6 | 1.276 | 2.900 | 65.301 | 1.276 | 2.900 | 65.301 | 3.486 | 7.922 | 55.405 |
| 7 | 1.168 | 2.656 | 67.957 | 1.168 | 2.656 | 67.957 | 3.374 | 7.669 | 63.074 |
| 8 | 1.014 | 2.305 | 70.262 | 1.014 | 2.305 | 70.262 | 3.163 | 7.188 | 70.262 |
| 9 | .950 | 2.159 | 72.420 | | | | | | |
| 10 | .847 | 1.926 | 74.346 | | | | | | |

Note: Only partial results displayed up to component 10

Source: Calculated from research results

Principal component analysis was selected as factor extraction method because this method is appropriate when the objective of factor analysis is to reduce the original information into a smaller set of components (Hair *et al*. 2010:107; Tredoux & Pretorius 1999:362; Yang 2005:182).

According to Kaiser's criterion only the factors having eigenvalues greater than 1 are considered significant. Applying the eigenvalue for establishing a cut-off is most reliable when the number of variables is between 20 and 50 as is the case in this study where there were 44 variables (Hair *et al*. 2010:109).

This percentage is in line with the guideline that only the factors that explain 60–70% of the total variances should be retained (Hair *et al*. 2010:110; Tredoux & Pretorius 1999:365; Yang 2005:191).

In this study the factor matrix obtained was rotated to a simple structure by means of VARIMAX rotation. Subsequently, items with a high loading on a specific factor were grouped together (Hair *et al*. 2010:115), as reflected in Table 3.

**TABLE 3: Rotated component matrix**

| Item | Component | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Q14 | 0.713 | | 0.427 | | | | | |
| Q1 | 0.684 | | | | | | | |
| Q12 | 0.657 | | | | | | | |
| Q3 | 0.640 | | | | | | | |
| Q13 | 0.593 | 0.437 | | | | | | |
| Q2 | 0.538 | | | | | 0.512 | | |
| Q4 | 0.537 | 0.522 | | | | | | |
| Q9 | 0.468 | | | 0.407 | | | | |
| Q10 | 0.456 | | | | 0.402 | | | |
| Q40 | | 0.688 | | | | | | |
| Q25 | | 0.666 | | | | | | |
| Q31 | | 0.594 | | | 0.405 | | | |
| Q34 | | 0.558 | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Q30 | | 0.557 | | | | | | |
| Q29 | 0.401 | 0.470 | | | | | | 0.439 |
| Q43 | | 0.446 | | | | | | |
| Q41 | | | 0.729 | | | | | |
| Q42 | | | 0.727 | | | | | |
| Q22 | | | 0.622 | | | | | |
| Q44 | | | 0.514 | | | 0.419 | | |
| Q33 | | | 0.421 | | | | | |
| Q19 | | | | 0.697 | | | | |
| Q21 | | | | 0.625 | | | | |
| Q20 | | | | 0.600 | | | | |
| Q17 | | | | 0.548 | | | | 0.439 |
| Q18 | | | | 0.511 | | | | |
| Q36 | | | 0.430 | 0.507 | | | | |
| Q5 | | | | | 0.715 | | | |
| Q6 | | | | | 0.664 | | | 0.404 |
| Q24 | | | | | 0.575 | | | |
| Q32 | | | | | 0.509 | | | |
| Q39 | | | | | | 0.683 | | |
| Q16 | | | | | | 0.558 | | |
| Q38 | | | | | | 0.546 | 0.401 | |
| Q37 | | | | | | 0.481 | | |
| Q23 | | | | | | 0.436 | | 0.415 |
| **Q11** | | | | | | | | |
| Q15 | | | | | | | 0.695 | |
| Q7 | | | | | | | 0.631 | |
| Q8 | | | | | | | 0.550 | |
| Q35 | | 0.437 | | | | | 0.454 | |
| Q28 | | | | | | | | 0.634 |
| Q27 | | | | | | | | 0.600 |
| Q26 | | | | | 0.409 | | | 0.574 |

Source: Calculated from research results

Factor loadings in the range of 0.30 to 0.40 are considered to meet the minimal level for interpretation of structure, and loadings of 0.50 or greater are considered practically significant. Loadings exceeding 0.70 are considered indicative of well-defined structure and are the goal of any factor analysis. The significance of factor loadings is based on sample size and for samples of 200-250 a loading of at least 0.40 is needed (Hair *et al*. 2010:117). All items had factor loadings of 0.40 or higher and meet the minimum level for interpretation. The majority of variables (36 out of 44) had a factor loading of more than 0.50 and were considered practically significant.

Items are considered to have high communalities if 0.70 (Fabrigar *et al*. 1999:273) and items with lower than 0.50 should be discarded. All items displayed communality values of 0.50 or higher as specified by the researcher and in line with the cut-off value as proposed by Hair *et al*. (2010:119).

Some items loaded onto more than one factor and in each case the item was included in the factor for which it obtained the highest result. One of the items (Q11) did not load onto any of the factors and this item was rejected. Thus, the final questionnaire consisted of 43 statements that were regrouped and renumbered according to the factors identified in the factor analysis.

Factors with fewer than three items are generally considered weak and unstable and should be eliminated (Costello & Osborne 2005:5; Yang 2005:188). All eight factors had three or more items. Thus, the eight factors were accepted to be the meaningful dimensions that represented the variables measured (Tredoux & Pretorius 1999:632; Yang 2005:191).

In naming the factors, variables with higher loadings are considered more important and have greater influence on the name or label selected to represent a factor (Hair *et al*. 2010:120). The statements that loaded onto the eight factors were analysed and, based on the safety leadership behaviours as identified in the literature, were labelled and operationalised as follows (Esterhuizen 2014:193):

- **Credibility**

Credibility refers to whether people believe in the integrity of the safety leaders because their decisions and actions consistently match what they say. It also involves being consistent in setting and applying safety standards. In other words, the same rules should apply to everyone under the same circumstances. Another important aspect of credibility is that senior management must lead by example to show that they genuinely care about safety.

- **Accountability**

The dimension of accountability refers to the fact that safety leaders must accept responsibility but also hold others accountable for safety performance. This means that leaders must clearly establish and communicate what employees' role in safety is, what the expected safety behaviours are and what the consequences are for poor safety performance and not complying with safety rules. Effective safety leaders must instil the sense that people are responsible for safety in their own organisational unit and level.

- **Collaboration**

Collaboration means working well with other people and promoting participation in safety. This includes engaging in and leading discussions (communication) about potential safety risks, asking for input from people on issues that will affect them, treating all people with respect, and encouraging others to implement ideas and solutions to improve safety. All employees should be involved by contributing ideas for improvement and being encouraged to become aware of what safety performance means in terms of their own jobs.

- **Learning orientation**

A learning orientation refers to the willingness of safety leaders to identify, learn from and change unsafe conditions and behaviours. Leaders need to allocate sufficient resources and build employee competencies through training and communication. It is also important to provide a mechanism to review incidents and to give feedback about corrective actions taken. Another aspect of learning orientation is the value that is placed on the function and contribution of safety role players in the organisation such as the safety manager and health and safety representatives.

- **Business integration**

In every business there are competing priorities such as production versus safety and it is critical that senior management integrate safety into all business decisions and objectives also on a strategic level. Management must be fully committed to improving health and safety and focus their efforts on the most important priorities that include safety issues.

- **Action orientation**

An effective safety leader is proactive rather than reactive in addressing safety issues. This means that management must know the risk profile of the business and identify and address hazards and risks before they cause an incident or accident. A safety leader is performance-driven and takes advantage of opportunities to improve safety and consistently delivers results in solving safety-related problems.

- **Feedback and recognition**

The effective safety leader is good at providing feedback and giving recognition for accomplishments in terms of improving safety. This translates to publicly recognising the contributions of others, giving recognition for good safety performance, praising employees more often than criticising them, and finding ways to celebrate success. Safety leaders should not only give feedback but also be prepared to receive feedback about employees' grievances and ideas about safety. Employees should feel comfortable to report safety issues without fear of discipline or victimisation.

- **Vision and values**

The dimension of vision and values refers to the "picture" or ideal that the most senior executives have of what safety performance excellence looks like for the organisation. The safety leader must convey this vision in a compelling manner so that everyone in the organisation understands what is expected. Management must inspire employees to uphold the safety vision and values and also challenge behaviours that are not in accordance with the vision and values.

### *4.5.6 Reliability*

A measure can be valid but only if it is also reliable (Durrheim 1999:88; Yang 2005:195). Reliability refers to the consistency with which an instrument yields results (Holton & Burnett 2005:35; Durrheim 1999:88). In this study the reliability of the measuring instrument was determined by calculating Cronbach's coefficient alpha for the various factors or dimensions.

Factor analytical methods may result in factors that are sample-specific and inclined to yield high reliability results. In order to enhance the validity and generalisability of a measure, it is appropriate to gather information from additional, preferably independent, samples (Hair *et al*. 2010:125 Hinkin 2005:175).

In the interest of confidentiality and for ethical reasons, no identifying information was recorded on the surveys and therefore the pre-test and post-test results of individuals could not be paired. Subsequently, the pre-test and post-test data sets were treated statistically as independent samples.

According to Nunnally and Bernstein (1994:264), scores above 0.70 are sufficient to establish reliability. All of the dimensions obtained results of more than 0.70 in both the pre-test and post-test, as indicated in Table 4. Thus, the results were considered to be reliable.

**TABLE 4: Cronbach's coefficient alpha per dimension**

| Dimension | No of Items | Cronbach's alpha pre-test | Cronbach's alpha post-test |
|---|---|---|---|
| Dimension 1 – Credibility | 9 | 0.912 | 0.922 |
| Dimension 2 – Accountability | 6 | 0.882 | 0.893 |
| Dimension 3 – Collaboration | 6 | 0.852 | 0.848 |
| Dimension 4 – Learning orientation | 5 | 0.898 | 0.868 |
| Dimension 5 – Business integration | 4 | 0.808 | 0.797 |
| Dimension 6 – Action orientation | 5 | 0.848 | 0.850 |
| Dimension 7 – Feedback and recognition | 4 | 0.834 | 0.771 |
| Dimension 8 – Vision and values | 4 | 0.852 | 0.811 |

Source: Calculated from research results

Cacioppe (1998:48) purports that a leadership assessment measure must also be able to indicate the progress achieved as a result of development actions. The development actions were focused on the managers and a comparison of the pre-test and post-test scores for this group is illustrated in Figure 4 (Esterhuizen 2014:225).

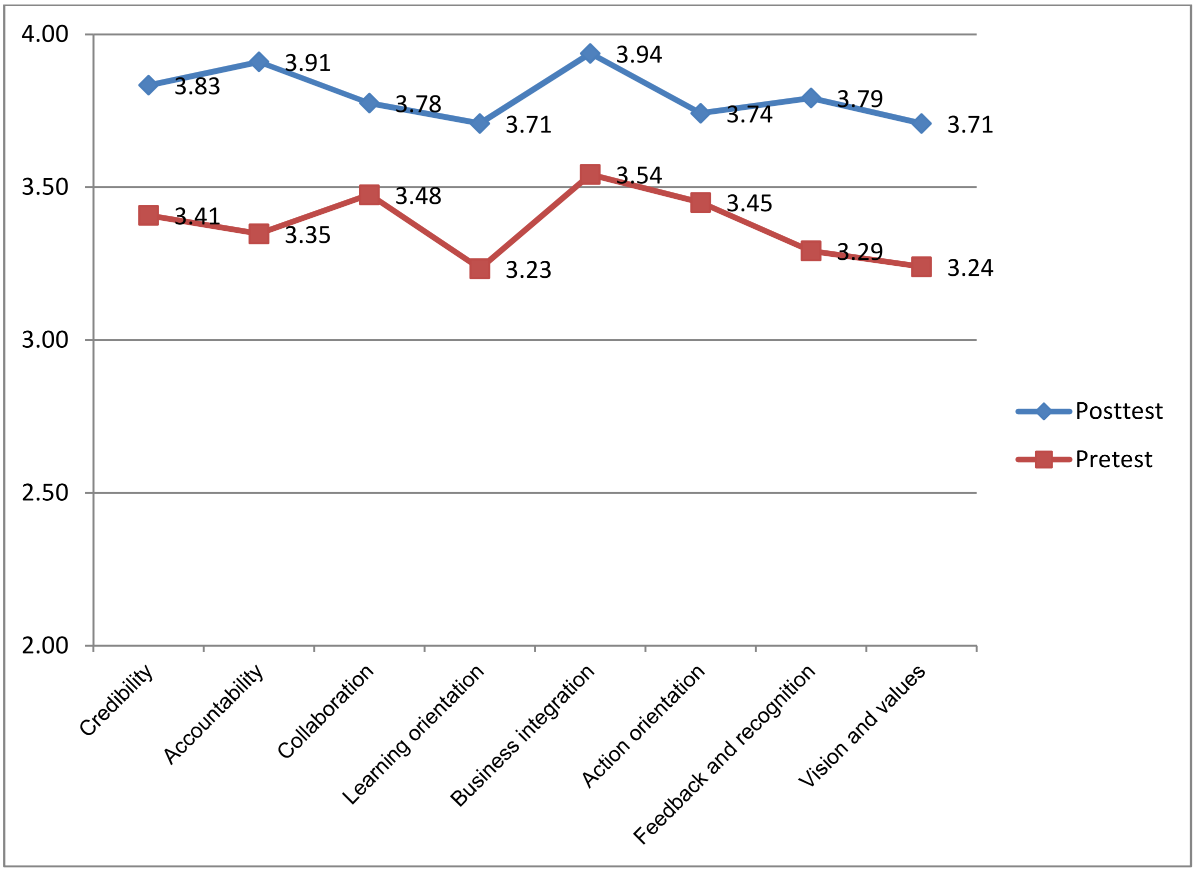


**FIGURE 4: Pre-test post-test means comparisons: management**

Source: Calculated from research results

The management level's post-test means were notably higher than the pre-test on all dimensions. Management's post-test ratings were on average 0.43 points higher than their pre-test ratings. This represents an average increase of 13% between pre-test and post-test results.

As presented in Table 5, the independent samples t-test highlighted significant differences on the 0.05 level between the pre-test and post-test results of management for credibility, accountability, learning orientation, business integration, feedback and recognition and vision and values. Management rated six of the eight dimensions significantly higher on the post-test (i.e. after the intervention) than on the pre-test.

## TABLE 5: Pre-test post-test comparisons of management: t-test for equality of means

| | | t | df | Sig. (2-tailed) | Mean differ-rence | Std. error differ-rence | 95% confidence interval of the difference | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Dimension_1 Credibility | Equal variances assumed | -2.381 | 46 | .021* | -.42593 | .17892 | -.78607 | -.06578 |
| | Equal variances not assumed | -2.381 | 45.868 | .021 | -.42593 | .17892 | -.78610 | -.06575 |
| Dimension_2 Accountability | Equal variances assumed | -3.471 | 46 | .001* | -.56250 | .16204 | -.88867 | -.23633 |
| | Equal variances not assumed | -3.471 | 42.823 | .001 | -.56250 | .16204 | -.88933 | -.23567 |
| Dimension_3 Collaboration | Equal variances assumed | -1.748 | 46 | .087 | -.30000 | .17158 | -.64537 | .04537 |
| | Equal variances not assumed | -1.748 | 45.826 | .087 | -.30000 | .17158 | -.64540 | .04540 |
| Dimension_4 Learning orientation | Equal variances assumed | -2.814 | 46 | .007* | -.47500 | .16882 | -.81481 | -.13519 |
| | Equal variances not assumed | -2.814 | 45.991 | .007 | -.47500 | .16882 | -.81481 | -.13519 |
| Dimension_5 Business integration | Equal variances assumed | -2.326 | 46 | .024* | -.39583 | .17020 | -.73842 | -.05325 |
| | Equal variances not assumed | -2.326 | 44.839 | .025 | -.39583 | .17020 | -.73866 | -.05301 |
| Dimension_6 Action orientation | Equal variances assumed | -1.609 | 46 | .114 | -.29167 | .18127 | -.65655 | .07321 |
| | Equal variances not assumed | -1.609 | 41.973 | .115 | -.29167 | .18127 | -.65749 | .07416 |
| Dimension_7 Feedback & recognition | Equal variances assumed | -2.756 | 46 | .008* | -.50000 | .18141 | -.86517 | -.13483 |
| | Equal variances not assumed | -2.756 | 44.120 | .008 | -.50000 | .18141 | -.86559 | -.13441 |
| Dimension_8 Vision & values | Equal variances assumed | -2.689 | 46 | .010* | -.46875 | .17429 | -.81958 | -.11792 |
| | Equal variances not assumed | -2.689 | 45.584 | .010 | -.46875 | .17429 | -.81967 | -.11783 |

* $p \leq 0.05$

Source: Calculated from research results

## 5. CONCLUSION

The main aim of this article was to describe how factor analysis was applied to validate the LAT and establish its validity and reliability as a measure of safety leadership. These aims were achieved by conceptualising safety leadership, describing the theoretical framework that was followed and reporting on the key decisions in terms of the factor analysis process including the factor extraction method, criteria to determine the number of factors, the rotation method and how the factors were defined. Reporting of the results included descriptive statistics, measures of sample adequacy and correlation of variables, eigenvalues, communalities, the factor loading matrix, the rotated matrix, the percentage of variance accounted for by each factor, as well as results of the reliability measures.

The results indicated that the LAT is a valid and reliable measure to assess safety leadership. It meets the requirements for a leadership assessment measure, namely to indicate the current level of competency and provide information for individual development actions. In addition, it is able to indicate the progress achieved as a result of development actions as reflected in the comparison of pre- and post-test results. Thus, the LAT could be a valuable tool for organisational development practitioners to assist individuals and organisations in developing and improving safety leadership skills.

The ability to generalise the results of the study may be limited because of a few factors. The study was conducted in a relatively small organisation in the clay mining industry and this limits the ability to generalise the results to other types and sizes of mining concerns (e.g. platinum, coal, gold, diamond). For the same reason, a limitation exists in terms of the unbalanced distribution of race, gender and job level in the sample (e.g. lack of Indian and coloured participants). A suggestion for further research is to repeat the study in other mining companies as this would provide bigger and more gender and racially balanced samples to increase the generalisability of the results.

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