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Factor Analysis of Elements Influencing Occupational Safety and Health Management System Development in Trinidad and Tobago

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Abstract: *It is increasingly important that organisations focus on occupational safety and health (OSH) to enhance their competitive edge. In Trinidad and Tobago (T&T) the OSH Act aims to reduce risk levels through development of safe systems of work. This paper reports on factor analysis conducted upon a recent survey of Occupational Safety and Health Management System (OSHMS) implementation in the manufacturing sector of T&T. The survey targeted a group of 40 small and medium-sized manufacturing enterprises (SMEs). It explored the factors influencing OSHMS development from among 22 elements. It was found that two overarching factors correlate significantly to OSHMS implementation in SMEs. Factor 1, "Safety Structure and Practices", consisted of 11 OSHMS elements in two groups ("OSH Oversight" and "OSH Arrangements") with factor loadings ranging between 0.599 and 0.876. Factor 2 "Improvement Drivers" consisted of 4 OSHMS elements with factor loadings ranging between 0.805 and 0.846. The remaining 7 elements were eliminated during the course of the analysis due to low correlation or low communality of elements, or double-loading on factors. The paper puts forward that government- and industry-supported systems could be critical aids to promote collaboration among SMEs and help them to set up their own formal OSHMS.*

Keywords: *OSH Act, Factor Analysis, Occupational Safety and Health Management System, OSHMS*

1. Introduction

Recent studies advocate the importance of safety and health practices that promote economic wellbeing and productivity for both businesses and nations (Abdul Raouf, 2004; Hawkins and Booth, 1998; ILO, 2001; Law et al., 2006). In Trinidad and Tobago (T&T), more focus is being placed on developing and growing the manufacturing sector so as to diversify its economy. This sector consists mainly of small and medium enterprises (SMEs). The Occupational, Safety and Health (OSH) Act encourages micro-enterprises to have OSH systems in place, but they are not mandated to maintain much documentation or even have OSH Committees or policies. However, in the case of larger organisations, the OSH Act does require more formal, documented systems (GORTT, 2004). At present, it is not known to what extent T&T manufacturing companies which have installed OSH Management Systems (OSHMS) are in compliance with the OSH Act, as data and statistics have not been publicly published. There is therefore a need to evaluate the extent to which OSHMS implementation has been effected in compliance with the OSH Act. This paper reports findings of a recent survey of OSHMS implementation, and identifies the main factors that contribute to the OSHMS development in the manufacturing sector with a focus on SMEs in T&T.

This paper has five (5) sections. Following the introduction, a Literature Review is presented in Section 2. An outline of the study approach is provided in Section 3. In Section 4, the various stages of analysis are described, ideal values of constants are compared to the empirically determined values, and further actions are rationalised. The paper concludes in Section 5 with recommendations based on the findings of the research.

2. Literature Review

There is, to a large extent, concurrence on good safety management practices around the world. For many years, the UK's Health and Safety Executive (HSE) using the POPMAR approach, recommends that OSHMS development and implementation include setting *policy* for OSH, *organising* staff, *planning* for health and safety, *measuring* OSH performance, and devising a system *audit* and *review* activities (HSE, n.d.). Since 2013, the HSE (2013) has aligned its recommendations with the 'Plan, Do, Check, Act' (PDCA) approach, pointing out that OSH management systems should be integrated within companies' overall management systems and rolled out in accordance with each individual company's risk profile. In addition to this overarching recommendation, the HSE makes several guidelines and templates freely available to its stakeholders via its website. The ANSI/AIHA (2005) OSHMS standard seems strongly aligned with this approach as well.

Commonly recommended OSH elements include developing an OSH policy, providing OSH training, setting OSH rules and regulations, performing inspections for hazardous conditions, performing job hazard analysis, conducting investigations of accidents and incidents, establishing programmes promoting OSH, establishing programmes to protect employee health and well-being, managing subcontractors, and establishing programmes to plan for emergencies (Nathai-Balkissoon, Pun, and Koonj Beharry, 2012). Teo and Ling (2006) also called for the use of team meetings, proper equipment maintenance, control of hazardous materials, and safe work practices. Chan, Kwok, and Duffy (2004) support the development of OSH organisation elements, including a safety committee, as well as OSH arrangements including programmes for process control and personal protection.

T&T's OSH Act (GORTT, 2004; 2006) requires the following to be included with an OSHMS: OSH policy, safety information, instruction, training, and supervision, risk assessments, accident investigation, health surveillance, measures to protect the safety, health and welfare of employees and non-employees, emergency preparedness, employee consultation and functioning of a safety committee in larger organisations, hazardous material management, personal protective equipment and devices, safe work systems and practices, including safeguarding of machinery. The challenge with the T&T OSH Act is that implementation of some elements is left to the discretion of the company. The likelihood that manufacturing organisations will place a high priority on OSHMS development is lowered because there is little enforcement by T&T's OSH Authority and Agency, OSHA (Nathai-Balkissoon, 2011). It is difficult to assess the state of OSHMS implementation across the industry sectors within T&T, since there is a paucity of published and publicly available data on the subject.

3. Methodology

3.1 Survey Instrument and Administration

A survey questionnaire was developed, with reference to the OSH Act content. Data, presented in this paper, were sourced from the section of the survey that evaluated the extent to which OSHMS elements had been implemented. Table 1 shows the survey question and the 22 items that were the focus of this factor analysis, along with the 5-point Likert scale and rating values used in coding the data.

For the convenience of respondents, an electronic version of the survey was developed within the Survey Monkey online survey programme, and disseminated using a web-link. The web-link was sent to the sample population via email, along with a message explaining the survey purpose, giving assurance of confidentiality, describing the approach to data treatment and requesting completion of the survey online.

The survey was distributed to 100 SMEs within the manufacturing industry. Attempts were made to increase the response rates of potential respondents by targeting persons who were safety or engineering practitioners. The representatives all had technical backgrounds and held some responsibility for safety performance in their companies. If they did not consider themselves suitable to complete the survey, they were asked to forward the survey to the appropriate person for completion. Efforts were also made to contact respondents through professional networks such as LinkedIn, obtain direct email addresses rather than those of administrative assistants, and send reminder messages a few weeks later in the survey process. Valid completed questionnaires were obtained from a total of 40 respondents.

3.2 Analysis Method

Quantitative analysis of multivariate data may be done using a range of techniques, including factor analysis and principal components analysis, multiple regression, multiple discriminant analysis, canonical correlation, variance and covariance multivariate analysis, conjoint analysis, cluster analysis, perceptual mapping, correspondence analysis, and structural equation modelling (Hair et al., 2010). If there are many independent variables which may help a phenomenon to be more easily understood by grouping them into dimensions of similarity, then factor analysis is likely to be useful (Hair et al., 2010). Factor analysis can help with both the identification of variables that correlate with one another, and with the identification of variables that are fairly independent of one another.

This paper presents the findings at the various stages of the factor analysis performed on the 22 survey items that evaluated the extent of the company's implementation of OSHMS. A total of 40 complete responses were received. While it is usually recommended that sample size exceed 50 for a factor analysis to be performed, given the difficulty experienced in obtaining further survey responses from the field, the choice was made to conduct an initial exploratory factor analysis. According to de Winter, Dodou, and Wieringa (2009), sample sizes of less than 50 are capable of yielding acceptable factor loadings as long as high communality values, a high number of observed variables, and a low number of factors characterise the undertaking.

Table 1. Survey Questionnaire Items

To what extent do you agree that the following elements are properly addressed at your company?		
No.	**Item**	**Rating**
1	There is a safety and health committee	SD D N A SA
2	There is a documented safety policy	SD D N A SA
3	There is a dedicated safety officer, safety practitioner, or other person hired or contracted with specific responsibility to fulfil this function	SD D N A SA
4	Top managers know the requirements of the OSH Act, and are committed to complying with them through planning, resource allocation, and provision of support	SD D N A SA
5	Employees know the requirements of the OSH Act and play an active role in developing and improving elements of the safety management system	SD D N A SA
6	The company identifies hazards, assesses risk levels, and implements action plans to prevent and control these hazards	SD D N A SA
7	The safety of at-risk persons have been considered, including pregnant or nursing females, young persons, and non-employees	SD D N A SA
8	There are checks in place to ensure contractor safety performance, when contractors perform duties at, or for, your company	SD D N A SA
9	Hazardous chemicals (materials) are properly identified and safely used, handled, stored, transported, and disposed of	SD D N A SA
10	Confined spaces have been identified and precautions have been taken to protect worker safety when accessing confined spaces	SD D N A SA
11	Emergency plans, fire safety arrangements, and safe access and egress points have been established	SD D N A SA
12	Proper safeguards (e.g. guards, fencing on equipment) are in place	SD D N A SA
13	Training, information, instruction, and supervision are provided to ensure employee safety and health	SD D N A SA
14	Reporting and investigation of accidents, injuries, and death is consistently done	SD D N A SA
15	The company is environmentally responsible	SD D N A SA
16	Conditions required to satisfy the OSH Act's Health requirements have been met	SD D N A SA
17	Conditions required to satisfy the OSH Act's Welfare requirements have been met	SD D N A SA
18	The company conducts medical examinations of employees	SD D N A SA
19	The company practices health surveillance of employees	SD D N A SA
20	The OSH Act is posted in the organisation as required	SD D N A SA
21	All information, notifications and records are submitted as required by the OSH Act	SD D N A SA
22	Protective clothes and devices are supplied to employees in accordance with the OSH Act	SD D N A SA

Rating scale (coding value) key: SD – strongly disagree (1), D – disagree (2), N – neither agree nor disagree (3), A – agree (4), SA – strongly agree (5)

For this analysis, three assumptions were made, namely:

- suitable data used in the analysis, with the intention of using appropriate statistical tests to evaluate the sampling adequacy.
- linearity among variables, with the intention of correcting for any non-linearity with transformations as appropriate.
- errors that were uncorrelated with each other.

The Statistical Package for the Social Sciences (SPSS-21) computer programme was used to perform the statistical analysis, with principal component analysis selected from within the factor analysis menu setting in that programme.

3.2.1 Principal Components Analysis

A total of 22 OSHMS variables were measured. This is to determine whether summative scales existed that could contribute to understanding the extent to which OSHMS implementation was achieved within the surveyed companies. The analysis method selected was factor analysis, which would help to derive an understanding of relationships among a large number of OSHMS variables by identifying a smaller number of variable clusters (Fang et. al, 2004). There are several approaches to factor analysis which may be used. principal components analysis (PCA) was performed so that the high number of variables could be grouped into summated scales, i.e. factors (Hair et al., 2010). Using PCA, the 22 OSHMS elements were structured into factor groupings in such a way that there would be high correlations between variables and their respective factor, as well as high between-variable correlations within individual factors (Jolliffe, 2002).

3.2.2 Correlation Matrix

One outcome of PCA was a correlation matrix (see Table 2) showing the extent to which the variables were correlated to each other. Since identification of factors depends on being able to group variables into areas of commonality (Fields, 2000), variables were expected to correlate highly with at least one other variable under consideration. A correlation lower than 0.3 was considered undesirable as this suggested that factorability of the variable is unlikely (Tabachnick and Fidell, 2007). Any variable having correlation <0.3 with other variables (underlined in Table 2) was discarded from further consideration.

3.2.3 Measures of Sampling Adequacy

Measures of sampling adequacy (MSA) were used to determine whether the data being analysed were sufficient to allow valid conclusions to be drawn. In SPSS, MSA values were computed for each individual variable under consideration. There was also an overall MSA evaluation done per iteration generated within the software. This overall MSA evaluation was located in the Anti-Image Correlation table, and included Kaiser-Meyer-Olkin (KMO) and statistical significance values. The KMO value is a measure of sampling adequacy for which Othman and Owen (2001) recommend a minimum value of 0.5. The Bartlett's test of sphericity looks at the distribution of the data and helps to judge whether it is adequate and suitable to apply factor analysis to the data as a test of its multidimensionality (Othman and Owen, 2001). It also includes a measure of the significance of the data, which should not exceed 0.05 (Fields, 2000).

3.2.4 Factor Extraction and Factor Rotation

The variance table was carefully scrutinised to ensure that an appropriate number of factors were selected for extraction. Eigenvalues inform the determination of the number of factors selected in PCA by successively extracting factors in descending order of total variance across all variables accounted for by each factor (Moonsamy and Singh, 2014). One may either look at a scree plot to see where the scree curve flattens off, thus indicating the point from which additional factors have reduced influence on the dependent variable, or as Kaiser (1960) recommends, one may choose the number of factors for which eigenvalues are greater than 1.000. For this study, SPSS was instructed to extract factors corresponding to eigenvalues greater than 1.000. Hair et al. (2010) suggest that when factors are extracted, their combined variances should not be less than 60% in order to derive a meaningful factor relationship.

When factors were extracted, item communality (extraction) values were also determined. High communality of a variable is desirable because it indicates that the proposed factors of the model explain a high portion of the variance of the variable. According to Moonsamy and Singh (2014), if communality exceeds 1.000, the solution is invalid and there is likely to be either too small a sample or an unacceptable number of factors. For the purpose of this study, an extracted communality of $\geq 0.5$was sought per variable.

Additionally, when two or more factors are extracted, the component matrix is unsuited to evaluating relationships among variables, since it is likely to find considerable occurrence of cross-loading onto more than one factor. By rotating the component matrix, variable loadings are maximised onto single factors and cross-loading of variables onto multiple factors is minimised. The rotated component matrix could then be used to discern the loadings of individual variables on single factors, and to recognise which variables may not fit well into summated factor scales. In SPSS, a varimax rotation was selected to minimise the number of variables loading onto factors and to reduce the likelihood of small loadings (Yong and Pearce, 2013).

3.2.5 Factor Analysis Iterations

Where measures are out of acceptable bounds for measures such as correlation, significance, factor loading, and communality, then further decisions were taken to treat with the data. A common approach to out-of-limit measures would be to discard the variable in question and to do another iteration within the software. In the course of the analysis, a total of 7 variables were discarded for various reasons (correlation <0.3, significance <0.05, communality <0.5, and cross-loading of variables onto more than one factor), and a total of 5 iterations were done before all conditions were met.

4. Survey Findings and Discussion

According to Nunnally and Bernstein (1994), the reliability of a survey questionnaire would be considered as acceptable if the Cronbach-α value exceeds 0.70. The Cronbach-α value for the 22-item scale being analysed was found to be 0.965. Also, every item correlated well with the rest of the scale (the minimum corrected item – total correlation value was 0.546) and it was observed that there was no benefit to deleting any item from the scale, as such alteration of the instrument would only cause the α value to rise by a maximum of 0.001 (negligible). Therefore, results showed that all items correlated well within the scale, and the survey scale had very strong inter-item consistency.

4.1 Data Factorability and Sampling Adequacy

Tabachnick and Fidell (2007) advise that, before performing a factor analysis, the data must be evaluated for suitability in terms of its factorability and the sampling adequacy using Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy. Factor analysis is considered an appropriate method once Bartlett's test is significant to the level of $p<0.05$, while the KMO value should be a minimum of 0.6 to support a good factor analysis. SPSS evaluation of the data yielded a KMO value of 0.811, and a significance of 0.000. From this, the data were considered adequate for use, and able to be used to perform factor analysis.

4.2 Factor Analysis: Initial Iteration

The initial factor analysis was performed on all 22 elements. As shown in Table 2, 20 of the 22 variables

Table 2. Correlation Matrix for the Initial 22 Elements

	OSH Cmttee exists	Doc'd SPol exists	Dedic'd SLead exists	Top mgmt committment	Employee participation	Risk Assessments done	At-risk grps considered	Contractor safety checks	HazMat practices	Confined space practices	Emergency planning	Proper safeguards	T.I.I.S.	AINM report & investig'n	Envir. responsibility	Health requirements met	Welfare requriements met	Med. exam of employees	Hlth surveill. of employees	OSh Act posted up	OSH submissions made	PPED for employees
OSH Cmttee exists	1.000	.825	.800	.464	.456	.541	.573	.644	.581	.624	.548	.507	.476	.486	.435	.424	.501	.521	.372	.327	.611	.607
Doc'd SPol exists		1.000	.863	.553	.455	.738	.667	.680	.727	.709	.786	.713	.602	.625	.481	.620	.699	.543	.465	.510	.662	.774
Dedic'd SLead exists			1.000	.479	.410	.684	.603	.716	.570	.629	.669	.464	.512	.527	.305	.605	.644	.413	.321	.493	.638	.663
Top mgmt committment				1.000	.712	.496	.532	.646	.663	.524	.560	.507	.713	.702	.510	.680	.663	.289	.268	.424	.397	.550
Employee participation					1.000	.486	.505	.654	.496	.463	.522	.372	.695	.665	.479	.610	.563	.298	.319	.387	.323	.470
Risk Assessments done						1.000	.682	.812	.631	.767	.818	.611	.667	.718	.347	.654	.666	.365	.385	.506	.538	.770
At-risk grps considered							1.000	.648	.693	.598	.700	.578	.508	.510	.417	.578	.666	.417	.202	.386	.540	.689
Contractor safety checks								1.000	.639	.768	.774	.561	.681	.695	.430	.804	.718	.441	.419	.564	.556	.767
HazMat practices									1.000	.717	.664	.786	.523	.526	.603	.688	.710	.532	.439	.426	.571	.645
Confined space practices										1.000	.726	.629	.572	.654	.355	.629	.608	.557	.461	.354	.565	.755
Emergency planning											1.000	.641	.704	.700	.521	.725	.776	.631	.541	.581	.700	.924
Proper safeguards												1.000	.619	.587	.609	.523	.641	.518	.456	.411	.419	.666
T.I.I.S.													1.000	.898	.528	.619	.688	.426	.414	.513	.483	.731
AINM report & investig'n														1.000	.343	.627	.669	.295	.316	.484	.449	.727
Envir. responsibility															1.000	.571	.682	.643	.613	.317	.496	.542
Health requirements met																1.000	.899	.399	.456	.658	.545	.709
Welfare requriements met																	1.000	.538	.495	.708	.564	.767
Med. exam of employees																		1.000	.787	.296	.494	.619
Hlth surveill. of employees																			1.000	.343	.378	.496
OSh Act posted up																				1.000	.497	.507
OSH submissions made																					1.000	.727
PPED for employees																						1.000

revealed correlation scores above 0.30 with at least one other variable, suggesting reasonable factorability. However the correlation scores were under 0.30 within elements 18 and 19, which addressed the conduct of medical examinations, and health surveillance checks on employees respectively. Principal components analysis yielded composite scores for the factors contributing to the OSHMS. The eigenvalues from the first iteration attributed 59.940% of the variance to a first factor, 7.355% of the variance to a second factor, and 6.300% of the variance to a third factor. Factors four, five, and six had eigenvalues of 0.954, 0.831, and 0.768, respectively, each factor explaining just about 4% of the variance. The three factor solution (which explained a high 73.595% of the variance) was selected because they matched the condition of the eigenvalue being greater than 1 (see Table 3).

4.3 Factor Analysis: Second Iteration

With elements 18 and 19 excluded, the factor analysis was repeated on the remaining 20 elements. For the second iteration, all correlations were greater than the required 0.3 and statistically significant at the 0.05 level. Looking at the anti-image correlation table, it was found that the MSA for each individual element was greater than 0.5, ranging from 0.594 to 0.911. The 0.803 KMO value also indicated that there was good sampling adequacy.

In iteration 2, three factors were again extracted, with variances of 62.586%, 6.977%, and 5.226%, totalling 74.789% of the full variance. The communality extraction values all exceeded the required 0.5 value (0.617 to 0.870) except for element 20 (*OSH Act posted up*) which had a value of 0.428. This element needed to be discarded.

Table 3. Total Variance Explained for the Initial 3-Factor Solution

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	13.187	59.940	59.940	13.187	59.940	59.940	6.648	30.216	30.216
2	1.618	7.355	67.295	1.618	7.355	67.295	5.973	27.149	57.365
3	1.386	6.300	73.595	1.386	6.300	73.595	3.571	16.230	73.595
4	.954	4.335	77.929						
5	.831	3.778	81.708						
6	.768	3.492	85.200						
7	.582	2.647	87.847						
8	.557	2.532	90.379						
9	.410	1.865	92.244						
10	.328	1.492	93.736						
11	.295	1.342	95.078						
12	.234	1.065	96.143						
13	.184	.838	96.981						
14	.164	.746	97.727						
15	.127	.579	98.306						
16	.124	.565	98.871						
17	.085	.385	99.256						
18	.054	.244	99.501						
19	.046	.208	99.709						
20	.031	.141	99.850						
21	.020	.091	99.941						
22	.013	.059	100.000						

Remarks; Extraction Method: Principal Component Analysis.

4.4 Factor Analysis: Third Iteration

Factor analysis on the remaining 19 elements returned all correlations greater than 0.3 and statistically significant at $p<0.05$. Each individual element's MSA had improved, now ranging from 0.724 to 0.954. Communality values were acceptable, ranging from 0.618 to 0.868. Again, 3 factors emerged; they accounted for 76.659% of the total variance. Because more factors were identified from the PCA, the component matrix could not be used to obtain further understanding of the variable relationships, and a rotated component matrix was called for instead. A varimax rotation was performed and the resulting rotated component matrix is shown in Table 4.

The component transformation matrix revealed that the three factors were highly correlated before and after the rotation, with the correlations being 0.688, 0.679, and 0.875 for Factors 1, 2, and 3, respectively. Because variables were reflecting high loadings on more than one component (i.e. factor), the structure of the PCA was considered complex. Examining the loadings of each variable revealed that items 8, 16, and 17 (*Contractor safety checks*, *Health requirements met*, and *Welfare requirements met* respectively) were cross-loading (i.e. showing loadings of similarly high magnitude) on multiple components, so these 3 variables were excluded.

4.5 Factor Analysis: Fourth Iteration

While the fourth iteration performed on the remaining 16 elements resulted in all correlations being statistically significant and greater than 0.3, only 2 factors were

Table 4. Rotated Component Matrix[a] generated using a varimax rotation in SPSS

Element/ Item	Component		
	1	2	3
OSH Committee exists	.776	.166	.230
Documented Safety Policy exists	.824	.272	.339
Dedicated Safety Lead exists	.851	.254	.113
Top management commitment	.212	.730	.403
Employee participation	.150	.798	.251
Risk assessments done	.714	.520	.113
At-risk groups considered	.616	.332	.359
Contractor safety checks	.630	.622	.187
Hazardous materials practices	.524	.307	.643
Confined space practices	.712	.421	.190
Emergency planning	.684	.479	.336
Proper safeguards	.459	.297	.611
Training, Information, Instruction, and Supervision	.330	.799	.267
Accident/Incident/Near Miss report and investigation	.408	.824	.102
Environmental responsibility	.148	.241	.882
Health requirements met	.410	.593	.465
Welfare requirements met	.451	.527	.578
OSH submissions made	.698	.121	.369
Personal Protective Equipment and Devices for employees	.699	.453	.348

Remarks: Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalisation[a]
[a] - Rotation converged in 6 iterations.

yielded, instead of 3 as in all prior iterations. Of the cumulative variance loading of 70.978%, Factor 1 accounted for 62.622%, while Factor 2 accounted for 8.356% of the variance. All communality values were acceptable (ranging from 0.595 to 0.876) except for the element *Environmental responsibility*, which reflected an extracted value of 0.426 and was excluded in yet another iteration.

4.6 Factor Analysis: Final Iteration

The final iteration was performed on the remaining 15 elements and all correlations were statistically significant and acceptably high (ranging from 0.323 to 0.924, as seen in Table 5 and Figure 1).

All individual item MSA values ranged from 0.822 to 0.941 and the overall KMO-MSA value was 0.886, high enough to be categorised as "meritorious" (Hair et al., 2010). Principal components analysis again yielded just 2 factors with the eigenvalue >1, as seen in Table 3 and Table 6. Of the cumulative variance loading of 73.208%, Factor 1 accounted for 64.419% of the variance, while Factor 2 accounted for 8.789%. Communalities were all acceptable, ranging between 0.578 and 0.876.

Because more than one factor were identified from the PCA, a varimax rotation of the data space was performed in order to maximise the variance of the factors, strengthen the distinction between factors, and clarify the relationships of variables loading onto factors (Jabnoun and Sedraani, 2005; Kakkar and Narag, 2007). The emerging result from the completed principal component analysis of the pilot data is summarised in Table 7. The factor loadings showed that 11 of the factor loadings were excellent (>0.7), while the remaining 4 factor loadings were very good (>0.63). Therefore, it was postulated that these 15 items could be structured into just 2 factor groups that correlate with the existence of a safety management system.

Table 5. Correlation Values for the Final 15 Extracted Elements

	1.OSH Cmttee exists	2.Doc'd SPol exists	3.Dedic'd SLead exists	4.Top mgmt committment	5. Employee participation	6. Risk Assessment is done	7.At-risk grps considered	8. HazMat practices	9. Confined space practices	10.Emergency planning	11. Proper safeguards	12. T.I.I.S.	13. AINM report & investig'n	14. OSH submissions made	15. PPED for employees
OSH Cmttee exists	1.000	.825	.800	.464	.456	.541	.573	.581	.624	.548	.507	.476	.486	.611	.607
Doc'd SPol exists		1.000	.863	.553	.455	.738	.667	.727	.709	.786	.713	.602	.625	.662	.774
Dedic'd SLead exists			1.000	.479	.410	.684	.603	.570	.629	.669	.464	.512	.527	.638	.663
Top mgmt commitment				1.000	.712	.496	.532	.663	.524	.560	.507	.713	.702	.397	.550
Employee participation					1.000	.486	.505	.496	.463	.522	.372	.695	.665	.323	.470
Risk Assessments done						1.000	.682	.631	.767	.818	.611	.667	.718	.538	.770
At-risk grps considered							1.000	.693	.598	.700	.578	.508	.510	.540	.689
HazMat practices								1.000	.717	.664	.786	.523	.526	.571	.645
Confined space practices									1.000	.726	.629	.572	.654	.565	.755
Emergency planning										1.000	.641	.704	.700	.700	.924
Proper safeguards											1.000	.619	.587	.419	.666
T.I.I.S.												1.000	.898	.483	.731
AINM report & investig'n													1.000	.449	.727
OSH submissions made														1.000	.727
PPED for employees															1.000

Table 6. Total Variance Explained for the Final 2-Factor Solution

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	9.663	64.419	64.419	9.663	64.419	64.419	6.528	43.519	43.519
2	1.318	8.789	73.208	1.318	8.789	73.208	4.453	29.688	73.208
3	.789	5.261	78.469						
4	.749	4.990	83.459						
5	.536	3.576	87.035						
6	.480	3.200	90.235						
7	.371	2.475	92.710						
8	.287	1.915	94.625						
9	.224	1.493	96.118						
10	.197	1.310	97.428						
11	.115	.764	98.192						
12	.095	.632	98.824						
13	.077	.511	99.335						
14	.058	.386	99.722						
15	.042	.278	100.000						

Table 7. Rotated Component Matrix Showing Final Factor Loadings

Element/ Item	Component/ Factor	
	Factor 1, Safety Structure and Practices	Factor 2, Improvement Drivers
Documented Safety Policy exists	.876	.330
Dedicated Safety Leader exists	.838	.215
OSH Committee exists	.795	.209
OSH submissions made	.780	.168
Personal Protective Equipment and Devices for employees	.758	.486
Emergency planning	.741	.503
Confined space practices in place	.718	.430
Risk Assessments done	.695	.492
At-risk groups considered	.682	.394
Hazardous Material practices in place	.680	.451
Proper safeguards in place	.599	.467
Training, Information, Instruction, and Supervision	.364	.846
Accident/Incident/Near Miss reporting and investigation done	.387	.829
Employee participation	.192	.826
Top management commitment evident	.298	.805

Remarks: Extraction Method: Principal Component Analysis; Rotated Component Matrix[a] - Rotation Method: Varimax with Kaiser Normalisation.
[a]. Rotation converged in 3 iterations.

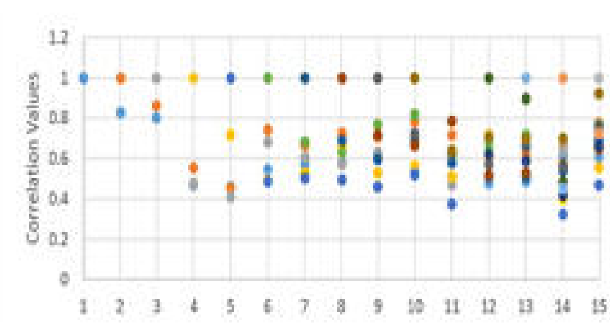

Figure 1. Scatterplot of Correlation Spread for Final 15 Extracted Elements

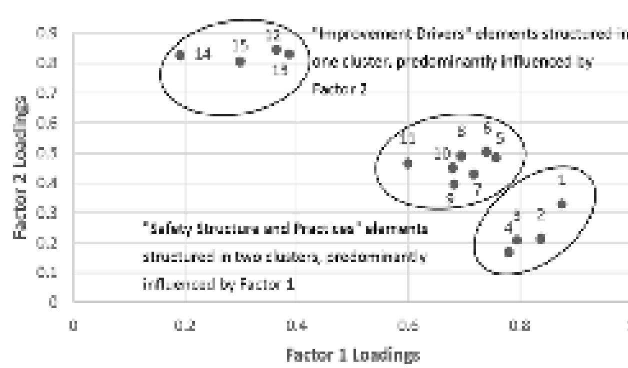

Figure 2. Factor Loadings plot illustrating relationships between the elements and factors

Besides, a plot was constructed of the factor component weightings for each element, and this revealed that the points fell into three clusters. The plot added to an understanding of the relationships between elements and factors, as annotated in Figure 2.

Based on the elements loaded onto factors, titles were assigned to the factors. With 11 elements, Factor 1 “Safety Structure and Practices”, consisted of two clusters near to the base of the plot. The first 4 of those 11 elements were influenced predominantly by factor 1, with very little influence from factor 2. The remaining 7 elements were influenced somewhat more heavily by factor 2. Considering the plot's dual cluster pattern, the 11 elements within Factor 1, "Safety Structure and Practices" were arranged into two sub-groupings, namely (1) "OSH Oversight" with the following 4 elements: *Documented safety policy exists*, *Dedicated safety leader exists*, *OSH committee exists*, and *OSH submissions made* and (2) "OSH Arrangements" with the following 7 elements: *Personal protective equipment and devices for employees*, *Emergency planning*, *Confined space practices in place*, *Risk assessments done*, *At-risk groups considered*, *Hazardous material practices in place*, and *Proper safeguards in place*.

Factor 1, "Safety Structure and Practices", highlights the critical impact that formal structure and routine practices have on the existence of an OSHMS. *OSH Oversight* is borne through policy and leadership elements. A safety policy must focus the OSHMS effort, leadership must control the reins and operate through a functional OSH Committee, and there must be continual monitoring of statutory submissions to meet the mandates of the OSH Act.

OSH Arrangements must be put in place to keep core aspects of the OSH System operating well. Perhaps most critical is the documentation of risk assessments that consider at-risk groups. Also, systems must be in place to promote safety with regard to emergency planning, confined spaces, hazardous materials control, safeguarding, and personal protective equipment and devices.

On the plot, all elements of the "Improvement Drivers" factor fit into one cluster. For all of these elements, there is the predominant influence of Factor 2 ($\geq$0.805) and much smaller influence of factor 1 ($\leq$0.387). Hence, Factor 2 (Improvement Drivers) consists of 4 elements, including: *Top management commitment*, *Employee participation*, *Training, information, instruction, and supervision*, and *Accident/incident/near miss reporting and investigation*.

Factor 2, "Improvement Drivers", would promote buy-in and continual improvement of the OSHMS by ensuring that managers and employees are involved in the day-to-day functioning of the OSHMS, leading by example, providing and benefitting from training, instruction, information, and supervision, and using proper accident, incident, and near miss reporting and investigation to identify root causes of challenges and bring about improved systems. Based on the above rationale, a model was derived showing how the elements influence the existence of an OSHMS (see Figure 3).

One might try at this point to make sense of why 7 of the initial 22 elements were discarded in the course of the analysis. These 7 elements were *Medical examination*, *Health surveillance*, *OSH Act posted up*, *Contractor safety checks*, *Health requirements met*, *Welfare requirements met*, and *Environmental responsibility*. These variables are important considerations in any OSHMS but it appears that they were not sufficiently prioritised by the SMEs being studied.

It is possible that many SMEs would perceive these elements as "nice to have" but would not yet recognise them as critical to the OSHMS. Companies might consider these elements as areas in which time, effort, and financial investment could be saved. The lack of focus on these areas could be compounded by the relatively low level of enforcement existing in the manufacturing industry. Employers are currently implementing elements of an OSHMS on a voluntary basis, because there are few resources available to enable the OSH Authority to perform inspection activities. Rather than carrying out safety checks on their contractors, for example, SMEs might hold the view that the onus is on contractors to adhere to the OSH Act.

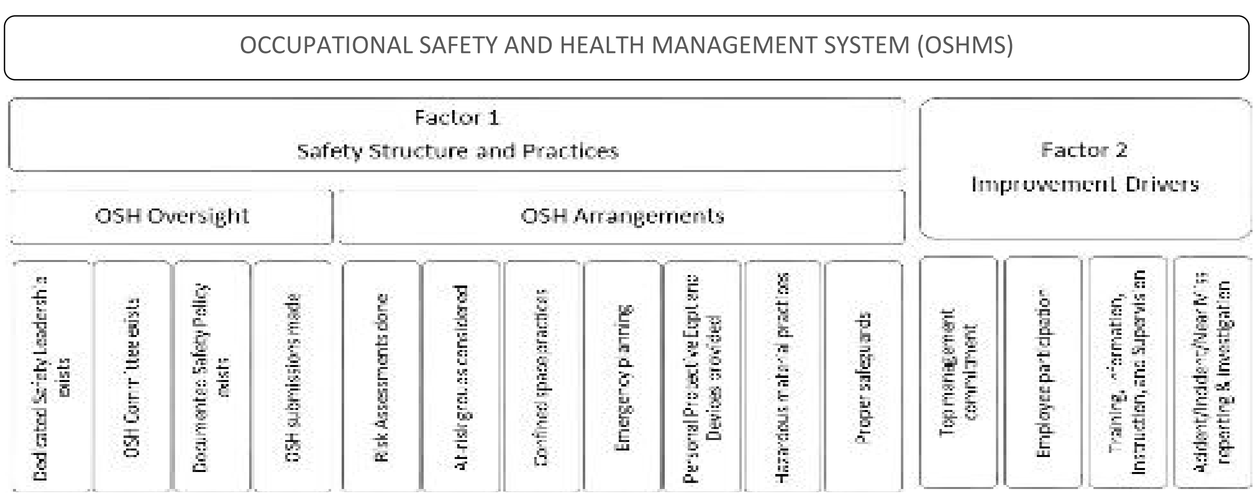

Figure 3. How SMS elements influence the existence of an OSHMS

Moreover, since the OSH Act advises that medical checks and surveillance are voluntary unless an inspector mandates such practices, few SMEs are motivated to incur such “unnecessary expenses”. Finally, where health, welfare, and environmental requirements are stipulated in the OSH Act and other legislation, the near-absence of enforcement would still be enabling lax practices in SMEs in T&T.

5. Conclusion and Recommendations

Out of the 22 elements that were considered in this factor analysis, 15 elements significantly correlate with the establishment of an OSHMS in the companies sampled. Based on the principal components analysis performed on the sampled manufacturing SMEs, this study concludes that two main factors are linked to a large extent to the establishment of an OSHMS.

Factor 1, “Safety Structure and Practices”, is a summated scale consisting of 11 variables addressing OSH oversight and OSH arrangements, and accounts for over 64% of the variance contributing to the establishment of an OSHMS. Factor 2, “Improvement Drivers”, is a summated scale consisting of 4 variables, and accounts for almost 9% of the variance contributing to the establishment of an OSHM

Several recommendations are put forward based on the study. These are:

1. The findings of this paper are based on a survey of 40 SMEs from Trinidad’s manufacturing sector. The study therefore is not generalisable to the whole manufacturing sector, and there is a need to carry out a wider, more representative survey of SMEs from the entire manufacturing sector. Given the relatively low response rate obtained in this study, the conduct of a more representative, wide-ranging study would require buy-in and active support from T&T’s manufacturers’ associations and chambers of commerce to incentivise or otherwise encourage participation by their members.
2. While the posited model cannot be considered as final because of the relatively small sample size of respondents, it can nevertheless provide some insight into variables that likely impact on OSHMS as they currently exist in T&T. There is a need for T&T’s OSH Authority and Agency to support implementation of the model’s factors and elements by documenting a full range of standards, codes of practice, guidelines, checklists, and other tools to aid companies in establishing or enhancing their OSHMS.
3. Perhaps the 7 elements not included in the model were excluded because survey respondents perceived them as unimportant as they appear in the OSH Act as non-mandatory or are perceived as being non-mandatory. The documented materials mentioned in Recommendation 2 will also raise implemented OSHMS standards by communicating how even elements perceived as voluntary could reduce risk and expense to businesses.
4. Many a local SME may hold the view that several OSH Act requirements require large budgets, and that their companies will be unable to discern sufficient return on this investment. It is up to OSHA to convince employers that investing in safety will bear them rich dividends. OSHA should more consistently track and disseminate data about the cost of lax safety, and the savings to be gained by investing in an effective OSHMS.
5. Data can also provide insight into the needs of companies in certain subsectors. There is a need to empower SMEs to develop themselves, rather than expecting them to hire experts to build their systems. This latter expectation might be impractical as costs may be too high for some companies. Certainly, there will always be aspects of OSHMS development that can only be adequately addressed through the involvement of specialist-experts, but there are also many aspects that can be addressed by making appropriate guidance, information, and stories/cases freely available to companies, as has been done in the case of the UK’s Health and Safety Executive website and social media outreach efforts. Similar outreach should be done via the T&T OSHA website.
6. OSHA is not the only entity from whom insights and data dissemination should be generated. There is a need for more active sharing of best practices within the field. Research is needed to share updates on approaches that have worked and those that have failed in industry sectors. Studies should put forward recommendations on OSHMS establishment and improvement, with a special focus on sectors (such as manufacturing) that may not be current priority areas for OSHA.
7. With a little support and structure from an umbrella organisation (such as the Ministry of Labour or the Trinidad and Tobago Manufacturing Association), SMEs should be encouraged to collaborate on setting up their own formal OSHMS and auditing each other’s systems, in a thrust for continual improvement and competitiveness. Research geared toward structuring user-friendly OSHMS development, implementation, and/or evaluation tools would assist in this regard.

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