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DIMENSIONS OF LEARNING ORGANISATION IN MALAYSIAN MANUFACTURING COMPANIES: TESTING MEASUREMENT INVARIANCE AND COMPARING LATENT MEANS

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ABSTRACT

This paper presents a study on the practice of organisational learning in Malaysia. Specifically, the study investigated the applicability of a learning organisation model, based on the Dimension of Learning Organisation Questionnaire, in the context of Malaysian manufacturing companies. The study also investigated the differences in organisational learning practices between large and small-and-medium sized (SME) manufacturing companies. The study involved the use of Structural Equation Modelling measurement invariance tests and latent mean comparison. Results of study prove that the learning organisation measurement model is equally valid for both large and SME manufacturing companies. The results also show that the practice of organisational learning is more prevalent in large companies than in SME companies. Overall, from practical point of view, Malaysian companies can use the learning organisation model as a tool to measure their current level of organisational learning.

Keywords : *Learning organisation, organisational learning, measurement invariance, latent mean.*

1.0 INTRODUCTION

A learning organisation refers to an organisation where there is a culture and climate that are conducive for development and promotion of learning [1]. According to Watkins and Marsick [2], it is an organisation whose employees engage or participate in a collaborative process, and collective changes for the purpose of realising shared values or principles. Such an organisation is also able to engage in continuous learning and consistently improve itself [2].

The exact meaning of a learning organisation, however, is still not clear and there has never been an agreement of what it really is [3]. Nonetheless, it is an interesting concept that has gained traction in many organisations around the world. Its potential applications in the management of an organisation have been widely researched over the years. One area of research relates to how an organisation can leverage its organisational learning ability to improve its organisational performance and increase its competitiveness [4-6].

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An organisation that excels at organisational learning can learn quickly, and that may be the only factor that can sustain its competitive advantage against its competitors in the future [7].

In the context of the Malaysian manufacturing industry, it is beneficial for companies to start looking at their organisational learning practice as a way to improve their competitiveness. However, the learning organisation's concept and theoretical framework come from the West and whether they are equally applicable in a Malaysian manufacturing context have not been adequately investigated.

This paper presents an empirical study that investigated the suitability of the concept of learning organisation in Malaysian manufacturing companies. Specifically, the study looked at the presence of organisational learning practice in those manufacturing companies, based on the Dimension of Learning Organisation Questionnaire (DLOQ) proposed by Watkins and Marsick [8]. The study involved both large and small-and-medium sized (SME) manufacturing companies. These researchers administered the DLOQ survey questionnaire among employees of large and SME companies to get their perspectives on organisation learning practice in their respective companies. Since the study involved both large and SME companies, it examined the differences in organisational learning practices between large and SME manufacturing companies. However, in such a comparative study, it was crucial to understand whether the items and structure of the DLOQ survey instrument were equivalent across large and SME companies, because items might mean different things to different groups, and thus the structure of the measurement instrument might not hold across groups. When a measurement instrument was not equivalent in a cross-group study, the validity of research findings would be problematic and need further investigation.

This study attempted to answer these research questions:

1. Is the DLOQ a valid and reliable instrument for usage in Malaysian manufacturing companies?
2. Does the DLOQ learning organisation model possess measurement invariance across large and SME companies allowing for valid statistical comparisons across groups?
3. Are there significant DLOQ latent mean factor differences between large and SME companies on learning organisation dimensions?

From the perspective of structural equation modelling (SEM), this involves testing of measurement invariance and latent mean comparison within the framework of multi-group confirmatory factor analysis (CFA).

2.0 METHODOLOGY

2.1 Questionnaire Design

In this study, characteristics of a manufacturing company with regards to organisational learning were measured by using Watkins and Marsick's DLOQ survey questionnaire. The adequacy of the DLOQ as a tool to evaluate how an organisation practises organisational learning, has been reported in several studies before [4, 9-11]. In those studies, there is adequate evidence to validate the psychometric properties of the DLOQ.

The original DLOQ is made up of 43 items that were designed to measure the level of learning dimensions within an organisation. In this study, however, a condensed version of 21 items, using a 5-point Likert scale, was used instead.

The condensed version was developed by Yang et. al. [7]. Series of exploratory and confirmatory analyses have been conducted by Yang et. al. [7], and concluded that it is a superior measurement model than the original version. Table 1 lists the 21 question items.

Table 1: Questionnaire items (adapted from [8])

Dimensions	Items
Continuous learning	1) In my company, people help each other learn. 2) In my company, people are given time to support learning. 3) In my company, people are rewarded for learning.
Dialogue and inquiry	4) In my company, people give open and honest feedback to each other. 5) In my company, whenever people state their view, they also ask what others think. 6) In my company, people spend time building trust with each other.
Team learning	7) In my company, teams/groups have the freedom to adapt their goals as needed. 8) In my company, teams/groups revise their thinking as a result of group discussions or information collected. 9) In my company, teams/groups are confident that the company will act on their recommendations.
Embedded system	10) My company creates systems to measure gaps between current and expected performance. 11) My company makes its lessons learned available to all employees. 12) My company measures the results of the time and resources spent on training.
Empowerment	13) My company recognizes people for taking initiative. 14) My company gives people control over the resources they need to accomplish their work. 15) My company supports employees who take calculated risks.
System connection	16) My company encourages people to think from a global perspective. 17) My company works together with the outside community to meet mutual needs. 18) My company encourages people to get answers from across the company when solving problems.
Leadership	19) In my company, leaders mentor and coach those they lead. 20) In my company, leaders continually look for opportunities to learn. 21) In my company, leaders ensure that the company's actions are consistent with its values.

2.2 Sample and Data Collection

The intended respondents of the survey were employees of manufacturing companies throughout Malaysia. The names and addresses of the manufacturing companies were selected from a database of Federation of Malaysian Manufacturers. The survey was delivered by mail to the intended respondents. The respondents were expected to return the survey via the self-addressed stamp envelope that was included together with the mailed survey. In some instances respondents were personally met and asked to complete the survey by the first author.

2.3 Statistical Analysis – Item Analysis

DLOQ consists of seven dimensions and each dimension is measured by a set of questionnaire items. In order to determine how well the questionnaire items measure the learning organisation dimension, an item analysis was carried out. In item analysis, the internal consistency (Cronbach's alpha) for each of the seven learning organisation dimensions was calculated. The purpose of Cronbach's alpha is to explain the extent of internal consistency for a set of questionnaire items, taking into consideration how well the correlation to one another in measuring the relevant learning organisation dimension. Cronbach's alpha will be calculated based on the number of questionnaire items used for each dimensions, and the average correlations of each questionnaire items with every other. The value of Cronbach's alpha is between 0 (no internal reliability) to 1.0 (perfect reliability). Value about 0.70 is normally taken as the acceptable level of reliability [12].

2.4 Statistical Analysis – Measurement Invariance

Whether items and factorial structure of a measurement instrument are invariant across different groups can be best examined by using multi-group CFA [13]. In this study, the measurement invariance was carried out by using an orderly sequence of tests, as suggested by Brown [14]. First, a preliminary single-group CFA was carried out to check the factorial structure of the DLOQ instrument. The preliminary single-group CFA was based on combined data from both large and small-and-medium size companies. Then, two separate single-group CFAs was carried out for large and small-and-medium size companies, respectively. Finally, a multi-group CFA – that simultaneously used data from both groups - was conducted. Within this multi-group CFA, three nested models were constructed for configural test, metric invariance test, and scalar invariance test, respectively.

The first model was the baseline model where no equality constraints were imposed. This was the configural test to check whether the factorial structure of the measurement instrument was valid across different groups. The second model was the measurement weight model where the factor loadings were constrained across a group. This was the metric invariance test to check whether factor loadings of the measurement instrument were equal across different groups. Metric invariance test is important in a sense that if the equality of factor loading is upheld then items in the measurement instrument convey the same meaning for samples across different groups, and then the latent construct underlying these items are comparable across groups [14]. On the other hand, if the equality is violated, then data from the different groups are not comparable and it is no longer necessary to check the results of other tests of more restrictive constraints (e.g. equal intercept)[14]. The third model was the measurement intercept model where the intercepts were fixed as equal for both groups. This was the scalar invariance test to check whether the invariance of the intercepts was upheld across different groups. Multi group CFA is essentially a nested hierarchy of models. One model has its own constraint and, since it is nested within its prior model, also carries the constraints of the prior model.

The equality of these parameters (i.e. factor loadings and intercepts) across different groups can be determined by looking at chi-square differences between the nested models. A non-significant chi-square difference means that the equality constraints are indeed valid [15]. In this study, both single-group and multi-group CFAs were carried out in AMOS version 18.

2.5 Statistical Analysis – Latent Mean Structure

Once measurement invariance across groups has been established, then comparisons of group means on latent constructs of interest can be carried out. In this study, the focus was on the differences between level of learning organisation dimensions between large and SME companies. The learning organisation dimensions were represented by seven latent dimensions or constructs (as shown in Table 1). As such, the statistical differences between the means of those seven latent constructs were investigated.

In a typical multi-group comparison using univariate and multivariate analyses, the focus is on the statistical differences between means representing the various groups. Those means are derived directly from raw data and are considered observable. However, in multi-group SEM analysis, the focus is on the differences between means of latent constructs. These latent construct means are not considered directly observable since they themselves are derived from their indicators (i.e. questionnaire items). The indicators are the ones that are directly observed and measurable. For example, in this study, one of the latent constructs of learning organisation measurement model is continuous learning. The mean of the latent construct continuous learning is derived from the means of three indicators that are directly measurable based on the survey participants' responses. The use of multi-group SEM analysis is deemed appropriate since it ensures error-free measures of the latent constructs by eliminating the random error of measurement for the observed indicators associated with the latent constructs [16].

The comparison of latent means was carried out by running two simultaneous measurement models representing two different samples (i.e. large and SME companies) in AMOS. In the AMOS graphic, when the default setting 'estimate means and intercepts' button was checked, mean and variance were automatically assigned to all latent constructs of both measurement models. The first measurement model (which used the first data sample) was set as the reference model by setting the means of all the latent constructs to zero. The other model (which used the second data sample) was set as the comparison model and the means of the latent constructs of the model were set to be freely estimated. In AMOS graphic, this was done by attaching nominal non-integer labels to those latent constructs. As a consequence, means were interpretable only in a relative sense. In other words, the statistical differences between the means of different groups can be determined, but the absolute means of each latent construct of each group cannot be estimated. The variances of the latent constructs in each model were set to be freely estimated. As for factor loadings, some factor loadings of each measurement model were set to 1.0 for the purpose of model identification, while the remainder factor loadings were all set equal across the groups by assigning the same nominal non-integer labels in both measurement models. As for the observable indicators, there were intercept terms associated with the indicators. These intercept terms were also set equal across the groups by assigning the same nominal non-integer labels in both measurement models.

At the end of the test, the statistical differences of the latent means across groups were determined based on the significance of the parameter estimate in the comparison model. Statistical significance was determined by the critical ratio value of the latent mean (i.e. parameter estimate of the latent mean divided by its standard error (SE)). A critical ratio value of more than 1.96 was set as the criteria for statistical significance. Goodness of fit indices such as CFI and RMSEA were also used to determine the fit of the measurement models.

3.0 RESULTS AND DISCUSSION

In total, 3000 questionnaires were sent out, and 321 usable responses were eventually returned (effective return rate of 10.7%). Details of the survey respondents are shown in Table 2.

3.1 Item Analysis

An item analysis was carried out and the results (refer to Table 3) show that all dimensions of learning organisation have acceptable Cronbach's alpha, ranging from 0.81 to 0.88. The values are not much different from the ones obtained in several previous studies. From the results, it can be concluded that all items are internally consistent, and reliable to be used for Malaysian manufacturing companies.

Table 2: Profile of respondents

Categories		**# of respondents**	**Percent**
Size	Large	196	38.94%
	SME	125	61.06%
Regions	Northern Malaysia	147	45.79%
	Central Malaysia	82	25.55%
	Southern Malaysia	92	28.66%
Respondents' position	Senior manager	161	50.79%
	Middle manager	126	39.75%
	Junior manager	30	9.46%
Type of manufacturing	Electrical and electronics	124	38.63%
	Automotive	86	26.79%
	Metal	36	11.21%
	Wood & paper	10	3.12%
	Plastics	7	2.18%
	Others	58	18.07%

Table 3: Reliability of DLOQ

	Cronbach's alpha					
Dimensions	**Current study**	**Song *et al* [17]**	**Zhang *et al* 2004 [18]**	**Lien *et al* 2006[11]**	**Ellinger 2002[4]**	**Yang *et al* 2004 [7]**
Continuous learning	0.85	0.74	0.80	0.72	0.81	0.71
Dialogue and inquiry	0.88	0.80	0.78	0.89	0.86	0.78
Team Learning	0.84	0.78	0.78	0.86	0.85	0.79
Embedded System	0.87	0.76	0.82	0.71	0.85	0.75
Empowerment	0.88	0.78	0.82	0.75	0.84	0.68
System Connection	0.84	0.79	0.84	0.89	0.87	0.75
Leadership	0.81	0.84	0.85	0.91	0.89	0.83

From the results shown in Table 3, each dimension of learning is reliable since Cronbach's alpha value is more than 0.70 [12]. The DLOQ was originally developed in the West, but it has been proven reliable to be used in a different national or cultural context [4, 9-11, 19]. In this study, the DLOQ was also found to be reliable when used for Malaysian manufacturing companies.
From a theoretical perspective, the results obtained serve as additional confirmation on the generic nature and applicability of DLOQ instrument in measuring the organisational learning practice in a situation different from that for which it was originally developed.

For practical purpose, DLOQ could provide a manufacturing company with a reliable way to measure its current practice of organisational learning.

3.2 Measurement Invariance

This section explains the results of several types of measurement invariance tests that were conducted on the learning organisation measurement model across both data groups – large and SME companies. First, a preliminary single-group CFA was conducted using the data from both large and SME companies (n = 321). In this context, CFA was used to determine the fitness of the learning organisation measurement model against the data. The learning organisation measurement model was a pre-specified seven-dimension model based on the DLOQ. Each dimension is measured by three separate items as shown in Table 1.

As displayed in Table 4, results of the CFA analysis shows a statistically significant chi square (χ^2 (168) = 308.3, p=0.00), thus suggesting that the model did not fit the data well. However, chi-square analysis was not the only fit index used in this study. Chi square analysis is known to be sensitive to sample size [7]. Therefore, alternative fit indices such as ratio χ^2/df, Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) were also used to evaluate the model fit. As a rule of thumb, values of ratio χ^2/df less than two or three indicate a good model fit, values of RMSEA less than .08 indicate a reasonable fit, and values of CFI larger than 0.90 indicate an acceptable fit [20]. Overall, the learning organisation measurement model exhibited a good fit. The results were also comparable with those from previous studies as shown in Table 4. Figure 1 shows the factor structure of the learning organisation measurement model.

Table 4 : Fit indices for learning organization measurement model

Fit indices	**Current study**	**Song *et al* [17]**	**Zhang *et al* 2004 [18]**	**Lien *et al* 2006[11]**	**Ellinger 2002[4]**	**Yang *et al* [7]**
χ^2	308.3	920.1	632.6	830.2	328.5	617.4
df	168	168	167	168	157	168
Ratio (χ^2/df)	1.83	5.47	3.78	4.94	2.09	3.68
CFI	0.96	0.99	0.88	0.93	0.94	0.91
RMSEA	0.05	0.054	0.077	0.076	0.073	0.080

Additionally, two separate single group CFAs were carried out. The first one used only data from large companies (n=196), while the second one used data from SME companies (n=125). The results (as shown in Table 5) of the two separate single-group CFAs show overall fit, indicating that the factorial structure of the DLOQ is equally demonstrated in both large and SME companies.

Next, a multi-group CFA was conducted. The first model within the multi-group CFA was a baseline model #1 that was constructed with no equality constraints imposed. This was the configural invariance test that was carried out to check whether the factor structure of the learning organisation measurement model was indeed equivalent across both large and SME companies. The model was run against data from both groups simultaneously.

As can be seen from Table 5 the fit of the baseline model #1 was acceptable (χ^2 = 562.7, df = 336, *p* = 0.00, ratio χ^2/df = 1.67, RMSEA = 0.046, CFI = 0.94) suggesting that the factorial structure of the learning organisation measurement model was indeed consistent for both large and SME companies. In short, configural invariance was confirmed.

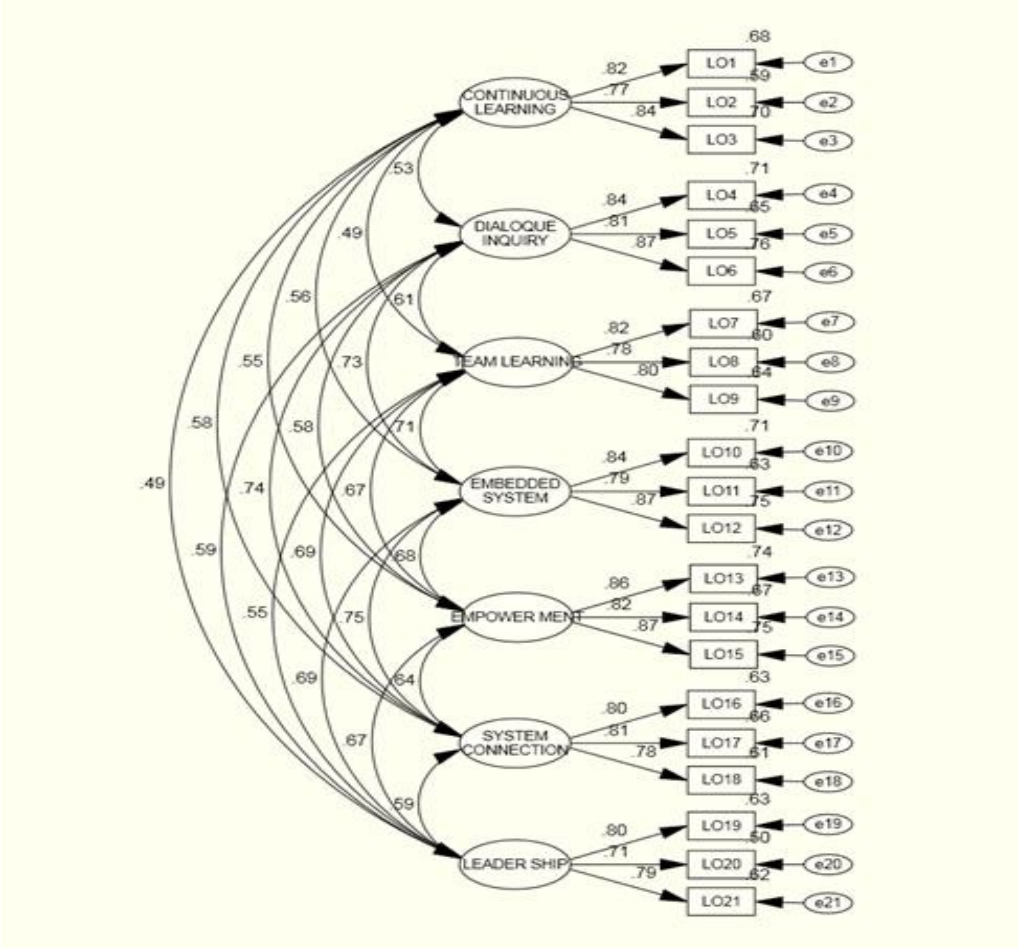

Figure 1: CFA for learning organization measurement model

Table 5 : Fit comparison for configural invariance test for learning organisation measurement model

	χ^2 (*p* value)	**df**	**Ratio (χ^2/df)**	**CFI**	**RMSEA**	**Fit (Yes/ No)**
Large (n=196)	300.3 (*p*=0.00)	168	1.78	.94	0.064	yes
SME (n=125)	262.3 (*p*=0.00)	168	1.56	.95	0.067	yes
Base-line model #1	562.7	336	1.67	.94	0.046	yes

The second model constructed within the multi-group CFA was a measurement weight model (model #2).

Model #2 was nested within the unconstrained baseline model #1. In model #2, the measurement weights (factor loadings) were constrained as equal across both large and SME company data. The results are shown in Table 6.

Given that the difference in χ^2 test between the constrained model #2 and the baseline model #1 was not significant (p=.406), metric invariance was therefore confirmed. The differences in other fit indices were also within the acceptable limit, further confirming the metric invariance of the learning organisation measurement model.

The third model constructed within the multi-group CFA was measurement intercept model (model #3). Model # 3 was nested within model #2 for the purpose of testing for scalar invariance. In model #3, in addition to equality constraints on factor loadings, the intercepts were also constrained to equal across groups. Table 7 shows that the fit of model #3 was acceptable but the test of differences in fit between model #3 and model #2 was not good, suggesting that the imposition of constraints (equal intercepts across groups) resulted in the statistically significant decrease in the fit of model #3. Thus, some equality constraints of intercepts did not hold across the two groups.

Table 6 : Fit comparison for metric invariance test for learning organisation measurement model

	χ^2 (p value)	**df**	**Ratio (χ^2/df)**	**CFI**	**RMSEA**	**Fit (Yes/ No)**
Base-line Model #1	562.7 (p=0.00)	336	1.67	.94	0.046	
Model #2	577.3 (p=0.00)	350	1.65	.94	0.045	
Difference	χ^2 (df =14) = 14.6, p=0.406					yes

Since scalar invariance was not supported, the next step would be to look for the possibility of partial scalar invariance. Under partial scalar invariance, the equality constraints are relaxed, and some of the intercepts are allowed to be freely estimated during the invariant test. If the number of freely estimated intercepts constitutes only a small portion of the model, then they will not affect cross-group comparisons to any significant extent and partial scalar invariance can be established.

To identify those potential intercepts that can be freely estimated, the unstandardised intercepts in the AMOS 18 outputs from both data groups were checked. Those intercepts that were significantly different from the rest were targeted as potential intercepts to be freely estimated. Several trial and error runs were carried with different combinations of intercepts freely estimated. Finally, when intercepts for measured items 5 and 17 were freely estimated, the difference became non-significant.

Table 7 : Fit comparison for scalar invariance test for learning organisation measurement model

	χ^2 (*p* value)	**df**	**Ratio (χ^2/df)**	**CFI**	**RMSEA**	**Fit (Yes/ No)**
Model #2	577.3 (*p*=0.00)	350	1.65	.94	.045	
Model #3	616.2 (*p*=0.00)	371	1.66	.94	.046	
Difference	χ^2 (df =21) = 38.9, *p*=0.010					No
Model #4 *	606.5 (*p*=0.00)	369	1.64	.94	.045	
Difference	χ^2 (df =19) = 29.2, *p*=0.063					yes

*Intercepts for measured items 5 and 17 were freely estimated for both data groups

The results as shown in Table 7 indicates that the difference in χ^2 test between the partially constrained model (model #4) and model #3 was not significant (p=.063), so partial scalar invariance was supported. The partial scalar invariance was also confirmed by the differences in other fit indices which were within the acceptable limit. At the minimum, partial scalar invariance needs to be satisfied in order to carry out meaningful comparison between data from large and SME companies.

From the results shown in Tables 4 to 7, it is clear that the seven-dimension learning organisation measurement model is valid when used against data collected from Malaysian manufacturing companies. The model can be used as guidance for manufacturing companies to become a learning organisation, namely by monitoring and improving on their current practice of seven dimensions of learning organisation spelt out in the model.

The model also passed a series of measurement invariance tests (configural invariance, metric invariance and partial scalar invariance) indicating that the model is equally applicable to be used for large and SME manufacturing companies. Since measurement invariance is proven, the testing for group mean differences could be carried out in a meaningful way.

3.3 Latent Mean Structure

This test is related to research question number 3 that suggests there are significant differences in the level of learning organisation dimensions between large and SME companies.

The testing for mean comparison was carried out by using latent mean structure analysis as described previously. The results of the analysis are shown in Table 8. The latent mean structure analysis only checked for significant differences between means, but did not calculate the absolute values of the means. The absolute values of the means were calculated separately but are also included in Table 8 to better visualise the differences between large and SME companies.

Table 8 shows that the combined large and SME companies had slightly above average score for each dimension of learning organisation, suggesting that Malaysian companies still have a long way to go in building a learning organisation. Table 8 also shows that, in large companies, most respondents perceived their organisations to be highest in terms of promoting dialogue and inquiry among employees and between employees and management, but low in term of empowering employees. Similarly, those from SME companies also thought that their respective companies were good at promoting dialogue and inquiry but paid less attention to empowerment of employees.

Table 8 : Latent means comparison

Dimensions	**Mean (large n=196) ***	**Mean (SME n=125) ***	**Estimate**	**Standard error**	**Critical ratio**	***p***	**Significant at α=0.05**
Continuous learning	3.65	3.34	.313	.098	3.194	.001	Yes
Dialogue and inquiry	3.81	3.65	.176	.096	1.838	.066	No
Team learning	3.62	3.37	.251	.099	2.537	.011	Yes
Embedded system	3.61	3.35	.252	.097	2.610	.009	Yes
Empowerment	3.40	3.12	.285	.103	2.767	.006	Yes
System connection	3.65	3.30	.365	.087	4.187	.000	Yes
Leadership	3.57	3.26	.317	.085	3.711	.000	Yes

* Mean is calculated using simple average

From the results shown in Table 8, it is clear that large companies perform significantly better than SME companies in all dimensions of a learning organisation, except in term of dialogue and inquiry. These results are expected since many SME companies are known to be constrained in many ways that make them less capable of building a learning organisation [21]. For instance, one recipe for building a learning organisation is by creating learning opportunities from everyday problems that is encountered in the workplace[21]. However, Malaysian SME companies, already faced with increasing international and domestic competition [22], may be too occupied that they tend to adopt a quick fix problem solving approach to eliminate or minimise what ever problem that may arise at the workplace. Such an approach takes away the opportunity to dedicate time and resources to systematically understand the problem by thorough review, debate and questioning. It prevents a learning process from taking place either at an individual or organisation level. An important ingredient for building a learning organisation is that an experimentation process should be encouraged and any collateral mistakes should be tolerated as a means to generate a meaningful learning process. However, some SME companies can be so financially constrained that such a collateral mistake is not acceptable lest it create undue financial problems to the companies. Under such a condition, experimentation is seen as unnecessary, too risky and often discouraged.

One important point to note is that when it comes to dialogue and inquiry, there is no significant difference between large and SME companies. The result suggests that employees in SME companies find it as easy as employees in large companies to communicate and interact with one another. Perhaps, a SME company, being small, has a relatively flat hierarchical structure, and therefore easy for employees from different levels to engage in meaningful dialogue and inquiry.

4.0 CONCLUSION

From an operations management point of view, organisational learning is seen as a way to improve organisational performance and productivity. An organisation needs to leverage its organisational learning practice to improve its performance and productivity. However, before it can do that, it needs to know how to measure its own level of learning practice first. This study has shown that DLOQ is a valid reliable instrument for usage in Malaysian manufacturing companies. The study has also shown that the DLOQ, as a learning organisation model, possess measurement invariance across large and SME companies. Therefore, it can be concluded that Watkins and Marsick's DLOQ should be adopted by both large and SME Malaysian manufacturing companies as a measuring tool to assess their current level of organisational learning practice. The current level of organisational learning practice should be the starting point before companies embark on any future organisational change or improvement initiative. The study has also shown that SME companies lagged behind large companies in many dimensions of learning organisation due to the many constraints faced by them. Therefore, SME companies should adopt a different approach from large companies to manage the development of learning organisation dimensions. They should first assess the levels of learning organisation dimensions in their companies. Results of the assessment should then be used to prioritise the development of learning organisation dimensions, bearing in mind the specific constraints they are facing.

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