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Study of Six Sigma Implementation in SMES in Developing Countries in Asia

A. Seetharaman,
Dean Academic Affairs

Nitin Patwa,
Assistant Professor, Director of Simulations

Rajiv Aserkar,
Professor, & Head of Logistics and Supply Chain

Himali Rane,
P G Scholar
S P Jain School of Global Management – Dubai – Mumbai – Singapore – Sydney

Abstract: Due to expanding global supply chain network, some of the giant organizations are encouraging their supplier's i.e. small and medium enterprises (SMEs) to adopt Six sigma in order to improve product and process quality for gaining competitive advantage. Earlier studies have shown that SMEs face issues for implementation of Six sigma. This study identified the factors affecting implementation of Six sigma identified through a literature review of 70 journals. The factors identified are awareness, training, management support and commitment, organization culture and resource constraints. A survey of SME professionals was performed to check the influence of the above factors on Six sigma implementation. For analysing the response data and constructing structure equation model, ADANCO 1.1.1 software tool has been used. The result shows that SMEs are aware about the Six sigma, however, there is lack of management support and commitment. Organization culture is most significant factors affecting implementation of Six sigma, followed by resource constraints and training.

Keywords: Six sigma, Organization culture, Resource constraints, Training, Management support and commitment

1. Introduction

According to W. Edwards Deming, "85% of the reasons for failure to meet customer requirements are related to deficiencies in systems and processes…rather than the employee. The role of management is to change the process rather than badgering individuals to do better."

One of the effective process improvement tools is Six Sigma. Six Sigma came to an existence at Motorola in 1980. In the 1990s, Six Sigma became a business-centric system of management when General Electric Corp. ushered in the second generation of Six sigma. The focus of Six Sigma shifted from product quality to business quality. It was possible to produce defect-free products using lowest cost of production and earn high profit. Though the original goal of Six sigma was to focus on manufacturing processes, later marketing, purchasing, billing, and invoicing functions were also involved (Raghunath A, Dr. Jayathirtha R V, 2013).

There are numerous Six sigma success evidences in large corporations. Due to growing market and global supply chain management network, large firms are heavily dependent on small and medium size enterprises (SMEs) for providing best in class quality goods and services at optimum cost. For this, SMEs are considering implementation of Six sigma under business strategy (Antony, J., Kumar, M., & Madu, C. N., 2005) However, research has shown that SMEs face constraints for extensive use of Six sigma. From the research conducted and published so far, it seems that Six sigma is not being deployed by developing economies to its full potential (Desai and Patel, 2009). Though, much mitigation have been developed to overcome the same, yet issues are not eliminated fully.

The literature review in this paper shows that many studies have been conducted on the six sigma implementation in SMEs in which the constraints and critical success factors affecting Six sigma implementation in SMEs are identified. The main objective of this thesis is to investigate less researched factors,

such as management focus and culture in greater depth, as well as to build on research on the impact of factors already identified in the literature, by building and verifying a model determining influence of those factors on Six sigma implementation in SMEs. In addition, this research study also shows effectiveness of Six sigma at SMEs in terms of internal satisfaction, product quality and bottom line performance.

2. Literature review

Approach for review of the literature:

The existing literature identified the scope for future research which is presented as the driving forces for Six sigma implementation in SMEs. They are factors described as independent variables namely awareness, training, resource constraints, organization culture, management support and commitment. The literature review deals with independent variables and sub variables through which the survey questions were formed. Though the normal practice is to present path coefficient along with data analysis section (and too early to present it here), it is felt that the reliability of independent variables as well questionnaire representing sub variables can be given in the literature review itself to indicate the perfect fit to literature with its quantitative validity. Hence path coefficients are presented along with literature review which shows strong statistical validity for the questionnaire.

2.1 Awareness

Past literature shows that one of the critical success factor for implementation of Six sigma is awareness about Six sigma. Wessel, G., & Burcher, P. (2004) mentions majority of the company do not know about the Six sigma. Creating awareness is very important step for building organization culture to take step towards Six sigma implementation. For successful implementation, knowledge about Six Sigma methodology is essential at every level of organization (Gijo, E. V., Bhat, S., & Jnanesh, N. A., 2014). Six sigma failure was observed due to unawareness on how to get started and linkage of Six sigma to strategic business goals (Kumar, Antony & Tiwari, 2011). Awareness need to be created throughout the organization. In this study, the three sub variables considered for awareness are management awareness, employee awareness and awareness creation in lower level employees

2.1.1. Management awareness about Six sigma

Study shows one of the reasons for not implementing Six sigma is SME organisations including top management are unaware or have little knowledge about the Six sigma approach. If management is aware about Six sigma, it is easier to buy in management support and commitment in SMEs than in large multinationals (Antony, J., Kumar, M., & Madu, C. N., 2005).

Kumar, Antony & Tiwari (2011) argued that few SMEs Six sigma failed due to unawareness on how to get started. To overcome the same, training and awareness sessions should be conducted for senior management so that then creates further awareness in downstream.

H1: Awareness about six sigma significantly influences Management commitment and support

2.1.2. Employee awareness about Six sigma

Six sigma methodology awareness needs to be created among all employees to make sure active participation of employees. Also it is necessary that all employees are aware of the improvement actions implemented in the process (Gijo, E. V., Bhat, S., & Jnanesh, N. A., 2014)

2.1.3. Awareness creation in lower level employees

Most of the time, people at lower level in small traditional organizations think that if improvement projects are carried out, and cycle time and rework in the process are reduced, that may lead to reduction of head count and loss of job opportunity in the organization. Thus, giving awareness training in the Six sigma methodology to the lower-level people in the organization about the focus of this improvement initiative will help them to understand the purpose of this methodology. This will also create a sense of urgency for improvement projects at lower levels of the organization itself (Gijo, E. V., Bhat, S., & Jnanesh, N. A., 2014)

H2: There is scepticism and less awareness about Six sigma in lower level employees.

Structural equation modeling (SEM) is an statistical methods that fit networks of constructs to data and testing hypotheses about relations among observed and latent variables (Hoyle, 1995). It helps in building and testing statistical models, which are often causal models.. Path Analysis tests models and relationships among various MVs, and Path Analysis with SEM is similar regression analysis in many ways with a bit of distinction

i.e. Regression methods assume a normal distribution, while Path Analysis assumes multivariate normality (Suhr, 2008). Path analysis is very comprehensive methodology because of being highly flexible.
Path Analysis allows researchers to recognize the imperfect nature of their measures. SEM explicitly specifies error or unexplained variance while Regression Analysis assumes measurement occurs without error. Path coefficient greater than 0.7 and above shows a strong impact of the constructs on the independent variable, whereas path coefficient between 0.5-0.7 shows a moderate impact. (Chin, Marcolin, &Newsted, 2003). As shown in figure 1, all loading constructs are above 0.7 which shows significant impact of constructs i.e. management, employees and lower level employee's awareness on organization awareness about Six sigma.

2.2 Training

In order to increase the level of understanding and reduce chance of resistance, it is important to provide the basic training to shop floor employees who are less educated prior to implementing Six sigma (Shokri, A., Oglethorpe, D., & Nabhani, F.,2014). Along the same lines, Deskhmukh and Lele (2009b) reiterate importance for training. Their research indicates employee commitment which is important for successful implementation of Six sigma, can be developed by training the employees on regular basis.
Rowland (2004) suggests that instead of adopting to traditional approach, SMEs need to use Porters value chain analysis and consider resources available for identifying the needs of training for deployment of Six sigma. A through education and training program is necessary for using diverse tools which Six sigma provides (Timans, W., 2012)

2.2.1 Training resources

Research by Antony (2006) shows training is one of the critical successful factor for Six sigma implementation in SMEs. However, (Kaushik, P., Khanduja, D., Mittal, K., & Jaglan, P., 2012) it is harder for SMEs to conduct training due to other constraints such as time and limited resources. Another reason is structure of training offered by external institutes has been changed. Recently, since training materials and guides are available at ease, it is becoming simpler for SMEs to use the external resources (Kaushik, P., Khanduja, D., Mittal, K., & Jaglan, P., 2012). Top management commitment can effectively promote the company wide training allowing involvement of all employees in the project (Tjahjono et al., 2010)

H3: Management commitment and support has significant relationship with training

2.2.2 Budget for training

One of the hurdles for SMEs to conduct training is no specified budget for training. It is one of the SME weaknesses. Also extent of training in SMEs is limited and informal (Antony, Labib & Kumar, 2008). The traditional Six sigma approach to black belt training is not desirable in the case of SMEs. Hence, there is need to consider the company's skill base and resources for deployment of the Six sigma (Antony, J., Kumar, M., & Madu, C. N., 2005)

2.2.3 Statistical tools and techniques

A study on the implementation of Lean Six sigma revealed that manufacturing SMEs recognized not only the importance of DoE but also those DoE techniques were seldom used in practice. There is more potential for the use of statistical tools (Timans et al., 2012).

H4: Adequate training resources has significant impact on implementation of Six sigma in SMEs

2.3 Management commitment and support

Many research has identified management focus, support and commitment as one of the Critical success factor (Fadly Habidin, N., & Mohd Yusof, S. R.,2013). Top management ignores importance of Six sigma. Drive from leadership team across downstream is distorted (Grima, P., Marco-Almagro, L., Santiago, S., & Tort-Martorell, X., 2014). Many Six sigma projects have failed due to weakness in project management skill of leadership (Eckes, 2001). One of the important component for six sigma implementation is requirement of strong leadership with excellent project management skills (Achanga, P., Shehab, E., Roy, R., & Nelder, G., 2006). It is desirable that the senior management approves the Six sigma initiative, defines the purpose and scope of Six sigma, and links it to the mission and vision of the organization (Kumar, M., Antony, J., & Tiwari, M. K.,2011).

Following table shows responsibilities of top management for Six sigma implementation.

Table 1: Responsibilities and performance measures of top management

Main responsibility	Performance measures
Linking Six Sigma to company's mission, vision and values	Develop a strategy for deployment
Making Six Sigma one of the top three priorities of the business	Develop a 3-5 year strategic Six Sigma plan
Communicate the need for Six Sigma	Allocate budget and resources
Ready to address any resistance to change	Introduce incentives and reward schemes
Breaking down stumbling blocks or barriers to implementation	Control through visibility
Motivate and support the employee in the implementation process	Monitor progress Committing themselves for 1 or 2 days training on Six Sigma

Source: Adapted from Motwani (2001), Writers (2007)

2.3.1 Management commitment

Research by Psychogios & Tsironis (2012) states committed leadership drives the quality in the organisation. However, there is a lack of senior management commitment to Six sigma in SMEs (J. Thomas, A., Ringwald, K., Parfitt, S., Davies, A., & John, E. 2014).

Wang and Chain (2010) provided a view that Six sigma implementation requires commitment from all levels of managers is required so as to provide training, resources, knowledge and authority to solve problem.

2.3.2 Management involvement

Involvement of managers at all levels in any organisation is important for Six sigma deployment. (Moosa, K., & Sajid, A., 2010)

Tjahjono et al., (2010) says that management commitment which can provide companywide training to allow involvement of all employees in the project, is the main enabler for implementation of Six sigma

2.3.3 Management support

Shokri, Oglethorpe & Nabhani (2014) mentions one of the key success factor for Six sigma is strong management support.

Six sigma can be deployed effectively by adopting top down approach i.e. when leadership team owns, drives and support it (Pande et al., 2000). Active support from management is required for continuous improvement culture (Fadly Habidin, N., & Mohd Yusof, S. R., 2013).

H5: Management commitment, involvement and support significantly influences organisation culture

H6: Management commitment and support has significant relationship with Six sigma implementation in SMEs

2.4 Organizational culture

The term ‘organisational culture’ refers to a set of properties in the work environment, perceived directly or indirectly by the people who live and work there, and is assumed to influence motivation and behaviour (Litwin & Stringer, 1968). Pirsig (1974) pointed out, that quality and culture are tied together.

Another argument says for Six sigma there is lot of focus on training people about tools and techniques, however very little focus on understanding human factor i.e. how to build right company culture. (Dahlgaard, J. J., & Mi Dahlgaard-Park, S., 2006). Culture should be built at 3 levels – Individual, Team and Organization. For achieving this, promoting cultural transformation before advancing to Six sigma is required (Shokri, A., Oglethorpe, D., & Nabhani, F.,2014)

2.4.1. Continuous improvement approach

Successful Six sigma implementation requires focus on continuous improvement culture (Fadly Habidin, N., & Mohd Yusof, S. R.,2013). Six sigma initiatives develop continuous improvement approach and data-based thinking throughout the organization (Gijo, E. V., Bhat, S., & Jnanesh, N. A., 2014). Providing

training to the lower level employees will help them understand the purpose of Six sigma methodology. This will create sense of urgency for improvement projects at lower level of organization itself.
A strong commitment to quality requires developing Culture of information sharing and developing culture of continuous improvement (Malik, A., & Blumenfeld, S.,2012)

H7: Training and proactive attitude helps in understanding purpose and ultimately improves organisation culture

2.4.2. Quality culture

Davison, L., & Al-Shaghana, K. (2007) concludes that Six sigma management plays important role in development of quality culture. Six sigma provides ways to perform processes right first time (Kaushik, P., Mittal, K., & Jaglan, P., 2012).
Previous research also shows that for successful Six sigma implementation, pre requisite is development of quality awareness and a quality culture and a particular level of quality maturity (Van Iwaarden, J., van der Wiele, T., Dale, B., Williams, R., & Bertsch, B.,2008). However, often Quality culture has been largely been ignored or given less importance in the SME sector (Deshmukh and Lakhe, 2010). Adapting Six sigma methodology help shifting culture to pro-active and open quality culture (Dahlgaard, J. J., & Mi Dahlgaard-Park, S.,2006).

2.4.3 Pro-active attitude of employees and open culture

Six sigma is changing corporate cultures from a passive and defensive culture to a pro-active and open culture (Dahlgaard, J. J., & Mi Dahlgaard-Park, S.,2006). Same is supported by Gamal Aboelmaged, M. (2010) who mentions Six sigma alters the organizational culture from reactive to pro-active mode.

H8: Organization culture of quality and continuous improvement has significant contribution in implementation of Six sigma in SMEs

2.5 Resources constraints

In most countries, SMEs operate under various constraints including financial, non-financial, human resources and constraints relating to enable favourable environment. (Deshmukh, S. V., & Chavan, A.,2012)
Past study shows that SMEs do not have sufficient resources to implement Six sigma projects. Resources include time, human and financial budget. (Antony and Kumar, 2005). Wessel, G., & Burcher, P. (2004) mentions adoption of optimum resource allocation method for projects.
Most of the implementation framework ignored how model can be implemented with limited resources. One of the framework (Tiwari, M. K., Kumar, M., & Antony, J., 2011) suggest provide GB/BB training to executives, ask them to complete the project related to business strategy and once the project is completed rotate them back to their original responsibilities. This way SME can minimize the human resources limitation

2.5.1 Non financial constraints such as dedicated employees and time

Due to lack of dedicated Six sigma professionals, insufficient time to work on projects due to day to day work load and insufficient financial budget SMEs find it difficult to implement Six sigma extensively. (Gamal Aboelmaged, M., 2011). Also, resources are not equipped with knowledge of statistical tools and techniques (Timans, W., Ahaus, K., & Antony, J.,2014).

2.52 Financial resources

One of the critical success factor for Six sigma implementation is provision of appropriate budget (Desai, D. A., Antony, J., & Patel, M. B.,2012). In line with previous statement Achanga et al.(2006) has classified four CSFs of lean in SMEs including finance .
Antony, Kumar & Madu (2005) describes budget as weakness of SMEs. Since there is no specified training budgets. Lack of budget also hampers reward and recognition program

2.5.3 Rewards and recognition

Antony, Kumar & Madu (2005) mentions no incentive or reward program as weakness of SMEs.
Snee, R. D. (2010) mentions leadership should ensure recognition and rewards for Six sigma projects participants to encourage and motivate employees. Providing rewards is also part of building culture for consistent support from employees (Zare Mehrjerdi, Y., 2011)

H9: Resource constraint has significant relationship with implementation of Six sigma in SMEs

3. Research Methodology

Using primary data from survey and secondary data from literature review, research was developed. Secondary data collection derived from a literature review of 70 articles listed in high impact journals. The independent variables that impact Six sigma implementation in SMEs were identified through the literature review. Following figure shows relation of the independent variables with dependent variables.

3.1. Data Collection

An online survey formulated for the collection of primary data. The survey questionnaire pilot testing completed with 33 SME professionals & industry experts. Industry experts included participants from various industry sectors who are familiar with Six sigma. By conducting personal interviews with some of the SME industry experts for feedback, final questionnaire was modified & finalized. In addition to 3 questions for each variable, It also included 3 questions to capture the demographic of the respondents. A 5 scale Likert scale was used to measure indicators. A five-point scale reference, with one indicating strongly disagree and five indicating strongly agree, was used.

The final survey questionnaire was sent to 600 SME professionals located in developing countries. The usable responses of 87 were chosen for the study, out of 95 responses received, which is considered as average response rate among SMEs.

Demographic information: Demographic detail pertaining to sample companies including a proper blend of local, joint venture companies from manufacturing and service industries with 71(i.e. 82%) from manufacturing and 16 (18%) with services; location of firms within India (48) and China (29) and position of the respondents including CEO/Managing Director, departmental head, quality manager and others.

4. Data Analysis

For analyzing the data collected from primary research ADANCO 1.1.1 was used. ADANCO 1.1.1 is a structural equation modeling tool. ADANCO was used to build the research framework and test the hypothesis (Ringle, Wende, & Will, 2005). ADANCO employs composite modeling approach to test the hypothesis. ADANCO was selected because it does not impose a normality condition on the data (Hulland, 1999). Analysis conducted in two-stages, first for assessing the quality of measures of the structural model with reliability and validity measurement (Sekaran & Bougie, 2010) and then during second stage, to check model fit, carried out path analysis and estimated the model parameters.

4.1. Reliability

The reliability of constructs scores should be sufficiently high, constructs or the independent variables are considered to be reliable when the Cronbach's alpha values or composite reliability i.e. Joreskog's rho scores are 0.7 and above (Ringle et al., 2011; Bagozzi & Yi, 2011; Wertz, Linn, & Jöreskog, 1974) As shown in the Table I below, the Cronbach's alpha values and composite reliability sufficiently above 0.7 this support the reliability of the model.

Realibility Validation

Construct	R^2	Jöreskog's (Composite reliability) ρ_c	Cronbach's alpha(α)	Average variance extracted (AVE)
Six sigma in SME	0.713	0.9470	0.9162	0.8562
Awareness		0.9020	0.8357	0.7549
Training		0.9730	0.9585	0.9232
Management support		0.8555	0.7705	0.6643
Organization culture		0.8830	0.8020	0.7164
Resource constraint		0.8294	0.7069	0.6204

4.2. Convergent validity

Convergent validity examines variable indicators i.e. conformity between scores. Convergent validity value also studies construct validity. Minimum acceptable value for the average variance extracted (AVE) of

each construct is 0.50 as per (Bagozzi & Yi, 1988). As indicated in Table 3, the minimum AVE score is 0.6204 which is above minimum acceptable value. This proves convergent validity is satisfactory.

4.3. Discriminant validity

To analyze relation between latent variable discriminant validity assessment has become a generally accepted prerequisite. For variance-based structural equation modelling, such as partial least squares, examination of cross loading and the Fornell-Larcker criterion are the dominant approaches for such evaluations. Discriminant validity values indicate the degree of discrimination between variables. ADANCO evaluates discriminant validity by comparing the measured value for each variable with other constructs. Square root of the AVE value should be greater than the AVE of other variables (Fornell & Larcker, 1981). Table 4 shows the results of the discriminant validity testing. Square root of AVE is greater than AVE of other variables, so the discriminant validity is proven

Table 4 *Discriminant validity*

Construct	Six sigma in SME	Awareness	Training	Management support	Organization culture	Resource constraint
Six sigma in SME	**0.8563**					
Awareness	0.3153	**0.7549**				
Training	0.4256	0.5982	**0.9232**			
Management support	0.2772	0.1942	0.3098	**0.6643**		
Organization culture	0.6193	0.6033	0.6614	0.4029	**0.7147**	
Resource constraint	0.3982	0.1339	0.1153	0.4799	0.2964	**0.6204**

4.5. Structural equation modeling

ADANCO 1.1.1 the structural equation modelling (SEM) tool which can test the hypothesis. Theoritically linear and additive casual models are tested using SEM. An unknown population can be modelled using bootstrapping methods (Hesterberg et. Al., 2003).

This research tested nine hypotheses, tests were evaluated at 1% level of significance (i.e. p value <0.01) and t values more than 2.592 were considered accepted, corresponding t-values are referred for the outcomes. The results are shown in table 6

Table 6

Hypothesis	Effect	Path coefficient(β)	Mean value	Standard error	t-value	Supported
H1	Awareness > Management commitment and support	0.441***	0.4476	0.0859	6.5162	YES
H2	Awareness > Six sigma in SME	-0.182***	-0.0386	0.0859	-0.5445	NO
H3	Management commitment and support > Training	0.557***	0.5663	0.0469	11.8727	YES
H4	Training > Six sigma in SME	0.264***	0.6845	0.0868	7.8974	YES
H5	Management commitment and support > Organization culture	0.264***	0.6406	0.0480	13.2123	YES
H6	Management commitment and support > Six sigma in SME	-0.240***	0.3152	0.0977	3.1530	YES
H7	Training > Organization culture	0.666***	0.6670	0.0556	11.9758	YES
H8	Organization culture > Six sigma in SME	0.632***	0.6276	0.1346	4.6971	YES

H9	Resource constraints > Six sigma in SME	0.432***	0.4329	0.0820	5.2645	YES

*** indicates 99.99% significance level.

5. Research findings

First hypothesis H1: tests that there is awareness of six sigma significantly influence Management commitment. The t value (6.5162) indicates significance. Thus H1 ($\beta = 0.441$, $P < 0.01$) is supported. This indicates that management which is more aware about Six sigma is more committed. This is also indicated by the positive path coefficient. This supports the study by Antony, Kumar & Madu (2005) which mentions management awareness makes it easier to get management support in SMEs than in MNCs

Second hypothesis H2: tests that there is less awareness about the Six sigma in SMEs. The t value (-0.5445) indicates less significance. Thus H1 ($\beta = -0.182$, $P > 0.01$) is not supported. This indicates that SMEs are aware about Six sigma. This is also indicated by the negative path coefficient. This finding argues against the earlier research by Dalu and Deshmukh (2005) which says low awareness impacts quality management in SMEs. However, this supports the opinion that majority of SMEs are aware about Six sigma (Deshmukh and Lakhe., 2010)

Third hypothesis H3: tests the relation between management support and training. The t value (11.8727) shows very high significance. Thus H3 ($\beta = 0.557$, $P < 0.01$) is supported. This indicates that management commitment and support have significant relation with training. This supports the earlier finding that top management commitment can effectively promote the company wide training allowing involvement of all employees in the project (Tjahjono et al., 2010)

Fourth hypothesis H4: tests the effect of training on implementation of Six sigma in SMEs. The t value (7.8974) is significant. Thus H4 ($\beta = 0.264$, $P < 0.01$) is supported. This indicates that Training have significant impact for implementation of Six sigma in SMEs. This supports the earlier finding that training is one of the critical success factor for implementation of Six sigma in SMEs (Deshmukh & Lakhe.,2010, Shokri & Nabhani., 2014). Finding is in line with previous suggestion (Wessel, G., & Burcher, P., 2004) which says training should be provided for Six Sigma project managers and also awareness training program should be deployed for the rest of the organization.

Fifth hypothesis H5: tests that management commitment and support significantly influences organization culture. The t value (13.2123) is highly significant. Thus H5 ($\beta = 0.264$, $P < 0.01$) is supported. This indicates that management commitment and support highly influences organization culture which plays important role in six sigma implementation. It supports the claim that active support from management is required for continuous improvement culture (Fadly Habidin, N., & Mohd Yusof, S. R., 2013).

Sixth hypothesis H6: tests that management commitment and support has significant relationship with Six sigma implementation in SMEs. The t value (3.1530) is significant. Thus H6 ($\beta = -0.240$, $P < 0.01$) is supported. This indicates that SMEs face issue of management commitment and support for implementation of Six sigma. There is a lack top management commitment to Six sigma in SMEs. Management fails to heap the cross functional support for Six sigma project implementation. This is in line with previous finding that top management ignores importance of Six sigma. Drive from leadership team across downstream is distorted (Grima, P., Marco-Almagro, L., Santiago, S., & Tort-Martorell, X. ,2014). There is less management involvement and support for Six Sigma implementation (Antony, J., Kumar, M., & Madu, C. N., 2005). It also supports finding (Kumar, M., Antony, J., & Tiwari, M. K., 2011) that in SMEs, there is lack of management support for training and education of Six Sigma

Seventh hypothesis H7: tests effect of training on organization culture. The t value (11.9758) is highly significant. Thus H7 ($\beta = 0.666$, $P < 0.01$) is supported which indicates that training significantly contributes to organization culture build for six sigma implementation. This agrees with study which mentions (Gijo, E. V., Bhat, S., & Jnanesh, N. A., 2014), providing training to the lower level employees will help them understand the purpose of Six sigma methodology. This will create sense of urgency and continuous improvement culture.

Eighth hypothesis H8: tests organization culture has significant contribution in implementation of Six sigma in SMEs the t value (4.9671) is quite significant. Thus H8 ($\beta = 0.632$, $P < 0.01$) is supported which indicates that organization culture significantly contributes to the implementation of Six sigma in SMEs. Study shows

organization culture is most important factor and it has been observed that adoption of Six sigma leads to development of continuous improvement approach, whereas earlier study found Six sigma methodology help shifting culture to pro-active and open quality culture (Dahlgaard, J. J., & Mi Dahlgaard-Park, S.,2006). It is in-line with previous finding (Fadly Habidin, N., & Mohd Yusof, S. R., 2013) that leader should drive the continuous improvement culture in organization for successful implementation of Six Sigma.

Ninth hypothesis H9: tests effect of resource constraints on implementation of Six sigma in SMEs. The t value (5.2645) is highly significant. Thus H5 ($\beta = 0.432$, $P < 0.01$) is supported which indicates that resource constraints impact on the implementation of Six sigma in SMEs. Study shows SMEs face resource constraints in terms of time, human and budget. There is lack of dedicated employee for carrying out Six sigma projects due to their daily workload. Employees lack statistical tool knowledge. Also, some SMEs face budget constraint to implement the improvements identified from Six sigma projects. This supports the previous research findings that SMEs face issue of resource constraints in terms of human, time and budget for implementing Six sigma (Deshmukh, S. V., & Lakhe, R. R., 2010). The finding of this research that SMEs do not have budget for improvements identified through Six Sigma projects is in line with previous research outcome (Fadly and Mohd Yusof, 2013) saying company financial capability is one of the critical success factor for Six Sigma implementation.

All above findings are not only adding value to the existing earlier findings, but giving new insights

To summarize, research findings show that there is awareness about Six Sigma in SMEs in developing countries of Asia region at managerial as well as employee level, however, there is still lack of management commitment and support for implementation. Management commitment and support as well as training impact organization culture. Both, training and organizational culture have significant effect on implementation of Six sigma. SMEs face various resource constraints such as human, time and budget for implementation

The result of the bootstrapped structural model is shown in Figure. The path coefficients are displayed with all paths showing significant correlation between dependent and independent variables

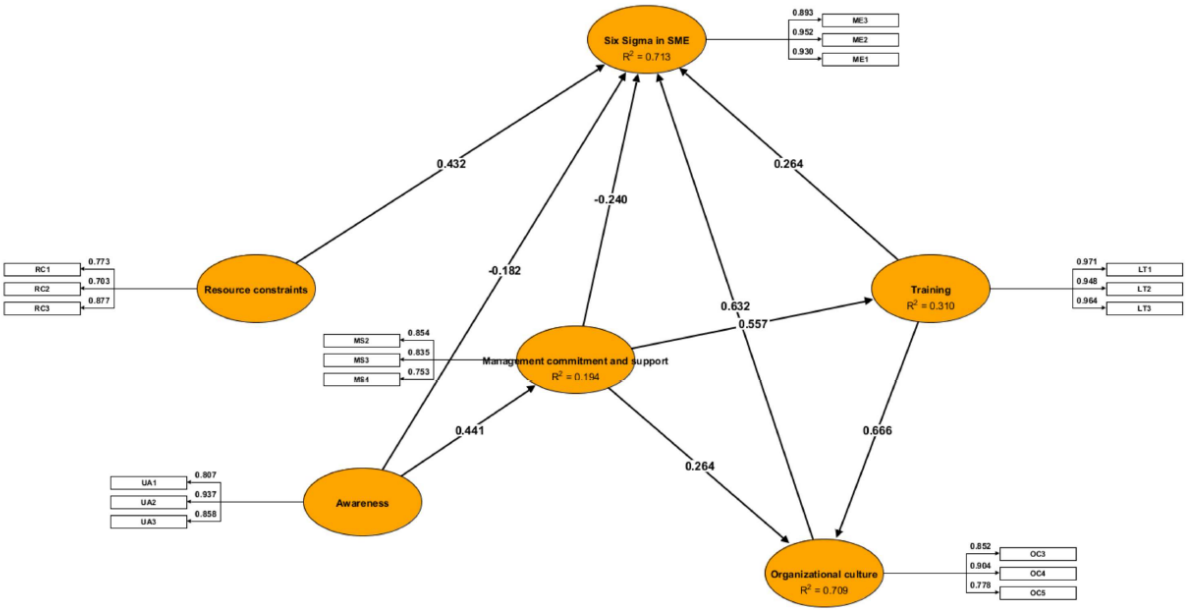

Figure 6. Bootstrapped structural model

6. Contribution:

6.1 Performance measures of Six sigma

6.1.1 Improvement in quality of goods or services

With increasing global supply chains, dependency of large organization on SMEs has increased for demand of high quality products and services (Antony, J., Kumar, M., & Madu, C. N., 2005). Li et al. (2005) mentions Six sigma had direct advantage on improving the quality of product. Also, it ensures smooth manufacturing flow by improving productivity to the level of quality products.

The goal of Six sigma is to design a highly reliable process that ultimately produce consistent products and services (Coronado and Antony, 2002).

6.2.2 Improvement in profitability

Six sigma places a clear focus on savings which directly impact profitability. No Six sigma project will be approved unless team finds out savings associated with it (Antony, J., Kumar, M., & Madu, C. N.,2005). Goh and Xie (2004) state achieving Six sigma goal reduces cycle time and cost dramatically which impact bottom line. Same is supported with the statement of (Tang et al., 2007) which says that Six sigma is highly disciplined and profit driven initiative.

6.3.3 Internal process improvement

Sigma means amount of variation in the process (McAdam and Lafferty, 2004). Snee (2004) provides a view that Six sigma provides the system which focuses on performance characteristics that are critical to customers for identifying defects in process. It is a powerful tool for process improvement by minimizing the wastes in the processes according to Harry and Schroeder (2000). Kumar & Spector (2006) mention benefits of Six sigma to process improvement by reduction in process variation, defect reduction and waste elimination.
Park (2002) described Six sigma uses statistical measurement to assess how well the process is performing.

7. New contribution to research

Implications for SMEs to follow the Six sigma

The findings of this research are multi-fold. Firstly, it indicates organization culture, resource constraints and training impact significantly on implementation of Six sigma in SMEs. Secondly, research shows that now SMEs professionals including employees and manager are aware about Six sigma as a process improvement tool, however, there is not enough management commitment and support for implementation of Six sigma. The awareness has been increased because many companies which already have adopted Six sigma methodology extensively are now encouraging their suppliers i.e. small and medium enterprises for using Six sigma for product quality improvement. The research also shows organization culture is the most influencing factor for Six sigma implementation. SMEs often ignore building culture which would drive Six sigma with focus on product quality improvement and thereby reduce warranty cost and ultimately benefit bottom line. Industry experts' suggestions are in line with earlier research which says human resource limitation can be minimized by training executives to GB/BB, asking them to complete the project and then roll them back to their original responsibilities. (Kumar, Tiwari & Antony, 2011)
Large organizations have been implementing and reaping the benefits of Six Sigma in the last two decades. However, its application in SMEs is still less evident in the literature. Establishing effect of five independent variables on implementation of Six sigma, this research also points out the implications of adopting Six sigma which prompt SMEs to use Six sigma. This research proves that various other inter-relationships do exist between the five core variables, which are significant, as explained by the various hypotheses above. For example, if management is aware about Six sigma and its impact, management would be more committed and supportive for the implementation across organization in terms of conducting training across all levels, providing resources and budget which in turn would build more proactive and open organization culture. It is imperative for SMEs to have a strong management commitment and good leadership skills before embarking on the implementation. Research had shown that Six sigma initiative in many organizations have failed either due to lack of understanding of how to get started or due to failure to link the initiative to strategic business goals and measurable objectives

8. Limitations and scope for future research

This research focused on in depth study of only five variables on the basis of previous research literature. During the survey, observations are mentioned by SMEs such as cross functional team support, lack of knowledge of statistical tools and prioritization of projects also may affect implementation of Six sigma. These factors are not covered in this research. Survey was carried out in India and China, but since there is growing recognition of importance of small and medium enterprises in economic development, research could be extended to BRICK nations. There is scope for further research in this area. Also, research can be carried out to find out how customer organization can support SMEs for Six sigma implementation. There is also scope for benchmarking study of SMEs which have deployed Six sigma to seek solutions for various constraints faced in initial phase of deployment. Public policy at local, regional and national level also plays an integral part in successful growth of SMEs.

9. Conclusion

Six sigma methodology adoptions requires a paradigm shift i.e. necessitating action that are counter-intuitive, this requires linking Six sigma to company's mission, vision and values, develop a deployment strategy, necessary allocation of budget and resources, continuous monitoring which will certainly help to improve product quality, to reduce process wastes and improve profitability, but it needs right focus and commitment. To implement Six sigma, top management should devise a plan specific to their strategy objectives, allocate resource accordingly. There should be focus on training so that Six sigma becomes innate to culture of organization and its employees leading to build continuous improvement approach. As demonstrated by this research, top management commitment is one of the most important factors in implementation for SMEs. Commitment and drive from top management would certainly help SMEs for sound implementation of Six sigma. Concluding, one of most important factor attributed to making a Six-sigma program succeed or fail in an organization, it is how deeply the top management gets involved in the learning of Six sigma philosophies and ideas, and takes the lead in implementation.

References

[1]. Achanga, P., Shehab, E., Roy, R., & Nelder, G. (2006). Critical success factors for lean implementation within SMEs. *Journal of Manufacturing Technology Management*, 17(4), 460-471.

[2]. Antony, J. (2006). Six sigma for service processes. *Business Process Management Journal*, 12(2), 234-248.

[3]. Antony, J., Kumar, M., & Labib, A. (2008). Gearing Six Sigma into UK Manufacturing SMEs: Results from a Pilot Study. *Journal of the Operational Research Society*, 482-493

[4]. Antony, J., Kumar, M., & Madu, C. N. (2005). Six sigma in small-and medium-sized UK manufacturing enterprises: Some empirical observations. *International Journal of Quality & Reliability Management*, 22(8), 860-874

[5]. Ates, A., Garengo, P., Cocca, P., & Bititci, U. (2013). The development of SME managerial practice for effective performance management. *Journal of Small Business and Enterprise Development*, 20(1), 28-54.

[6]. Brun, A. (2011). Critical success factors of Six Sigma implementations in Italian companies. *International Journal of Production Economics*, 131(1), 158-164

[7]. Canato, A., Ravasi, D., & Phillips, N. (2013). Coerced practice implementation in cases of low cultural fit: Cultural change and practice adaptation during the implementation of Six Sigma at 3M. *Academy of Management Journal*, 56(6), 1724-1753

[8]. Dahlgaard, J. J., & Mi Dahlgaard-Park, S. (2006). Lean production, six sigma quality, TQM and company culture. *The TQM magazine*, 18(3), 263-281.

[9]. Davison, L., & Al-Shaghana, K. (2007). The link between Six Sigma and quality culture–an empirical study. *Total Quality Management & Business Excellence*, 18(3), 249-265.

[10]. Desai, D. A., Antony, J., & Patel, M. B. (2012). An assessment of the critical success factors for Six Sigma implementation in Indian industries. *International Journal of Productivity and Performance Management*, 61(4), 426-444

[11]. Deshmukh, S. V., & Lakhe, R. R. (2010). Six Sigma awareness in Central Indian SMEs. *International Journal of Productivity and Quality Management*, 5(2), 200-212

[12]. Desouza, K. C., & Awazu, Y. (2006). Knowledge management at SMEs: five peculiarities. *Journal of knowledge management*, 10(1), 32-43

[13]. Fadly Habidin, N., & Mohd Yusof, S. R. (2013). Critical success factors of Lean Six Sigma for the Malaysian automotive industry. *International Journal of Lean Six Sigma*, 4(1), 60-82

[14]. Gamal Aboelmaged, M. (2010). Six Sigma quality: a structured review and implications for future research. *International Journal of Quality & Reliability Management*, 27(3), 268-317.

[15]. Gamal Aboelmaged, M. (2011). Reconstructing Six Sigma barriers in manufacturing and service organizations: The effects of organizational parameters. *International Journal of Quality & Reliability Management*, 28(5), 519-541.

[16]. Gijo, E. V., Bhat, S., & Jnanesh, N. A. (2014). Application of Six Sigma methodology in a small-scale foundry industry. *International Journal of Lean Six Sigma*, 5(2), 193-211.

[17]. Green, F. B. (2006). Six-Sigma and the revival of TQM. *Total Quality Management and Business Excellence*, 17(10), 1281-1286

[18]. Grima, P., Marco-Almagro, L., Santiago, S., & Tort-Martorell, X. (2014). Six Sigma: hints from practice to overcome difficulties. *Total Quality Management & Business Excellence*, 25(3-4), 198-208

[19]. Hagen, M. (2010). The wisdom of the coach: A review of managerial coaching in the Six Sigma context. *Total Quality Management*, 21(8), 791-798

[20]. Hargis, M. B., & Bradley III, D. B. (2011). STRATEGIC HUMAN RESOURCE MANAGEMENT IN SMALL AND GROWING FIRMS: ALIGNING VALUABLE RESOURCES. *Academy of Strategic Management Journal*, 10(2).

[21]. Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: updated guidelines. *Industrial Management & Data Systems*, 116(1), 2-20.

[22]. Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115-135.

[23]. Hyun Cho, J., Hoon Lee, J., Geun Ahn, D., & Soon Jang, J. (2011). Selection of Six Sigma key ingredients (KIs) in Korean companies. *The TQM Journal*, 23(6), 611-628

[24]. J. Thomas, A., Ringwald, K., Parfitt, S., Davies, A., & John, E. (2014). An empirical analysis of Lean Six Sigma implementation in SMEs–a migratory perspective. *International Journal of Quality & Reliability Management*, 31(8), 888-905.

[25]. Kaushik, P., Khanduja, D., Mittal, K., & Jaglan, P. (2012). A case study: application of Six Sigma methodology in a small and medium-sized manufacturing enterprise. *The TQM Journal*, 24(1), 4-16

[26]. Kumar, M., & Antony, J. (2008). Comparing the quality management practices in UK SMEs. *Industrial Management & Data Systems*, 108(9), 1153-1166

[27]. Kumar, M., Antony, J., & Douglas, A. (2009). Does size matter for Six Sigma implementation? Findings from the survey in UK SMEs. *The TQM Journal*, 21(6), 623-635

[28]. Kumar, M., Antony, J., & Tiwari, M. K. (2011). Six Sigma implementation framework for SMEs–a roadmap to manage and sustain the change. *International Journal of Production Research*, 49(18), 5449-5467

[29]. Kumar, M., Antony, J., Madu, C. N., Montgomery, D. C., & Park, S. H. (2008). Common myths of Six Sigma demystified. *International Journal of Quality & Reliability Management*, 25(8), 878-895

[30]. Lytras, M. D., Castillo-Merino, D., & Serradell-Lopez, E. (2010). New human resources practices, technology and their impact on SMEs' efficiency. *Information Systems Management*, 27(3), 267-273.

[31]. Malik, A., & Blumenfeld, S. (2012). Six Sigma, quality management systems and the development of organisational learning capability: Evidence from four business process outsourcing organisations in India. *International Journal of Quality & Reliability Management*, 29(1), 71-91.

[32]. McAdam, R., Antony, J., Kumar, M., & Hazlett, S. A. (2014). Absorbing new knowledge in small and medium-sized enterprises: A multiple case analysis of Six Sigma. *International Small Business Journal*, 32(1), 81-109.

[33]. McAdam, R., Reid, R., & Shevlin, M. (2014). Determinants for innovation implementation at SME and inter SME levels within peripheral regions. *International Journal of Entrepreneurial Behavior & Research*, 20(1), 66-90

[34]. Mendes, L., & Lourenço, L. (2014). Factors that hinder quality improvement programs' implementation in SME: Definition of a taxonomy. *Journal of Small Business and Enterprise Development*, 21(4), 690-715.

[35]. Moosa, K., & Sajid, A. (2010). Critical analysis of Six Sigma implementation. *Total Quality Management*, 21(7), 745-759.

[36]. Nakhai, B., & Neves, J. S. (2009). The challenges of Six Sigma in improving service quality. *International Journal of Quality & Reliability Management*, 26(7), 663-684.

[37]. Prajogo, D. I., & Brown, A. (2006). Approaches to adopting quality in SMEs and the impact on quality management practices and performance. *Total Quality Management & Business Excellence*, 17(5), 555-566

[38]. Psychogios, A. G., & Tsironis, L. K. (2012). Towards an integrated framework for Lean Six Sigma application: Lessons from the airline industry. *Total Quality Management & Business Excellence*, 23(3-4), 397-415

[39]. Quader, M. S. (2007). Human resource management issues as growth barriers in professional service firm SMEs. *Journal of Services Research*, 7(2), 115.

[40]. Shokri, A., Oglethorpe, D., & Nabhani, F. (2014). Evaluating Six Sigma methodology to improve logistical measures of food distribution SMEs. *Journal of Manufacturing Technology Management*, 25(7), 998-1027

[41]. Snee, R. D. (2010). Lean Six Sigma-getting better all the time. *International Journal of Lean Six Sigma*, 1(1), 9-29.

[42]. Suresh, S., Antony, J., Kumar, M., & Douglas, A. (2012). Six Sigma and leadership: some observations and agenda for future research. *The TQM Journal*, 24(3), 231-247

[43]. Thomas, A., & Barton, R. (2006). Developing an SME based six sigma strategy. *Journal of Manufacturing Technology Management*, 17(4), 417-434

[44]. Timans, W., Ahaus, K., & Antony, J. (2014). Six Sigma methods applied in an injection moulding company. *International Journal of Lean Six Sigma*, 5(2), 149-167

[45]. Timans, W., Antony, J., Ahaus, K., & van Solingen, R. (2012). Implementation of Lean Six Sigma in small-and medium-sized manufacturing enterprises in the Netherlands. *Journal of the Operational Research Society*, 63(3), 339-353

[46]. Van Iwaarden, J., van der Wiele, T., Dale, B., Williams, R., & Bertsch, B. (2008). The Six Sigma improvement approach: a transnational comparison. *International Journal of Production Research*, 46(23), 6739-6758.

[47]. Wessel, G., & Burcher, P. (2004). Six Sigma for small and medium-sized enterprises. *The TQM Magazine*, 16(4), 264-272

[48]. White, G. R. T., Samson, P., Rowland-Jones, R., & Thomas, A. J. (2009). The implementation of a quality management system in the not-for-profit sector. *The TQM Journal*, 21(3), 273-283

[49]. Williams, S. J. (2006). Managing and developing suppliers: can SCM be adopted by SMES?. *International Journal of Production Research*, 44(18-19), 3831-3846.

[50]. Yew Wong, K., & Aspinwall, E. (2005). An empirical study of the important factors for knowledge-management adoption in the SME sector. *Journal of knowledge management*, 9(3), 64-82.

[51]. Zare Mehrjerdi, Y. (2011). Six-Sigma: methodology, tools and its future. Assembly Automation, 31(1), 79-88