Evaluate Contribution of Engineering Management to Output: A Model Building Approach for Manufacturing SMEs

Houssein. M.A. Elaswad, Shahidul,M.I., Syed Shazali,S.T, Abdullah Yassin

Abstract— **this study aims to develop and test a model to measure the outputs and to evaluate the contribution of engineering management to outputs of manufacturing SMEs. The ultimate target is to evaluate the performance of machinery manufacturing SMEs. Based on literature review a mathematical has developed. Short term input-output data have used to test the developed model. The results revealed that elasticity of output in respect to labor is 0.6, capital 0.12, raw materials 0.18, and engineering management 0.234. The contribution of engineering management is found about 2.5 with a significant p-value (P-value>0.05).The findings concludes that the developed model is useful to evaluate the outputs of machinery manufacturing SMEs and engineering management contribution to outputs. Thus, the study successfully achieved the objectives of the research.**

Index Terms— **Machinery manufacturing, engineering management, input output model, elasticity of outputs.**

1. Introduction and Background

This study aims to develop and test a model to measure the outputs and to evaluate the contribution of engineering management to outputs of manufacturing SMEs. The ultimate target is to evaluate the performance of machinery manufacturing SMEs. The known fact is that machinery manufacturing SMEs are commonly categorized to be the component manufacturers for large companies. Thus, in many developing countries, SMEs account for a significant share of employment and therefore, directly connected to poverty alleviation. Nowadays, SMEs are challenged by the globalization business, and new competitive determinants have appeared for them [1]. However, SMEs has power to contribute to economy.

SMEs in developing countries are important socially and economically for a number of reasons including: Firstly, wide dispersion across rural areas and important for rural economies; Secondly, the ability to employ a significant amount of the labor in local economies; and ability to provide opportunities for entrepreneurial skills development [2]. But, what are not fully addressing by the relevant stakeholders to reinforce its capability are labor skills, optimization of capital, raw materials, engineering management capability for improving product quality, and production management capability. Basically, engineering management is a determinant of quality engineered product and a vital input to outputs. However, the proposed model is to evaluate the optimum level of outputs and to measure the level of engineering management contribution is not available. Hence, it is important for building inputs-outputs model and testing [3]. This study attempts to fill the gap by building and testing input-output models related to the labor, capital, raw materials, and engineering management. The paper has four main sections: introduction and background is placed in section 1; the literature review and objectives are stated in section 2; theoretical framework and research methodology are described in section 3; research findings and conclusion are in section 4.

2. Literature Review and Theoretical Framework

This section highlights an overview of the literature review and theoretical framework related to manufacturing industries. The review work started to study academic research papers and textbooks on the conceptual model and manufacturing SMEs. In this study, researchers studied (32) papers; and about (30) percent of these are published before the year (2010) and (70) percent of papers studied are published after (2010). Related titles were taken into account during the research was presented and discussed.

2.1 Production and Process of Machinery Manufacturing SMEs

Production is the process of transforming inputs to outputs for manufacturing using the all resources that include labor, raw materials, energy, machinery, and management [4]. Production Process is a series of stages to accomplish a production process within the manufacturing SMEs and determine their objective. The manufacturer is able to configure the production process with quick response to produce design and manufacture planning change [5]. However, by exploiting the similarity in the products, variety, and production process aim to keep costs and prices of the product down for production economics. Therefore, manufacturing machinery consists of technologies that are being used in many other manufacturing industrial

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applications. For example, machine tools for cutting metal, wood, plastics and rubber [6]. Manufacturing machinery and the technology are being used in industries to production processes. Manufacturing process technology includes basic engineering equipment such as electric pumps, electric motors, valves, compressors, hydraulic controls, and material handling equipment. Control systems of process are important for achieving product quality and monitoring operations reliability.

2.2 Theoretical Frame Work

2.3

2.3.1 Output of Machinery Manufacturing SMEs

The concept of 'output' is the aggregated production that transforms from total inputs by the aid of processing. The process by which products are produced can be included step by step creation of one form of materials into another [4]. Therefore, production function shows the contribution of transforms through the relationship of inputs into outputs. However, traditional Cobb-Douglas production function is used in this study to evaluate outputs which are stated below:

$Q = A.K^{\alpha}L^{\beta}$, here A>0, (α+β) =1 (1)

Where, Q=output, K=capital of inputs, L= labour input, A is the technological parameters, α and β are elasticity of inputs or contribution of inputs to outputs. Furthermore, this model is not suitable for micro economy and short term production function as mentioned by, [7] and [8]. The argument is that during the short period labour skills, product demands, machinery performance, and raw materials parameters would remain almost unchanged.

2.2.2 Contribution of Inputs to Outputs

Elasticity of outputs is a measure of contribution from inputs. The common inputs to production are capital (K), labour (L), raw material (R), and engineering management (M). The elasticity or the contribution is the degree of outputs potential with respect to inputs [9]. The contribution has been recognizing as a function of production process for final products [10] and [4]. The elasticity of output with respect to inputs can be stated by the equation (2):

$$\text{Elasticity } (\varepsilon) = \frac{dQ}{Q} \cdot \frac{X}{dX} \quad (2)$$

Here, dq = change in output. X = Inputs, dX = change in inputs.

2.2.3 Findings of Literature Review

Most literatures focused on inputs-outputs model of labour and capital with respect to long term time series data. Inputs-outputs analysis with short term production function for manufacturing SMEs is not reported in the published literatures. Moreover, input-output model with the inputs of engineering management is not reported in literature. In that regards, a gap exist in manufacturing SMEs domain. This research is undertaken to fill this gap.

2.2.4 Research Problem Statement

Machinery manufacturing SMEs is a powerful element in supply chain of large capital machinery manufacturing industries. In this respect, this sector is essential for economy. To improve its production performance to a sustainable level, contribution from professional engineers is essential for conducting R&D, designing, planning, quality control and measuring reliability [11] and [12]. All these elements are being considered as the higher value added inputs to production process [13]. In this context, the questions are: what is the degree of contributions that engineering management able to do for enhancing outputs? Is the contribution of engineering management significant for achieving sustainable growth? This study is undertaken to answer the questions.

2.2.5 Objectives of the Study

The broad objective of this work is to develop a model to evaluate outputs of machinery manufacturing SMEs and to measure the contribution of engineering management to outputs, ultimately the developed will be sued to evaluate performance level of manufacturing SMEs. The specific objectives of study are listed below:

- **i.** Model building to evaluate the outputs of manufacturing SMEs.
- **ii.** Model building to evaluate the contribution of engineering management to outputs of manufacturing SMEs.
- **iii.** Model building to evaluate the significant level of contribution

2.2.6 Scope Study

The following work was conducted to evaluate the contribution of engineering management to output of manufacturing SMEs. A data sheet was designed to gather information on production process. Manufacturing SMEs was selected for the information related to the model. Statistical Package of Social Sciences (SPSS) software was used for analysing the data.

2.2.7 Novelty of the Study

An input-output production model is essential to evaluate the contribution of engineering management to outputs; but this model is not available in the published literature. This indicates that a gap exits in the manufacturing domain of SMEs; therefore, this study aims to fill up this gap. Hence, the novelty of this study is to develop a production model with the element of engineering management to evaluate the contribution to manufacturing SMEs.

3. METHODOLOGY

Literature review, model building, testing, and validation are based of this study. The dependent variable of this study is the outputs (Q) of manufacturing SMEs. The independent variables are L-Labour engaged in production process while K -Capital is used to manage and to operate production process; R-Raw materials are used to produce products (cost of raw materials); M-Engineering management is known as the cost of engineering management.

3.1 Modelling

The current study evaluates the contribution of engineering management to outputs based on short terms production function. The specified dependent and independent variables are incorporated into the input-output model which can be used to measure the contribution of inputs. The conceptual model of the production function is shown in Figure 1 below.

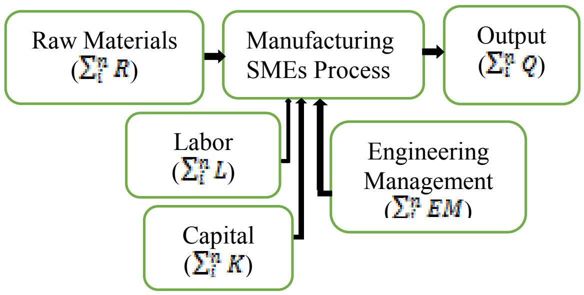

Figure 1: Conceptual Inputs-Outputs Model

The mathematical model of this concept is presented by equation (3):

$$Q(t) = A.K^{\alpha} L^{\beta} R^{\lambda} M^{\gamma} \quad (3)$$

This model is valid for: $\alpha+\beta+\gamma+\lambda=1$: $\alpha+\beta+\gamma+\lambda<1$ and $\alpha+\beta+\gamma+\lambda>1$

The log form of this equation is:

$$Log(Q) = log(A) + \alpha log(K) + \lambda log(R) + \beta log(L) + \gamma log(M) \quad (4)$$

Here; $Q(t)$=Average output of production over time t. K= capital of machinery and production operations. R = Raw materials used. L= number of labor on the manufacturing process. A= transformation factor from inputs to outputs, M= engineering management needs to manage production.

3.2 Modelling Contribution of Engineering Management to Outputs

The input-output conceptual model shown in Figure 1 indicates that positive changes in outputs occur due to change in input over a certain period of time. This type of positive change is recognized as contribution of input to output. Meaning is the marginal change in output in respect to marginal change in engineering management as inputs that can be recognized as the contribution of engineering management [C (m)]. This phenomenon is shown in Figure 2.

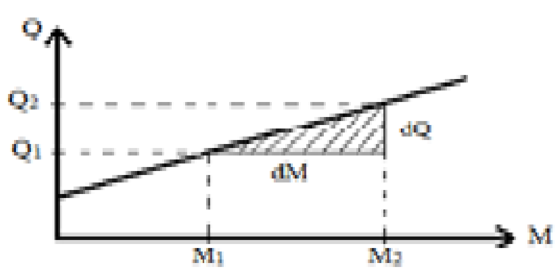

Figure 2: Changes in output with respect to change in engineering management

Figure 2 highlighted the areas that represent C (M), which is known as the marginal change of output in respect to marginal change in engineering management inputs. This can be represented by (5):

$$C(M) = \frac{Q_2-Q_1}{M_2-M_1} = \frac{dQ}{dM} \quad (5)$$

The value of $C\ (m)$ can also be obtained from the equation 4. If there is no change in A, K, R and L then we have:

$$\frac{d(logQ)}{dM} = \frac{d(logA)}{dM} + \alpha\frac{d(logK)}{dM} + \lambda\frac{d(logR)}{dM} + \beta\frac{d(logL)}{dM} + \gamma\frac{d(logM)}{dmM},$$

$$\frac{d(logQ)}{dm} = 0+0+0+0+\gamma\frac{d(logM)}{dm},$$

$$\frac{1}{Q}\frac{dQ}{dm} = \gamma\frac{1}{m} \text{ or } C(M) = \frac{dQ}{dm} = \gamma\frac{Q}{M} \quad (6)$$

3.3 Time Effect on Contribution

The contribution is not static and changes occur with the passage of time. A professional body or a technical person tends to gain experience over time which is used to enhance the contribution capability. This type of skill growth is known as the exponential distribution [14]. Therefore, the increasing capability of contribution can be presented by the equation (7):

$$A(t) = A_0\, e^{\theta t} \quad (7)$$

Here, θ = Time efficiency parameters of inputs of a production process is also known as a technological parameters [14]; [15]; [16]; [17] and [18].

3.4 Modeling the Effect of Time on Engineering Management Contribution

Equation 7 indicates that the contribution is time dependent. If the equations 6 and 7 are combined; in results, the time dependent contribution model gets a new shape which presented by the equation (8):

$$C(M) = \gamma(t)\ \frac{Q(t)}{M(t)}\ e^{\theta t} \quad (8)$$

Equation (8) indicates that the value of $C\ (M)$ depends on the elasticity of outputs $[\gamma\ (t)]$ and time efficiency parameter of skill $[\theta t]$. Practice shows that $C\ (M)$ for machinery manufacturing SMEs is more than one $[C\ (M) \geq 1]$.

3.5 Modelling to Measure Significant Level of Engineering Management Contribution to Output

Here, significance is used to measure the degree of engineering management contribution to outputs; in this current study, 95% confident level is used to measure the degree of contribution. If P-value is less than 0.05; it means the machinery manufacturing SMEs did not use targeted amount of engineering management resources in production process to produce products. To test the significance level, the right tail test model is used and is shown below in Figure 3:

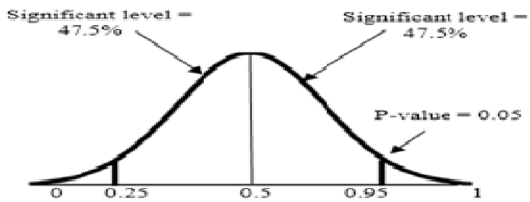

Figure 3: Significant Level Test

Whereas, P-value can be estimated by using the equation (9) stated below:

$$Z = \frac{(\bar{X}-x)}{\frac{\sigma}{\sqrt{n}}} \quad (9)$$

Where; the standard devotion of (CM) is σ in SMEs; and n is the sample size of SMEs.The (CM) is shown as $x_{(i,\dots,n)}$ of20 SMEs outputs .The average of (CM) is$\bar{X}$.

4. MODELS ESTIMATE

This study uses time-series data of 2009-2013. First, equation 3 is used to evaluate the outputs of machinery manufacturing SMEs; second, equations 4,5,6,7 and 8 are used to evaluate the contribution of inputs to outputs of machinery manufacturing SMEs, and finally, equations 9 is used for measuring the level significance of contribution engineering management.

4.1 Data Analysis and Findings

Inputs-outputs data of 20 SMEs on the 5 years production is analysed; and findings are reported in Table 01 and Table 02.

Table 1 Model Estimate of 20 Machine Manufacturing SMEs

Parameters	α	β	λ	γ	R^2	DW
Model estimate	0.6	0.12	0.18	0.234	0.85	2.147

The value of effect size (R2) is 0.85 that indicates 85 percent inputs used in outputs. The DW statistics 2.3 indicates that auto correlation is within acceptable limit. The estimated value of elasticity of labor, capital, raw materials, and engineering management are α=0.6, β=0.12, λ=0.18 and γ = 0.234 respectively.

4.2 *Output Model Estimate of Machinery Manufacturing SMEs*

This part of the analysis is designed to address the research objective number 01. The short term input-output data is used to estimate output model. The estimated value of contribution of labor, capital, raw materials, and management to outputs are A=0.88, α=0.6, β=0.12, λ=0.18 and γ=0.234. Equation (3) is the model used to estimate average output of a short term production process. By using these values; the output model of machinery manufacturing SMEs becomes:

$$Q(t) = 0.88\, L^{0.12}\, K^{0.08}\, R^{.6}\, M^{0.234} \quad (10)$$

The transformation factor from inputs to outputs A is 0.88 that indicates only 88 percent inputs converted to outputs. The capital contribution (elasticity) is indicated as $K^{0.08}$ and is shown as 0.08. Similarly, $L^{0.12}$ indicates labor contribution (elasticity) which is 0.12; while $R^{.6}$indicates the raw materials contribution (elasticity) as 0.6. Whereas, $M^{0.234}$ indicates the engineering contribution (elasticity) as 0.234. From equation 10, it is found that the total elasticity of production with the factor of inputs is 1.03. The estimation model is attached in Appendix A1.

4.3 The Contribution of Engineering Management to output of machinery manufacturing SMEs.

This part of analysis is addressed the research objective number 02. The objective is "Model building to evaluate the contribution of engineering management to outputs of manufacturing SMEs". To evaluate the contribution, equations 8 and 9 are estimated by using audited inputs-outs data of 20 SMEs from 2009 to 20013. The detail estimation is attached in Appendix A2. The results of the model estimation are reported in Table 02.

Table 2 the Estimated Contribution Engineering Management to Outputs.

Sample SMEs	Contribution C(M)	Significant level of contribution P-Value
SMEs1	2.620659	0.28
SMEs2	2.603117	0.242
SMEs3	2.639542	0.3192
SMEs4	2.44426	0.05*
SMEs5	2.734007	0.4562
SMEs6	2.518588	0.1093
SMEs7	2.520122	0.1112
SMEs8	2.508919	0.1
SMEs9	2.668997	0.39
SMEs10	2.524509	0.12
SMEs11	2.490274	0.0808
SMEs12	2.49363	0.0838
SMEs13	2.550088	0.1515
SMEs14	2.531156	0.1251
SMEs15	2.575844	0.1922
SMes16	2.533539	0.1292
SMEs17	2.478502	0.0708
SMEs18	2.548411	0.1492
SMEs19	2.50603	0.0968
SMEs20	2.83299	0.000*

*One tail test at 95% confidence level

The results indicate that the ranges of contribution are from 2.44-2.73. The p-value indicates that the contribution of two SMEs is only significant. The level significance of contribution is depicted in Figure 4. The detail estimate of significance is attached in Appendix A3.

4.4 Significance Test for Contribution

This part of analysis is addressed the research objective number 03. The objective is "Model building to evaluate the significant level of contribution". To evaluate the contribution significance, equations 9 is estimated by using audited inputs-outs data of 20 SMEs from 2009 to 20013. The detail estimation is attached in Appendix A3.

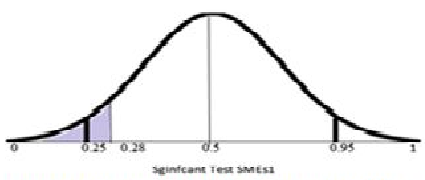

Figure 04: Significancy Level of Contribution of SMEs 1

The results of the model estimate are reported in Table 02. Significant Test for SMEs 1 is depicted in Figure 4 and others are attached in Appendix A4.The significant test is conducted at 95 percent confidence level; and the p-value of contribution is found 0.28 which is more than 0.05. The location of p-value is within 0.95 which indicates that the engineering management resources are not fully utilized. The gap of resources utilization is 67% (95% - 28 %). This finding concludes that the contribution of engineering management to SMEs1 is not significant.

4.5Scenario Analysis of Findings

Model of production function, engineering management contribution, estimated significance measurement are reported in section 4.1, 4.2, 4.3 and 4.4. The findings demonstrated the relationship between inputs and outputs of production process. Model test results have indicated that the major contributory element of the production process is raw materials with elasticity 0.6. The second highest contributory element is the engineering management with elasticity 0.234. The third is the labor with elasticity 0.12, and finally the lowest contributory element is the capital with elasticity 0.08.

The production model presented by equation (10) shows that the transformation efficiency of SMEs or productivity is only 0.88. It indicates that the SMEs that are used to test product models are inefficient. However, our developed model shows its effectiveness in evaluating the performance level of SMEs.

The production model shows that elasticity of labor is 0.12. It means due to change of 100 unit labors at inputs; outputs will change only 12 units. This finding is in-line with other investigators such as [19] was estimating labor productivity of Hungary and Mexico; he found elasticity of labor at Hungary is 0.262 and elasticity of labor at Mexico is 0.155. 1 measured the technical efficiency of SMEs food enterprise in Malaysia; he found that the elasticity of labor is 0.0407. Correspondingly, the technical efficiency was measured by [21] related to manufacturing SMEs in Thailand; they found the range elasticity of labor was from 0.168 to 0.316. The performance and structure of manufacturing SMEs was evaluated [22] in Pakistan indicated the elasticity of labor is inelastic with elasticity -0.5836. The elasticity of labor at Romanian SMEs in Industry sector [23] was found and is 0.6374. The performance of metal fabricating SMEs in Zimbabwe [24] was estimated; they reported the elasticity of labor was 0.565.

The production model shows that elasticity of capital is 0.08. It means due to change of 100 unit capital at inputs; outputs would change only 8 units. This finding is in-line with other previous studies such as [20] measured the technical efficiency of SMEs food enterprise in Malaysia and found the elasticity of capital is 0.03217. The technical inefficiency factors for Thai manufacturing SMEs was identified by [25] and found the capital elasticity ranges from 0.147 to 0.299. The SMEs and found the elasticity of capital are 0.056 (overall manufacturing SMEs), 0.044 for micro enterprises and 0.090 for small and medium sized enterprises [26]. The SME policy and firms' productivity in Latin America was investigated by [27] and they found the elasticity of capital is 0.126. The technical efficiency in the Indian manufacturing SMEs was examined by [28] and found the elasticity of output with respect to capital is in the range of 0.25 in textiles industrial group to 0.65 in 'others' industrial group.

The production model shows that elasticity of raw materials is 0.6. It means due to change of 100 unit raw materials at inputs; 60 units of output would be changed. This finding is in-line with other investigators such as [20] estimated the technical efficiency of Malaysian SMEs and found elasticity of raw materials is 0.67634. The relationship between investment in Information and Communication Technologies and Technical Efficiency in Italian manufacturing firms was found by [29] and mentioned that the elasticity of raw materials is 0.240. The efficiency of firm processing oil products (palm oil) in Ghana [30] was found the elasticity of raw materials is 0.433. Similarly, the firm-level efficiency and productivity growth in Indonesian manufacturing industries was explored by [31]; he found the elasticity of raw materials is 0.396.

The production model shows that elasticity of engineering management is 0.234. It means due to change of 100 unit engineering management at inputs; outputs would change only 23.4 units. This finding is in-line with other investigators such as [32] tested the effect of firm-level innovation on subsequent productivity on Australian SMEs and they found the elasticity of operational processes is -0.031 and organizational/management processes is 0.030. The technical efficiency of small and medium food enterprise in west Malaysia was found by [20] and informed that the elasticity of administration is 0.0948. This study shows that the elasticity of capital, labor, and raw materials estimated from the production model is in line with findings of others. But the elasticity of engineering management does not match with findings of others. The fact is that publication on engineering management contribution to production is insignificant numbers and cannot be comparable.

5. Conclusion and Summary

This study was designed to build model to measure the outputs of manufacturing SMEs. The main focus of this research is to evaluate the contribution of engineering management to outputs with level of significance. For testing the developed models, short-term input-output data of 20 SMEs from 2009 to 2013 were used.

The first part of this study was to build input-output model for measuring the outputs. The developed model (Equation 10) shows that the transformation efficiency of manufacturing SMEs or productivity of the manufacturing SMEs is only 0.88. The results also indicate that the elasticity of labour is 0.12, capital 0.8, raw material is 0.6, and engineering management is 0.234. It indicates that the SMEs used to test product models are incompetent and cannot be sustainable. However, the developed model shows its effectiveness to evaluate performance level of SMEs.

However, the second part was building a model to evaluate the contribution of engineering management C (M) to the outputs of production process. The test result shows that the engineering management is positively related to production outputs. The results indicate that the ranges of contribution are from 2.44 to 2.73. Therefore, engineering management is a significant factor to the output of production performance.

Therefore, the changing number of unit in inputs of engineering management would affect the performance production of machinery manufacturing SMEs. The third part evaluated the significance level of engineering management contribution to output. The results indicated that the contribution of engineering management only two manufacturing SMEs from twenty are significant in the production of machinery manufacturing SMEs at (0.05). Others are not considered significant which indicate that the engineering management resources are not fully utilized. This study has emphasised the importance of further study of the cases required for engineering management contribution of outputs to each manufacturing SMEs.

Appendix A1

Estimate short term production function and elasticity of outputs

The outputs for SMEs 1.

$Q(t) = A.K^{0.6} L^{0.12} R^{0.18} M^{0.234}$

$Q(t) = 0.88 * (281479.0207)^{0.6} * (307050.48)^{0.12} * (322855.5276)^{0.18} * (84482.83094)^{0.234}$,

$Q(t)$ =1040161.47

Elasticity of Outputs

E (t) = 0.12+0.08+0.6+0.234

=1.03>1

Appendix A2

Estimate the Contribution of Engineering Management Model

$C(M) = \gamma(t) \frac{Q(t)}{M(t)} e^{\theta t}$, $A(t) = A(Q) e^{\theta t}$

$\frac{A_{2013}}{A_{2009}} = e^{\theta t}$, $Ln\left(\frac{A_{2013}}{A_{2009}}\right) = -0.07182865$, than

$\theta = \frac{(-0.07182865)}{4} = -0.017957162$, $e^{\wedge} - 0.017957162 = 0.99047368$,

$C(M) = 0.234 * (11.66431) * (0.99047368)$,

The total average, $C(M) - 2.703446938$. The results are listed in Table 3.

Appendix A3

Estimate the Significant Level of Contribution Engineering Management

Estimate P-value by Using Z-test: $Z = \frac{(\bar{X} - x)}{\frac{\sigma}{\sqrt{n}}}$,

Standard deviation: $\sigma = \sqrt{1/n}\,(x_i - \mu)^2$,

Where σ is known as the standard devotion of (CM) in SMEs, N is the sample size of SMEs, x_i is the average (CM) to twenty SMEs within operating time 2009-2013, μ is the total average of (CM), $\bar{X}$ is the total average of (CM),

$\sigma = \sqrt{1/20\,(10.32018)^2}$ = 0.71834.

Then $Z = \frac{\sqrt{20} * ((\bar{X} - x))}{0.71834} =$ P-vale =1- P.

The results are listed in Table 4.

Table 3: Contribution of Engineering Management Model

SMEs	Av(M)	Av Q	Av (Qt./Mt)	Av(Q2/Q1)	Av Ln (Q2/Q1)	(t)	Av(Θ)	Av e^{θ}	$\gamma(t)$	Av C(M)
SMEs1	50952.96	574112.9	11.31387812	1.0639431	-0.0611438	4	-0.015285951	0.989881398	0.234	2.620659013
SMEs2	85827.6	950259.6	11.11194395	1.09122672	-0.01955653	4	-0.004889132	1.001123941	0.234	2.60311735
SMEs3	83887.44	951081.6	11.35651908	1.07698263	-0.05812199	4	-0.014530497	0.993270241	0.234	2.639541631
SMEs4	50270.9	542944.8	10.84626132	1.03123451	-0.21210703	4	-0.053026759	0.963056045	0.234	2.444260463
SMEs5	77162.5	851720.4	11.03801853	1.25229052	0.147596926	4	0.036899232	1.058504419	0.234	2.734007186
SMEs6	80989.77	894174	11.09662291	1.02418348	-0.14787166	4	-0.036967916	0.969952329	0.234	2.518587686
SMEs7	51673.02	583872.7	11.27411554	0.99348583	-0.20815444	4	-0.052038611	0.955263756	0.234	2.520122425
SMEs8	129495.2	1419683	10.99511646	1.03004123	-0.11631493	4	-0.029078734	0.975149121	0.234	2.508919487
SMEs9	72230.69	765256.2	10.76136923	1.25761429	0.149493262	4	0.037373316	1.059899681	0.234	2.668997405
SMEs10	85721.97	951019.3	11.13079637	1.0195905	-0.14455332	4	-0.036138329	0.969247661	0.234	2.524508613
SMEs11	55641.01	618252.1	11.13219279	0.99569205	-0.20656462	4	-0.051641155	0.955983935	0.234	2.490274207
SMEs12	131396.5	1434318	10.94809134	1.0264994	-0.12399795	4	-0.030999487	0.97336943	0.234	2.493629757
SMEs13	82693.62	926253.2	11.22975822	1.02385663	-0.14313234	4	-0.035783085	0.970440629	0.234	2.55008839
SMEs14	95550.72	1021931	10.76072268	1.10050644	-0.00385694	4	-0.000964236	1.005221289	0.234	2.531156361
SMEs15	123670.4	1396882	11.28786075	1.0296048	-0.1150467	4	-0.028761676	0.975196142	0.234	2.575843511
SMes16	54760.63	595359.2	10.94628303	1.0631396	-0.0658982	4	-0.016474549	0.989110892	0.234	2.533538537
SMEs17	118412.3	1289767	10.88072268	1.02534703	-0.12103938	4	-0.030259845	0.973454385	0.234	2.478501606
SMEs18	132083.3	1473200	11.1653577	1.03028091	-0.11473015	4	-0.028682537	0.975395904	0.234	2.548410734
SMEs19	88056	971431.7	11.02280378	1.02853314	-0.14297354	4	-0.035743384	0.971579625	0.234	2.506030385
SMEs20	39180	905837.8	22.98776447	1.30060025	0.271400345	4	0.067850086	1.084372778	0.234	5.832989611
Average	**84482.83**	**955867.9**	**11.66430995**	**1.07323265**	**-0.07182865**	**4**	**-0.017957162**	**0.99047368**	**0.234**	**2.703446928**

Table 4: Estimate the Significant Level of Contribution Engineering Management

SMEs	C(M)	$\bar{X} - X$	Standard Deviation	$\sqrt{N}$	$\sqrt{N}(\bar{X} - X)$	Z-Value	Probability(P)	P-value
SMEs1	2.620659	0.0955	0.71834	4.472136	0.427089899	0.594551	0.72	0.28
SMEs2	2.603117	0.113042	0.71834	4.472136	0.505538602	0.70376	0.758	0.242
SMEs3	2.639542	0.076618	0.71834	4.472136	0.342644264	0.476995	0.6808	0.3192
SMEs4	2.44426	0.271899	0.71834	4.472136	1.215968197	1.692747	0.95	0.05
SMEs5	2.734007	-0.01785	0.71834	4.472136	-0.079818542	-0.11112	0.5438	0.4562
SMEs6	2.518588	0.197572	0.71834	4.472136	0.883566752	1.230012	0.8907	0.1093
SMEs7	2.520122	0.196037	0.71834	4.472136	0.876703191	1.220457	0.8888	0.1112
SMEs8	2.508919	0.20724	0.71834	4.472136	0.926804253	1.290203	0.9	0.1
SMEs9	2.668997	0.047162	0.71834	4.472136	0.210914041	0.293613	0.61	0.39
SMEs10	2.524509	0.191651	0.71834	4.472136	0.857087561	1.19315	0.88	0.12
SMEs11	2.490274	0.225885	0.71834	4.472136	1.010188478	1.406282	0.9192	0.0808
SMEs12	2.49363	0.222529	0.71834	4.472136	0.995182003	1.385391	0.9162	0.0838
SMEs13	2.550088	0.166071	0.71834	4.472136	0.742691321	1.033899	0.8485	0.1515
SMEs14	2.531156	0.185003	0.71834	4.472136	0.827357927	1.151764	0.8749	0.1251
SMEs15	2.575844	0.140316	0.71834	4.472136	0.627510917	0.873557	0.8078	0.1922
SMes16	2.533539	0.182621	0.71834	4.472136	0.816704514	1.136933	0.8708	0.1292
SMEs17	2.478502	0.237658	0.71834	4.472136	1.062837153	1.479574	0.9292	0.0708
SMEs18	2.548411	0.167748	0.71834	4.472136	0.750194025	1.044344	0.8508	0.1492
SMEs19	2.50603	0.210129	0.71834	4.472136	0.939724709	1.308189	0.9032	0.0968
SMEs20	5.83299	-3.11683	0.71834	4.472136	-13.93888926	-19.4043	0.000	0.000
Average	**2.716159**							

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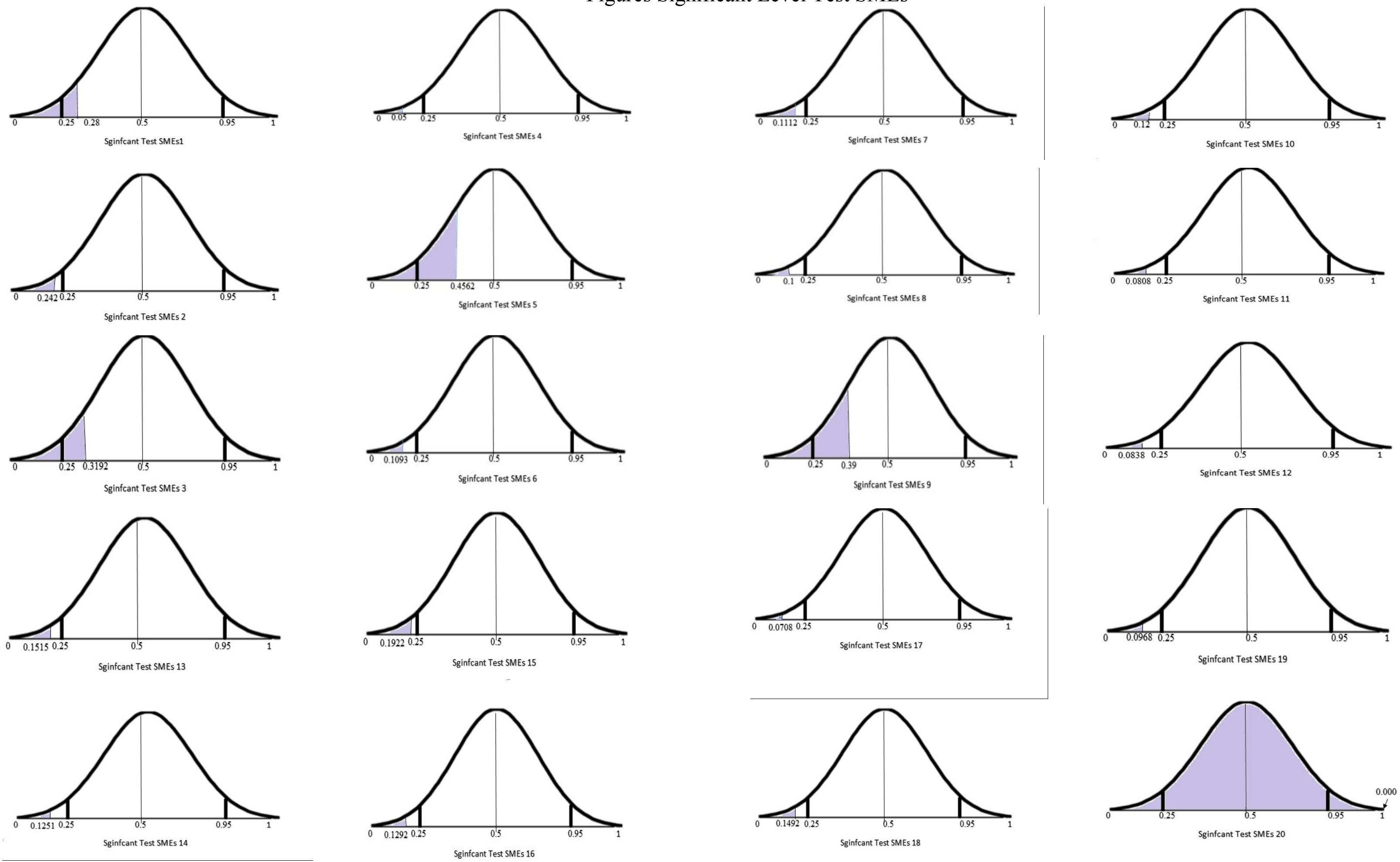
Appendix A4

Figures Significant Level Test SMEs



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