Using Stepwise Regression and Nonparametric Tests to Analyze the Landed Cost Competitiveness of Producing Apparel in Different Countries

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Abstract
This study analyzed the landed cost competitiveness of producing apparel in 18 countries for the U.S. market, as well the sensitivity of different factors, including labor wages, exchange rates, and productivity, on the cost. Detailed cost models were used to compute the landed costs of T-shirts and denim jeans. A Design of Experiments (DOE) with six factors and five levels was generated, yielding a total of 281,250 data points, for both T-shirts and denim jeans. A stepwise regression analysis was used to determine the most significant factors for further experimentation. By using nonparametric multiple comparison tests, the competitiveness of countries in Asia, Sub-Saharan Africa, and Latin America was analyzed, and what if analyses were performed on the regions.

Keywords: Apparel, DOE, Stepwise Regression, Nonparametric

1. Introduction

The global apparel market is valued at $3.3 trillion (fashiounited, n.d.). Staritz & Fredrick (2014) states that 80 percent of the world's apparel imports are from developing countries. Imports into the U.S have grown substantially over the past several decades from $27 billion in 1990 to $85 billion in 2015 (OTEXA, 2016). Over 90 percent of apparel in the U.S. is imported (Frings, 2010) from developing countries in Asia, Latin America and the Caribbean (OTEXA, 2016; Gereffi, 2002). One of the fundamental reasons for outsourcing production of a lot of consumer products is the cheap labor in developing countries. Since apparel production is a labor-intensive process and requires relatively low capital to start, it is attractive to developing countries.

The most important criteria used in sourcing decisions and selecting suppliers are cost, quality, lead time, flexibility and reliability (Sarkis & Talluri, 2002; Ho, Xu and Dey, 2010; Wu and Barnes, 2011; Chen, 2011). While cost is not the only factor, it has always been one of the most important criteria in sourcing and supplier selection within the apparel industry (Ho, Xu, & Dey, 2010). Lowson (2002) noted that the reason for sourcing apparel globally is the low cost that international suppliers offer.

Several cost methods and models have been used in evaluating suppliers, including traditional methods that do not account for all of the costs involved in sourcing to conventional cost management methods that provide more information and cost factors is assessing overall cost (Hergeth, 1996; Rendall et al., 1999). However, it has been recognized that not all costs are taken into account when making sourcing/supplier selection decisions. These costs are considered hidden costs and include labor cost inflation, overhead, currency fluctuation, risk in transportation, political and economic instability, response time, cost of poor quality, lost flexibility and tariffs (Holweg et al., 2011; Rendall et al.,1999; Hergeth, 2002; Hines, 2002; Lowson, 2002, 2003; Hartman et al., 2012).

Within supplier selection, there are broader evaluation metrics which assess both qualitative and quantitative criteria (Benyoucef et al., 2003) using different supplier selection decision-making models that are mathematical and statistical in nature. Wu and Barnes (2011) conducted a literature review and found four major models [data envelopment analysis models (DEA), cluster analysis models, categorical models and artificial intelligence models] used in evaluating and selecting suppliers based on several criteria most important to the buying company.

Statistics has been recognized to provide a better understanding in making sound and well informed decisions (Pullinger, 2013). In today's complex economic and data driven environment, decision makers use statistics as one of the tools to inform policies, and manage businesses. The apparel industry is no exception to using data in forecasting trends and selecting suppliers globally who enhance their competitiveness in the apparel market.

This study focuses on one criteria, cost, and looks at several cost factors throughout the apparel supply chain in determining the cost competitiveness of countries for apparel sourcing. Furthermore, we use several statistical analysis methods to determine how Sub-Saharan Africa (SSA) can improve its competitiveness based on several factor combinations.

2. Generating data for analysis

To statistically determine the competitiveness of countries for apparel sourcing, the results from a landed cost model adapted from Fiallos (2009), which analyzes the cost of production along the apparel supply chain shown in Figure 1, was used. Equations 1 and 2 reveal the main cost factors used in the landed cost model. Tables 1 and 2 show the results from the landed cost analysis.

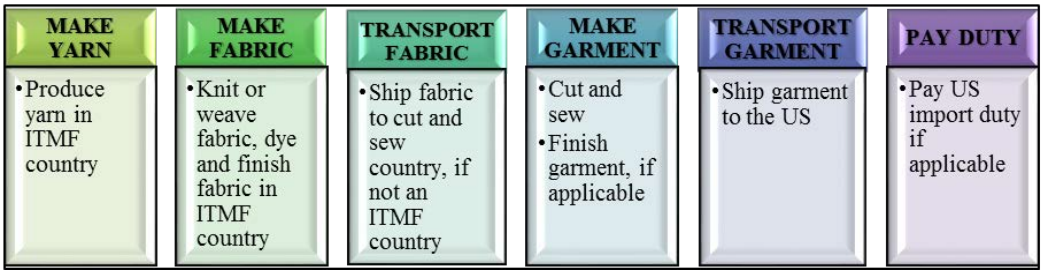

Figure 1:Apparel Supply Chain Studied in this Analysis

Equation 1–Landed Cost

$$\frac{\$}{garment} = \frac{\$_{exit-factory}}{garment} + \frac{\$_{garment\ transportation}}{garment} + \frac{\$_{duty}}{garment}$$

Equation 2–Exit-Factory Cost

$$\frac{\$_{exit-factory}}{garment} = \frac{\$_{fabric}}{garment} + \frac{\$_{trim}}{garment} + \frac{\$_{apparel\ labor}}{garment} + \frac{\$_{apparel\ energy}}{garment} + \frac{\$_{garment\ finishing}}{garment} + \frac{\$_{off-quality}}{garment}$$

Table 1: Landed Cost per T-shirt in U.S. Dollars

Country	Fabric Cost ($)	Trim Cost ($)	Apparel Labor Cost ($)	Apparel Energy Cost ($)	Off-Quality ($)	Garment Transportation ($)	Duty Charge ($)	Landed Cost ($)
Mexico	1.2802	0.2567	0.1180	0.0135	0.0334	0.0225	0.0000	1.7243
Nicaragua	1.2810	0.2567	0.1275	0.0212	0.0337	0.0251	0.0000	1.7452
Swaziland	1.3117	0.2567	0.0268	0.0146	0.0322	0.1428	0.0000	1.7848
Ghana	1.3259	0.2567	0.0440	0.0198	0.0329	0.1111	0.0000	1.7904
Ethiopia	1.3237	0.2567	0.0301	0.0035	0.0323	0.1544	0.0000	1.8006
El Salvador	1.2808	0.2567	0.1948	0.0260	0.0352	0.0243	0.0000	1.8177
Lesotho	1.3117	0.2567	0.0905	0.0022	0.0332	0.1428	0.0000	1.8370
Guatemala	1.2809	0.2567	0.2499	0.0125	0.0360	0.0247	0.0000	1.8607
Kenya	1.3305	0.2567	0.0766	0.0110	0.0335	0.2040	0.0000	1.9122
Madagascar	1.3374	0.2567	0.0402	0.0225	0.0331	0.2264	0.0000	1.9163
Honduras	1.2818	0.2567	0.2988	0.0241	0.0372	0.0270	0.0000	1.9257
Indonesia	1.1955	0.2567	0.0709	0.0101	0.0307	0.1120	0.2580	1.9339
Mauritius	1.3390	0.2567	0.1170	0.0121	0.0345	0.2316	0.0000	1.9908
India	1.2880	0.2567	0.0632	0.0123	0.0324	0.1035	0.2727	2.0288
Bangladesh	1.2957	0.2567	0.0593	0.0157	0.0325	0.1128	0.2739	2.0467
Vietnam	1.4421	0.2567	0.0826	0.0154	0.0359	0.1097	0.3024	2.2447
China	1.4379	0.2567	0.1387	0.0178	0.0370	0.0788	0.3115	2.2784
U.S.	1.2734	0.2567	1.3852	0.0091	0.0585	0.0000	0.0000	2.9828

Table 2: Landed Cost per Pair of Denim Jeans in U.S. Dollars

Country	Fabric Cost ($)	Trim Cost ($)	Apparel Labor Cost ($)	Apparel Energy Cost ($)	Garment Finishing ($)	Off-Quality ($)	Garment Transportation ($)	Duty Charge ($)	Landed Cost ($)
Mexico	6.1934	1.3799	0.3540	0.0405	0.0552	0.2407	0.0489	0.0000	8.3125
Nicaragua	6.2000	1.3799	0.3824	0.0637	0.1109	0.2441	0.0545	0.0000	8.4355
Swaziland	6.4597	1.3799	0.0805	0.0438	0.0769	0.2412	0.3102	0.0000	8.5922
Ethiopia	6.5621	1.3799	0.0902	0.0105	0.0178	0.2418	0.3352	0.0000	8.6375
El Salvador	6.1979	1.3799	0.5845	0.0779	0.1069	0.2504	0.0527	0.0000	8.6502
Ghana	6.5801	1.3799	0.1319	0.0595	0.0887	0.2472	0.2413	0.0000	8.7287
Lesotho	6.4597	1.3799	0.2714	0.0065	0.1035	0.2466	0.3102	0.0000	8.7779
Guatemala	6.1990	1.3799	0.7497	0.0376	0.2031	0.2571	0.0536	0.0000	8.8801
Madagascar	6.6776	1.3799	0.1207	0.0674	0.0408	0.2486	0.4916	0.0000	9.0267
Kenya	6.6196	1.3799	0.2297	0.0331	0.0784	0.2502	0.4429	0.0000	9.0338
Honduras	6.2068	1.3799	0.8965	0.0724	0.1659	0.2616	0.0586	0.0000	9.0417
Mauritius	6.6910	1.3799	0.3511	0.0362	0.0840	0.2563	0.5029	0.0000	9.3014
Indonesia	5.9148	1.3799	0.2128	0.0302	0.0358	0.2272	0.2433	1.2949	9.3389
India	6.2878	1.3799	0.1897	0.0368	0.0375	0.2379	0.2248	1.3562	9.7505
Bangladesh	6.3528	1.3799	0.1780	0.0472	0.0428	0.2400	0.2449	1.3680	9.8536
Vietnam	7.4546	1.3799	0.2477	0.0462	0.0646	0.2758	0.2383	1.5718	11.2790
China	7.4196	1.3799	0.4160	0.0534	0.0954	0.2809	0.1712	1.6011	11.4175
U.S.	6.1351	1.3799	4.1555	0.0274	0.6810	0.3714	0.0000	0.0000	12.7503

2.1 Analyzing competitiveness of landed costs using ANOVA and stepwise regression

Several factors (labor, energy, water, productivity, transportation, exchange rates) from the landed cost model were used in a design of experiment (DOE). These factors were assigned several levels to generate more data for statistical analyses of the landed cost competitiveness of the 18 countries. Since the landed cost, in itself, is a model built in Excel, the DOE analysis using stepwise regression is not intended to develop a model to predict the landed cost. The purpose of the analysis is to obtain significant factors that impact the landed cost for further experimentation using JMP Pro version 12.0.1. Table 3 shows the factors and levels used in the DOE analysis. Note, the levels were chosen to be percentages. Thus, -20% would represent, for example, a 20% decrease in energy costs for a country, with 0% being the base value used in the landed cost.

Table 3: DOE for Landed Cost - Factors and Their Levels

Factors	Level 1	Level 2	Level 3	Level 4	Level 5
Labor	0%	5%	10%	20%	30%
Energy	-20%	-10%	0%	10%	20%
Water	-20%	-10%	0%	10%	20%
Productivity	-20%	-15%	-10%	-5%	0%
Transportation	-20%	-10%	0%	10%	20%
Exchange Rate	-40%	-20%	0%	20%	40%

Using the factors and levels from Table 3 and data for T-shirts and denim jeans from Table 1 and Table 2 together with a full factorial design, 281,250 ($5^6 \times 18 = 281{,}250$) data points each were generated for both T-shirts and denim jeans. These data points were generated using VBA inside of Excel. The data was then transferred to JMP for further analysis. An ANOVA test was first performed to determine if countries statistically differ considering all the factors and levels from Table 3 for T-shirts and then for jeans. The null and alternative hypotheses for these tests are stated as follows:

H_o: The mean T-shirt/denim jeans landed cost for all countries is equal.

H_a: At least one country's mean is different.

Furthermore, multiple comparison tests were performed to determine specifically which countries were different from each other. Subsequently, a stepwise regression analysis was used to determine which factors contribute to the competitiveness of countries.

2.2 Sensitivity analysis

Authors of several extant studies have noted that popular brands and retailers are showing interest in starting or increasing apparel sourcing in SSA (Berg et al., 2015; AAFA, 2012). These studies also noted that due to increases in production costs and labor wages, particularly in China, buyers are looking at other countries for their sourcing needs. Therefore, this part of the study focused on further improving the competitiveness of one region, Sub-Saharan Africa since it is the region with the least amount of apparel imports (1.2% of the 2015 imports) into the U.S. However, SSA countries have relatively low labor wages in addition to their duty-free access to the U.S. through the African Growth and Opportunity Act (AGOA).

As will be explained in Section 3.2, from the stepwise regression analysis, it was determined (at a p-value= <0.0001) that factors such as exchange rates, labor and

productivity have significant effects on landed cost. Consequently, an experiment was carried out using labor, exchange rates and productivity in a 'what if' analysis to determine under what circumstances will SSA countries be more competitive than Latin American and Asian countries if the factor levels are varied.

Table 4 shows the five different labor wage scenarios that were analyzed, varying labor levels among regions to determine what combination of factor levels will improve SSA countries' competitiveness. Labor wages of SSA and the U.S. were kept constant at 0%, while the labor wages for Asian and Latin American countries were varied as shown in Table 4. All other factors were varied as specified in the DOE in Table 3. A 0% means that the 2015 labor rate used in the landed cost was used, while a 30% means a 30% increase in the 2015 labor wages was used.

Table 4: What if Scenarios on Labor for Both T-shirts and Denim Jeans

Region/Country	What if 1	What if 2	What if 3	What if 4	What if 5
SSA	0%	0%	0%	0%	0%
Latin America	0%	5%	10%	20%	30%
Asia	0%	5%	10%	20%	30%
U.S.	0%	0%	0%	0%	0%

The same approach used for the what if analysis on labor was used for exchange rates and productivity by varying factor levels for the regions as shown in Table 5 and Table 6 respectively. Finally, combinations of factor levels were then analyzed and suggested to further improve the competitiveness of Sub-Saharan African countries.

Table 5: What If Scenarios on Exchange Rates for Both T-shirts and Denim Jeans

Region/Country	What if 1	What if 2	What if 3	What if 4	What if 5
SSA	-40%	0%	0%	0%	40%
Latin America	0%	-40%	0%	40%	0%
Asia	0%	-40%	0%	40%	0%
U.S.	0%	0%	0%	0%	0%

Table 6: What If Scenarios on Productivity for Both T-shirts and Denim Jeans

Regions/Country	What if 1	What if 2	What if 3	What if 4	What if 5
SSA	0%	-10%	-10%	-20%	-20%
Latin America	0%	0%	-10%	-10%	-20%
Asia	0%	0%	0%	0%	0%
U.S.	0%	0%	0%	0%	0%

The null and alternate hypotheses for the five what if analyses for labor, exchange rates and productivity were developed, where i represents the number of the what if scenario, j is the factor (j=1 for labor, j=2 for exchange, j=3 for productivity), and k is the garment (k=1 for T-shirts and k=2 for denim jeans). The null and alternative hypotheses are stated as follows:

H_{oijk}: There are no significant differences in countries' mean landed costs for product *k* in what if scenario *i* for *j*.
H_{aijk}: At least one country's mean is different for product *k* in what if scenario *i* for *j*.

3. Results

3.1 Results of analyzing competitiveness of landed costs using Kruskal-Wallis

The assumptions of normality and equal variance were violated. Therefore, a Kruskal-Wallis test was performed. It was concluded that for T-shirts, at least one country's mean is statistically different from the other countries ($p<0.0001$). Similar results were obtained for denim jeans. It was also concluded that at least one country's mean is statistically different from the others for jeans. Figure 2 shows the Oneway analysis for T-shirts.

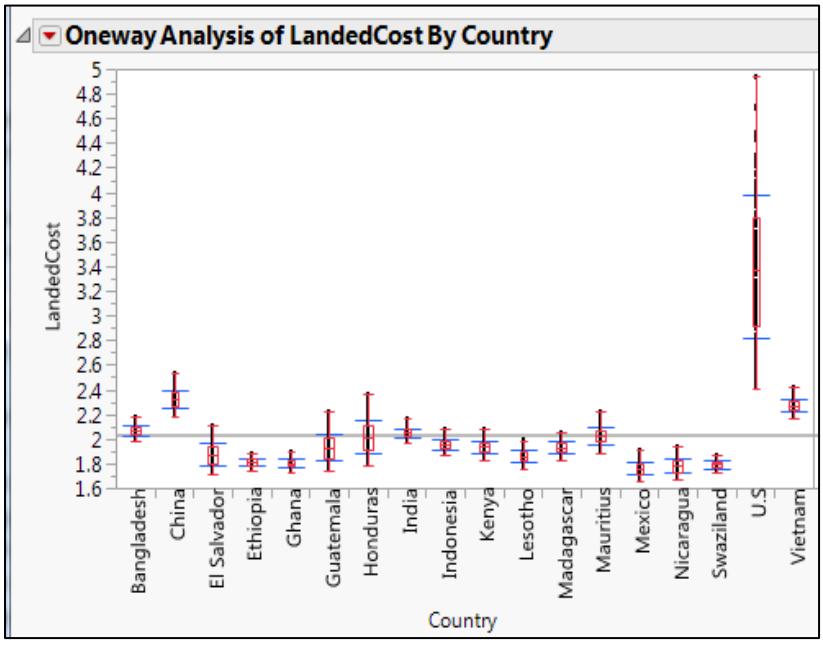

Figure 2: One-Way Analysis for T-shirt Landed Cost by Country

After determining that at least one country statistically differs from the others for both T-shirts and jeans, it was essential to examine which countries differ from each other and which do not. Nonparametric multiple mean comparison tests using the Wilcoxon test were performed. It was determined that most of the countries differed from each other at a p-value of <0.0001. For T-shirts, a few others significantly differed at p-values ranging from 0.0055 to 0.0362. The means of Guatemala and Kenya however were not significantly different from each other (p=1.000).

3.2 Results of analyzing competitiveness of landed costs using stepwise regression

To determine factors that significantly impact the cost competitiveness of the countries, a two-degree full factorial design and a backward stepwise regression analysis were used. Figure 3, Figure 4 and Figure 5 show the effects test and prediction profilers for all countries for T-shirts.

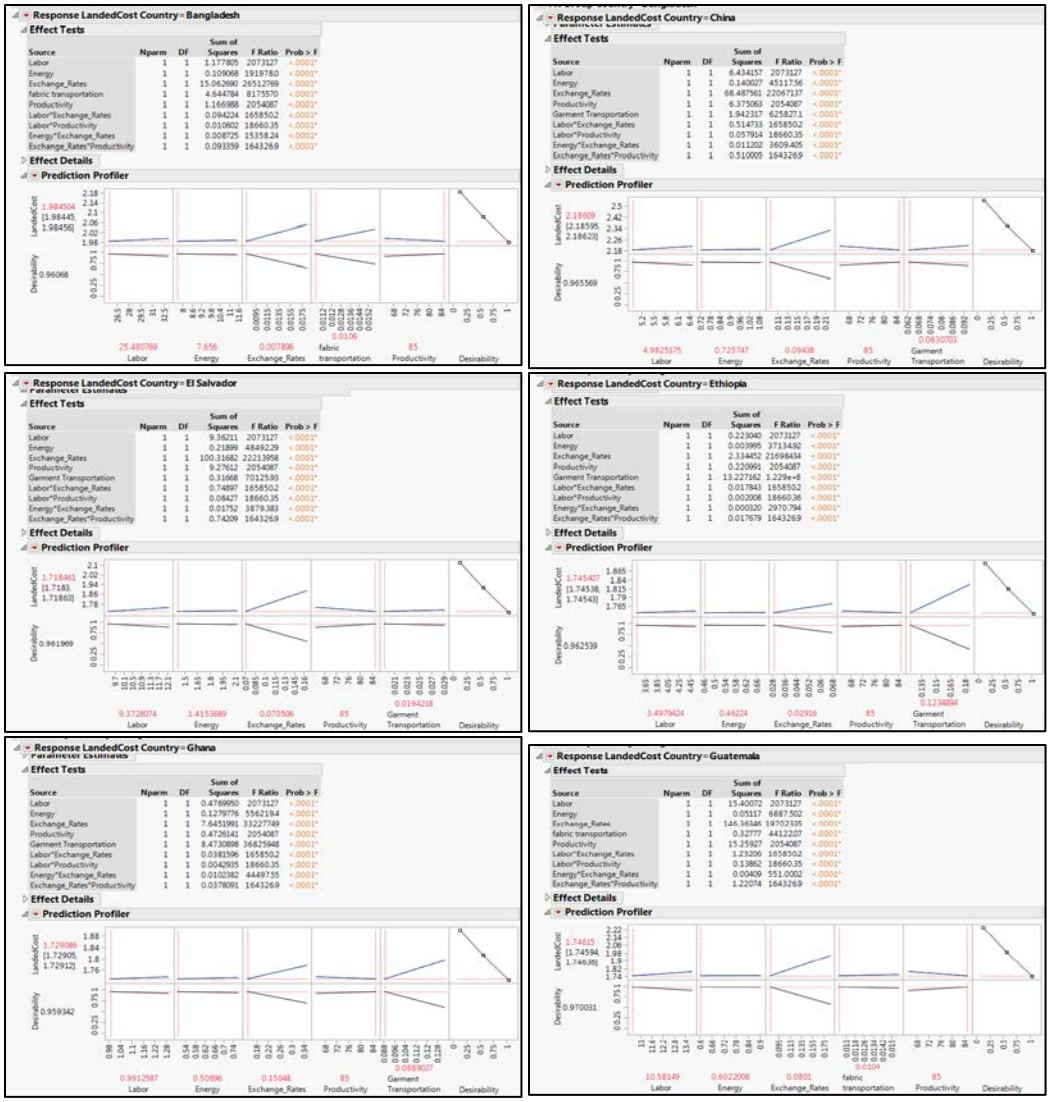

Figure 3: T-shirt Effect Table and Factor Profiler for Bangladesh, China, El Salvador, Ethiopia, Ghana and Guatemala

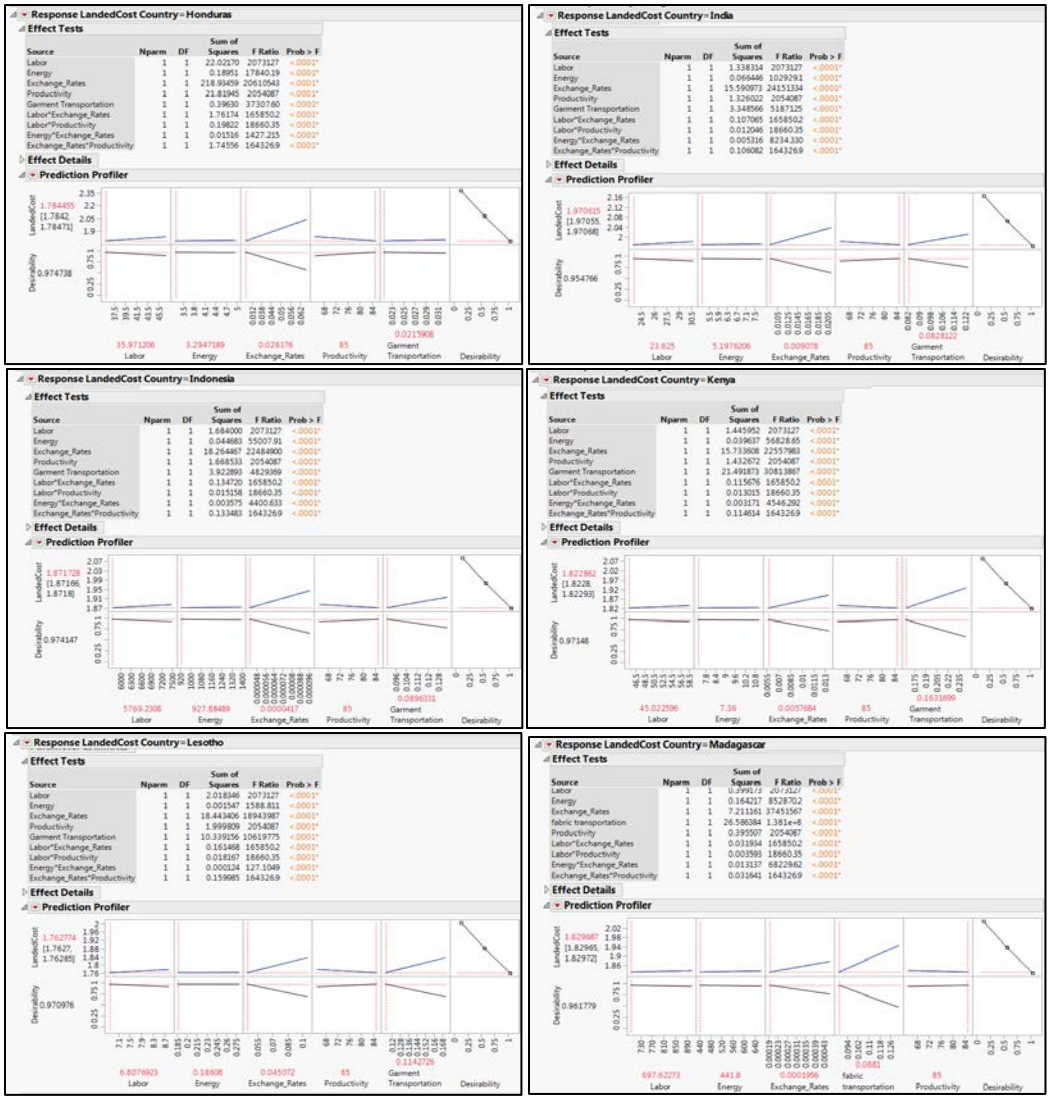

Figure 4: T-shirt Effect Table and Factor Profiler for Honduras, India, Indonesia, Kenya, Lesotho and Madagascar

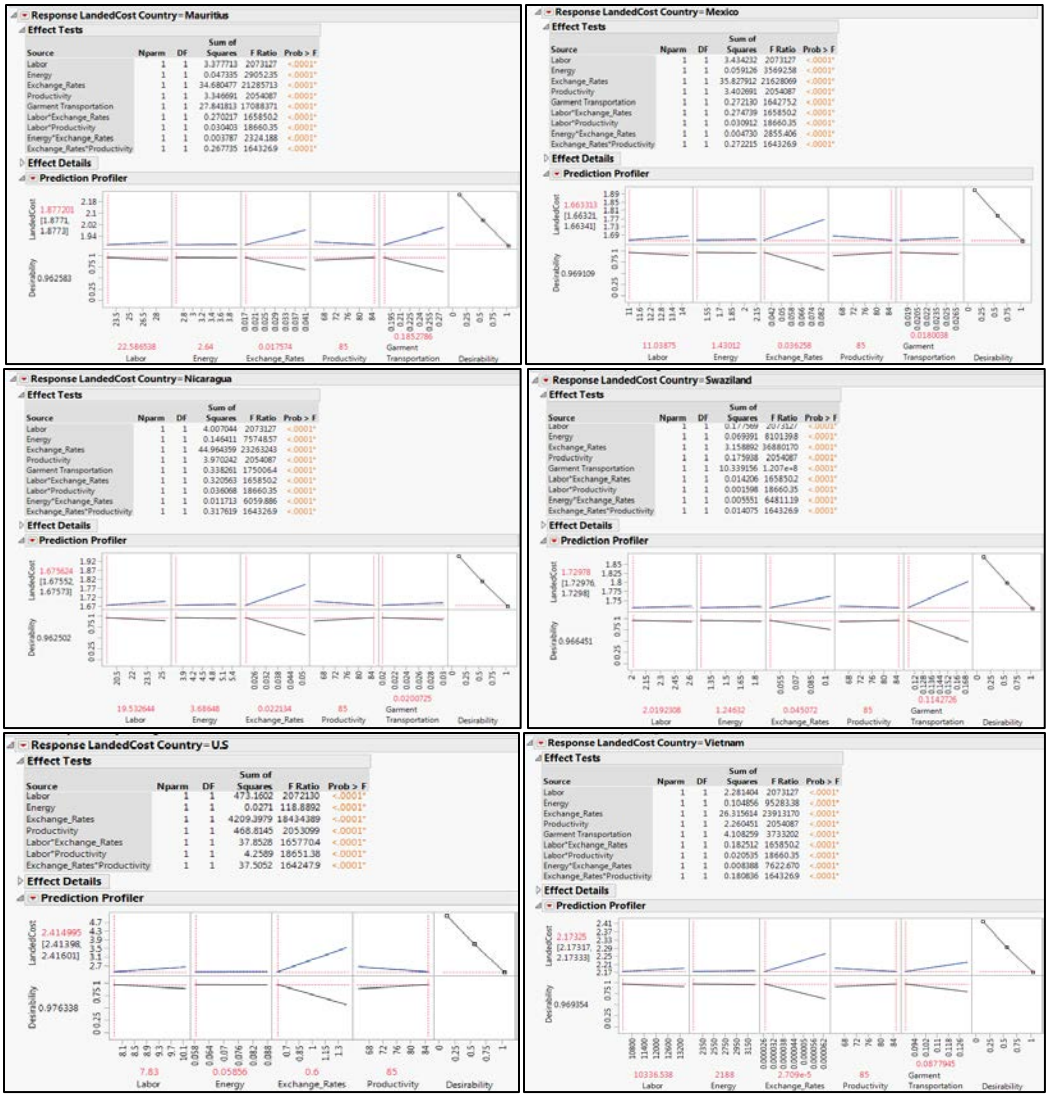

Figure 5: T-shirt Effect Table and Factor Profiler for Mauritius, Mexico, Nicaragua, Swaziland, U.S. and Vietnam

It was determined that for both T-shirts and denim jeans, exchange rates, garment transportation or fabric transportation, labor, productivity and energy were significant factors (all yielding a p-value of <0.0001), which one would expect since the data was generated directly from a model. The power in the data was also high because of the large data size. For two-way interactions, labor and exchange rates, exchange rates and productivity, labor and productivity, and energy and exchange rates were significant interactions with p-values of < 0.0001. For denim jeans, in addition to the above stated significant factors and interactions, water and the interaction of water and exchange rates were also significant at a p-value of < 0.0001. For the U.S., note that fabric transportation and garment transportation, however, had no effect on the landed cost because there was no fabric transportation nor garment transportation cost in the U.S. supply chain.

Looking at the most significant factors from the prediction profiler, exchange rates had the most pronounced slope for many countries. This makes sense because it is a multiplier of

three factors in the landed cost model (i.e., labor, energy, and water). For SSA countries it was determined that fabric or garment transportation had a large effect, owing to the very expensive transportation costs from these countries to the U.S for T-shirts and denim jeans, respectively. For Latin American and Asian countries, exchange rate was more significant than fabric transportation or garment transportation.

3.3 Results of sensitivity analysis

The Levene test for equal variance was violated (p-value= <0.0001) in all scenarios for labor, exchange rates and productivity for both T-shirts and denim jeans. Hence, the Kruskal-Wallis test was performed, and a p-value= <0.0001 was obtained for all what if scenarios. It can be concluded that at least one country's mean is statistically different from the others in each scenario for both T-shirts and denim jeans. Furthermore, to determine the specific countries that significantly differ from each other, Wilcoxon tests were performed for each scenario for all three factors. The results revealed that most of the countries differed significantly from each other (p-value =<0.0001). Due to the large size of the data set and the numerous outputs from the analysis, the results from the analysis were used to rank the countries from the most cost competitive country to the least competitive country in each what if scenario. Figure 6, Figure 7, and Figure 8 show the ranking of countries from the what if analysis for T-shirts for labor, exchange rates and productivity, respectively. Countries found not to be statistically different have the same rank and are indicated in red.

What if 1	Mexico	Nicaragua	Swaziland	Ghana	Ethiopia	El Salvador	Lesotho	Guatemala	Madagascar	Kenya	Indonesia	Honduras	Mauritius	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	9th	11th	12th	13th	14th	15th	16th	17th	18th
What if 2	Mexico	Nicaragua	Swaziland	Ghana	Ethiopia	Lesotho	El Salvador	Guatemala	Madagascar	Kenya	Indonesia	Honduras	Mauritius	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	9th	11th	12th	13th	14th	15th	16th	17th	18th
What if 3	Mexico	Nicaragua	Swaziland	Ghana	Ethiopia	Lesotho	El Salvador	Madagascar	Kenya	Guatemala	Indonesia	Honduras	Mauritius	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	8th	8th	11th	12th	13th	14th	15th	16th	17th	18th
What if 4	Mexico	Swaziland	Nicaragua	Ghana	Ethiopia	Lesotho	El Salvador	Madagascar	Kenya	Guatemala	Indonesia	Mauritius	Honduras	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	8th	10th	11th	12th	13th	14th	15th	16th	17th	18th
What if 5	Mexico	Swaziland	Ghana	Ethiopia	Nicaragua	Lesotho	El Salvador	Madagascar	Kenya	Indonesia	Guatemala	Mauritius	India	Honduras	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	4th	6th	7th	8th	8th	10th	11th	12th	13th	14th	15th	16th	17th	18th

Countries with the same position (in red) are not statistically different

Figure 6: T-shirt Ranking of Countries for the Labor What if Analyses

What if 1	Mexico	Ghana	Swaziland	Nicaragua	Ethiopia	Lesotho	El Salvador	Kenya	Madagascar	Guatemala	Indonesia	Mauritius	Honduras	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	2nd	4th	5th	6th	7th	8th	9th	10th	11th	11th	13th	14th	15th	16th	17th	18th
What if 2	Mexico	Nicaragua	El Salvador	Swaziland	Guatemala	Ghana	Ethiopia	Honduras	Lesotho	Indonesia	Madagascar	Kenya	India	Bangladesh	Mauritius	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th
What if 3	Mexico	Nicaragua	Swaziland	Ghana	Ethiopia	Lesotho	El Salvador	Madagascar	Kenya	Guatemala	Indonesia	Honduras	Mauritius	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	9th	11th	12th	13th	14th	15th	16th	17th	18th
What if 4	Swaziland	Ghana	Ethiopia	Mexico	Nicaragua	Lesotho	Madagascar	Kenya	El Salvador	Indonesia	Mauritius	Guatemala	India	Bangladesh	Honduras	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th
What if 5	Mexico	Nicaragua	Swaziland	Ethiopia	Ghana	El Salvado	Lesotho	Guatemala	Indonesia	Madagascar	Kenya	Honduras	India	Bangladesh	Mauritius	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	9th	11th	12th	13th	14th	15th	16th	17th	18th

Countries with the same position (in red) are not statistically different

Figure 7: T-shirt Ranking of Countries for Exchange Rates What if Analyses

What if 1	Mexico	Nicaragua	Swaziland	Ghana	Ethiopia	El Salvador	Lesotho	Guatemala	Madagascar	Kenya	Indonesia	Honduras	Mauritius	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	9th	11th	12th	13th	14th	15th	16th	17th	18th
What if 2	Mexico	Nicaragua	Swaziland	Ghana	Ethiopia	El Salvador	Lesotho	Guatemala	Madagascar	Kenya	Indonesia	Honduras	Mauritius	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th
What if 3	Mexico	Nicaragua	Swaziland	Ghana	Ethiopia	Lesotho	El Salvador	Madagascar	Guatemala	Kenya	Indonesia	Honduras	Mauritius	India	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	8th, 10th	10th	11th	12th	13th	14th	15th	16th	17th	18th
What if 4	Mexico	Nicaragua	Swaziland	Ghana	Ethiopia	El Salvador	Lesotho	Guatemala	Madagascar	Indonesia	Kenya	Honduras	India	Mauritius	Bangladesh	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th
What if 5	Mexico	Swaziland	Nicaragua	Ghana	Ethiopia	Lesotho	El Salvador	Madagascar	Indonesia	Kenya	Guatemala	India	Mauritius	Bangladesh	Honduras	Vietnam	China	U.S.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th

Countries with the same position (in red) are not statistically different

Figure 8: T-shirt Ranking of Countries for the Productivity What if Analyses

Since the outputs from all scenarios cannot be displayed here, the output from the scenario that most improves the competitiveness of SSA countries for each factor (labor, exchange rates and productivity) were selected. Table 7 shows the factor levels that yielded the best combination of factor levels. Figure 9, Figure 10 and Figure 11 show the output from the oneway analysis that revealed that at least one country is statistically different from the other countries. The Wilcoxon test used to determine which specific countries differ from each other revealed that all countries were statistically different from each other except Ethiopia and Nicaragua, Madagascar and Kenya and, India and Honduras at p-values of 0.2366, 0.3580 and 0.1556, respectively.

Table 7: Selected Factor Levels that Improve SSA Countries' Cost Competitiveness

Region/Country	Labor	Exchange Rate	Productivity
SSA	0%	0%	-20%
Latin America	30%	40%	-20%
Asia	30%	40%	0%
U.S.	0%	0%	0%

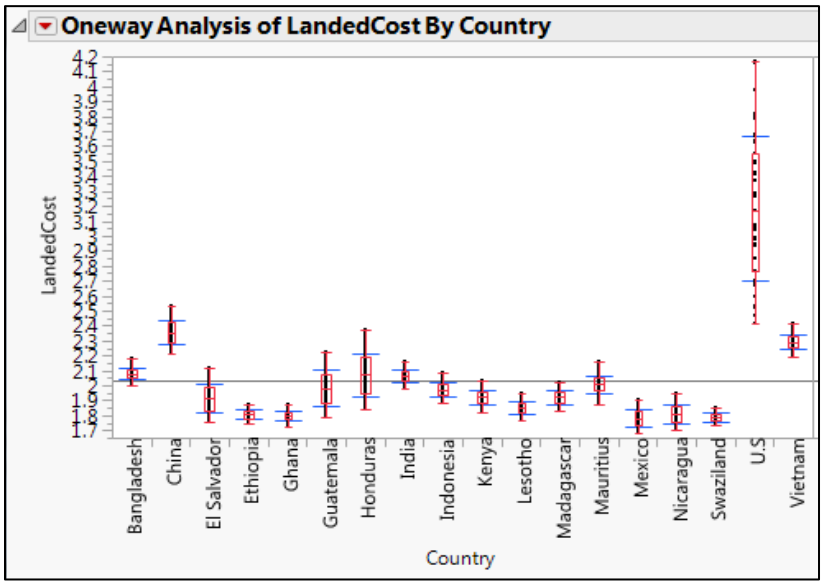

Figure 9: One way analysis and Wilcoxon tests for What if 5 for T-shirts Where Labor is at 0% for SSA Countries and the U.S., and 30% Higher in Asian and Latin American Countries

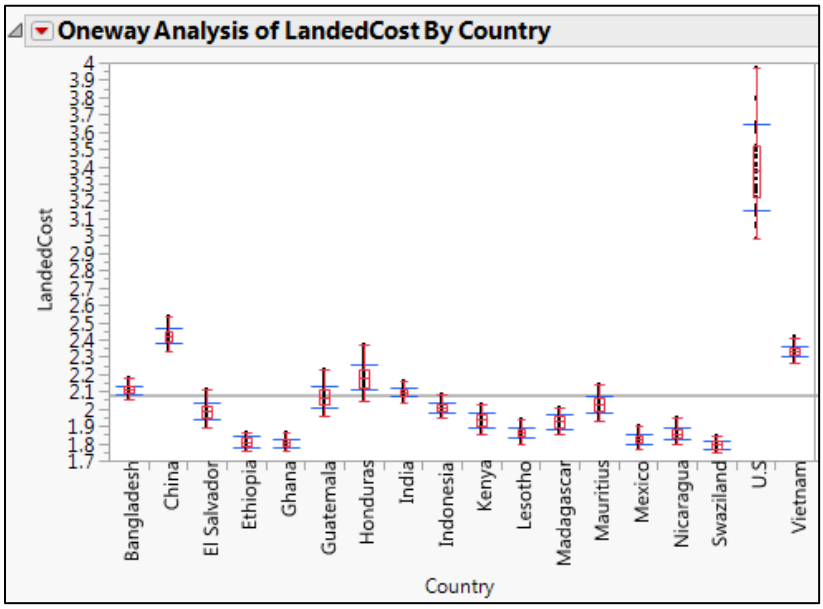

Figure 10: Oneway analysis and Wilcoxon tests for What if 4 for T-shirts Where Exchange Rate is 0% in SSA and the U.S., and 40% in Asia and Latin America

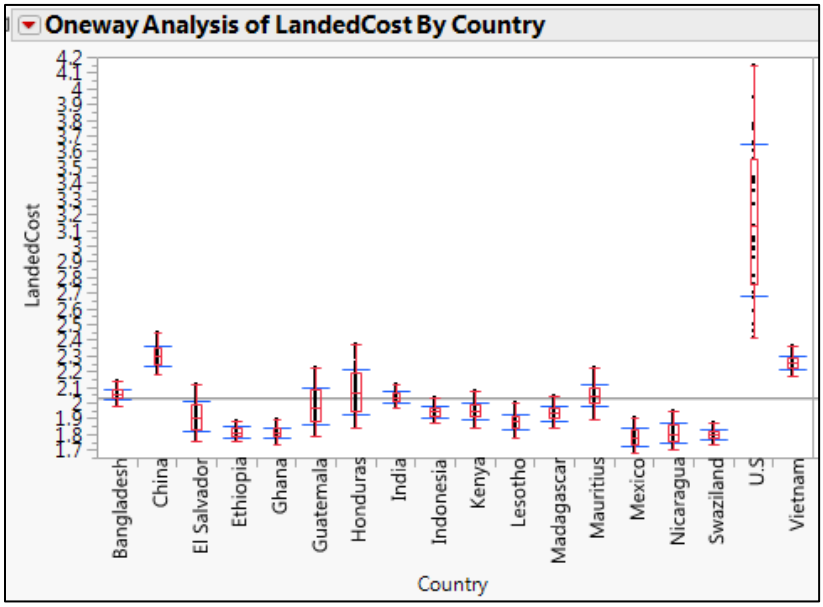

Figure 11: Oneway analysis and Wilcoxon tests for What if 5 for T-shirts Where Productivity is -20% in SSA and Latin American Countries, and 0% in Asian Countries and the U.S.

4. Discussion

From Figure 6, it was observed that as labor wages continuously increase from 5% to 30% in Latin America and Asia, some individual SSA countries gained competitiveness over some Latin American countries. For example, at a 5% increase in labor wages in Latin

America, Lesotho becomes competitive over El Salvador when producing T-shirts. Similarly, Madagascar and Kenya gain competitiveness over Guatemala when labor rates increase 10% in Latin America. Swaziland becomes competitive over Nicaragua at a 20% labor wage increase in Latin America, while Swaziland, Ghana and Ethiopia gain competitiveness over Nicaragua at a 30% labor wage increase in Latin America. All SSA countries, with the exception of Mauritius, are competitive over Asian countries in the case of T-shirts, regardless if labor wages increase in Asia or not.

Figure 7 shows that when exchange rates falls by 40% in SSA (see what if 1), Mexico still maintains its position. However, Ghana and Swaziland become competitive over Nicaragua. When exchange rates falls by 40% in Latin America (see what if 2), Mexico, Nicaragua and El Salvador are competitive over SSA countries. However, when exchange rates increase by 40% in Latin America (see what if 4), Swaziland, Ghana and Ethiopia become competitive over all Latin American and Asian countries.

From Figure 8, the best scenario that makes SSA countries competitive when producing T-shirts is what if 5, when productivity is lowered by 20% in both SSA and Latin American countries, but constant at 0% in Asia and the U.S. Ideally it is expected that a higher productivity level should decrease the cost of production and improve the cost competitiveness of a country. Assuming the productivity level in SSA improves over that of Latin American countries, SSA countries might do even better in ranking. An alternative factor level combination was therefore suggested and analyzed as shown in Table 8.

Table 8: Alternative Productivity Level that Improves SSA Countries' Cost Competitiveness

Region/Country	Labor	Exchange Rate	Productivity
SSA	0%	0%	0%
Latin America	30%	40%	-20%
Asia	30%	40%	0%
U.S.	0%	0%	0%

When comparing the mean form the initial landed cost to the alternative mean landed cost, a significant change is ranking among countries particularly SSA countries was observed. Figure 12 and Figure 13 show the difference in ranking of SSA countries. While Mexico maintain its position as the least expensive country to produce T-shirts in the initial analysis, Swaziland became the least expensive country after the factor combination analysis using the alternative factors.

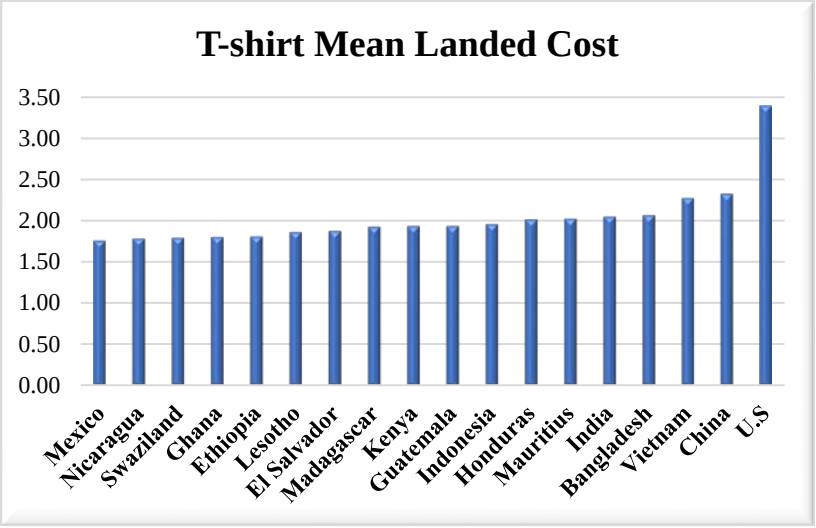

Figure 12: Mean T-shirt Landed Cost in Order of Least Expensive to Most Expensive Country Based on Initial Landed Cost Analysis

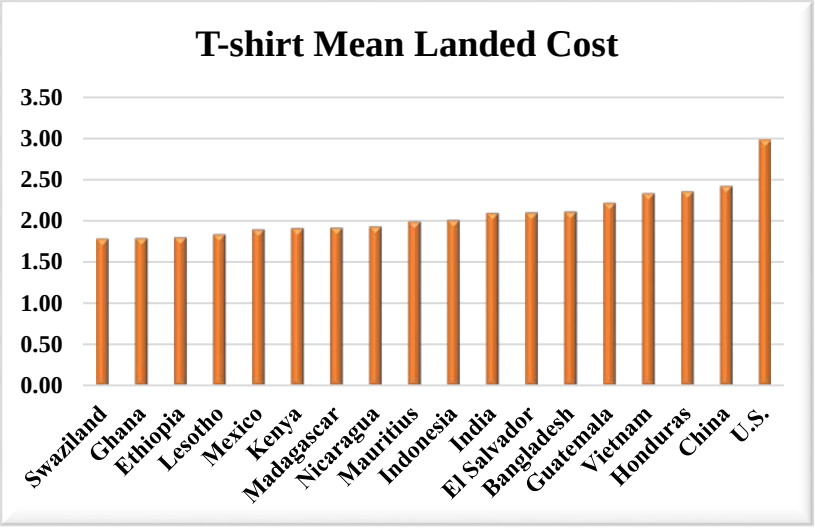

Figure 13: Mean T-shirt Landed Cost in Order of Least Expensive to Most Expensive Country Based on Alternative Factor Combination Analysis

5. Conclusion

From this study, it was established that factors such as labor wages, exchange rates and productivity levels affect the cost competitiveness of countries. Low labor wages in developing countries have always been a driving force for sourcing executives as they make strategic decisions about where to source from. Fluctuating exchange rates also affect the cost of doing business internationally and must be accessed critically when sourcing globally. When the value of a country's currency lowers, it weakens the currency making the U.S. currency much stronger over the other country. This analysis was a simulation of current trends in the global business world in accessing the true cost to outsourcing globally. The what if analysis show how factors can affect the competitiveness of countries

when changes such as increases in labor wages, exchange rate fluctuations and variations in productivity level affect the cost of doing business. SSA countries can be very cost competitive under many circumstances based on changes in labor wages, exchange rates and productivity levels compared to top apparel producing regions.

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