Thesis—statistical analysis and interpretation

This sample document covers the following:

1. Reliability analysis
2. Factor analysis
3. Confirmatory factor analysis (CFA)
4. Structural Equation Modelling (SEM)

Reliability Analysis

Before going to start the analysis, internal consistency of data is checked through cronbach's alpha (α) value. Cronbach's alpha value is one of the measurements in reliability analysis. There is a relation between cronbach's alpha and correlation. Cronbach's alpha generally increases when the correlation among the item increase.

Based on the Cronbach's alpha value, we concluded the following about the data:

- If $\alpha \geq 0.9$ – Excellent
- If $0.7 \leq \alpha < 0.9$ – Good
- If $0.6 \leq \alpha < 0.7$ – Acceptable
- If $0.5 \leq \alpha < 0.6$ –Poor
- If $\alpha < 0.5$ – Unacceptable

Cronbach's alpha value – What amount of internal consistency existing among the data of items.

Cronbach's alpha if item deleted – It gives the information about which item appeared to have low consistency among other items.

Reliability Analysis for the items on the factors of supply chain planning, sourcing and procurement, supply chain execution (n=560)

Factors	No. of items	Mean±SD	Cronbach's alpha
Overall	**81**	**3.62±0.50**	**0.922**
1).Supply Chain Planning	**40**	**3.55±0.54**	**0.926**
Demand Forecasting	9	3.64±0.61	0.929
Material Requirement Planning	10	3.63±0.69	0.928
Vendor Managed Inventory	8	3.32±0.75	0.929
Logistics Planning	5	3.52±0.86	0.933
Inventory Management	8	3.64±0.68	0.928
2).Sourcing and Procurement	**18**	3.77±0.52	**0.924**
Supplier relationship	3	4.00±0.57	0.931
Spend Analysis	4	3.56±0.79	0.926
Contract Management	6	3.81±0.62	0.927
Supplier Integration	5	3.69±0.79	0.925
3).Supply Chain Execution	**23**	3.56±0.72	**0.920**
Reverse logistics	4	3.58±0.89	0.926
Radio Frequency Identification (Bar Code)	7	3.43±0.99	0.925
Warehousing	5	3.66±0.85	0.925
Inventory Management linked to Execution	3	3.45±0.94	0.926
Transportation	4	3.66±0.86	0.926

The reliability for overall items that includes in the Supply Chain Planning, Sourcing and Procurement, Supply Chain Execution were 0.926, 0.924, and 0.920 respectively. Although a value of 0.70 and higher is often considered the criterion for internally consistent established factors (Hair, J.F.J., Anderson, R.E., Tatham, R.L., Black, 1998); (Nunnally, 1978) suggests that the a value of 0.50 and 0.60 is acceptable in the early stages of research. Since, Cronbach's a value for each factor is above 0.50; both factors are accepted as being reliable for the research. The present study values for Cronbach's alpha for the Supply Chain Planning forty item scale reported strong reliability for Supply chain planning range from 0.92-0.93. The factor loadings and reliability coefficients show a high level of reliability with a Cronbach's alpha value of 0.926. The results show that there is a high level of congruence among the items measuring a particular factor. For Sourcing and Procurement factor, the eighteen item scale reported strong reliability for Sourcing and Procurement for 0.924 with coefficient alphas ranging from 0.925-0.93 which demonstrated that scale demonstrates acceptable reliability. The Supply Chain Execution factor has twenty three items scale reported acceptable reliability for Supply chain

execution for 0.92 with coefficient alphas ranging from 0.902-0.926 which demonstrated that scale demonstrates acceptable reliability.

Exploratory Factor Analysis (EFA)

Factor analysis is used to extract the factors from independent variables. Generally, this analysis is used to develop questionnaires. Suppose your data contains so many variables. That situation you can use this analysis to reduce the number of variables from the data. This analysis groups variables with similar features together. The reduced factors can be used for further analysis.

- Kaiser-Meyer-Olkin measure must be greater than 0.5
- Bartlett's test of sphericity should has the p-value less than 0.05
- From the total variance explained table, we can estimate the amount of variance explained by each factor.

Factor analysis for supply chain planning, sourcing and procurement and supply chain execution.

Exploratory factor analysis with varimax rotation was performed on the SCM practices in order to extract the dimensions underlying each construct. The EFA of the eighty one variables has yielded three factors explaining 41.8percent of the total variance. A total of forty items were loaded on five factors. Based on the item loadings on each factor, the first factor was labelled as demand forecasting, while the second and third factor were named as material requirement planning and vendor managed inventory and fourth and fifth factor was named as logistics planning and inventory management. The detailed explanation for EFA have been discussed below

Table 1: Factor analysis for Supply chain planning (n=560)

	Factors					% explained variance
	1	2	3	4	5	
Do you feel that the role of Material requirement planning in your Supply Chain planning is very important?(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)	.675					18.38
Do you order only when the product has the demand or whenever you get the information about a new procduct,you keep ordering those products just for small smple?(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)	.640					
As a retailer never wants to be out of stock and does not want to be loaded with over stock	.639					
Do you agree that Demand Forecasting plays an important role in your Regular Supply Chain Planning	.633					
Do you Suppliers keep informing about various product for making smooth Material requirement planning. (1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)	.585					
Warehouse is compulsorily required for better product storage.	.565					
Do you agree that for fast moving product you always need to maintain high level of stock?Do you maintain or not?	.562					
Do you agree that with a proper Inventory planning you can make a perfect Supply chain Planning and it has an impact on overall performance of your shop. (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)	.479					

As a retailer I need to observe the changing priorities of the customers/consumers for a better Demand Forecasting(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)	.469					
By observing the priorities of customers;stock planning will be done rationally by you.Do you agree or not?(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)	.465					
Do you agree that as a retailer you always need to calculate and maintain safety level quantity? (How much quantity you maintain as safety stock to avoid out off stock situation) (1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)	.440					
As a retailer we expect the suppliers in helping to get back the left out stock back to the company.	.440					
As store in-charge I collect timely data by analyzing market for the success of the store.	.433					
I have a separate warehouse for storing my stock.	.403					
Do your suppliers, increase the credit time when there are no sales and during the out of stock situations? (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)	.397					
As a small retailer I always maintain single item lots more than the multiple item lots	.394					
By making a maximum lorry or truck space load, the overall freight cost will reduce, hence I always prefer to get maximum loads through shipment.		.603				25.85

Do you that when ever there is a change in the Govt.Policies,you need to predict your stock?(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)		.591				
Do you agree that your Demand Forecasting depends on logistics?(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)		.563				
After receiving information about new products from suppliers,even if you are not interested also,do you sell your shelf space to the supplier to display their products for some time,so that you don't take the risk?(1.Strongly Disagree 2. Disagree 3.bala		.533				
As a retailer I do forecast the future demand to go for joint business proposal/agreement(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)		.474				
Based on the packaging process of the Manufacturer or by the supplier, the stock will be ordered.(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)		.438				
When a product is having low sales or very low sales; do I will list out the product.		.422				
The changes in price will make the retailer to increase or decrease the stock levels (Planning of stock as per price fluctuations).Do you agree or not?(1.Strongly Disagree 2. Disagree 3.balanced 4.agree 5. strongly agree)		.413				
Do you agree that always you need to order stock keeping units(product lots)for each product separately and should be delivered independently?		.411				

The Stock keeping lots are ordered and delivered jointly for a subset of products		.397				
Do you agree that you need to give importance to the lead time quantity(quantity a retailer maintains from the day of order to the day they receive the stock,without touching the safety stock)and always calculate lead time quantity?(1.Strongly Disagree 2		.382				
Do you depend on centralized warehousing or Direct store distribution		.350				
Lot of planning and demand forecasting is linked for deciding the volumes to be carried by own vehicles or through the 3rd party logistics			.754			
I give special interest (priority) for some supplier because without those supplier my business survival is a question. Do you agree with this or not (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)			.749			
Do you agree that without proper logistics planning (Transportation, Vehicles, Volume, Route planning etc) your business performance will decrease? (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)			.678			30.90
By using third party logistics I can reduce the inventory and also the lead time to minimum and feel that it is far better than the own vehicles or supplier vehicle			.673			
Only based on the freight and route planning do you plan to raise the indent (purchase order) with the supplier?			.655			
When the SKUs not sold out, Suppliers will take back the stock (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)				.706		35.46

Do you get the support and help from your vendors in giving some specifications and suggestions in displaying their product as well training knowledge? (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)				.625		
Do you feel that the role of Vendor Managed Inventory plays an important part in the Supply chain Planning? (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)				.556		
As a retailer I share my Stock keeping Units (SKU) with my Supplier to maintain the track of Inventory (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)				.548		
I use third party (agent) in helping me in sharing the SKU information with my Vendors (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)				.507		
Because of proper exchanged information system, I could maintain smooth and continuous flow of product as per consumption. (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)				.482		
If Yes, do you give timely and accurate information to you distributor? (1-Strongly Disagree, 2-Disagree, 3-Balanced, 4-Agree, 5-Strongly Agree)					.911	39.54
As a retailer are you maintaining channel partnership? 1-Yes, 2-No					-.884	

The forty item questions are taken into factor analysis. The total forty questions are reduced into five factors. The five factors are demand forecasting (16 items), material requirement planning (12 items), vendor managed inventory (five items), logistics planning (6 items) and inventory management (1 items). The total forty questions reduced into five main factors explaining 39.5 percent of total variance. Sixteen items were loaded under Factor one

with loading ranging from 0.67 to 0.39. Twelve items were loaded under Factor Two with loading ranging from 0.60 to 0.35. Five items were loaded under Factor Three with ranging from 0.75 to 0.66. Six items loaded under Factor Four with ranging from 0.71 to 0.48.One item loaded under Factor Five with ranging from 0.91 to 0.88.

Structural Equation Modeling (SEM) is an extension of the general linear model. It is used to test a set of regression equations simultaneously. The advantages of SEM Analysis are as follows:

- SEM provides overall tests of model fit and individual parameter estimate tests simultaneously.
- Regression coefficients, means and variances may be compared simultaneously.
- It is the graphical interface software.

SEM represents the relationship between dependent (unobserved) variable and independent (observed) variables using path diagrams. In this analysis, ovals or circles represent dependent variable and rectangles or squares represent independent variable. Residuals (error term) variables also represent by ovals or circles, because they are always unobserved.

If the hypothesized model has a good fit, the statistical test values should be in the following manner.

- Chi-square value should be less than 5
- P value should be greater than 0.05
- GFI, AGFI and CFI values should be greater than 0.90
- RMR & RMSEA values should be less than 0.08

Full data (Both Organized and Unorganized retailer)

In the first order model, if the modification Indices is higher in independent variables, then the error terms (e_i) should be intercorrelated and in Supply Chain Execution the factor Reverse Logistics is less so that factor is removed from the model.

Figure 1: First-order model for Supply Chain Planning, Sourcing and Procurement and Supply Chain Execution

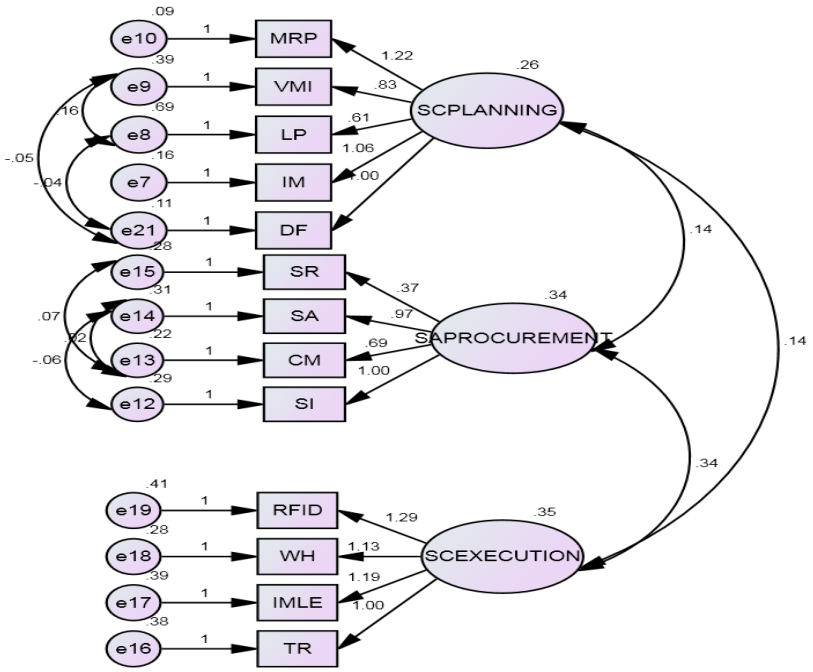

Table 2: CFA for First-order Model for dimensions of Supply Chain Planning, Sourcing and Procurement and Supply Chain Execution

Variables			Un-standardised co-efficient	S.E	Standardised co-efficent	P value
IM	<---	SCPLANNING	1.064	0.049	0.838	<0.001**
LP	<---	SCPLANNING	0.609	0.079	0.805	<0.001**
VMI	<---	SCPLANNING	0.828	0.066	0.350	<0.001**
MRP	<---	SCPLANNING	1.219	0.049	0.561	<0.001**
DF	<---	SCPLANNING	1.000		0.905	
SI	<---	SAPROCUREMENT	1.000		0.736	
CM	<---	SAPROCUREMENT	0.687	0.048	0.648	<0.001**
SA	<---	SAPROCUREMENT	0.969	0.067	0.715	<0.001**
SR	<---	SAPROCUREMENT	0.367	0.044	0.374	<0.001**
TR	<---	SCEXECUTION	1.000		0.690	
IMLE	<---	SCEXECUTION	1.186	0.075	0.744	<0.001**
WH	<---	SCEXECUTION	1.130	0.068	0.781	<0.001**
RFID	<---	SCEXECUTION	1.289	0.079	0.764	<0.001**

Note: 1. ** Denotes significant at 1% level

To examine the theoretical interdependence between three factors (Supply Chain Planning, Sourcing and Procurement, Supply Chain Execution) structural equation modelling was used. This analysis allows to test all the relevant paths and measurements errors and feedbacks are included directly into the model. The fit indices show an adequate fit as the factors are found to be significant at the $p<0.05$ (Table 3). The model fit, which was assessed using global fit (seven different fit indices) and 'r' to identify the degree to which the hypothesized model is consistent with the data in hand. In other words, the degree to which the implicit matrix of co variances, (based on the hypothesized model), and the sample covariance matrix, based on data it seems to fit (Bollen, 1989).The structural model, the quality of fit was acceptable representation of the sample data (χ^2 (560)= 106.587, GFI (Goodness of Fit Index)=0.972; AGFI **(**Adjusted Goodness of Fit Index) = 0.954 which is much larger than the 0.90 criteria as suggested by Hu and Bentler (1999) and Joreskog and Sorbom (1981). Similarly, CFI=0.984, RMSEA **(**Root Mean Square Error of Approximation) =0.040 and RMR (Root Mean Square Residuals) =0.036, values are lower the 0.05 critical value (Steiger, 1989).

Table 3: Model fit summary

Variable	**Value**	**Suggested value**
Chi-square value	106.587	
Degrees of freedom (df)	56	
P value	0.000	P-value >0.05 (Hair et al., 2006)
GFI	0.972	>0.90 (Hair et al., 2006)
AGFI	0.954	> 0.90 (Daire et al., 2008)
CFI	0.984	>0.90 (Hu and Bentler, 1999)
RMR	0.036	< 0.08 (Hair et al., 2006)
RMSEA	0.040	< 0.08 (Hair et al., 2006)

Second-order model (Operational Performance as dependent variable)

Full data (Both Organized and Unorganized retailer)

In the second order model, if the modification Indices is higher then error terms are intercorrelated and also in independent variables Demanding forecasting, Reverse Logistics factor is removed from the model and in dependent variable Operational performance (Item no. 2) is removed due to low correlation.

Figure 2: Second-order model for Supply Chain Planning, Sourcing and Procurement and Supply Chain Execution with Operational Performance

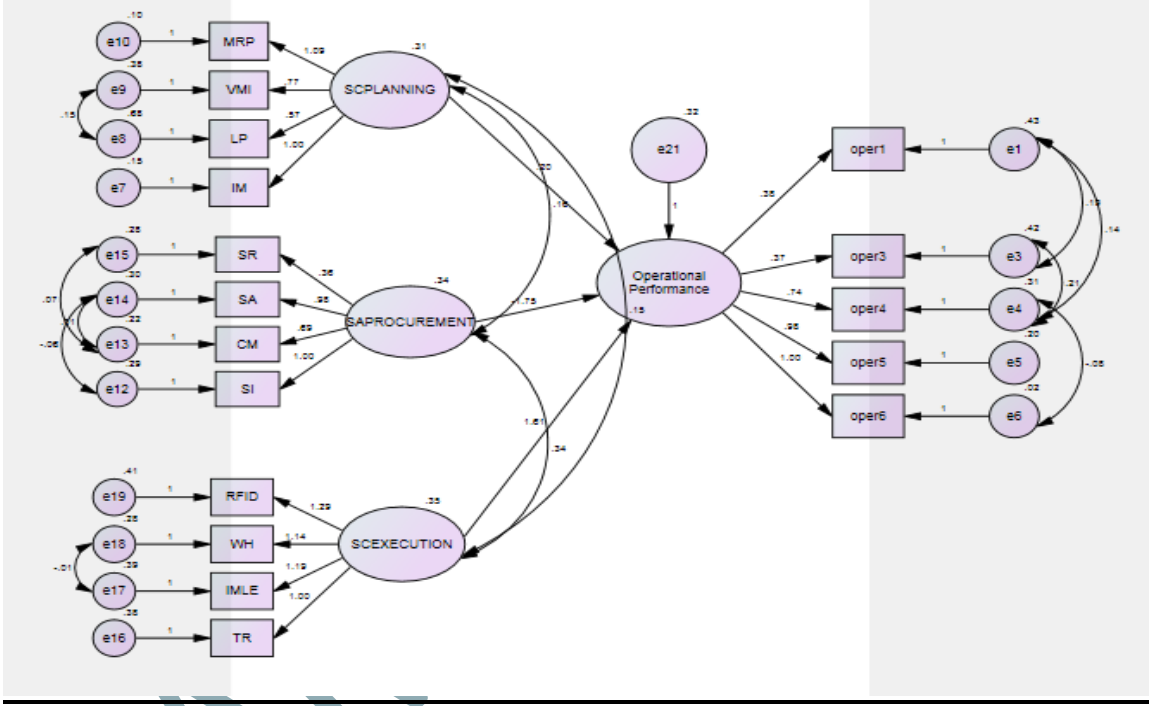

Table 4: Second-order Model for dimensions of Supply Chain Planning, Sourcing and Procurement and Supply Chain Execution with Operational Performance

Variables			Un-standardised co-efficient	S.E	Standardised co-efficent	P value
Operational Performance	<---	SCPLANNING	0.200	0.146	0.181	0.170 (NS)
Operational Performance	<---	SAPROCUREMENT	-1.752	1.887	-1.684	0.353 (NS)
Operational Performance	<---	SCEXECUTION	1.613	1.791	1.561	0.368 (NS)
oper1	<---	Operational Performance	0.383	0.053	0.337	<0.001**
oper3	<---	Operational Performance	0.367	0.053	0.326	<0.001**
oper4	<---	Operational Performance	0.744	0.057	0.629	<0.001**
oper5	<---	Operational Performance	0.976	0.079	0.803	<0.001**
oper6	<---	Operational Performance	1.000		0.977	
IM	<---	SCPLANNING	1.000		0.822	
LP	<---	SCPLANNING	0.566	0.072	0.354	<0.001**
VMI	<---	SCPLANNING	0.769	0.058	0.566	<0.001**
MRP	<---	SCPLANNING	1.093	0.061	0.882	<0.001**
SI	<---	SAPROCUREMENT	1.000		0.737	
CM	<---	SAPROCUREMENT	0.686	0.048	0.648	<0.001**
SA	<---	SAPROCUREMENT	0.976	0.066	0.721	<0.001**
SR	<---	SAPROCUREMENT	0.363	0.044	0.371	<0.001**
TR	<---	SCEXECUTION	1.000		0.690	
IMLE	<---	SCEXECUTION	1.191	0.076	0.747	<0.001**
WH	<---	SCEXECUTION	1.137	0.069	0.786	<0.001**
RFID	<---	SCEXECUTION	1.288	0.079	0.763	<0.001**

Note: 1. ** Denotes significant at 1% level, NS- Not Significant

To examine the theoretical interdependence between three factors (Supply Chain Planning, Sourcing and Procurement, Supply Chain Execution) with Operational Performance as a dependent variable, structural equation modelling was used. This analysis allows to test all the relevant paths and measurements errors and feedbacks are included directly into the model. The fit indices show a model is good fit as the factors are found to be significant at the p>0.05 (Table

9). The model fit, which was assessed using global fit (seven different fit indices) and 'r' to identify the degree to which the hypothesized model is consistent with the data in hand. In other words, the degree to which the implicit matrix of co variances, (based on the hypothesized model), and the sample covariance matrix, based on data it seems to fit (Bollen, 1989).The structural model, the quality of fit was acceptable representation of the sample data (χ^2 (560)= 123.920, GFI (Goodness of Fit Index)=0.975; AGFI **(**Adjusted Goodness of Fit Index) = 0.963 which is much larger than the 0.90 criteria as suggested by Hu and Bentler (1999) and Joreskog and Sorbom (1981). Similarly, CFI=0.995, RMSEA **(**Root Mean Square Error of Approximation) =0.019 and RMR (Root Mean Square Residuals) =0.028, values are lower the 0.05 critical value (Steiger, 1989).

Table 5: Model fit summary

Variable	Value	Suggested value
Chi-square value	123.920	
Degrees of freedom (df)	104	
P value	0.089	P-value >0.05 (Hair et al., 2006)
GFI	0.975	>0.90 (Hair et al., 2006)
AGFI	0.963	> 0.90 (Daire et al., 2008)
CFI	0.995	>0.90 (Hu and Bentler, 1999)
RMR	0.028	< 0.08 (Hair et al., 2006)
RMSEA	0.019	< 0.08 (Hair et al., 2006)

End of the Sample Work