Marketing Research and Analysis - II (Application oriented)
Prof. Jogendra Kumar Nayak
Department of Management Studies
Indian Institute of Technology Roorkee

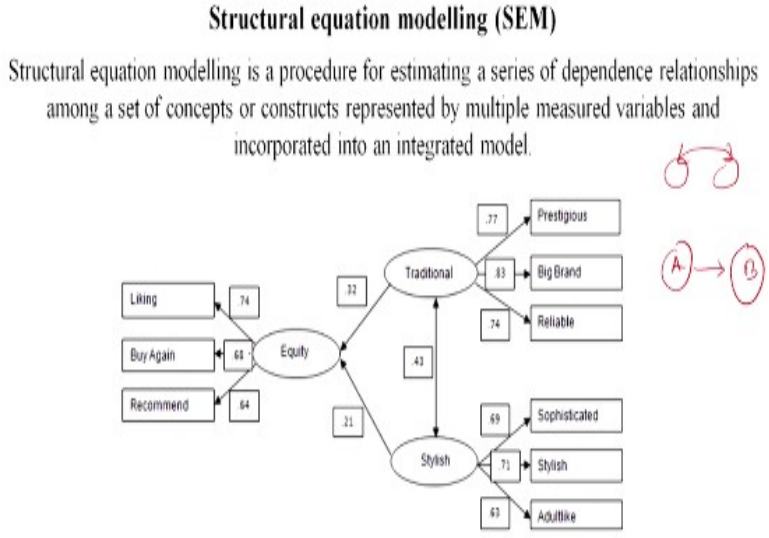
Lecture –57
Structural Equations Modelling in SPSS

Welcome everyone to the class of marketing research and analysis. So, we are coming to an end towards this course of this course. In the last class we were discussing about the confirmatory factor analysis and in which we said that it is nothing but measurement model. So, where the researcher tries to check whether the constructs used in a model are fitting or not fitting. But as you know that CFA was a non- directional or there was no direction provided.

But rather it was a covariance a model where you are a double headed arrow towards each construct that means each construct was connected to the other through double headed arrows. But we are not measuring any relationship in there directly. So, today we will talk about the next part of you know the next part which is called the structural equation modelling or we say here this is called the path analysis or sometimes which is also called it the structural model.

So, as far as name structural so we say it structural equation so what it says is structural model as you have seen in the you know in the measurement model.

(Refer Slide Time: 01:37)



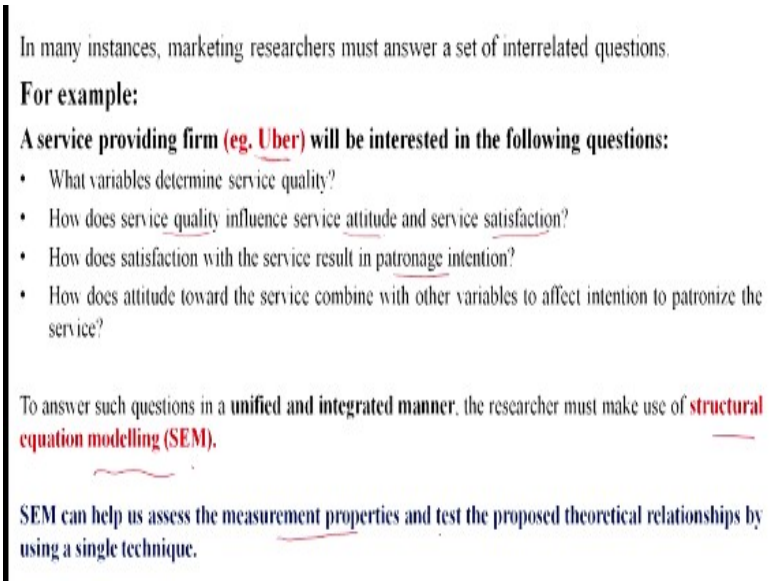
So, you had just a relationship equivalence relationship so but here we are talking that this relationship is directional. So, we know that A and B are related in this way right so what is structural equation modelling. It is a procedure for estimating series of independence relationships among a set of concepts or constructs represented by multiple measured variables and incorporated into an integrative model.

Now let us see this model, right so this model for example we say that equity traditional and stylish this three are related and each construct has got some number of indicators. So, equity has got a liking buying again or buy again they recommend. So, this is the equity of a brand so whether people like it whether they would buy it again whether they would recommend to others now what is this traditional constant.

Now this says whether what is the prestige symbol attached with the brand how big the brand is how reliable it is. Stylish as another concept it says which is sophisticated stylish and adult like that means it would people feel it is childish or adult like. So, these 3 are the concepts that are related so we are saying these two traditional and stylish are affecting the equity of particular brand or product.

So, this kind of a relationship structure is what we are exploring in a structural equation modelling so that is a clear cut path you see but these two being independent variables or we say an exogenous constructs. So, this is called the dependent variable or we may understand or assume we call it as endogenous construct. These two are called me independent in regression or my exogenous constraints. So, this exogenous constructs they are correlated to each other and they impact the equity and that is the final result.

(Refer Slide Time: 03:34)



In many instances marketing researchers must answer a set of interrelated questions you see how important they are. For example, a service provider like uber we will be interested in the following questions. What variables determine service quality? How does the quality influence service attitude and service satisfaction? So, is there any relationship between quality of service and the attitudes towards the service and the satisfaction towards the service?

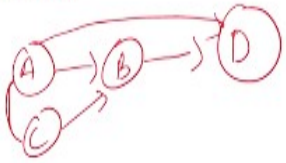
How does satisfaction with the service result in patronage or loyalty whether people would come in again and again how does the attitude towards the service combined with other variables to effort intention to patronize the service. So, these are some relationships so this complicated relationship cannot be done through a linear regression. Because in the linear regression there is only one direction but here we are multiple relationships.

So, that is why structural equation modelling comes into it very well becomes very handy so to answer such questions in a unified and integrated manner the researcher must use structural equation modelling. SEM can help us to assess the measurement properties which you did through the measurement model and then test the proposed theoretical relationships. Now the proposed relationship you will see here that you are saying traditional image affects the equity and stylish image also affects the equity so this is a relationship that you have depicted.

(Refer Slide Time: 04:59)

SEM vs. other multivariate techniques

- Representation of constructs as unobservable or latent factors in dependence relationships.
- Estimation of multiple and interrelated dependence relationships incorporated in an integrated model.
- **Explanation of the covariance among the observed variables**. SEM seeks to represent hypotheses about the means, variance and covariance of observed data in terms of a number of structural parameters defined by hypothesised model.
- SEM is also known by other names such as **covariance structure analysis, latent variable analysis, and causal modelling.**

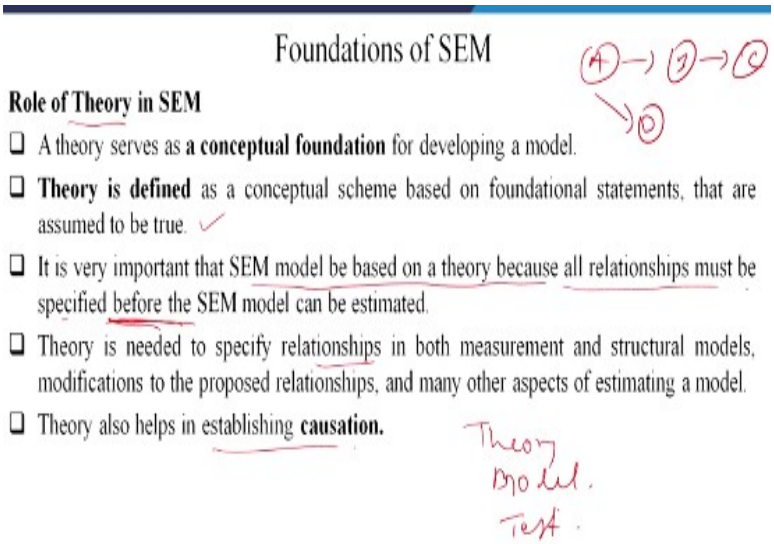


Assume as other multiple techniques we say the presentation of constructs you have seen that right as unobservable or latent constructs in dependency relationships. Estimation of multiple and interrelated dependence relationships in an incorporated in an integrated manner. Yes, there is a lot of relationships for example A is related to B let us say A and C is related to B and then B is related to D.

So, this is a very complicated it is a complicated and unique relationship explanation of the covariance among the observed variables. SEM seeks to represent hypotheses about the mean variance and covariance of the observed data in terms of a number of structural parameters defined by the hypothesised. So, it says a number of relationships can exist in between so maybe you may say that well it is not B does not affect D only.

A directly affects D also deal so we can see SEM is also known by other names such as covariance structure analysis latent variable analysis and causal modelling. But SEM becomes a very famous name now it is.

(Refer Slide Time: 06:13)



What is the role of theory? The foundation of SEMS is theory right this is the most important word when you talk about you know SEM because SEM is a like a priory like you have to first find a model. You have to first think about a model and then you have to test the model. So, you cannot change anything after you have you know a hypothesis the model. That is not permissible in SEM so that is why your model has to come from some theory.

That is why you say well I believe this is what the structure should look and then they should be the outcome. If it is not, it does not work that way then you are thinking is wrong or that means your theory that you have used maybe not proper. So, that is why a sound theory is very important to develop SEM theory serves as a conceptual foundation for developing a model so you do not go buy any gut feeling or just sometimes people what they do.

They if A and B and C are related and suppose you know this does not work out then they will say let us try something else. Put a D here and see the relationship no, this is not to be done like this you do not do anything on a gutsy feeling or you know just to try out something different. No it is already you have to give the model beforehand and say this is what I believe and now if it does not come then maybe.

I have to you know go add some more variables or delete some variables and check but that also on basis of the theory on basis of literature. Theory is defined as a conceptual scheme based on

foundation statements that are assumed to be true. It is very important SEM model maybe based on theory because all relationships must be specified before so this is what the highlighting word is.

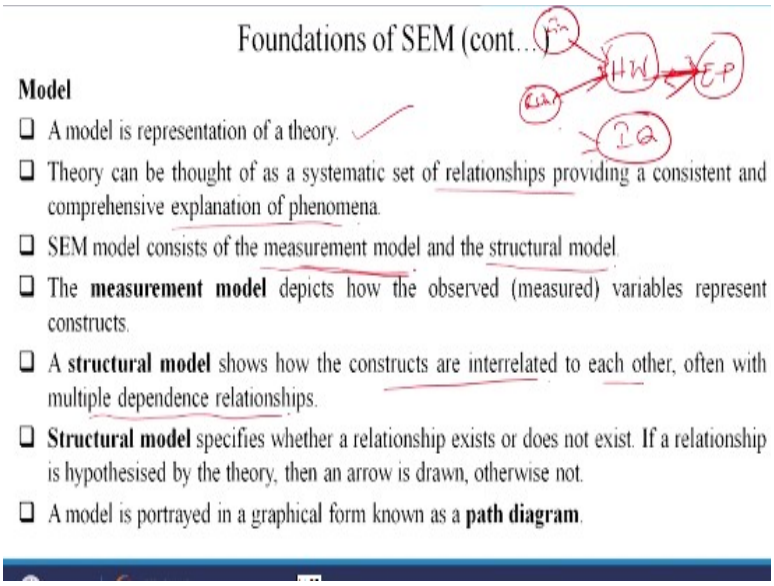
Before SEM model can be estimated you do not do it after which many people try to do a lot of iterations but that is a wrong thing you should not. That is against the spirit you may get a good model and very improved model but then there is no theory behind it. You are just you are not doing a lot of probabilities I know permutation and combination and iterations to check whether model value is improving and since it is only a mathematical number.

So, it might improve but then the spirit of the whole exercise is lost because you have not come out with a proper understanding why this should happen and you have not developed a theory. Theory is needed to specify the relationships in both measurement and structural models modifications to the proposed relationships and many other experts of estimating your model. This is why you see it helps him to establishing causation.

Why is SEM is little more complex it is because you are already you have to specify the theory on basis of the theory you build a model and after building the model you test it. And when you test it you are not allowed to go back again go back in the sense you are not allowed to play with the model. You are not allowed to do that because it has to be based on a sound understanding so that is why if something goes wrong,

Maybe you have to do the study or entirely or maybe add a completely new variable according to logic or delete something and maybe our data size also has to change.

(Refer Slide Time: 06:13)



So, a model is a representation of a theory nothing more than that and theory can be thought of as a systematic set of relationships providing a consistent and comprehensive explanation of phenomena. Why it is occurring or what affects what so this relationship has to be understood. SEM model consists of the measurement model and the structural model so we have talked about the measurement model earlier.

So, we just wanted to test whether the model is fit or not that means all the constructs are linked to each other or not. And in the structural model we are saying that you said proper relationship that means a direction is there. That is A effects B it does not mean that A and B both are dyadic both effect each other no. A effects B it is that very clear and that means it has come from query.

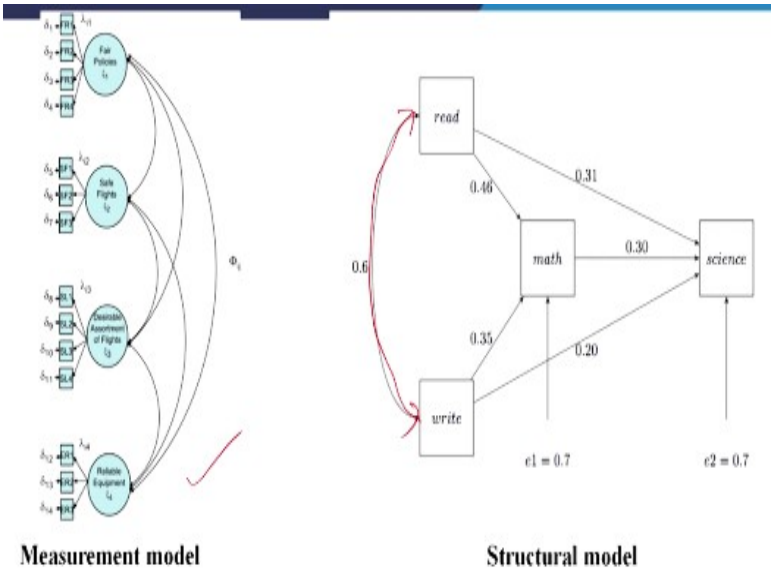
For example, you see now exam performance is affected by what the hard work hard or let us say exam performance is affected by hard work. And let us say I am taking 2 more constructs hard work and let us say IQ. Now hard work depends on 2 more variables. Let us say 1 is let us say your financial condition of your family and your ability to concentrate so when you do such a relationship.

It is already we understand it why we are doing it the measurement model depicts how the observed variables represent the constructs that is all nothing more than that. A structural model this is what we are talking about shows how the constructs are interrelated and to each other

often with multiple dependency relationships. So, this is not one relationship as you see here it is a multiple dependency relationship.

So, multiple dependency a hard work is again you know performance is effected by hard work and IQ and hard work is ever again affected by finance and you know maybe you know the condition of the house and IQ may be affected by something like you know which kind of environment you were born in and what is your parents education could be. I am just giving a guess a model is portrayed in a graphical form known as a path diagram. So, this entire thing is called a path diagram.

(Refer Slide Time: 11:40)

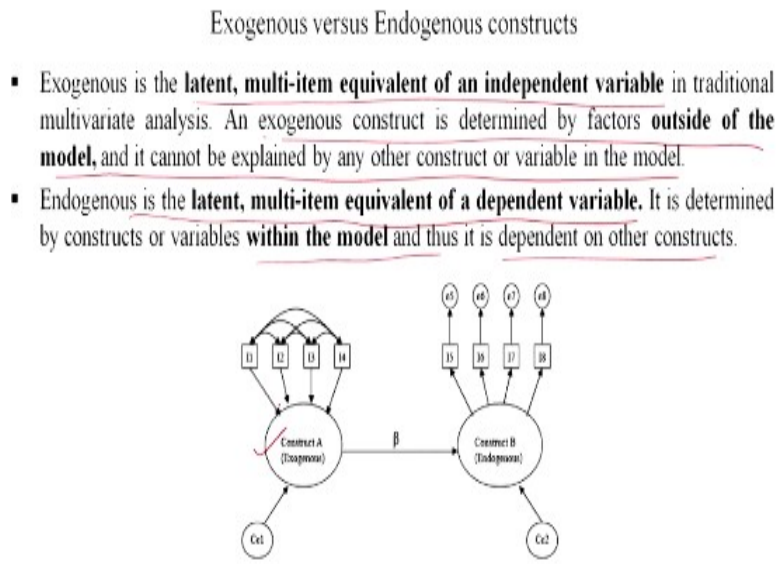


Measurement model Structural model

Now look at this is the measurement model so every construct was related to each itself and the integrators are here but here there is no proper direction as in this one. You see if you can see this kind of arrows the curve and the 2 edge arrows double arrows. It is only present here right this case because these two are independent variables and we are saying that they both affect each other.

But look at this case now so reading and writing ability is affecting the maths you know performance of a student and maths effort is then affecting the entire science so if somebody is good at maths. He will be good at science we are saying so the science mark depends on how good we are in maths and maths mark depends on how good you are in reading and writing.

(Refer Slide Time: 12:24)



Exogenous is the as I said earlier latent multi item equivalent of an independent variable and an exogenous construct is determined by factors outside of the model and cannot be explained by any other construct or variable. So, it is like an independent variable endogenous is the latent multi item equivalent of a dependent variable. It is determined by constructs or variable within the model and thus it is dependent on other constructs.

You say this is a exogenous construct which has got several variables and this is a endogenous constructs. Why is this endogenous? Because this is the dependent so this depends on the value of this only thing is it is this is a multi it is a construct latent construct both are latent constructs.

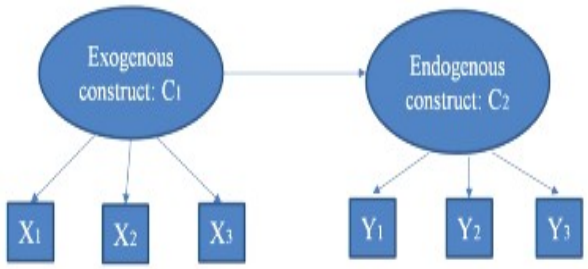
(Refer Slide Time: 13:07)

Dependence and Correlational Relationships

- A **dependence relationship** is shown by straight arrows.
- The arrows flow from the antecedent (independent) to the subsequent effect (dependent) measured variable or latent construct.
- A **correlational relationship**, also called ***covariance relationship***, specifies a simple correlation between exogenous constructs.
- A correlational relationship is depicted by a two-headed curved arrow.

A dependence relationship is shown by straight arrows so this is something like this the arrows flows from independent to the dependent measure variable or constructs. It correlation relationship also called covariance specifies a simple correlation between exogenous. So, exogenous constructs these are the two independent 1 and 2 so we will say this is covariance relationship.

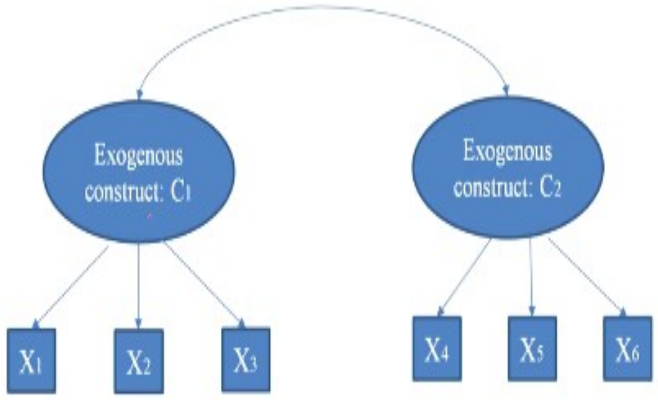
(Refer Slide Time: 13:30)



Dependence Relationship

So, let us see these so this is the exogenous construct and endogenous construct and these are 3 and this is how the relationship goes.

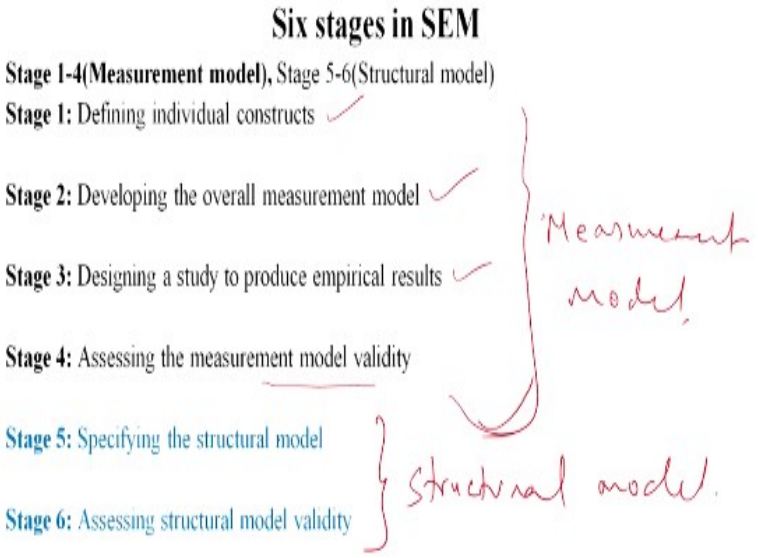
(Refer Slide Time: 13:36)



Correlational Relationship

And this is how the correlational relationship between two exogenous constraints. This was exogenous and endogenous this exogenous exogenous so this is it to a double headed arrow.

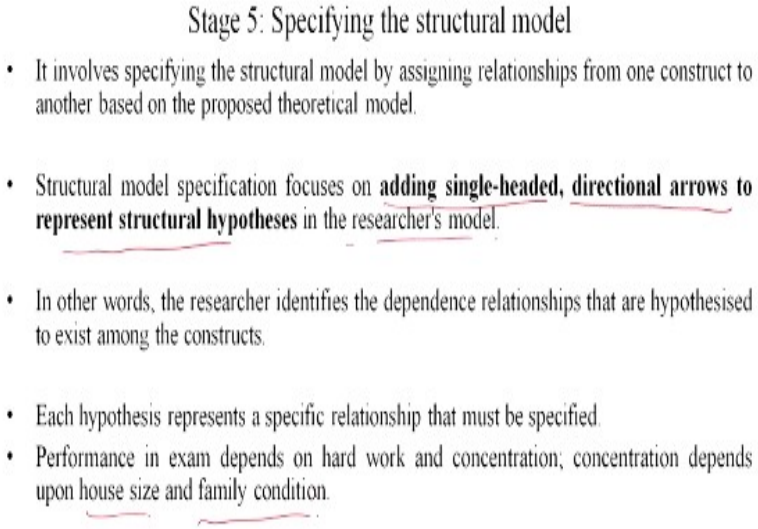
(Refer Slide Time: 13:47)



Six stages in SEM so what are the six stages? The first is the measurement model 1 to 4 so what is this 1 to 4 defining individual constructs develop the overall measurement model. Design a study to produce empirical results to understand whether the model is a fit model or not and to first then check the validity through a discriminate validity convergent validity all this. So, this stages 1 to 4 right is called my measurement model.

These 2 are my structural model so today we will be discussing on only these 2 because earlier in the last lecture we had already covered this for 4 that is 1st 4.

(Refer Slide Time: 14:33)



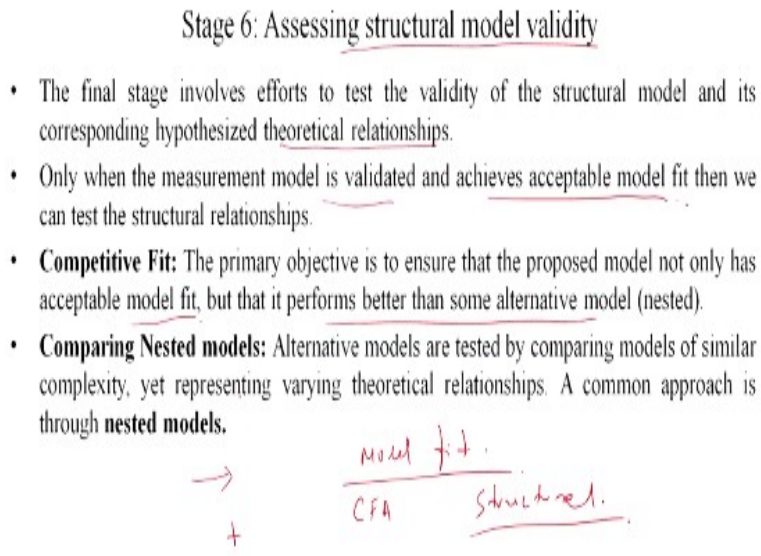
So, in the stage 5 this stage right it involves specifying the structural model by assigning the relationships from 1 construct to another based on the proposed theoretical model. So, on the basis of the proposed theoretical model you are now trying to specify your relationship. Structural model specification focuses on adding single headed directional arrows to represent the structural hypothesis.

So, you must have your hypothesis in your research work so you are trying to see by putting some directional arrows right in there such as model. But the arrows will be based only on sound theory I am repeating it again and again, Do not just put any arrow from anywhere to anywhere. It has to come from some theoretical perspective in other words the researcher identifies the dependency relationships that are hypothesized to exist among customers.

Each hypothesis represents a specific relationship so ABC for example so A effects B that is 1 hypothesis B effects C another hypothesis. A effects C another hypothesis so you have a number of hypothesis. Performance in exam depends on hard work and concentration this is what the example concentration depends upon how size of the house how big a size. You have a small very small house.

They are eight feet or a you know you have a house with 10 rooms where you can freely sit and family condition. Whether somebody father is you know there is a lot of fighting between the parents or something. So that also affects my concentration.

(Refer Slide Time: 16:05)



After that is done after you are done that model then you have to access the structural model validity. So, the final stage involves effort to test the validity of the structural model and it is corresponding hypothesis theoretical relationships. Only when the measurement model is validated the first point 1 to 4 and achieves acceptable model fit. Then we can test the structural relationships.

And remember one more thing I have not mentioned it here I always remember the model fit values that you will get. You should always compare the model fit values off the CFA model. The measurement model and the structural model and your structural model fitness should be more than the measurement model fitness. Then you can always say that you have depicted a relationship or build a model on a very sound theoretical perspective.

Okay competitive fit the primary objective is to ensure that the proposed model not only has acceptable model fit but it performs better than some alternative models. Suppose for example you have alternative models. That means what are nested models now I have a model which if I

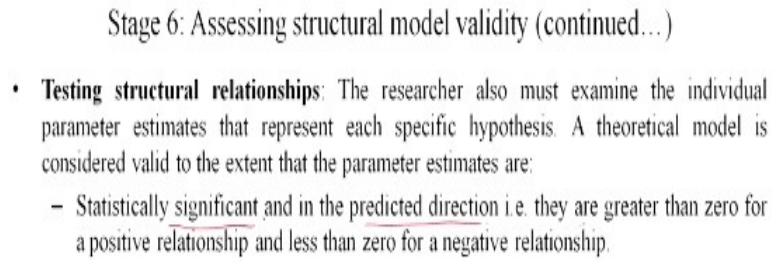
feel one of the variables is creating a weakness is creating a weakness to the entire model. So, we may delete one of the relationships or we may add a new relationship.

On basis of some theoretical perspective let us go back to this case so let us say I am saying hard work and concentration performance in exam. Now I feel this model is not adequate I want to add something more maybe if I add a new variable it will be better what the new variable is? Performance in exam depends on hard work concentration and IQ. So, which I had missed earlier by adding this if my model improves with theoretical is also true.

If it improves then I can say well I had missed on a variable rate so this is what needs to be checked then. So, when you add a new model this is called it when you add a variable or you delete a variable rate it is called the new variable. The new model is called a nested model or sometimes we call it a rival model so this nested model needs to be checked comparing so alternative models are tested.

By comparing models of similar complexity yet representing wearing theoretical relationships a common approach is through western models very clear that means you had a model. Now by adding or deleting a variable whatever change comes that new model is called a nested model. So, you compare the base model or the existing the 1st model with this new alternate model and you just see which one is performing better and the one which is performing better you need to accept that okay.

(Refer Slide Time: 18:48)



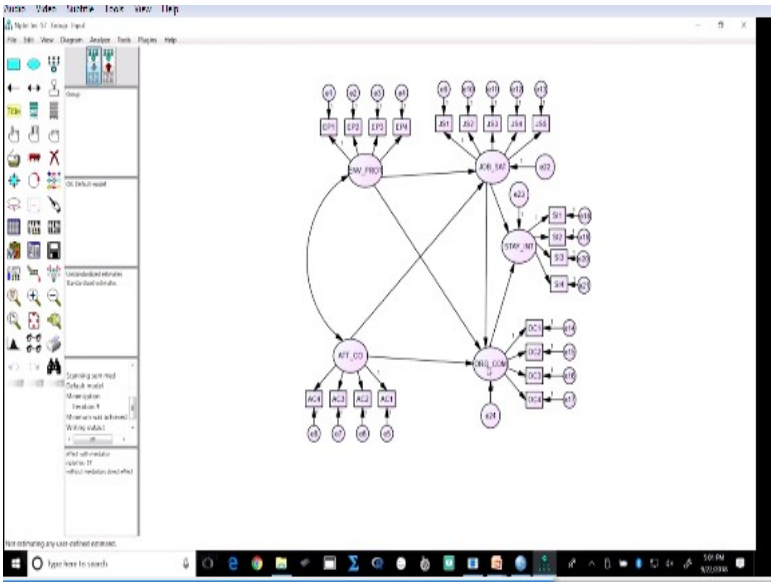
Testing structural relationship starts relationship. The researcher also must examine the individual parameter estimate that represents each specific hypothesis. A theoretical model is considered valid to the extent that the parameter estimates are statistically significant and in the predicted direction. That means the direction also should be as you think and it should be statistically significant.

They are greater than 0 for a positive relationship and less than 0 for a negative relationship now, how to do this let us see how to conduct this SEM in SPSS. Not in a SPSS actually we will conduct in SPSS is today is giving this facility.

(Refer Slide Time: 19:27)

Or we use software called AMOS or some people using LISREL okay but I am using an AMOS okay I will be using this one.

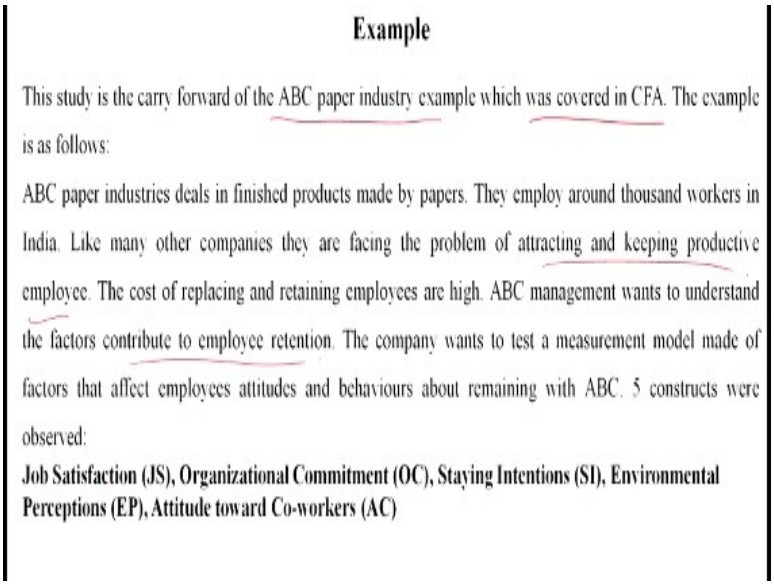
(Refer Slide Time: 19:36)



So let us open this file this is just a file how to do this is I have I know you are by now you know how to draw so there are several variables. In fact, this explanation this example is given later on also so I will show that that just have a look at it. Now in the last class when you were doing the last lecture every there was a two headed arrows to be connecting all the different costumes correct two headed arrows.

But here only these 2 have a 2 headed arrow and other there is a clear relationship so let us see. Now let us go back.

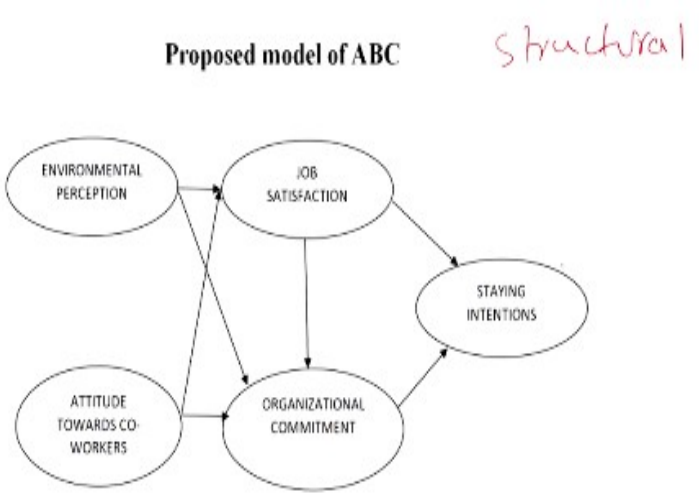
(Refer Slide Time: 20:08)



This study is you know the same example that we are done in the last lecture so we are covered this in CFA. So, the example is as follows ABC industry builds in finished products made by papers. Okay they employ around 1000 workers and you know there is a problem of attracting and keeping the productive employee. The cost of replacing and retaining employees that was high ABC management wants to understand the factors that contribute to employee retention.

The company wants to test him as admin model measurement models that effort the employee attitude and behavior about remaining with ABC. And it found that there are 5 different constructs. Okay so this was the same case that you are done in the last lecture. The case that now thing is changes here is that now we will create a directional relationship among the different constructs and we will create some hypothesis out of it.

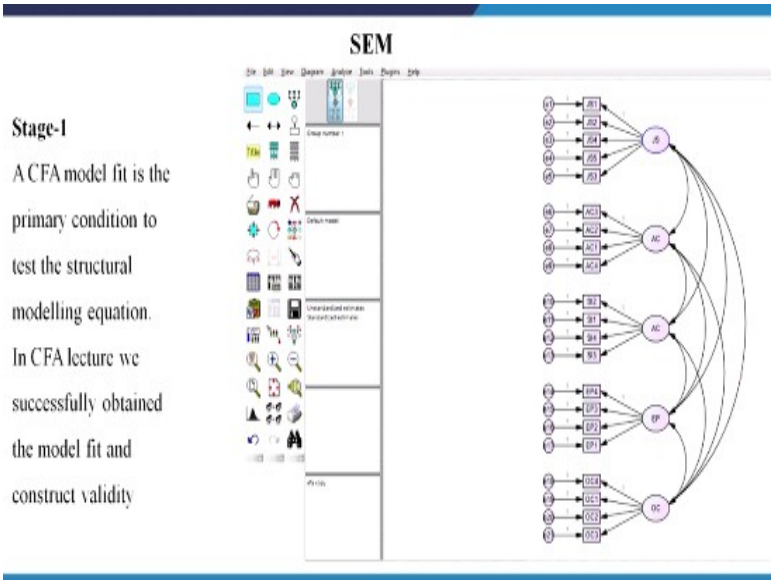
(Refer Slide Time: 21:01)



Okay now look at this so now it is no more a measurement model now it is a structural model Why it is a structural model? Because now clear cut relationship are there so environmental perception we see his efforts job satisfaction and attitude towards co- workers also effects job satisfaction. But in environmental perception affects organizational commitment also. Attitude towards co-workers also effects organizational commitment.

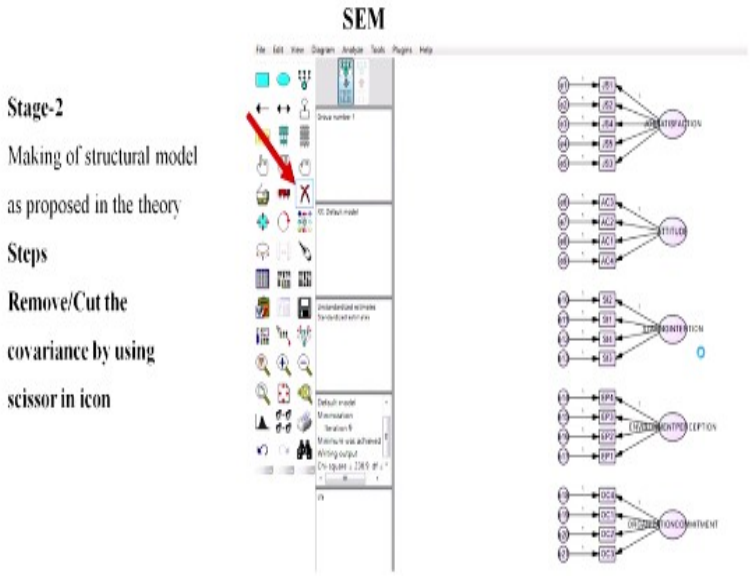
Job satisfaction effects organizational commitment and organizational commitment and job satisfaction both also effects staying intention in a form so this is the proposed model.

(Refer Slide Time: 21:40)



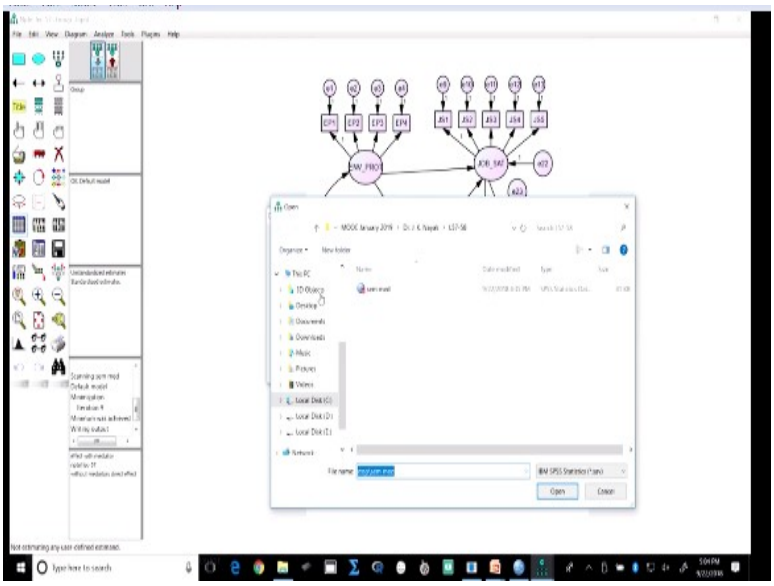
Now how do you do? Let us just have a look at it although I will be doing it for you so this is the CFA model. First of all, the different constructs are there with their related variables. So, you can see the reflective construct so now we are drawing a covariance structure and we will you know now we will connect these models and we will run it. So, these things I will show you with the example now.

(Refer Slide Time: 22:05)



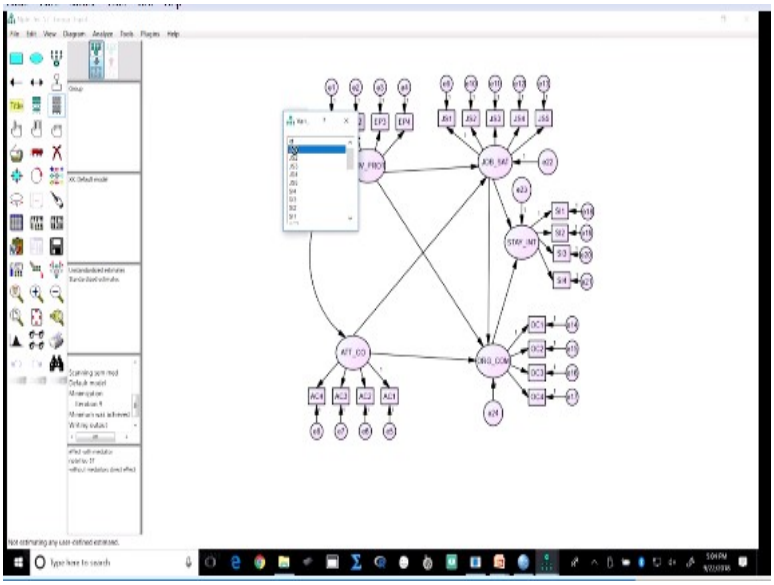
Now let us go back to the example so here you see what you have done so we are done the same thing here. Now the data you know how to connect with the data let me show you so that you do not get a in a problem. So, I have the file you go to the file go to the data file so where is your data file you will see.

(Refer Slide Time: 22:24)



For example, this is my data file so this is my data file open okay.

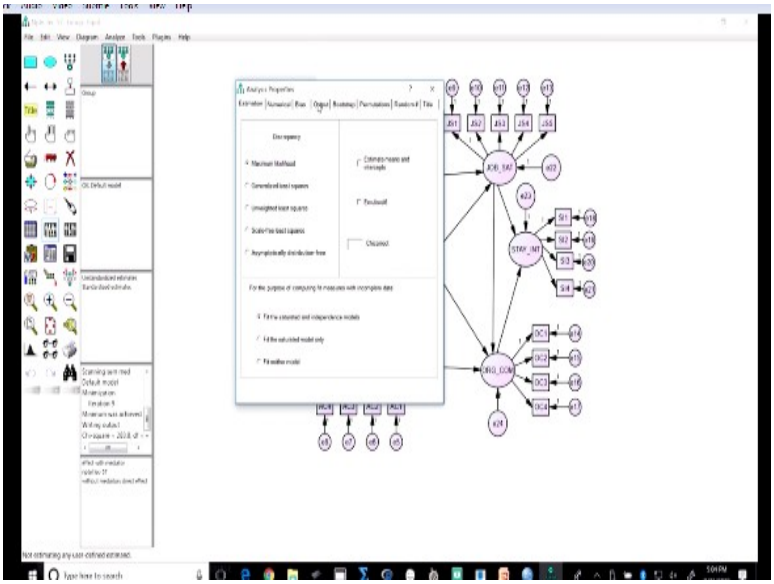
(Refer Slide Time: 22:28)



Okay now when you want to take the variables whichever variables you want to take variables and data set. So, all the variable side, okay all the variables are okay you can take it like this I am just showing you. So you can just drag something JS1 for example and you can take it here so this will come here. So, you can make this when you own when you do you can just drag and drop into the year and other things you know how to give the name to unobserved variables.

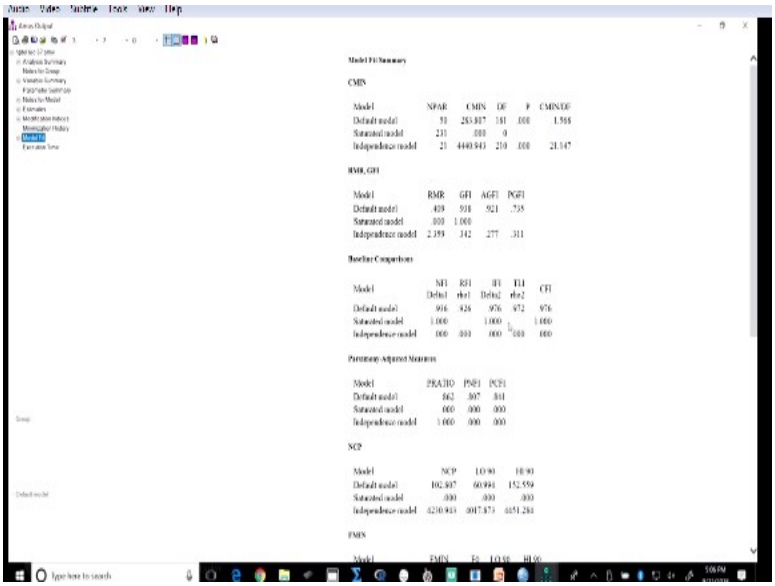
Just go there and click all the unobserved variables these are the error terms this will automatically be there right now. Now let us run this model and see what the condition is. So when we ran this condition before that you again you have to remember this.

(Refer Slide Time: 23:12)



You have to this is a maximum likelihood you know method and output we have given this some of the things which we require. So, indirect and direct effects minimization history standard estimates multiple correlation and modification indices. Okay, now we have run and let us see the output.

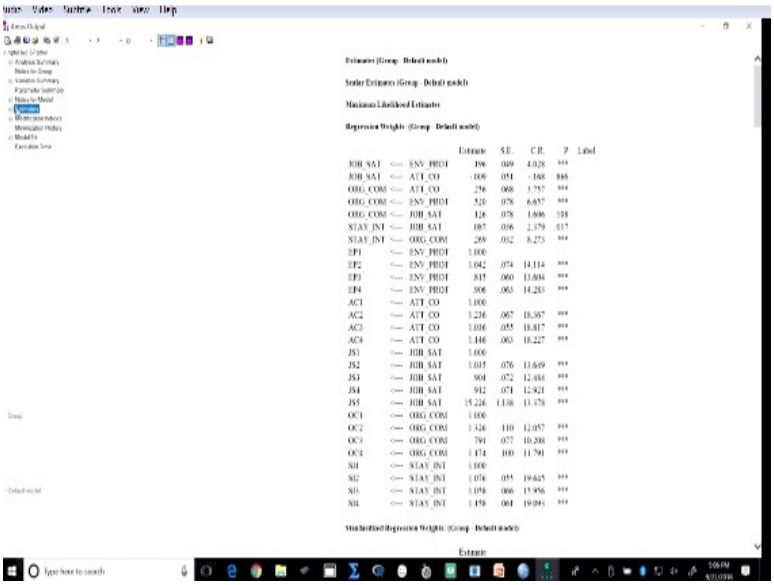
(Refer Slide Time: 23:28)



So, when you look at this output the output says that the model is 1.568 now if you remember we had said that anything below 3 is acceptable good right. Below 2 the chi square degree of freedom is very good. Above 3 and below 5 are moderate above 5 not so good above 10 not acceptable. Okay and let us see now since we are not only interested in the model fit. Now in the CFA what were you doing? You were checking this and then checking some of the parameters like the GFI.

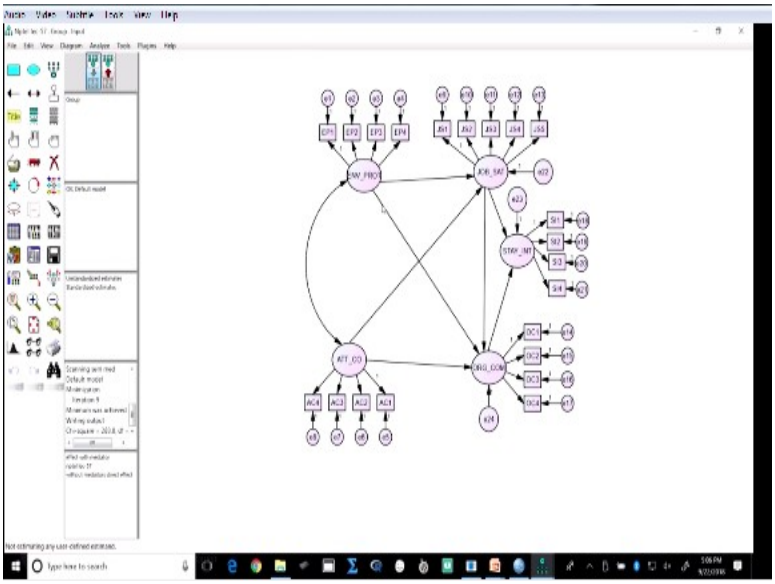
The IFI the CFI and we are trying to see whether model all these indices are good or not so they be about 0.9 and that is correct. But in this case now we are not only interested in that we are interested in looking at the relationships. So we will go to the estimates.

(Refer Slide Time: 24:24)



Now look at it so now you will see environmental protection effects job satisfaction so this was 1 of the hypothesis. Let us see the diagram.

(Refer Slide Time: 24:34)



And environmental protection effects job satisfaction and environmental protection effects organisational commitment attitude effects organisational commitment and let us see this so environmental effects protects job satisfaction is it a significant or not? Now look at this now this is the estimate this is my standard error if you divide these 2 you will get this right. And is this significant? Yes, it is significant.

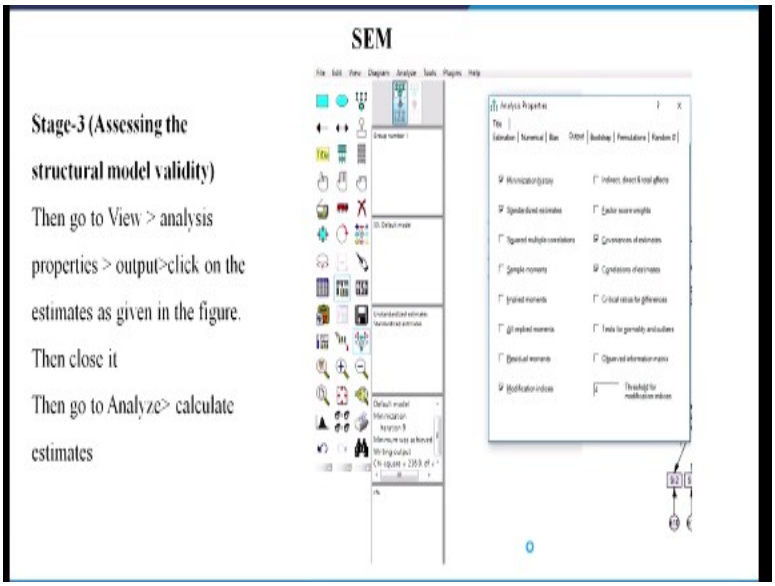
These 3 dots mean it significant at .001 levels. Is this significant 2nd one attitude if it effects job satisfaction no it is not why? Because it is above the 0.001 level or whatever you are taking 0.05 or something so this is much above so the null hypothesis you cannot reject it now? Is this a model? Is this relationships is significant no but these 2 in between attitude of co-workers effecting the organisational commitment.

And environmental protection effects the organisational commitment these two are again significant. This is also significant alerts that poor value if you take 0.001 not significant but if you take .01 or .05 let us say then it is significant. So, you can develop you can check this right by checking this now you can write in your results. Well that we found that this model is affecting this relationships are positively.

These are positivity related later that means environmental effects protection effects job satisfaction but attitude towards co-workers also efforts organisation commitment all these

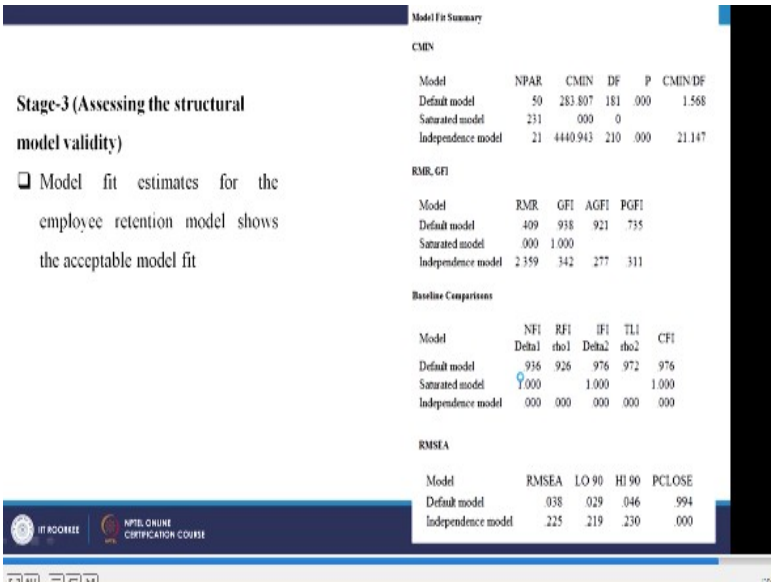
things. But this one you will say no attitude toward co-workers did not yield the result that it affects the job satisfaction positively so this is what you write in the hypothesis. Okay now let us go back.

(Refer Slide Time: 26:15)



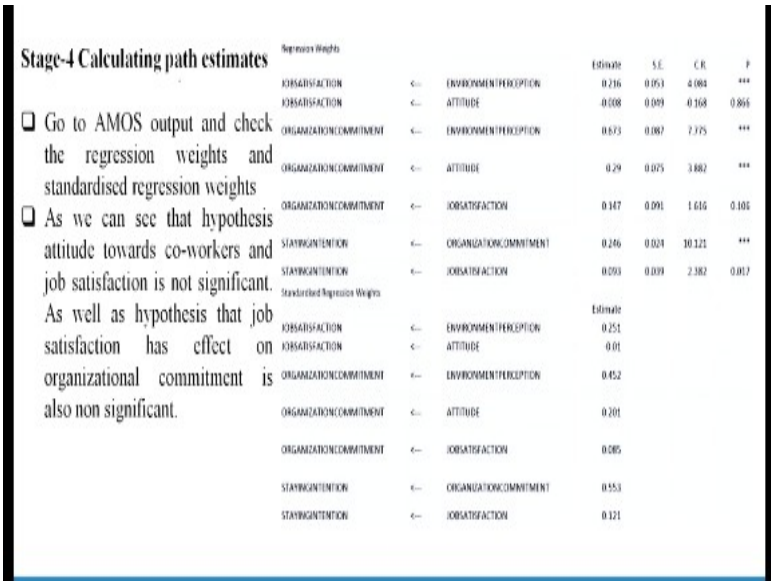
So, this is what you have done okay so this is what I was saying so go to the output and you take this.

(Refer Slide Time: 26:24)



And this is what you have got in the modern fit values okay.

(Refer Slide Time: 26:27)



And you see so now this is like calculating path estimates it is called calculating the path estimates. So, go to AMOS output and check the regression weights so we have checked the regression weights exactly this and a standardized regression rates as we can see that hypothesis towards added towards course with co-workers and job satisfaction is not significant. These were talking about this one as well as hypothesis.

The job satisfaction has effort on organizational commitment which one job satisfaction on organisational commitment. So, where is it job satisfaction or this 1.1063 has a effect on and also non significant and the rest are significant. Okay so this is how you write you know about the path estimates to say give this was my hypothesis and my hypothesis has been found to be true or not true.

So, this is what we have discussed today so we have understood what the structural model is? Why it is called structural model and what are the things that should keep in mind. While developing a structural model and finally how do you interpret the structural model. In the next lecture I will be talking on something more detail in the structural model itself right and we will continue from there. Thank you so much.