Business Analytics for Management Decision
Prof. Rudra P Pradhan
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur

Lecture – 44
Prescriptive Analytics (Contd.)

Hello, everybody. This is Rudra Pradhan here. Welcome to BMD lecture series and today, we will continue with prescriptive analytics that too coverage on linear programming problem. In the last couple of lectures we have already discussed this prescriptive analytics and too we have highlighted couple of issues like optimum solution and how to achieve optimum solutions a you know kind of you know maximization problem and minimization problems and the idea behind this particular structure is to get the values of the decision variables; corresponding to a particular business problem and the kind of you know management requirement.

So, technically we have solved some of the problems that is type of you know maximization case and the minimization case that is with respect to objective functions and the constants and the problems which we have solved for the management requirement or the business requirement where we have a you know normal case that too with respect to objective function maximization type the normal situations are the constraints must be in the less than type and in the case of minimization problem and that to minimizing the objective function and as usual the constraints will be greater than types.

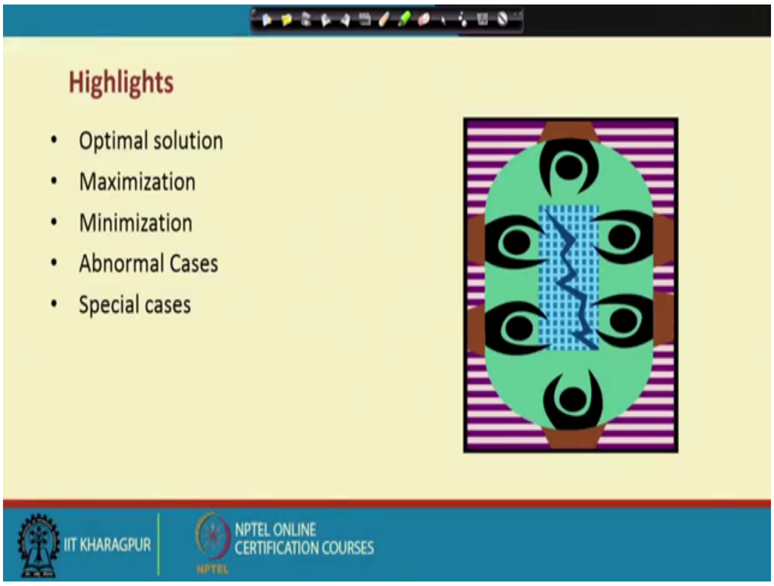
So, accordingly we have solved cases for maximization problem where the constants are less than type and solve some of the problems less than type where the constraints are greater than types. So, usually in the normal linear programming problem corresponding to means maximization problem constraints should be less than type and corresponding to minimization problem constraints should be less than type.

So, now, if the situations are other way around for instance having objective function maximization type the constraints are greater than type and with respect to minimization of objective function the constraints are less than type or in the third group with respect to maximizing objective function or minimizing objective function where the constraints are not in a kind of you know consistent structures like less typically less than type or greater than type. So, a that means, technically a irrespective of objective function maximization and minimizations and the constraints are you know kind of you know mixture kind of you know situations where we may have less than type we may have greater than type and we may have equality type.

So, that means, it actually depends upon a particular business problem and corresponding to business problems the idea is to formulate the LP is subject to you know the objective functions may be a maximization type and minimization type and then the constraints will be follow up as per the kind of you know business problem or the kind of you know management kind of you know requirement and so, once we design the models then we will look for the kind of you know solutions.

So, we have no issue to solve the problems irrespective of you know maximization of objective functions minimize[ation] or minimization of objective function subject to constraints which are not in a kind of you know typical format the less than type or greater than type where we may have actually mixture type. So, so the idea is that you know we may not have any problem.

(Refer Slide Time: 04:04)

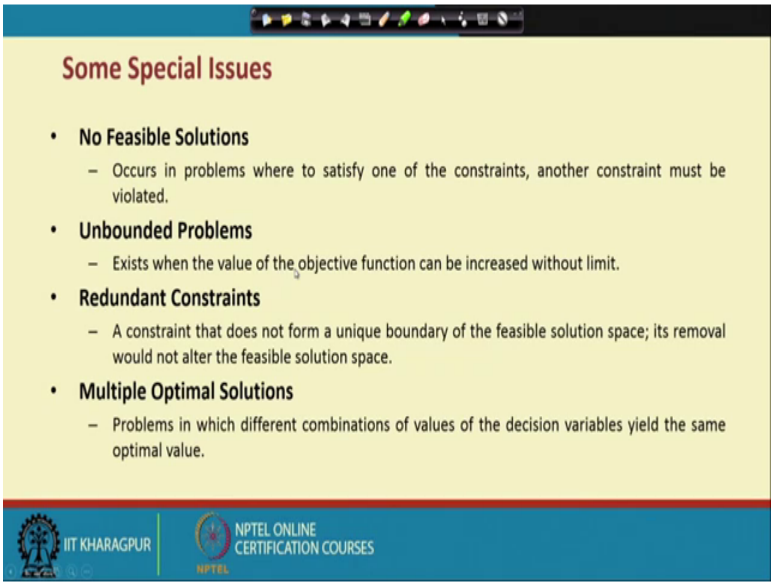


So, the first step of the particular process is we like to streamline the process depending upon the particular objective a may be maximization type or minimization type.

So, in totals you know we have solved problems and looking for optimum solutions in the case of maximization and in the kind of you know minimizations where the problems are more or less consistent without any obstacles or without any kind of you know issues or some kind of you know complexity. But, in reality a you know irrespective of objective functions maximization and minimizations then the mixture kind of you know constraints we may find some kind of you know abnormal cases and you know and the kind of you know special cases where the obj[ective] the objective function and consents may not give you some kind of you know unique you know optimum solution.

So, now, we like to address these issues in this particular you know lecture in reality there are certain business problems which may have such kind of you know indications then we should know how to solve these problems and look for the kind of you know solution or you know giving the kind of you know indication so that you know you know management decision can be taken into considerations.

(Refer Slide Time: 05:31)



So, now you know to highlight all these things so, some of the special cases or you know issues like sometimes we may not have no feasible solutions. So, you know you know the kin[d] the kind of you know structure is like this. Sometimes we may have objective functions maximization or minimization and the constraints may be consistence maybe some kind of you know mixture still you we may not every time get the feasible solution. So, that means, technically we like to know what are this you know you know you know specific cases where you may not have no feasible solution irrespective of you know objective function and the kind of you know constraints.

And, the second special issue is sometimes the problems is unbounded type, that means, say this may be the case where objective function and constants may not be consistent as per the particular you know business requirement or the kind of you know management requirement. In that case we may not be in a strong position to come with you a kind of you know management decision for a specific problem.

And, the third special case is the redundant constraints; that means, technically the usual structure of LPG we must have objective function and then subject to certain constraints maybe a typically less than types or typically greater than types or typically the mixture of both you know less than type or greater than ty[pe] and greater than type and you know sometimes may be equality type, a but widely you know doing the kind of you know solutions where you know the optimum solution is with respect to objective function the constraints must be consistent then in the process of you know you know optimality some constants may not be actually effective and as a result it can be a called as you know redundant.

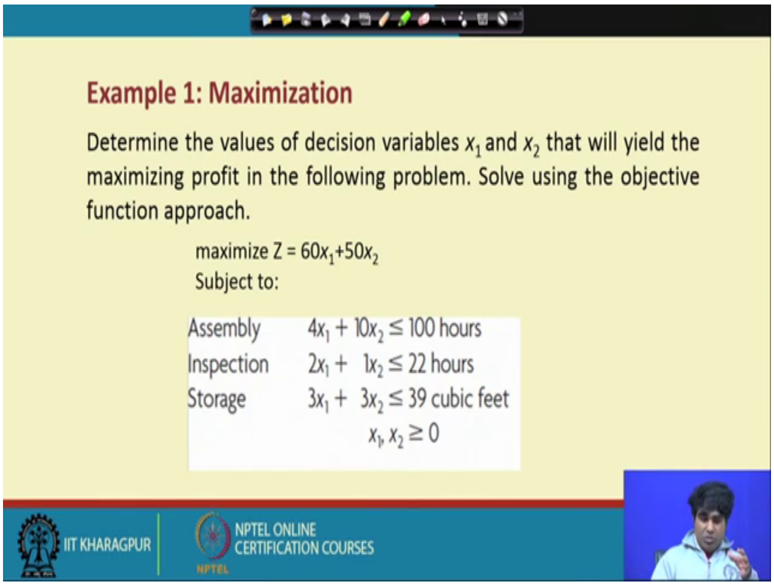
So, that means, in the final optimum solution this may not be you know the kind of you know the kind of you know linkage towards the optimum solutions. So, it is it is it may be the case of you know the dominance of you know other constraints to the objective function and the fourth special issue is the multiple solutions; that means, technically the usual structure of you know optimization or prescriptive analytics is that you know we like to find out the you know corner points; that means, every corner point may be in a position to give optimum solutions.

So, now, after knowing the corner points so, we had like to put all these corner points to the objective function and try to fix the particular point for optimality where the value of a objective function you know will be maximum for a maximization problem and you know extremely minimum for a minimization problem. But, we may find some special case where the values of the objective function are equal at two different corner points or three different corner points. So, in typical situations our you know structure is called as you know a problem having multiple optimum solutions.

So, these are all called as you know special cases and we like to see what are these you know special cases and how is this particular you know structure graphically and then we like to connect the LP structure with different you know application that too in the kind of you know management domain. So, that means, typically we like to you know how prescriptive structure is all about o and in a kind of you know problem like marketing, finance, operation research the kind of you know HR.

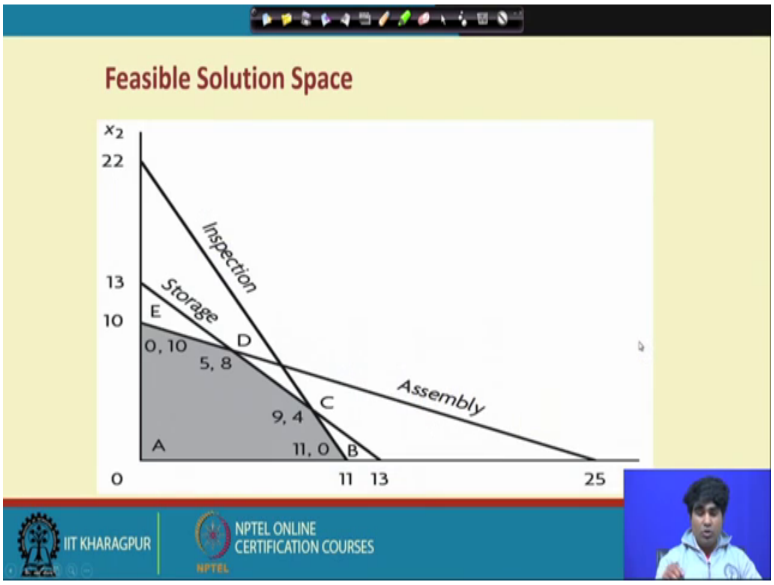
So, that means, typically in a kind of you know business environment prescriptive analytics is a kind of you know typical technique where you know all kinds of you know problems can be you know connected if provided it must be fitted with the linear programming format and then looking for the kind of you know solution and the kind of you know management decision.

(Refer Slide Time: 09:47)



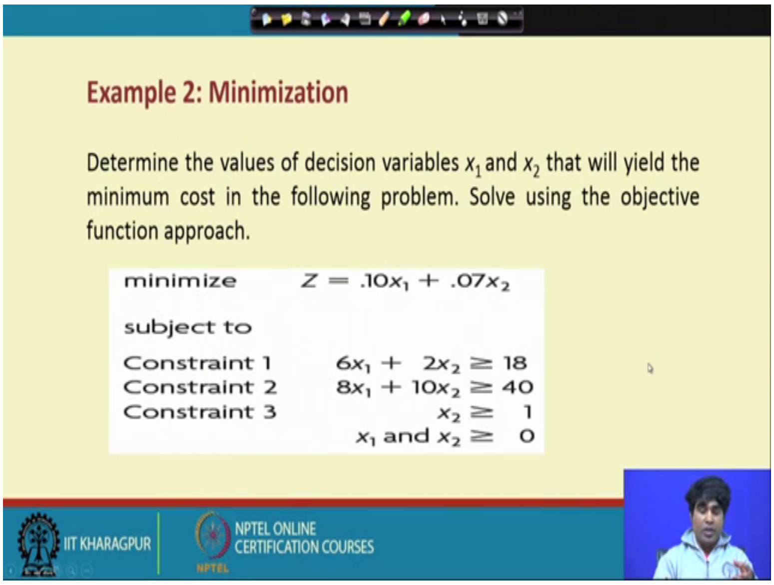
And, by the way so, we will see first in the case of you know maximization slide this is this is strongly you know normal case for maximization problem where the objective function is the typically the kind of you know maximization type and then the constraints are typically less than type. So, this is the normal case of the kind of you know LP problem in that too the other to the case of you know maximizing the objective functions and this problem we have already discussed.

(Refer Slide Time: 10:25)



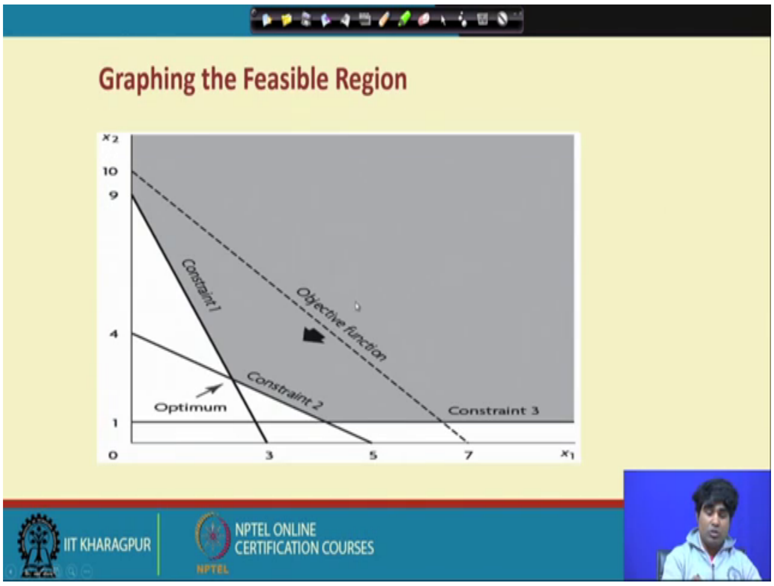
And, in the counterpart the you know the kind of you know you know solution will be like this and we like to you know plot the constraints as per the particular you know structure and finally, we look for the corner point and then think about the value of the objective function corresponding to the these you know corner points and where the value is the highest that will be the final optimum solutions in response to maximizing the objective functions and.

(Refer Slide Time: 10:53)



You know contrary to the maximization type the minimization problem structure will be like this and the objective function as usual minimizing a Z subject to constraints.

(Refer Slide Time: 11:09)



And that too so, this is the minimization kind of you know structure where the Z is the minimization type and the kind of you know constraint is the typically greater than type.

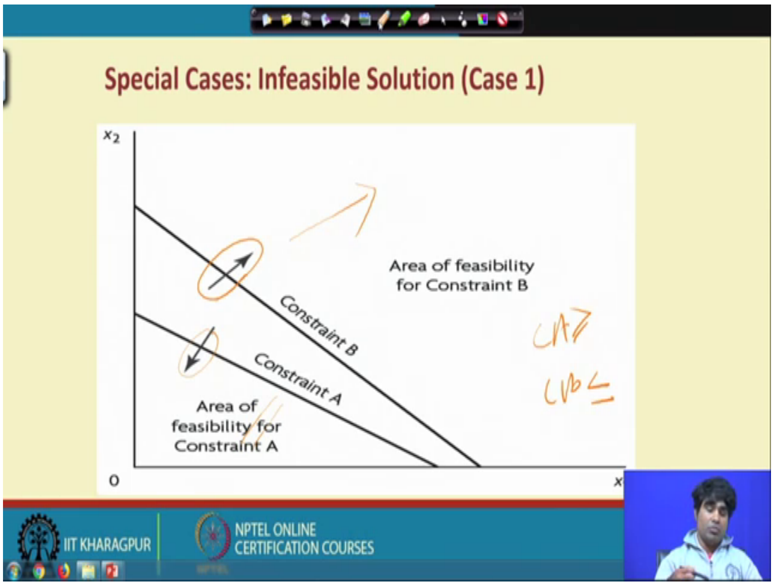
So, this, that means, technically this is the normal case of you know minimizations corresponding to objective function the constraint should be a you know greater than type and the as usual there will be restriction you know for decision variable that should be positive in nature.

So, this is a as usual you know structure of LP problem and corresponding to the maximization problems so this is how the structure about the minimization problem and accordingly, we are looking for the solutions and the solution will be also we try to find out the feasible zone and then looking for the corner points and then looking for the kind of you know optimality by putting all these corner points value to the objective function and fixing the optimality.

So, this is the typical case of you know minimization problem. So, that means, technically. So, this is how the structure about the maximization type and this is how the structure of the you know minimization type; that means, the feasible zone will be in the upper side and we are looking for the bottom of the sides and in the case of you know maximization type we like to fix the boundary and then the solution will be within the particular you know boundary.

So, that is the typical difference between the maximization structure and minimization structure and in the case of you know prescriptive analytics and that too in a kind of you know linear programming you know situations or the kind of you know management problem.

(Refer Slide Time: 13:01)



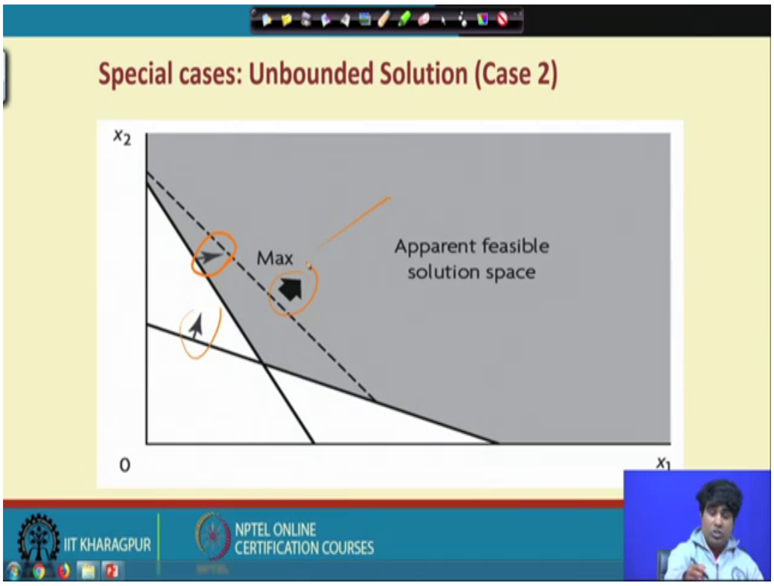
And, corresponding to the kind of you know maximization case and minimization case that too in the normal situation. So, we have already sited two different examples and now, we come to the kind of you know special case the first special case is the infeasible solution. And, typically the objective function may not give you the kind of you know optimum solution as per the particular you know business requirement or the kind of you know management requirement and it may be the situation where corresponding to a particular objective functions may be maximization type may be minimization type, but the constraints are not consistent.

For instance, if there are two variables say x 1 and x 2 means since we are you know doing the graphical kind of you know indication to know the normal case and the kind of you know special case so, for the a objective functions may not reach the optimality if you know the constraints are not consistent. For instance if there are two constraint one will be greater than type and another one will be less than type and that is the typical kind of you know situation where you may not get the kind of you know optimum solution.

The reason is that you know we may not in a position to find out the feasible regions through which you know we look for the corner points and look for the kind of you know optimum solution where depending upon the a kind of you know objective functions. So, that means, this is a typical case here and here so, the typical error indication represents that you know it is the greater than type of constraints and this error indicates that you know it is the less than type of you know constraint; that means, we have constraint A and constraint B constraint a is the kind of you know less than type of you know constraint and constraint A is the greater than type of you know constraints as a result.

So, to have a different kind of you know you know structural together as a result optimality may not you know possible and as a result we may not in a position to solve the business problem and may not get a kind of you know optimum solutions. So, this is a kind of you know inconsistent problem through which actually you know we may face in the case of you know management problems and as a result we may not get a optimum solution.

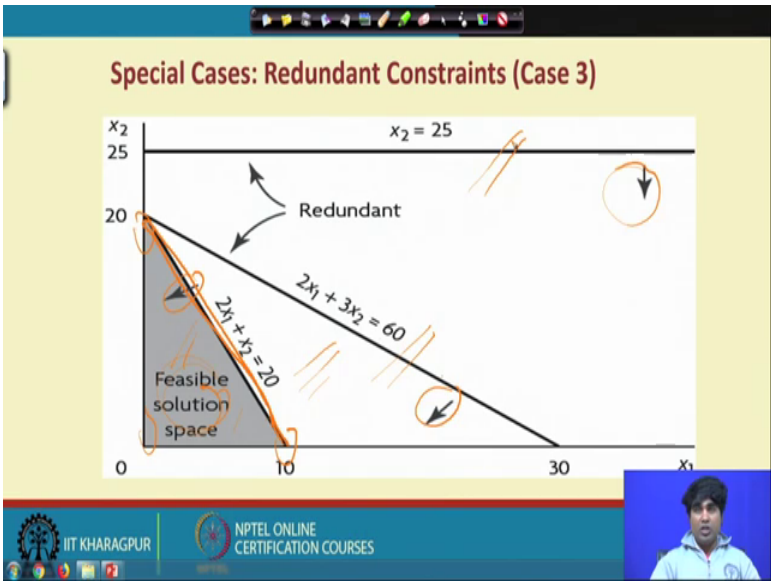
(Refer Slide Time: 15:20)



And, this is a typical case of you know another typical case that is the special case that that is called as you know unbounded case and a this is a this is a kind of you know situation where your objective function is the maximization type and the constraints are typically greater than type. So, that means, technically so, you know looking here the indication of you know arrow so it gives the indication that it is the you know kind of you know greater than type of you know constraint and this is also greater than type of constraint and this is also greater than type of constraint. So, that means, technically the zone will be in the right side and we are looking for you know maximization of you know Z value.

So, in this case of you know in this case your boundary is not actually finite. So, it is it is actually unbounded typically. So, the feasible zone has no boundary. So, as a result so, you may not in a position to find out the all possible corner points and as a result you may not get the optimum solution. So, this is the second special case you may face in the case of you know optimality or in the kind of you know prescriptive analytic structure.

(Refer Slide Time: 16:37)



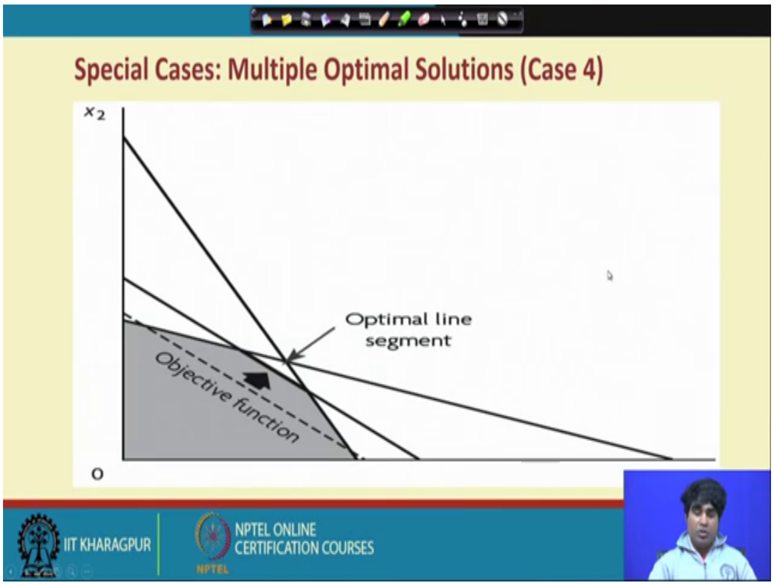
And, the third special case is the redundant constraints. So, that means, what I have mentioned already. So, having a kind of you know you know problems maximization problem or minimization problem so, sometimes you know few constraints may dominate the kind of you know structure in such a way that you know you may get the objective you know values of the objective function and you may get the optimum solution, but all the constraints may not finally, in a kind of you know operative.

You know it may happen sometimes because you know as per the particular you know requirement so, the out of you know three constraints two constraints are you know satisfying the case and as a results you may be in a position to get the optimum solution. For instance so, this is this is a kind of you know if you look the arrow so, it is the less than type and then the feasible zone will be accordingly this much and then this is also the case of you know second constraint the you know indication is also less than type. So, as a result so, your feasible zone will be also in the less than type.

Now, if you connect the first constraint and second constraint then technically the feasible zone will be only here. So, this will not be actually counted. So, that means, so, the first constraints will be you know dominate heavily and against coming to this particular you know constraint you know third constraint which is also less than type, but it is too much above. So, that means, the this particular constraints this particular constraints by default give you the kind of you know structure that you know optimal solution by default will be lying in these three corner points.

So, as a result this is not so effective and this is not so effective. So, but you know we are getting the optimum solution corresponding to the objective function, but these constraints are not so effective in the kind of you know optimum solution. Sometimes it may happens depending upon the kind of you know business problem and the kind of you know management problem. So, this is the third case a special case about the kind of you know prescriptive analytics.

(Refer Slide Time: 18:48)



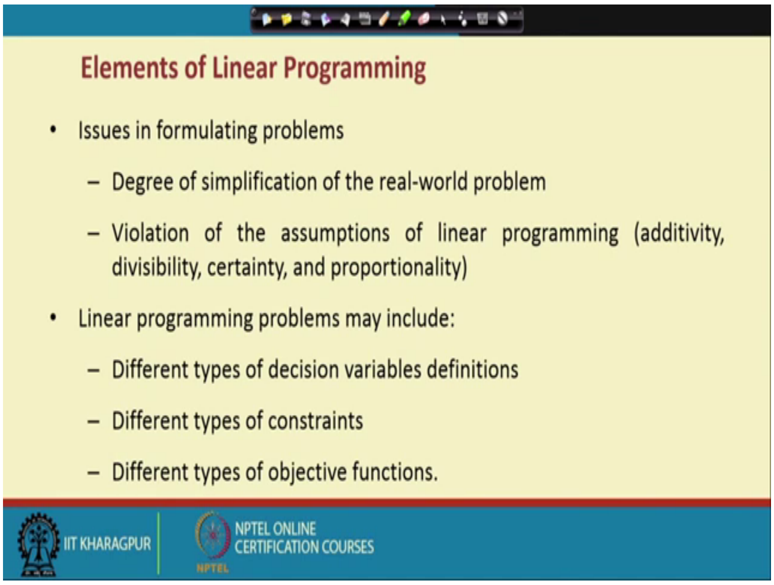
And, then the fourth case is the multiple optimal solutions and here. So, the constants are consistent corresponding to the objective function, but this is the case where at least you know two different corner point the value of the objective function is more or less similar. So, if that is the case then this will indicate that you know multiple optimum solutions or sometimes you know alternatives this is what I call called as you know alternative solution, that means, corresponding to a particular objective function. So, the there is another point where the objective values of the objective function you know is more or less same.

So, this is the case where we can call you can call a situation that you know the problem having multiple solutions. So, that means, it is you know you know flexible often flexible because when we are looking for the optimum solutions we must have a flexible points then we are we are you know checking and then declaring that this is the kind of you know optimality. Now, within the flexibility two different situation where the values of you know objective function will coincide and at least a two different situation then as a result so, this is the declaration about the multiple optimum solution.

So, now, if a particular problem is having indication about the multiple optimum solution; that means, it is good for the kind of you know business problem or the kind of you know you know management problem, that means, management decision will be more effective and efficient because we have the kind of you know alternative and that too it is called as a situation called as you know opportunity kind of based kind of you know situations where you can choose any of the two and as per the particular requirement.

Of course, the combination of the values of the decision variable will be different what you know the objective function value will be remain same sometimes you know depending upon the particular you know requirement for instance we have already discussed the case that you know economic feasibility and social feasibility. So, now, you know if you have a such kind of you know situation where the solution is multiple types then you can choose a particular of some which may not affect the objective function and then it may erase the social objective rather than you know economic objective.

(Refer Slide Time: 21:27)

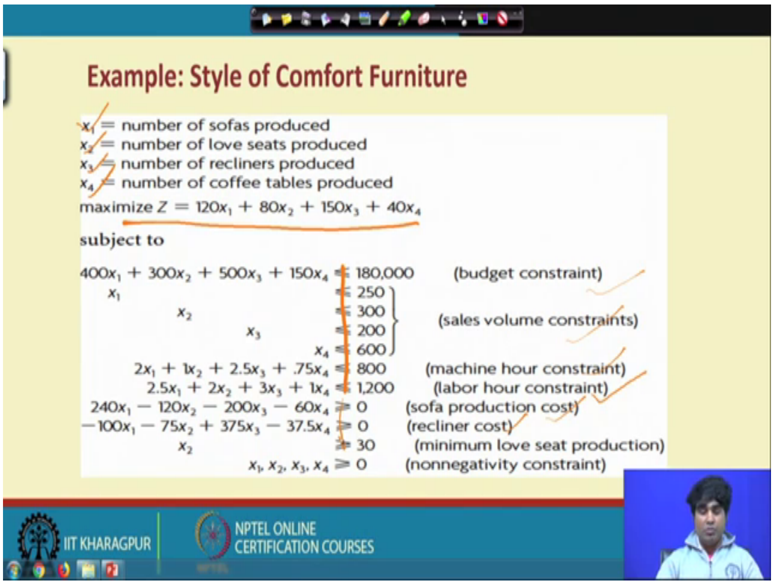


That means technically in this kind of you know situations we have this concept called as you know sustainability kind of you know situation where we can take care both economic objective and social objective and sometimes it is a very rare, but of course, if you have the kind of you know situation this is good or you know plus point for the kind of you know management so that you know they can come with you know effective management decision.

And, some of the a other issues are there in the linear programming like you know issues in formulating problems. So, first thing is a degree of simplification of the real world problem and violation of the some of the LP assumptions like you know additivity, a certainty, proprotionality, divisibility and the linear programming problems may include different type of you know decision variable definition and different types of you know constraints different types of you know objective functions. In fact, till now, whatever problems we have discussed it is with respect to single objective and in a real life scenario you may have a problem with you know multiple objectives and then we are looking for a kind of you know solutions which can satisfy all the objectives simultaneously.

So, in the that is the case called as you know goal programming and in the goal programming you may have a multiple objectives in the first end and then we are combining these objectives subject to constraint and looking for the kind of you know solution and this is how the typical you know structure through which you can actually solve some of the problems and some of the some of these you know corresponding to this you know different you know kind of you know structure or the kind of you know complexity a I will just you know highlight couple of examples corresponding to kind of you know complex kind of you know scenario where, objective functions are not you know normally follow the kind of you know typical less than type of you know constraints or the greater than type of you know constraints.

(Refer Slide Time: 23:23)

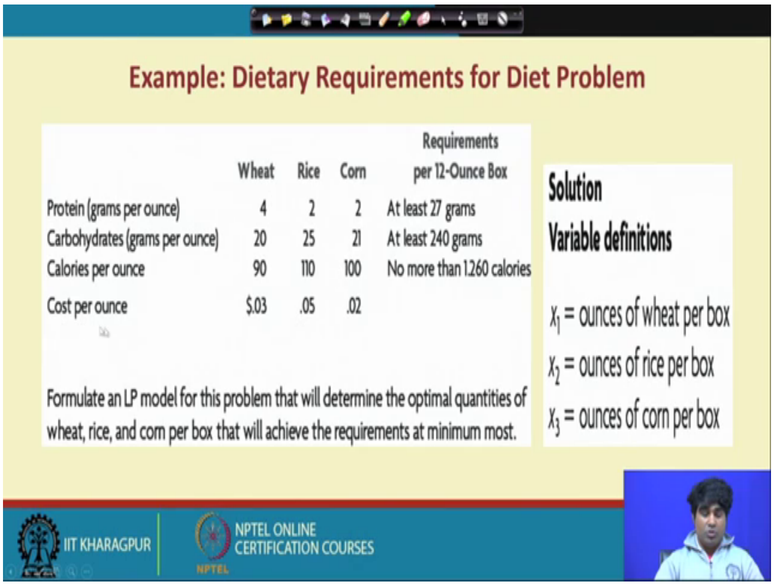


And, in this case first problem will be like this you see here this is a kind of you know problem where we have a maximization objective functions and we have a couple of constraints here like you know budget constraint, then sales volume constraint, machine hour constraint, labor hour constraint, then production cost other cost you know like you know lots of you know their typical you know constraints are there. So, we have a multiple constraints and then the a problem is also you know multivariate kind of you know structure having four different you know requirement that is the values of the decision variable that is typically x 1, x 2, x 3 and x 4.

And, then some of the constraint mod number of constraint and out of you know or you know all constraints so, first couple of constraints are you know less than type and then we have a another set of you know constraint which are you know greater than type. So, that means it is a kind of you know mixture and then we look for the kind of you know solution in this kind of you know problems usually graphically we cannot you know easily reach the optimality or optimum solution and in this kind of you know problems we like to solve or looking for the management decision by different you know approach or different methods which we called as you know simplex procedure or the kind of you know algebraic procedure.

So, that means, typically you have to write you know in fact, computer programming can be connected and then we are looking for the kind of you know solution. Of course, we will be connect with you know solver the case package and to solve this kind of you know problem to get the you know optimum results because when the problem is very big and complex it is not so easy to get quickly manually and in that context we like to use some of the sub tears may be or sub tears may be (Refer Time: 25:16) and the kind of you know solvers to look for the kind of you know solution.

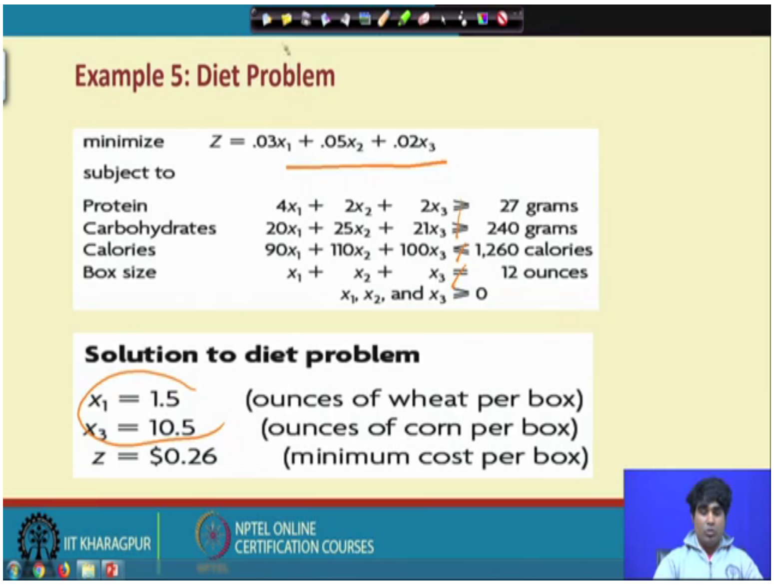
(Refer Slide Time: 25:33)



And, accordingly so, if you proceed I can you know give you more such examples where the situation is the you know kind of you know the kind of you know you know having you know inconsistent where some are you know less than type and the kind of you know or greater than type. So, this is another examples where we have objective functions and then we have the kind of you know the objective function is here cost per issues so; that means, technical it is a minimization type of you know problems subject to 3 constraint protein constraints, carbohydrates hydrates con constraints, then calories.

So, like you know these are all the at least means it is a greater than type kind of you know situation and a corresponding to this particular problem, so, that means, technically. So, this is the situation where we can have a less than type of you know situation and this is a profit functions and then and the kind of you know solution.

(Refer Slide Time: 26:23)



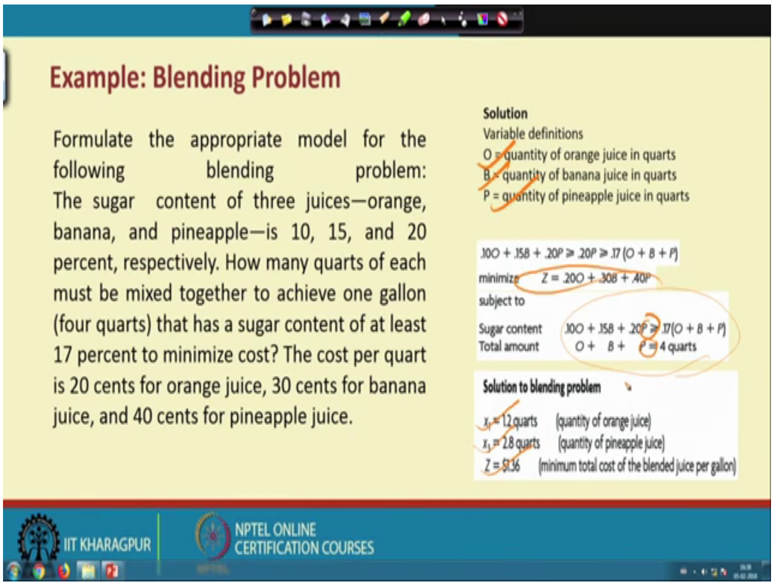
So, that means, corresponding to this so, the particular you know formulation will be maximum minimizing Z and subject to all the constraint and a typically the (Refer Time: 26:32) here. So, this is actually minimization objective functions and we have a we have actually a four constraints so two are greater than type, one is a less then type and one is equality type and this is typically you know different you know you know kind of you know situation that is that that is actually it is completely mixture type of you know situation where we are looking for the you know optimality that too minimizing the objective functions.

And, obviously, a you know there is the optimum solution even if you know we have a different kind of you know constraints and according to corresponding to this problem. So, the values of the decision variable will be x 1 equal to 1.5, x 3 equal to 10.5 and in fact, x 2 is not coming here and Z is coming 0.26.

So, that means, you know it is not necessarily that you know all the values of the I mean decision variable will be active sometimes because of you know constraints and the kind of you know requirement or the with respect to objective function and some decision variable may be finally, dropped. So, that is how we are looking for a kind of you know structure where you can take care the economic and social aspect simultaneously; that means, if you know consider the best structure through which you know business can be operative, if your objective is not so, you know commercial type of you know situation where you know you know we like to target you know more profit then, obviously, some of the recent variable may be dropped in the final you know solution, but in the kind of you know social kind of you know set up where all the decision variables should be a operative and then we look for the higher that could be the best way of you know kind of you know presenting the situation.

But, usually a we look for the solution as per the management requirement and business requirement and that too as per the specific objective you know a specific object is concerned you know. So, far as you know business requirement or the kind of you know management requirement.

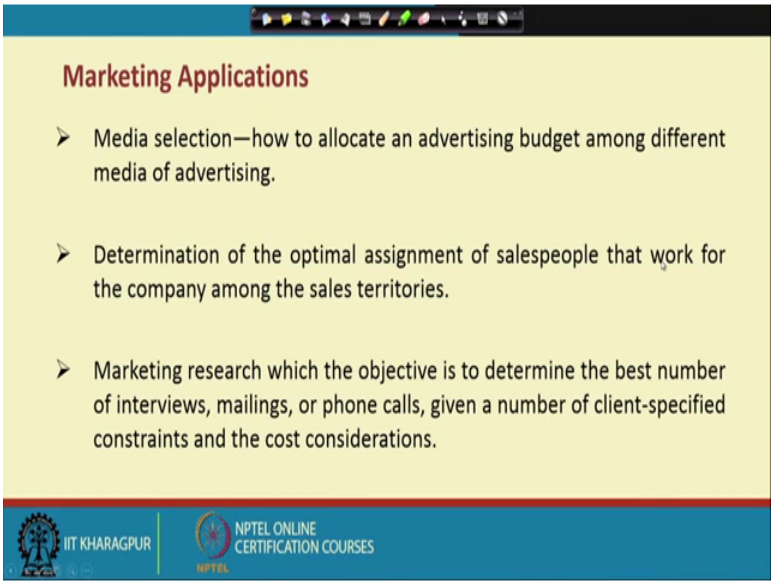
(Refer Slide Time: 28:46)



And, corresponding to the particular you know structure against I can highlight a couple of more problems and this is actually again a three decision variable case and O O, B, P and this is the quantity of you know three different fruits and then we have actually kind of you know minimization problem minimize you know objective function subject to certain constraint here and so here the constraint is you first one is the greater than type and the second one is the equality type and still we have the optimum solution and corresponding to this particular problem where we have actually three variables then finally, the optimum solution is coming with respect to two variable that too for x 1 and x 3 and the values of the objective function is also you know uniquely represented here.

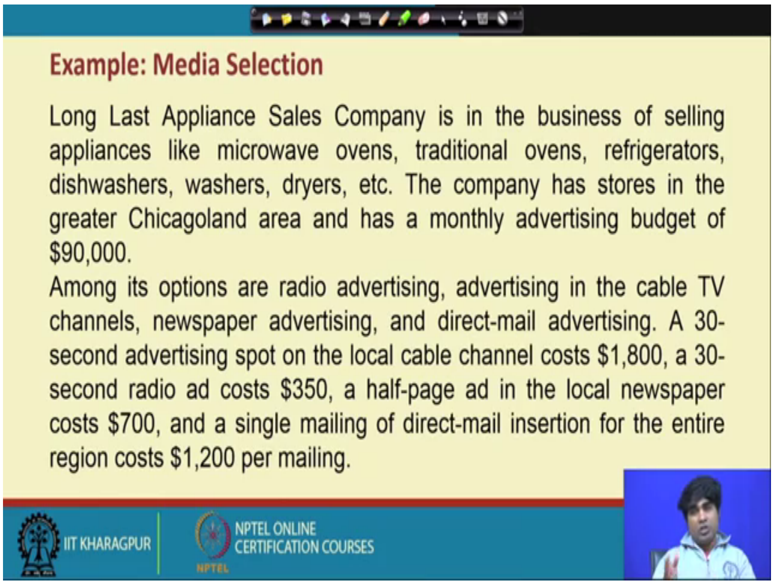
So, that means, you know even if the problem is consistent and the constraints are you know not in a kind of you know unique format still we can get the optimum solution and the and there may be the situation where all the values of the decision variable may not be in a kind of you know positive structure. So, some may be dropped and finally, we like to fix the kind of you know optimality a as per the specific objective or the management requirement.

(Refer Slide Time: 30:17)



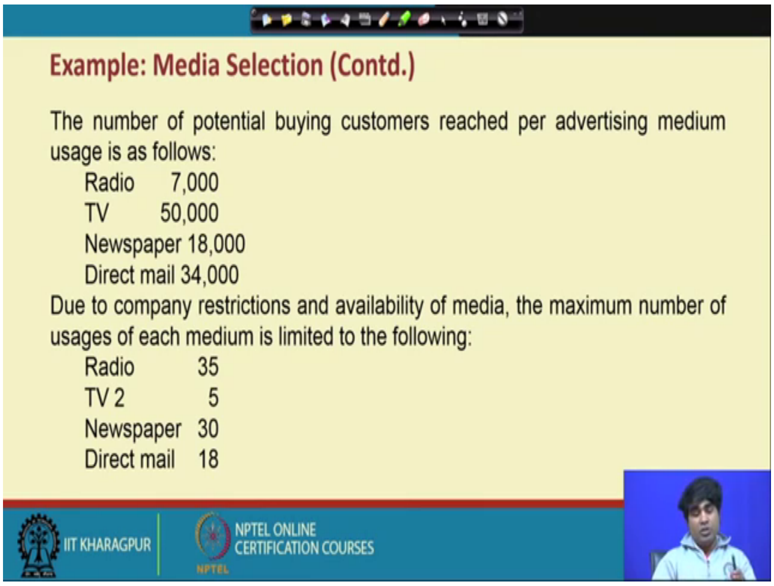
And, accordingly so we can have a more such kind of you know examples and where we can actually highlight the particular you know issue special issues and there are also you know you know similar kind of you know application in the marketing area typically media selection, how to allocate an advertising expenditure among different media you know; for you know advertising and determination of the optimal assignment of say you know sales people that work for the company among the sales regions and marketing research which the objective is to determine the best number of you know interviews, mailings, phone calls like that you know in order to you know the you know cost considerations. So, likewise you know several kind of you know situation.

(Refer Slide Time: 30:55)



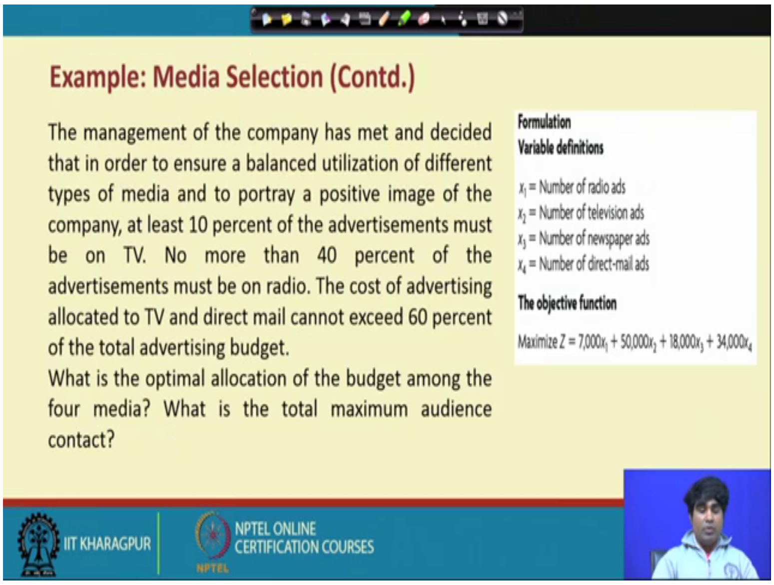
This is a kind of you know media selection problem and corresponding to this you know these are all actually business kind of you know effects and corresponding to the business effect and the kind of you know condition the kind of you know obstacles the kind of you know constraints.

(Refer Slide Time: 31:16)



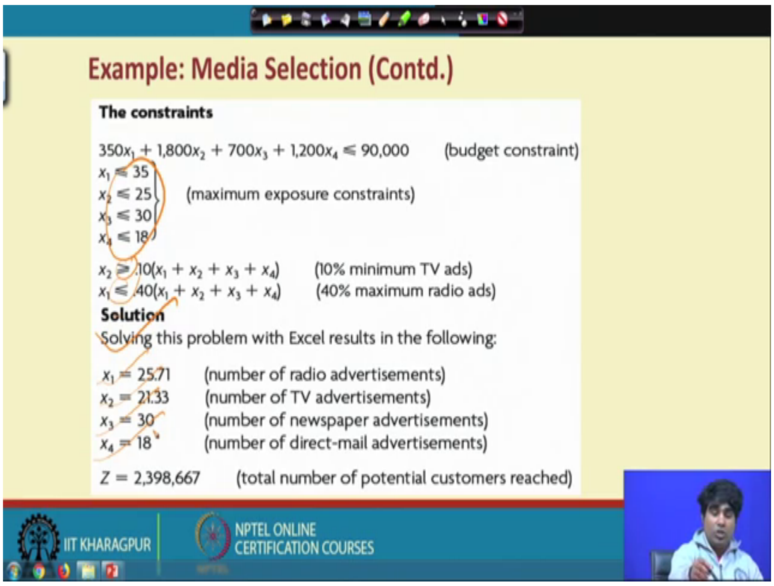
So, we have to transport the kind of you know structures to the kind of you know model and this is how the basic inputs to this you know particular problem.

(Refer Slide Time: 31:23)



And, finally, a again more such you know inputs and then finally, collect all such inputs and transferring into a kind of you know model. And, this is how the a for variable case that is the a x 1, x 2, x 3, x 4 and depending upon you know four different I mean say you know four different ways to put the advertising that is with respect to radio and televisions newspaper and you know emails and accordingly the objective function is to maximize a Z equal to 7000 x 1, 50000 x 2, 18000 x 3 and 34000 x 4 that is how the a problem structure is that you know basic requirement and then with respect to constraint we look for the kind of you know solution.

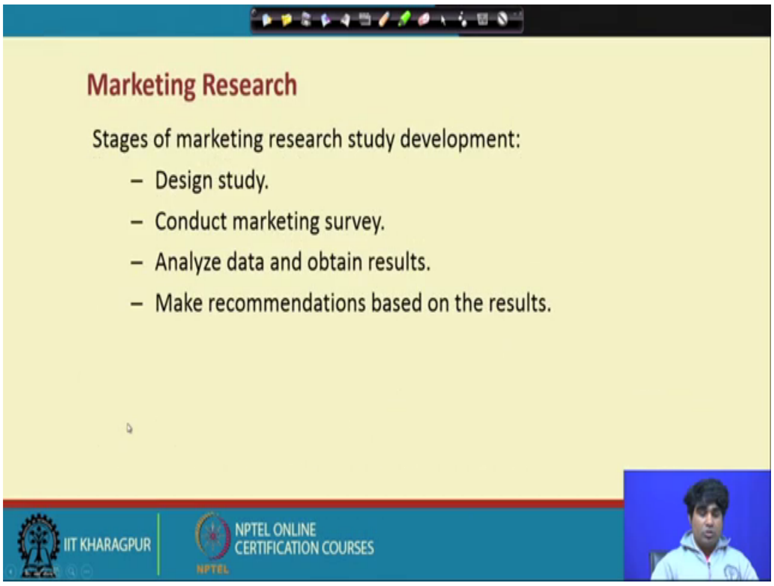
(Refer Slide Time: 32:09)



And, against this is a kind of you know problems where we have a less than type of a constraint greater than type of you know constraint and then still we are looking for the solution which can give you the kind of you know you know optimality. So, this is the less than type structure, this is the greater than type structure and this is again less than type of structure still we are getting the optimum solution and interestingly, in this particular you know structure here all the values of the decision variables are at the you know final you know kind of you know structure and then in the a then the objective function is also satisfactory.

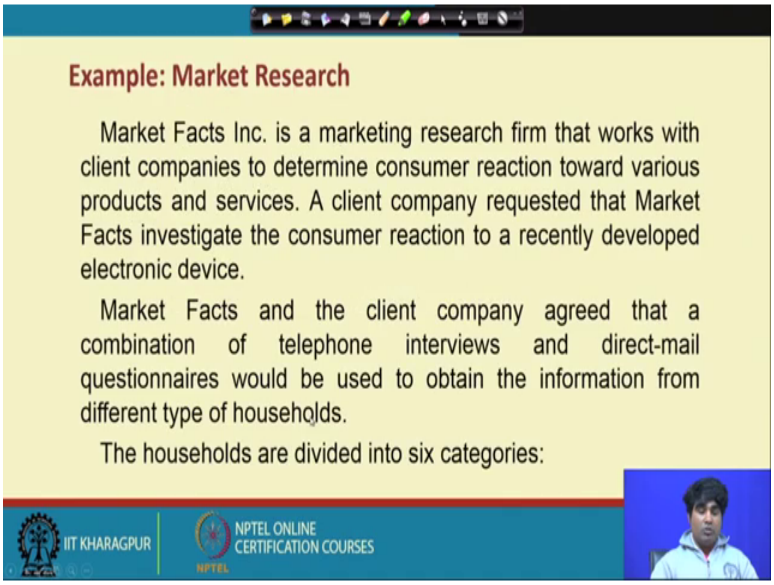
So, this is again you know the kind of you know structure through which actually we are looking for the solutions and then you are looking for the kind of you know management decisions.

(Refer Slide Time: 33:02)



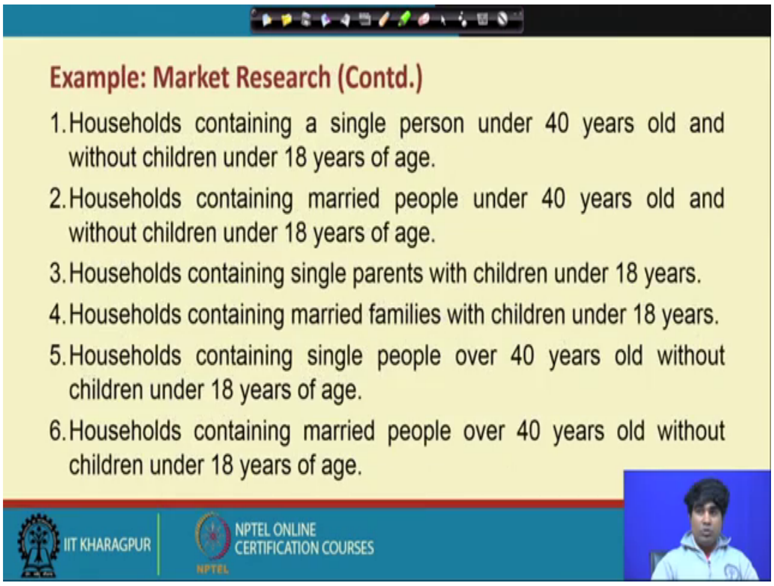
And, this is again similar kind of you know problems and some marketing research you know kind of you know design study, conduct marketing survey, analyze data.

(Refer Slide Time: 33:10)



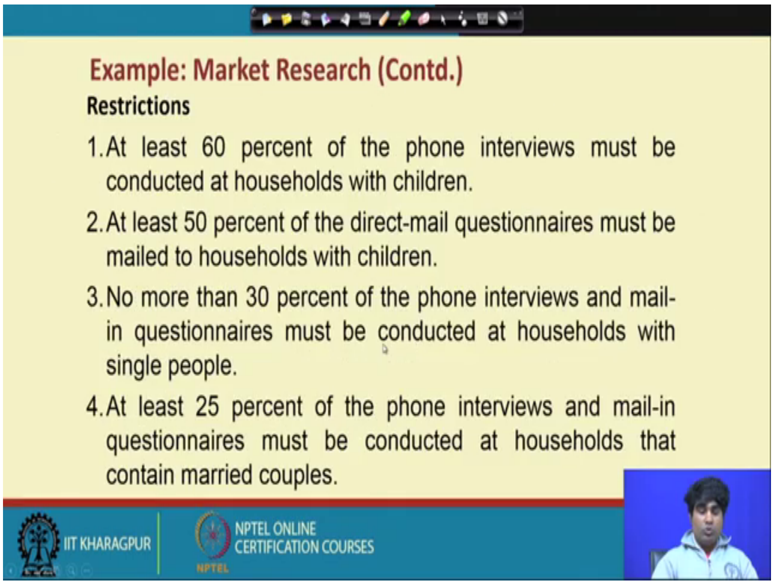
Like that you know we have another you know kind of interesting problem here again this is what the you know information's.

(Refer Slide Time: 33:19)



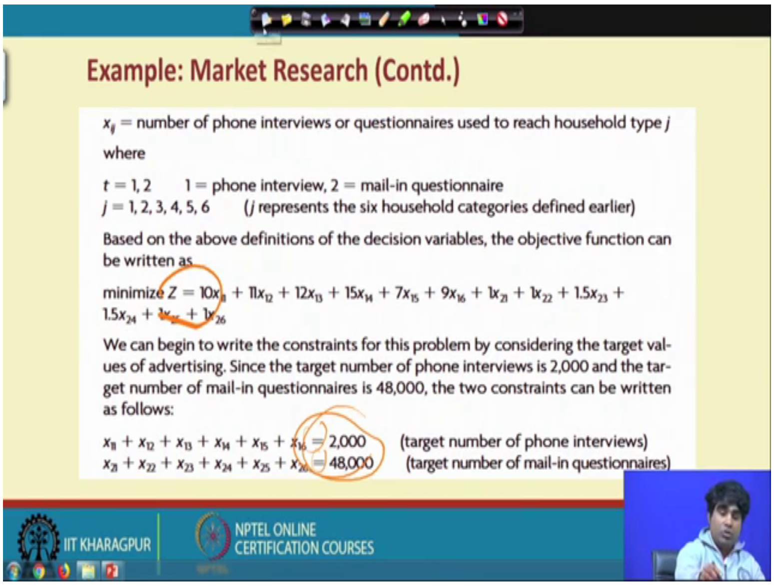
And, then the particular structure will be divided into different kind of you know inputs.

(Refer Slide Time: 33:24)



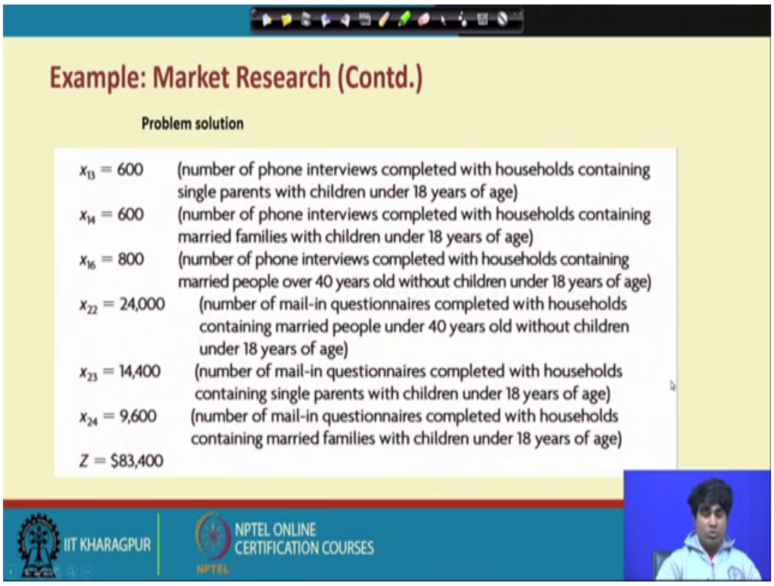
And, corresponding to these inputs we can have a you know some kind of you know restrictions.

(Refer Slide Time: 33:29)



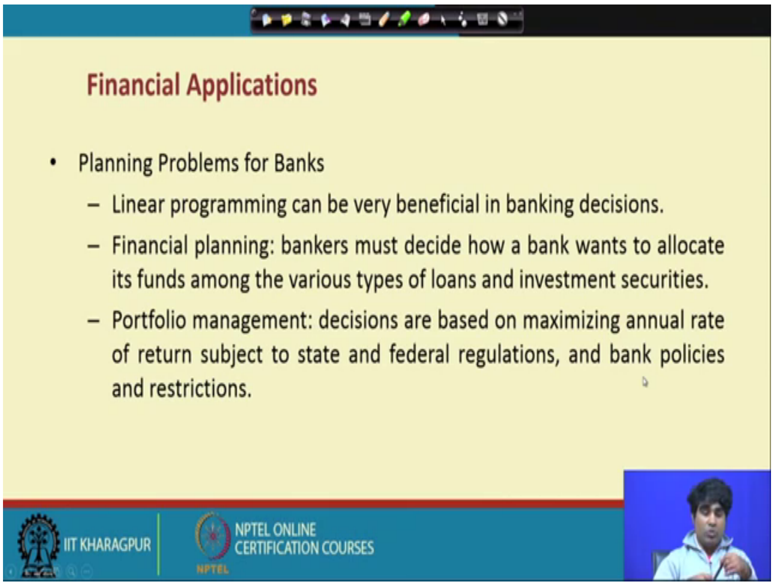
And, finally we have a the kind of you know LP structures where you know we have the objective functions and the constraint and here typically the constraints are you know all are you know equality type still we are you know looking for the solutions and then we are you know actually you know looking for the kind of you know management decision. If the constraints are you know equality type by default then you may not have a kind of you know big problem to get the solutions, but still you know we like to you know see what is the kind of you know reality and then we are looking for the kind of you know solution.

(Refer Slide Time: 34:06)



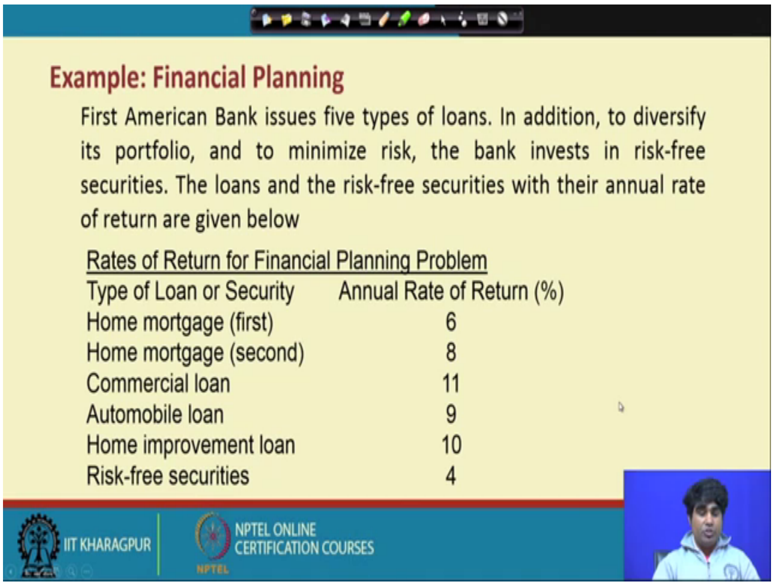
So, in this problem so, we have still you know solutions and the values of the decision variable and the kind of you know optimality of you know, objective function.

(Refer Slide Time: 34:13)



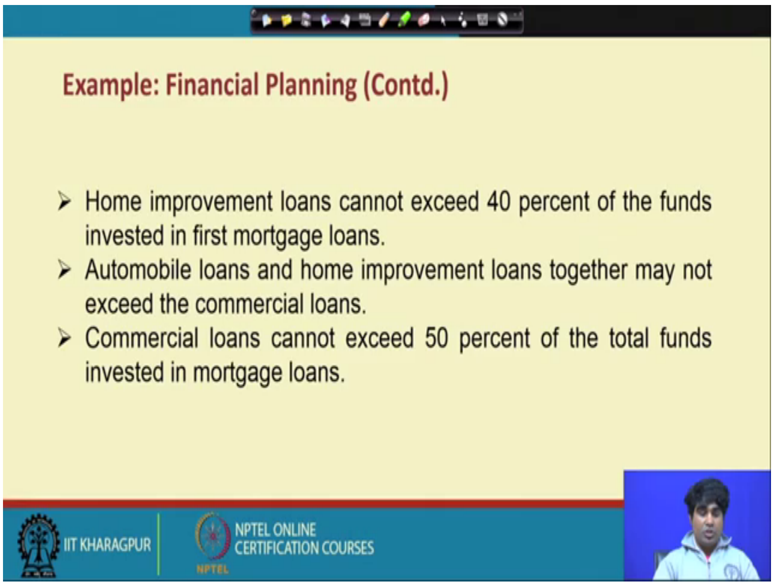
And, this particular problem again it can be applied to you know different financial you know problems and this is one typically know areas where a we can actually apply like you know banking decisions then the kind of you know portfolio management decision, financial planning. So, so many ways you can actually apply.

(Refer Slide Time: 34:38)

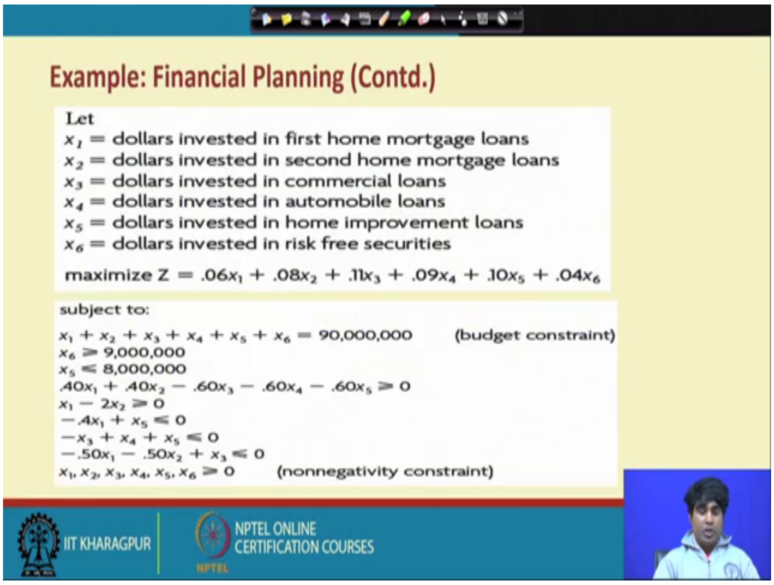


And, one such example is here with respect to financial planning and issues about you know five different types of you know loans and then we are looking for the kind of you know optimum solution corresponding to these you know information's.

(Refer Slide Time: 34:54)



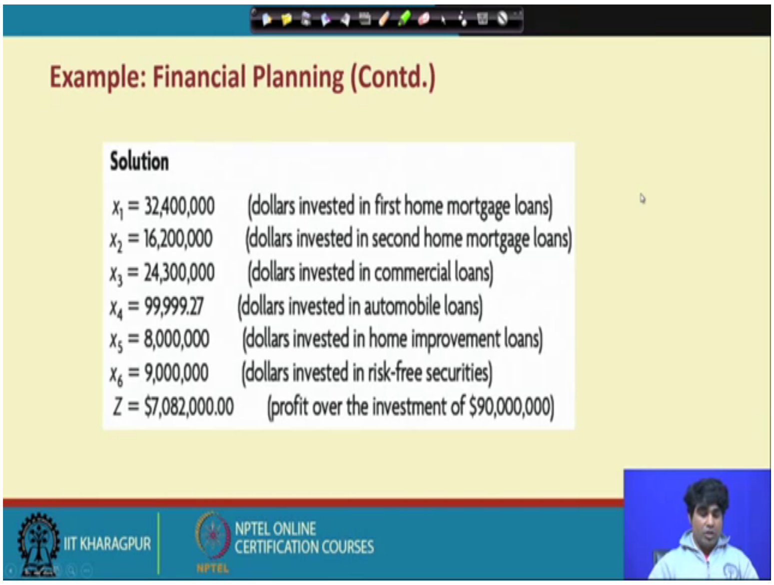
(Refer Slide Time: 03:55)



And, we like to formulate a problem like heres and here the problem is with respect to six variables and by the way a by the way the objective function is the maximize maximization type and then we have been a couple of constraints and some are you know equality type some are greater than type some are in less than type and again we have a multiple kind of you know scenario and that to with again non negativity restrictions and still we are you know you know looking for the solutions and you know having the kind of you know best solution as per the particular you know requirement.

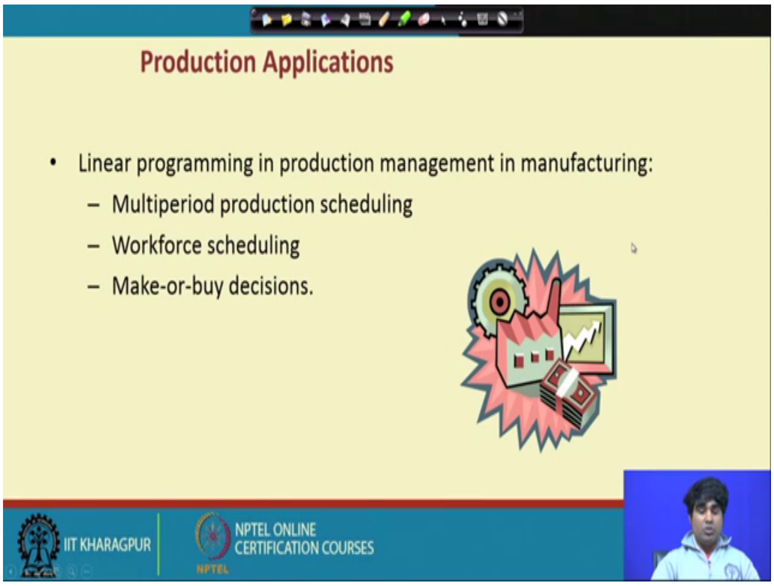
Now, corresponding to this a this particular you know situations so, the solution will be like this.

(Refer Slide Time: 35:42)



And, so the Solution is a against unique kind of you know situation where all the values of the decision variable are you know effective and the opti[mum] you know the values of the optimum function is also reached.

(Refer Slide Time: 35:55)

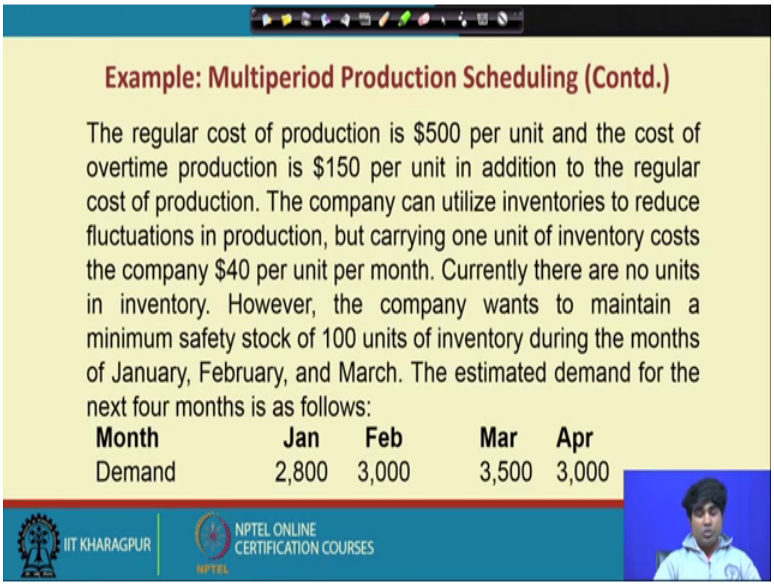


So, that means, technically we have actually kind of you know different structure and complexity still we have the optimality results and the kind of you know kind of you know values of the decision variable through which you can actually predict the business environment and then come for the kind of you know management decisions. And, it can be also in the kind of you know production area and like you know multi-period production scheduling, workforce scheduling and buying decisions all these things will be there.

(Refer Slide Time: 36:25)

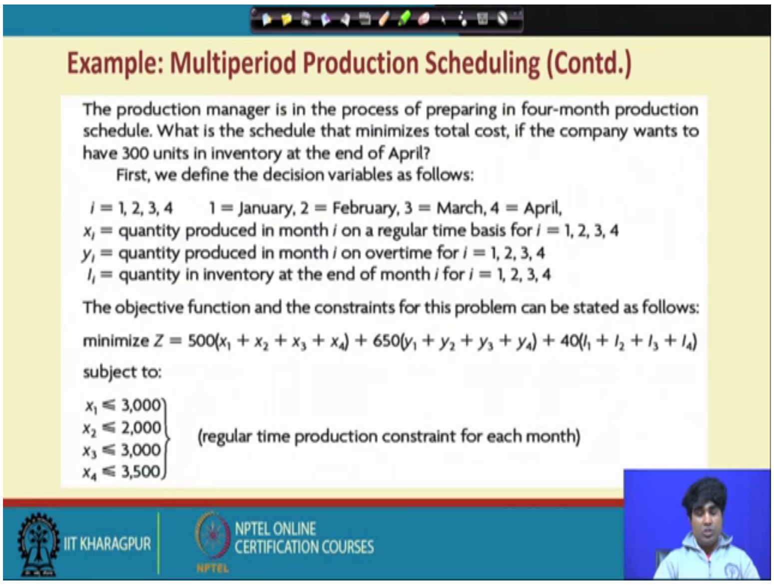
So, this is another kind of you know structure; monthly requirement, regular production, overtime production.

(Refer Slide Time: 36:32)



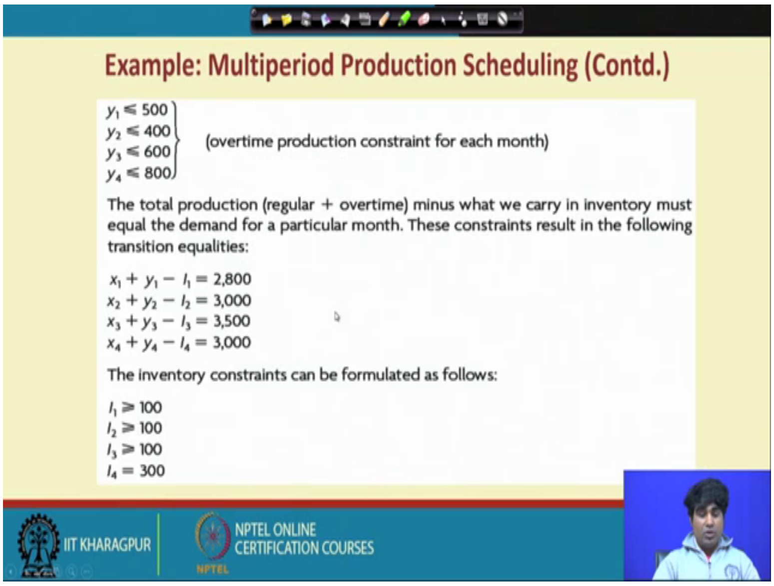
And, subject to typical you know constraints.

(Refer Slide Time: 36:35)



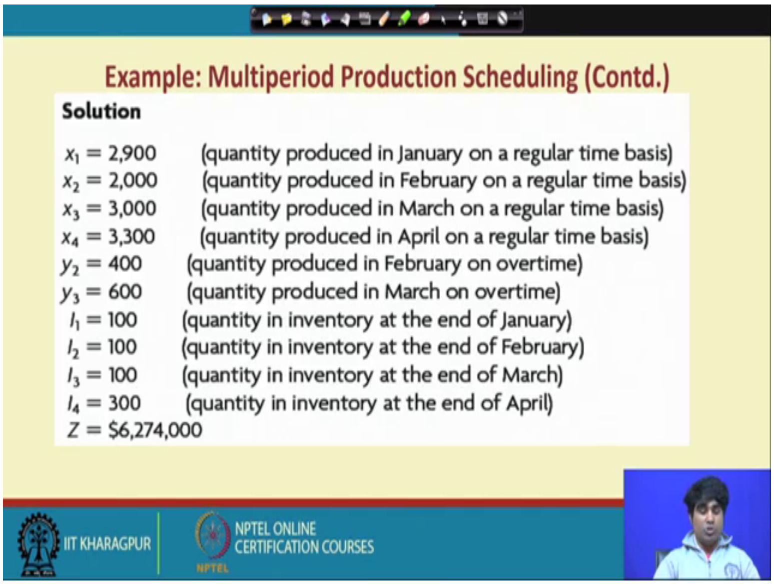
And, then finally, we have the objective function to minimize and that to with respect to different combination of you know inputs and against there are constraints which are less than type.

(Refer Slide Time: 36:47)



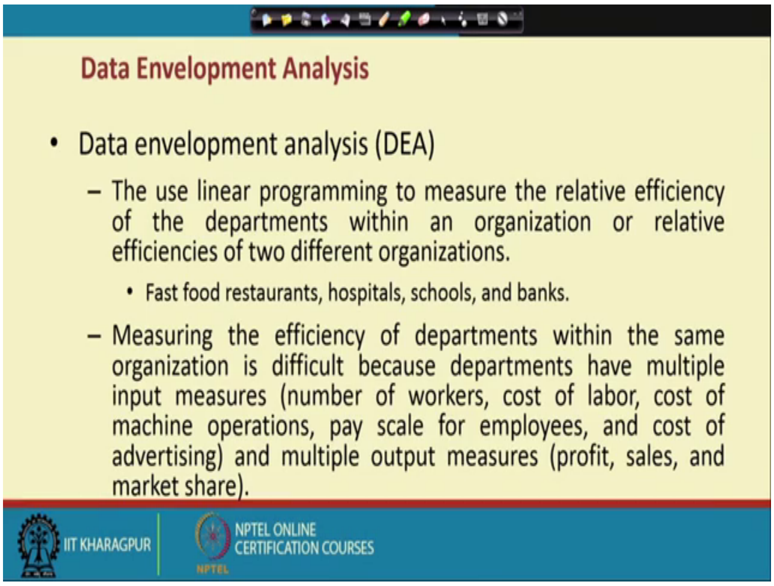
And, the kind of you know greater than type and the equality type still we are you know this is a very complex problem.

(Refer Slide Time: 36:56)



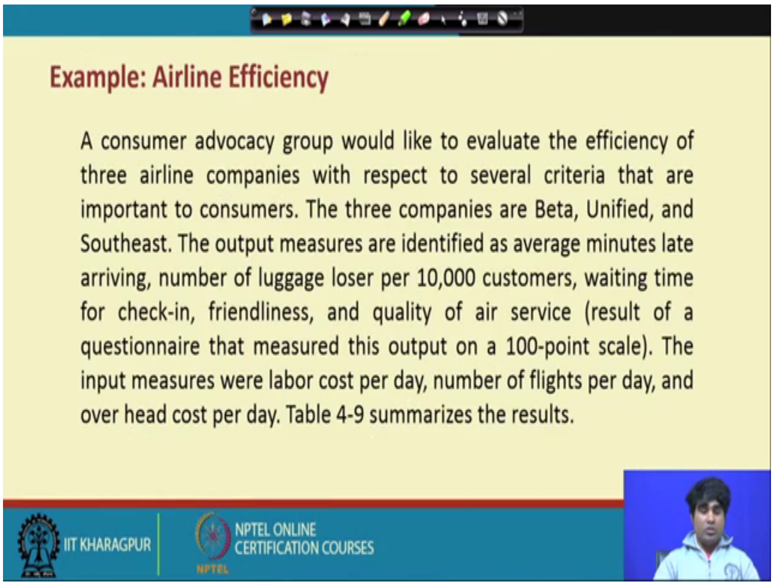
Still we are you know getting the optimum solution and the values of the objective functions.

(Refer Slide Time: 36:59)



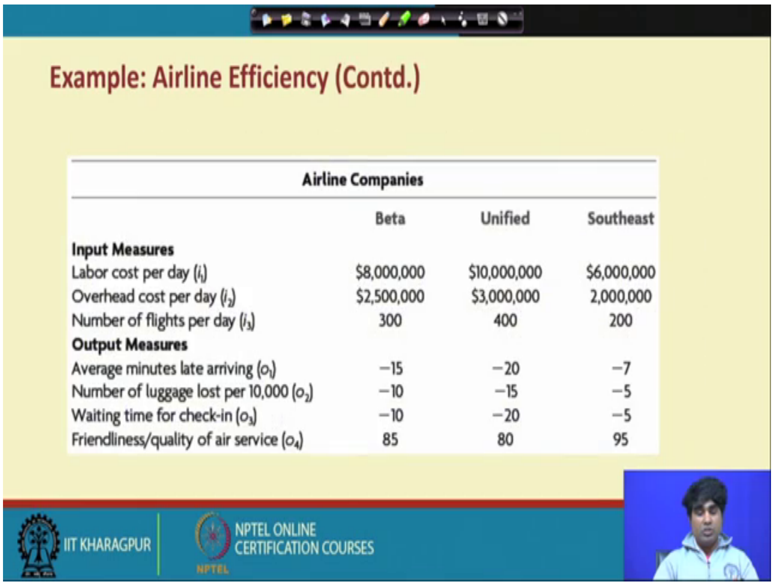
Likewise you know we can have also you know this particular you know predictive analytics that too linear programming in different a you know areas, that means, the application again with respect to data envelopment analysis where the linear programming is to measure the relative efficiency of the various departments within an organization or relative efficiency of two different organization. So, so, means this is a kind of you know efficiency measurement technique, but typically again a linear programming and the predictive analytics can be used or to get the a efficient you know you know kind of you know results or the kind of you know environment which you can actually solve the business problem and come with a kind of you know effective management decision.

(Refer Slide Time: 37:46)



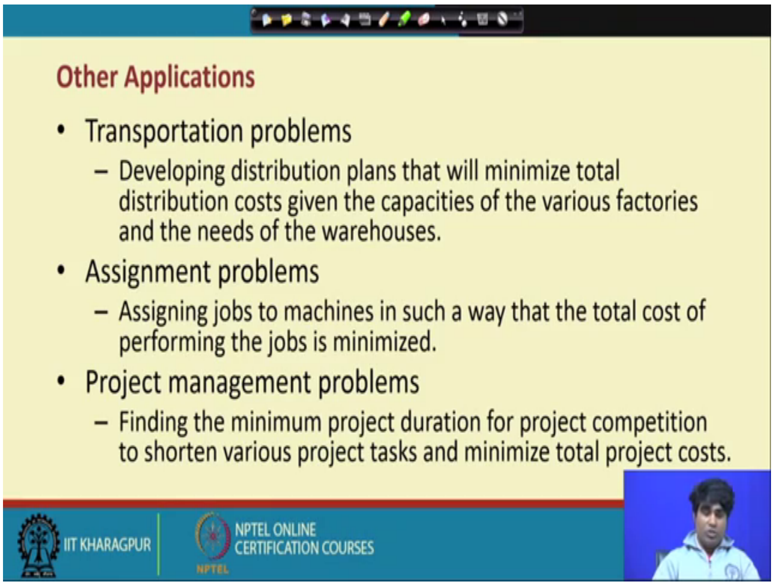
So, again so for as you know you know the application is concerned the we can actually look for the airline efficiency.

(Refer Slide Time: 37:54)



So, the typical structure of the DIG you may have actually input cluster more number of inputs and more number of outputs and again linear programming problem can be fitted and then we can have the kind of you know efficient solutions.

(Refer Slide Time: 38:07)



And, likewise we have also other application like you know we can apply the particular structure in transportation problem, we can apply in the assignment problems and the kind of you know project management problems. So, that means, you know whatever may be the kind of you know application area and if the particular problem is having you know typical you know objective means specify objective and the kind of you know constraints the kind of you know requirements.

Then the predictive analytics typically the kind of you know structure what we called as, you know the kind of you know linear programming structure through which you can look for the solution and that to optimum solutions and as a result we can address the problem, business problem more effectively and then we can you know come with you know kind of you know management decision as per the particularly you know business requirement.

So, with this we will stop here and thank you very much, have a nice day.