Product Design and Development
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Lecture - 10
Case Study on Value Engineering

[FL] friends, today we are going to have our last discussion on Value Engineering as we are aware we are in the process of discussion on week 2 in which we are discussing the various aspects of value engineering. Just to have a brief glimpse of what we have already discussed in the last one week that is related to value engineering. We have discussed what is value engineering definitions of value engineering and we have also covered the different aspects related to functional analysis and how we can analyze the functions with the help of examples we have try to see for a mobile phone that what are the basic functions and what are the secondary functions.

Similarly, we have also seen for a electric cattle that what are the basic functions and what are the secondary functions and we have also seen that how functional cost evaluation can help us to decide that what are the functions which are immaterial or are not relevant to the success of the product and those functions can thereby we eliminate it.

In the last lecture if you remember we have learnt a very important technique that is called the fast diagramming approach in which we have seen that using the fast diagram we can identify some of the functions which are not relevant. If you remember or you can again see we have seen the functional cost evaluation of a pencil using in that the cost was not considered in diagramming approach. But the cost was considered in a previous lecture and in fast diagramming approach we have seen the functional analysis of a pencil as well as the functional analysis of a overhead projector.

So, we have taken certain application points of view of value engineering also and today we are going to close our discussion on value engineering with the complete application of the techniques in a specific case study and the case study. As been selected based on your personal usage we are not taking a case study in which we are using a specific mechanical engineering compound and which may be difficult to understand for all the diverse group of students were attending this course. We have taken a general type of

case study in order to explain that how value engineering can be applied to solve the basic problems or basic day to day problems, So, let us start the discussion for today.

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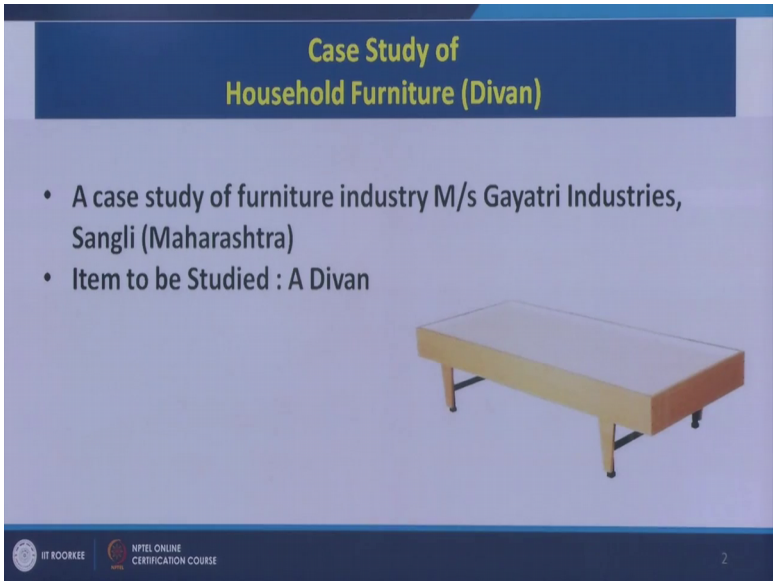

The case study is for a divan everybody uses a divan at his or her house. So, the case study is related to divan and this case study is a furniture industry that is a Gayatri Industries is Sangli Maharashtra and the item to be studied is divan. So, it is not a very technical component although it require certain degree of engineering also, but it is a general component a general furniture item which is used by each one of us and it is easy to relate to this item therefore, we have selected this particular case study which is you can say functional analysis of a divan. So, we will see if you remember we have seen in functional analysis that we break down the complete product into its individual components and then try to analyze those components in context of the cost.

So, if you see a divan just have a look at the structure of the divan there is a top then there is a side flanges there are legs, there will be a frame on which all these other parts are mounted. So, let us first try to understand the functional analysis of the divan.

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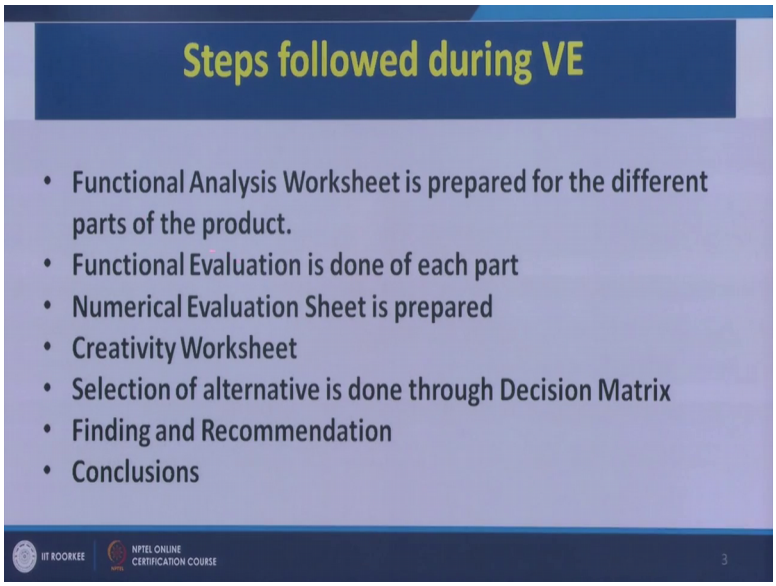

Now, what are the steps that we are going to follow I have already told functional evaluation we will do that is the second stage. So, functional analysis worksheet is prepared for the different parts of the product. So, I have highlighted different parts of the product and for each product or each component we will try to give a functional definition. Must I ask you that what is the functional definition or the method of giving the functional definition which we have already covered in the last four sessions.

I think all of you everyone of you should be able to answer that it is a verb and a noun type of definition which we use to define any product. So, define any component of a product or a product as well on the whole also. So, if I ask you what is a functional definition of a divan, so you can see provide seat maybe that seat maybe for sitting or for sleeping. So, for divan the functional definition is verb and a noun, but now we want to analyze it and to improve the divan therefore, we will go into the individual components of the divan and try to establish the functional definition of each and every part of the divan.

So, for first we will generate or maybe complete this functional analysis worksheet which will be prepared for different parts of the product which we have already done for pencil and for many other components. Functional evaluation is done on each part numerical evaluation sheet is prepared creativity worksheet in which we will try to develop different types of alternatives for improving the value of a product which in our

case today is divan. So, creativity worksheet will be prepared now selection of alternative is done through the decision matrix which is a common decision making technique.

Then we will what are the findings and what are the recommendations and finally, the conclusion. So, we have to complete this case study in today's session therefore, I will be slightly fast for today's lecture. So, here you can see this is a functional analysis of parts of a divan.

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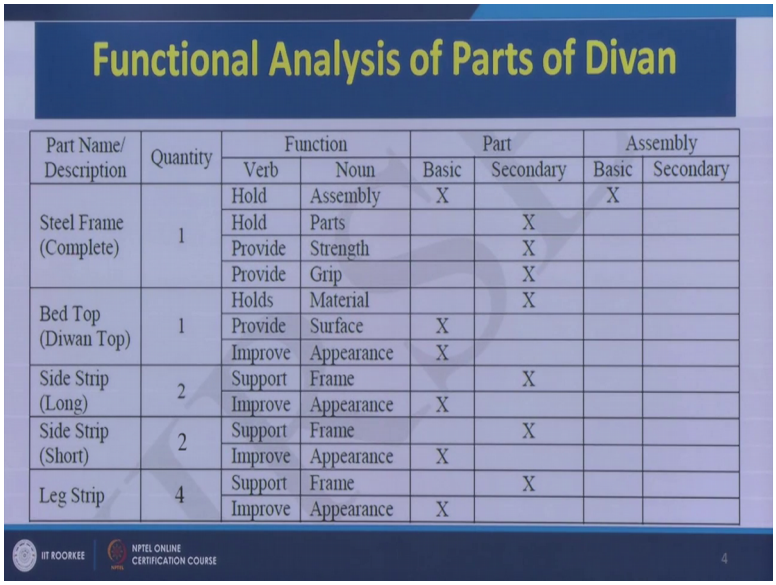

Part Name/ Description	Quantity	Function		Part		Assembly	
		Verb	Noun	Basic	Secondary	Basic	Secondary
Steel Frame (Complete)	1	Hold	Assembly	X		X	
		Hold	Parts		X		
		Provide	Strength		X		
		Provide	Grip		X		
Bed Top (Diwan Top)	1	Holds	Material		X		
		Provide	Surface	X			
		Improve	Appearance	X			
Side Strip (Long)	2	Support	Frame		X		
		Improve	Appearance	X			
Side Strip (Short)	2	Support	Frame		X		
		Improve	Appearance	X			
Leg Strip	4	Support	Frame		X		
		Improve	Appearance	X			

So, you can see broadly there are five parts first is the steel frame the top part, steel frame that is complete then the bed top divan tops also we can call it divan top side strip side strip short and leg strip. So, there are 5 components that makeup the complete divan. So, again I am calling the names steel frame, bed top, side strip which is long, side strip which is short, maybe on the shorter side and then the leg strip.

Now, let us see the quantity side strips are 2 functions if we see side strips long are 2 and side strip short is 2. So, maybe we can see the functional definition as I have already told we will have a verb and a noun type definition. So, we will say steel frame has got functions it will hold the assembly together, it will hold the various parts together provide strength to the structure and provide grip. So, steel frame of the divan has to satisfy all these function. Similarly the side strip has to support the frame and improve the appearance. So, similarly for each and every component or the part of the divan has

got certain functions this is the first stage of evaluation. Then we have to see which of these are basic functions and which of these are the secondary functions.

Now, let us try to understand that now basic functions are hold assembly is the basic function of the steel frame, but hold the parts together provide strength and provide grip are the secondary functions. So, this is for the part and for the assembly also because we are doing a functional analysis of the assembly as well. So, the basic function is of the steel frame is to hold the assembly together. So, we can see steel frame bed top side strip leg strip all these has got functional definition and we have further subdivided them into the basic and the secondary functions.

If you remember our main focus is on satisfying the basic function of the product and we are not least bothered, but we are less bothered about the secondary functions and we always look to redesign the product in such a way so that the secondary functions are either combined or they are eliminated or maybe sometimes they may be added on to a basic function in order to improve the overall value of the product for the customer. So, here you can see there are so many secondary functions being achieved by different components or parts of the divan.

Now, our job is to see or redesign the part in such a way that the overall cost of divan gets minimized, but without compromising the quality performance reliability durability of the product. So, without compromising all these quality characteristics we have to establish that how the cost can be reduced for the divan in our question and for the product in general. So, let us see now this is a first part that is a functional analysis worksheet dividing that product into its individual components and identifying the functional definition and then establishing the basic and the secondary functions of the various parts of the product.

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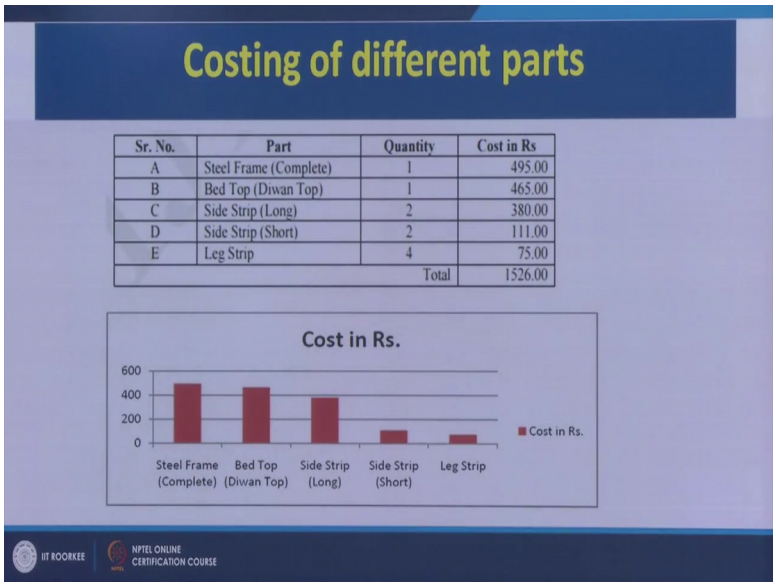

Now, let us see now here we see the cost because always in value engineering there are two important things one is the function second thing is a cost and then we have to map the two things together. Now let us see there are 5 components as we have shown in the previous slide there is a steel frame, bed top, side strip, side strip short long both and leg strip and the quantities are also given. And cost in rupees you can see 495 rupees for steel frame, 465 rupees for bed top.

So, similarly the cost for individual components are given and the overall cost of the present design is rupees 1526. Now this is the basic information we have seen that how to solve a value engineering study first part is the orientation. So, this is the orientation of the problem in which we have highlighted all the basic information which is related to the functions and the cost of the divan.

So, this particular design of divan is costing us 1526 rupees and this is just the representation of the same data on a scale in which steel frame maximum cost bed top slightly less and the leg strip are the least costly parts that go into the manufacturing of the divan. Now we have to see that how we can use the concepts of value engineering to save cost for the company or for the organization which is making the divans. So, this is the basic information we have not done any creative analysis, we have not done any redesigning, we have just systematically put the information which is already existing on our paper and we know now that what is the contribution of individual parts and what are

the functions to be achieved by the individual parts. So, with this information we will go to the next stage.

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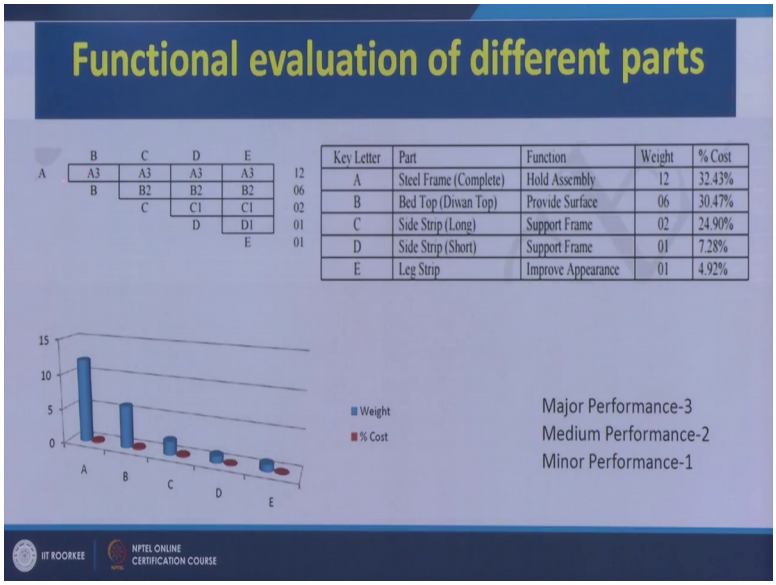

The next stage is the functional evaluation of different parts, now in case of a divan we have because of the paucity of time we were not able to discuss value engineering in totality. So, there is a term called interacting functions. So, one particular product is not only performing its own function, but it is also helping the other parts or products to perform their function. So, there were always be interaction between the various parts and that has been studied here we have tried to see this AB, how A and B are interacting, how A and C are interacting and how A or D are interacting.

So, here we can see the grading is given 3 2 and 1. So, what is the meaning of 3? 3 is major performance, two is medium performance and one is minor performance. Now suppose A and B, if we see A is steel frame and B is bed top now the bed top is fixed on the steel frame. So, they have a very good interaction. So, one is supporting the other therefore, we have given their grading 3. And if we see 1 D and E has 1. So, D is side strip and E is leg strip. So, not much conflicting or not much supporting. So, we will say that we are given the grading minor performance. So, in this way tabular form or matrix form we can give relative weightage to the interactive functions or the interactive parts and you can see we can calculate sum up all these gradings we have given three two and one relative grading of the interacting products. If you add up three plus 3 plus 3 plus 3

we get 12, 2 plus 2 plus 2 we get 6, similarly 1 plus 1 2 and 1. So, relative grading has been given a has got the maximum weight. So, weight is assigned to a that is steel frame 12 weight and overall weight percentage cost we can calculate based on the previous slide if you see. Steel frame what is the contribution of this cost in the overall cost of the product.

So, the overall cost of the product is 1526 and we can see 495rupees are being contributed by steel frame only and we can very easily calculate the percentage contribution of steel frame. So, here we can see percentage contribution is calculated percentage of cost and the relative weight is also calculated using this matrix approach and these criteria of giving major performance medium performance and minor performance. So, here you can see the weight is given by blue and this is a percentage cost I think yes maybe this is correct.

So, in this way we can plot this data.

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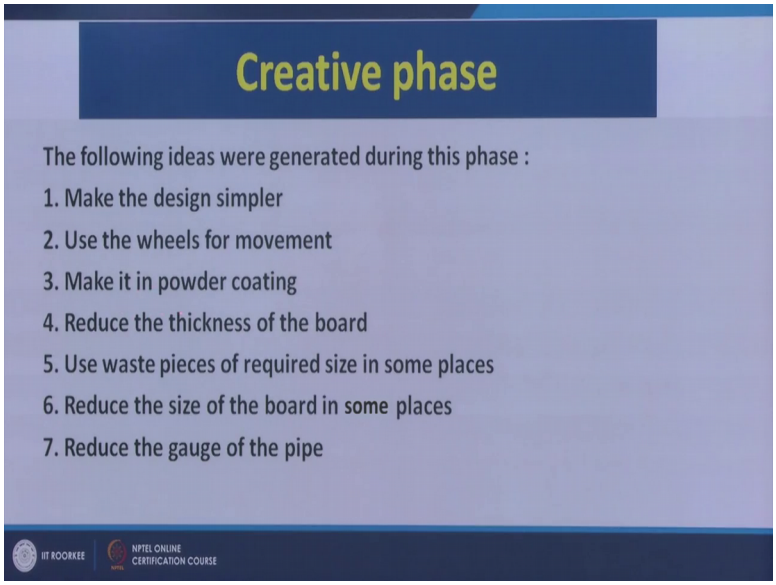

Now, creative phase, now this is the just the information that steel frame is contributing this much and the legs are called leg frames are contributing this much and then we have given the weights to the individual components and we can also calculate the percentage contribution. If we do not want to go into the weights phenomenon or weights technique we can directly see the percentage contribution of individual part in the overall cost of the product.

Now, we have to see that how we can make this divan in a cheaper manor or what can be the techniques or what can be the options available with us to reduce the cost of the divan without compromising the cost and quality and performance, without compromising the cost means that we are not going to compromise on the performance. Sometimes we may reduce the cost of the product by compromising the performance, but that is not the case in value engineering.

So, our focus would always be to map or to match the performance with the cost so that the cost is not reduced, but performance improves further. So, what are the creative phase, what are the options available we can see. The following ideas were generative during the creative phase maybe you have to look for alternative first is make the design simpler, use the wheels for movement, make it in powder coating, reduce the thickness of the board, use waste pieces of required size in some places, reduce the size of the board in some places reduce the gauge of the pipe. So, these are some of the options available, but we have to select only those options in which the performance is not getting compromised.

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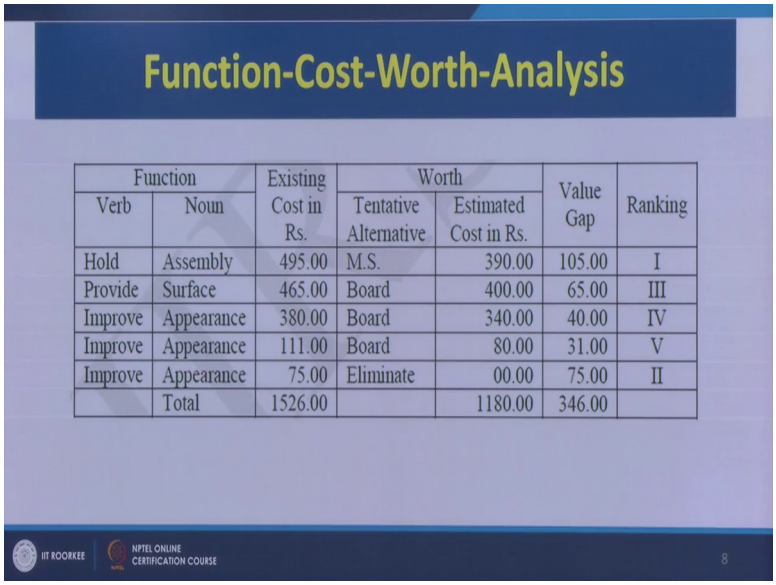

Function		Existing Cost in Rs.	Worth		Value Gap	Ranking
Verb	Noun		Tentative Alternative	Estimated Cost in Rs.		
Hold	Assembly	495.00	M.S.	390.00	105.00	I
Provide	Surface	465.00	Board	400.00	65.00	III
Improve	Appearance	380.00	Board	340.00	40.00	IV
Improve	Appearance	111.00	Board	80.00	31.00	V
Improve	Appearance	75.00	Eliminate	00.00	75.00	II
	Total	1526.00		1180.00	346.00	

Now, here we can see this is a gain the value gap that can be calculated. We have functions again hold assembly steel frame. So, this is A B C D E 5 parts are there. So, existing cost is also given up to this information already has been projected the overall cost is 1526. Now the worth is also calculated tentative alternative can be four this side

boards and legs and all these they can be the board and one part fifth part that is we can see that is part number 5 if you see to the leg strip. So, it is a being suggested the leg strip can be avoided. So, this particular component can be eliminated. So, this is being suggested that it has got no worth. So, it can be eliminated.

So, cost of leg last part e part leg strip or leg support can be eliminated and the estimated cost we can say 1180. So, it is getting eliminated, but it is not affecting the overall performance of the product. So, that is one thing that we eliminate a one particular part and thus you save some money for the product, so 75 rupees getting reduced from this. And the value gap has also been calculated that 495 the worth of the product is 390 and the value gap is 105 the board 65 rupees the estimated cost is 400 by this data is generated through the creative phase where it is suggested that you can reduce the thickness of the board slightly. So, their cost has been calculated for the reduced thickness. We are not going to going to the values that how much thickness has to be reduced, our purpose is to do the cost analysis therefore, we had directly going for the cost.

So, similarly for steel frame also there is a change and the cost has been reduced, similarly for the board also cost is reduced say and for side strip and leg strip for all that there is you can say substantial reduction in the cost and this is the value gap that we have achieved. In steel frame we have been able to say 105 rupees and for the board we have been for the you can say the second part again we can see the bed top which is made up of board we are also going to save and then the side strip and long strip also we have been able to save some money using this creative phase in which you can see four number reduce the thickness of the board, use the waste pieces of required size in some places.

So, if you redesign the part you can have a value gap of 346 rupees that exist and this is the worth that has been calculated. So, we can target 1180 by modifications in the design of the product.

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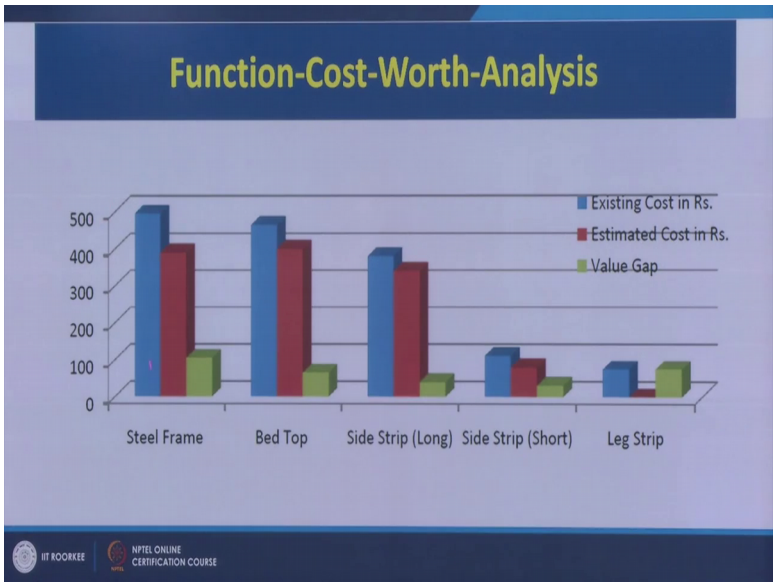

Now, here you can see function cost worth analysis existing cost is given in blue color, steel frame that 495, you can see it is touching 500 there and then the red color is the estimated cost in rupees estimated means this one that we have seen that what is the actual worth of that part that goes into the manufacturing of divan. And finally, is the value gap, so value gap exists for each and every part in many cases you will see then you will do the value engineering analysis you may not find any value gap which means there is no point in putting your efforts in that particular component because it has already been optimized and there is no better component available to replace that particular component. So, value gap become zero no opportunity to do any analysis on that.

But here you can see green color for each and every 5 parts that are used for manufacturing a divan green color is evident everywhere which means there is a scope of putting efforts to reduce the cost of the product without compromising the performance.

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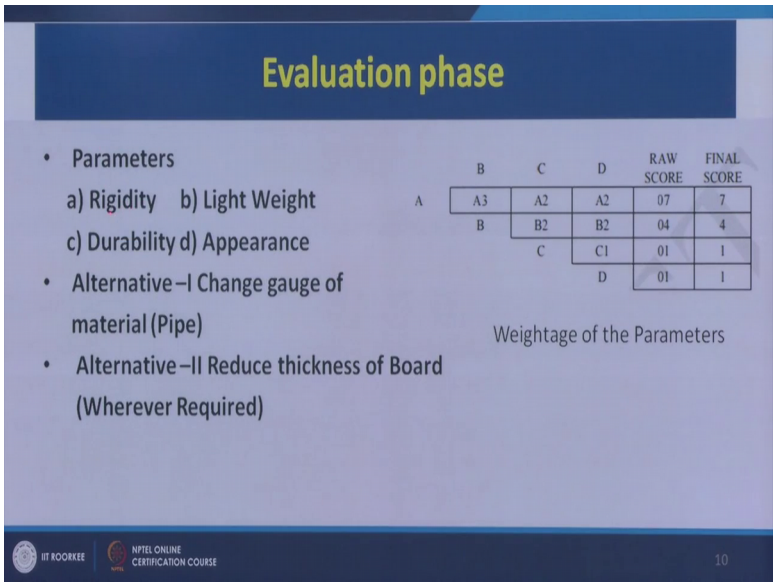

So, this is a gain evaluation phase now again we have existing design of the product, we have modified that design now we have to compare the two designs together. And as I have told you if we are saving money we are saving around 380 rupees you can sorry 346 rupees being saved by the change in that design. So, you have design one which is existing you have design 2 which is redesigned part using that creative phase. So, we have a redesigned part then there is a value gap that is existing. So, we are saving 346 rupees. These 346 rupees should not be at the cost of any reduction in the performance.

So, therefore, we can see we will evaluate the designs based on the rigidity lightweight durability and appearance. So, alternative I change gauge of the material pipe that is this is one alternative as compared to the existing design and alternative to is reduce the thickness of the board wherever required. So, in the creative phase we have seen that there is a scope to redesign the product in such a way that we are able to save some money.

We have then the worth cost worth function cost worth analysis in worth we have seen that yes there is a chance or there is an opportunity to save 346 rupees because of the design changes. Now we have trying to have two design changes here one is change in the gauge of the pipe maybe you can use a different gauge for the pipe and the reducer thickness of the board wherever required. So, now, we have three designs which we can compare one is the existing design, second one is the design with the reduced gauge of

the material that is pipe and third is a reduced thickness of the board. So, now we have to compare these three designs.

Now again using a same technique of matrix we can calculate the weightage of the parameters. Now what are the parameters that we have to compare? There are four parameters A B C and D we will see A and B; A 3. So, it means rigidity and light weight are having major interaction A and rigidity and lightweight, but somewhere there is one only that the this C and D it is C 1. So, you can see C and D durability and appearance does not make much of A interaction. So, the score given is 1. So, we can calculate the score A and B as I have again explained very good interaction rigidity and lightweight. So, that is good interaction than maybe it has to be considered. Then A and C, A rigidity and C durability. So, that also has medium interaction two.

Similarly, we can do 3 plus 2 plus 2 – 7, 2 plus 2 - 4 and 1 is 1. So, total this is a weightage given to the various factors that has been given 7. So, it means rigidity is that in the final score of seven that is the highest rating factor or highest weightage factor than A minimum weightage factor D is the appearance. So, in case of a divan if you see as a product always the divan will be covered by the bed sheet or the mattress. So, the appearance is not very prime important criteria or a prime criteria for you can say analysis, but rigidity is very important, weight is also important and durability is important. So, the first highest score goes to rigidity, second score goes to lightweight, third is durability and fourth is your aesthetics or the appearance. So, this way we can calculate the final score or the weightage of the various parameters.

Then we will compare these parameters now we have four parameters and what we have to compare. We have to compare three designs one is the existing design, second one is the design with the gauge length or different gauge type and third one is the design with the reduced thickness of the board, these 3 we have to compare.

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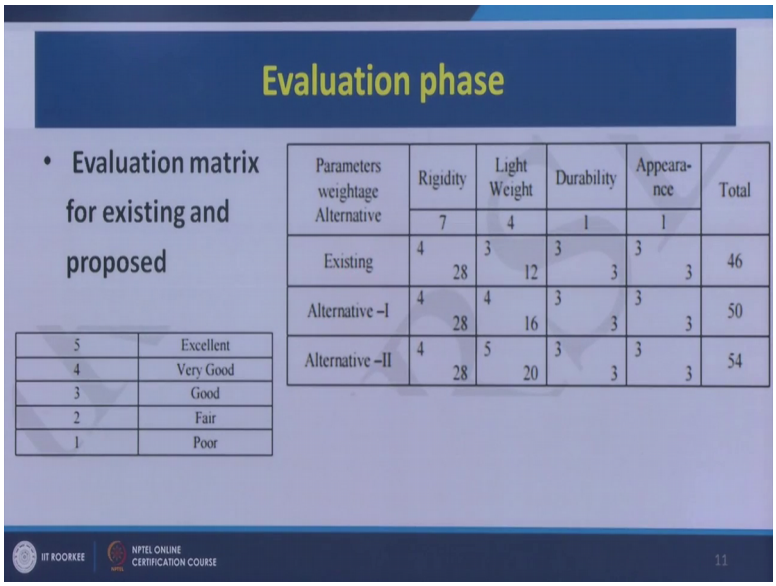

Now, let us see 3 designs here – 3 designs existing design which is the first design then reduced gauge pipe and reduced thickness of the board - rigidity lightweight durability and appearance scores 7, 4, 1 and 1. So, here we can see it is 1, yes it is 1 and 1 correct absolutely correct. So, there the scores are given 5 for excellent, 4 for very good, 3 for good, 2 for fair and 1 for poor.

Now, maybe you can collect the data from the customers or do the test marketing where people can use these products for a specified period of time and take data from them and then you can give the scores. Now for the existing design and rigidity point of view a score of 4 is given, for alternative I again score of 4 is given and alternative to again score of 4 is given. So, we multiply the weightage factor which we have already calculate the 7 by 4 and we get a score of 28 on rigidity for existing design. For modified design also change in the pipe we again get a score of 28, for reduced thickness of the board again we get 28. So, for all the 2 designs rigidity point of view there is no change in the rigidity and score is 28 only.

But from lightweight point of view if we are reducing the thickness of the board the score is 20. So, here you can see the score is 20 here, for alternative I 16 and existing 12 which means that the existing design is much heavier as compared to the proposed or the new design. So, you have a new design change in the gauge of the pipe 16 and change in the thickness of the board 20, so your lightweight maybe alternative number 2.

Similarly from durability point of view score remains same, for appearance point of view there is no change in the appearance score remains same. So, from lightweight point of view we can say that alternative II is scoring high. So, this can be the, this is some simple technique a sample data for performing the evaluation using the matrix technique. So, this we have covered because this is a important tool which can be used in other comparison issues also or other comparison problems also. So, this is a equally relevant in the value engineering problems.

So, let us see now what conclusions or what can be the final outcome of this case study. So, we have tried to redesign the divan in such a way that we have now two additional alternatives available with us without compromising the appearance and the durability and the rigidity, but the weight definitely is changing. So, what does that mean? If I get three products there is no change what. So, ever in rigidity durability and appearance, but one is lighter definitely I am going to choose the lighter product for maybe same cost or even sometimes for a higher cost also. Let us see the cost comparison also.

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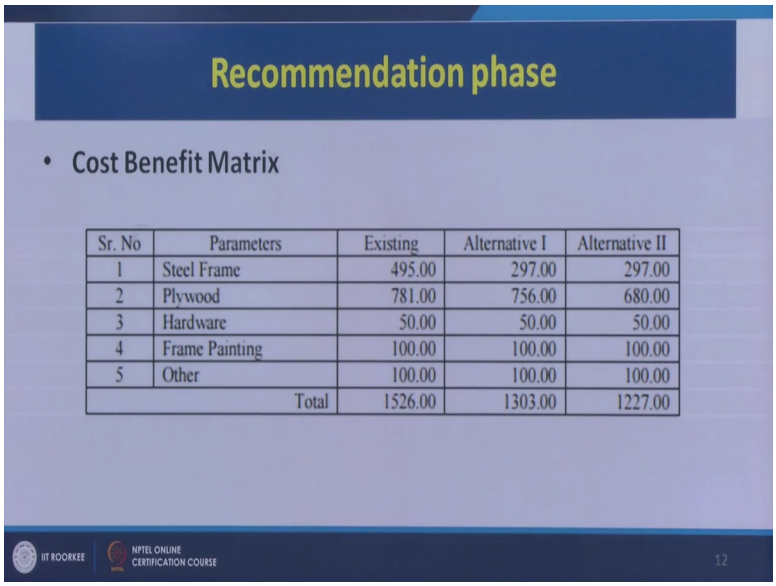

So, from cost comparison point of view if we see the 5 parts here, other costs are also included now maybe is which remaining same. So, existing design as we have already seen 1526 rupees this much data already, but was alternative I which is changing the pipe 1303 rupees and alternative to change in the thickness of the board 1227 rupees. So, we

are getting the cheaper product without compromising the rigidity durability appearance, but lightweight product.

So, always I will try to go for alternative II. I would as an engineer or as a manager I would like to redesign the product in such a way that my cost is reducing without compromising the performance of the product and that is the basic essence of value engineering that for all problems all across so, or all around the globe if we use these concepts we are able to achieve the function, but at a relatively lower cost without compromising the performance and reliability or other parameters which are the quality characteristics for that product.

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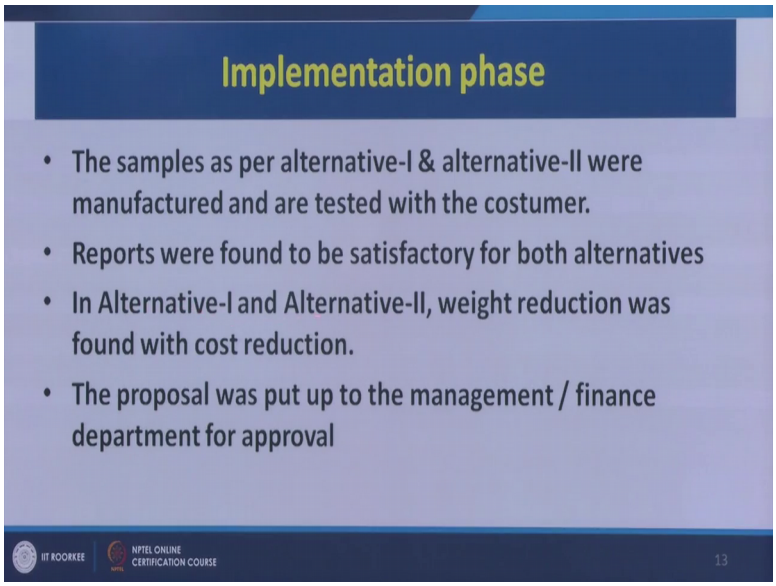

Now, we can implement this samples as per alternative I and alternative II or manufactured and tested with the customer, I think here we have a spelling mistake. Reports were found to be satisfactory for both alternatives. In alternative I and alternative II weight reduction was found with cost reduction. The proposal was put to the management finance department for approval.

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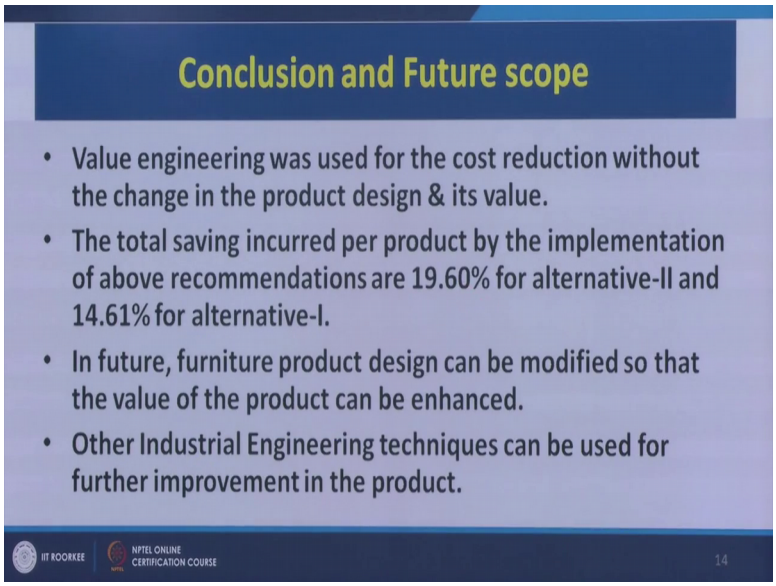

So, maybe we have seen that we can always redesign the product and we can say money for the organization that is the basic concept of value engineering.

Now, value engineering were used for cost reduction without the change in the product design and its value. The total savings incurred where we have done some change in the material, but the overall design more or less remains same. That total savings incurred per product by the implementation of the above recommendation are 19.6 percent for alternative II and 14.6 per percent for alternative I. So, more cost saving in alternative II which is lighter in weight. In future furniture product designs can be modified so that the value of the product can be enhanced.

So, other industrial engineering techniques can be used for further improvement in the product. So, this is not the only technique which will help us to improve the performance of this particular product that is a divan, but there can be other tools also which some of them we are going to cover maybe in our subsequent lectures. So, in today's lecture we have try to cover the case study related to the actual application or actual implementation of the principles of value engineering in solving our problems or solving a day to day product problem. So, if you see as an assignment you can see around you any product and try to do a value engineering analysis of that product using a standard approach that we have seen here.

So, with this we come to the end of week number 2 of our course on product design and development. In week 1 we have covered the basic concepts of product design and development the steps involved in the product design process the product life cycle and other related aspects. In week 2 we have covered everything related to value engineering the functional analysis, the functional cost analysis and finally, we have seen fast diagramming approach and today we have seen a application based case study based on the principles of value engineering.

So, in out next discussion in the next week we will start our discussion on the design tools or various tools which are used for the product design process and which help us to launch a successful product in the market.

Thank you.