Product Design using Value Engineering

Prof. Inderdeep Singh
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee

Lecture - 11
Function - Cost Relationship - I

Namaskar Friends! Welcome to the third week of discussion of our course on Product Design using Value Engineering. We have already completed 2 weeks of discussion, and I sincerely hope and sincerely wish that you may have enjoyed the discussion; at least some value addition as, the name of the course is product design using the value engineering. So, value is an important part for our course. So, I sincerely believe that some value addition must have taken place in your understanding about the concept of value engineering and analysis.

As you know that our target is to apply the concept of value engineering analysis into the product design process. We would here on like to focus more on the practical applicability of the concepts using very simple examples. If you remember in the previous session that was session number 10, we have covered two examples. We have taken a fast diagram for a pencil, and try to see that how the fast diagram can help us to design the pencil in a better way depending upon the needs and requirements of the customers who are going to use that product and the product taken was a pencil.

Another example in the same session that is session number 10, we have taken related to the design of an overhead projector. We have seen that the overhead projector is very well designed there are so many different parts, component, sub assemblies which are making up the overhead projector. But once we draw a fast diagram, we are able to identify the key areas where there is a poor value existing in that design.

So, that poor value once we are able to identify, we will be able to eliminate that poor value with better alternatives using our creativity, using our technical knowhow in terms of materials manufacturing design guidelines. We will be able to eliminate that poor value with a better value option and that is what is the target for us in value engineering. So, today also we will try to take an example, and try to understand that how the functional caused relationship actually works.

So, basically if we see that most of the products, if we try to understand, functional value in case of any product; if you will see that the basic function will account for a significant amount of cost. But that is not that significant that it must be taken as it is. What I mean to say is for example, if we take an example of the pencil again, and we write the basic functions of the pencil, we write the secondary functions of the pencil.

So, we can say that the cost contribution between the basic and the secondary functions, we have to understand, because the cost that we are locking with the primary function may not be all the cost that we are charging the customer for. So, we have to see that what is the cost distribution, what is the basic or the primary function of the product and how much cost must be associated with that.

And, what are the secondary functions, can we eliminate some of the secondary functions to save on the cost. Now let us quickly see one example, we have already taken example of a pencil which each one of us is using.

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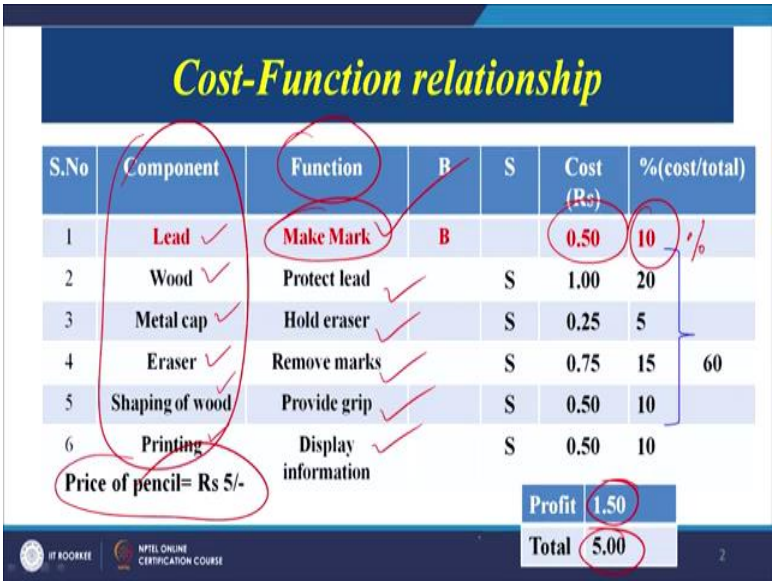

So, we can see that these are the components of the pencil or the cost components, we can say. There is lead, then we have a wood or productive coating. We have metal cap, we are assuming a pencil with eraser at the end shaping of the wood for making it a giving it a smooth finish or giving it a proper grip. So, we can see that there are different and then sometimes we print for example, save trees or save environment. So, we have that various functions for each of these. So, lead is make marks, then wood is protect

lead metal cap to hold, the eraser is to remove the mark shaping of wood to provide the grip. Printing is to display the information.

Now, if you remember in the previous session for the pencil, we have taken making of marks is one of the basic functions for the product and the cost is only 50 paisa whereas, the price of the pencil is rupees 5. So, we can see that only ten percent contribution is of the part or the component which is contributing to the basic function of the product and the 90 percent we can say is the profit is suppose 1.5 rupees, the total cost is 5 rupees.

So, we can see suppose I am paying rupees 5 to buy a pencil, the basic function can be achieved with a lead that is 50 paisa only. Now, we have to see that, how we can establish this functional cost relationship, what are the essential secondary functions that are required to achieve this basic function. So, may be sometimes, we may not like to hold the lead directly coating is essential or a covering of lead is essential whether it has to be a wooden covering or it has to be a plastic covering or what are the alternative designs that can be taken into account. So, this all is basically a functional cost relationship of a product.

We would like to find out that what is the percentage contribution of the basic function in the overall cost of the product or the overall price that we are charging from the customer or are their some secondary functions which we can plan to eliminate. So, with this we have taken an example of a research article which was published by Mr. Chougule Mahadeo in the International Journal of Innovative Research in Science and Engineering.

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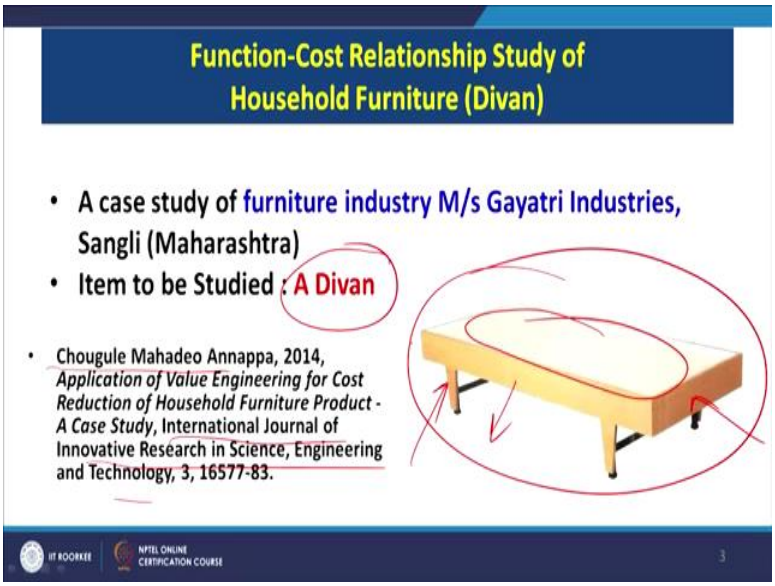

So, this is just an example that we have taken. The examples is of a Divan. Now, this is a divan which normally we use in our houses. These are the legs, this is a side strip, this is again short side strip, this is you can say bed or maybe the platform for the customer. Now, we can see that this design what we have to do.

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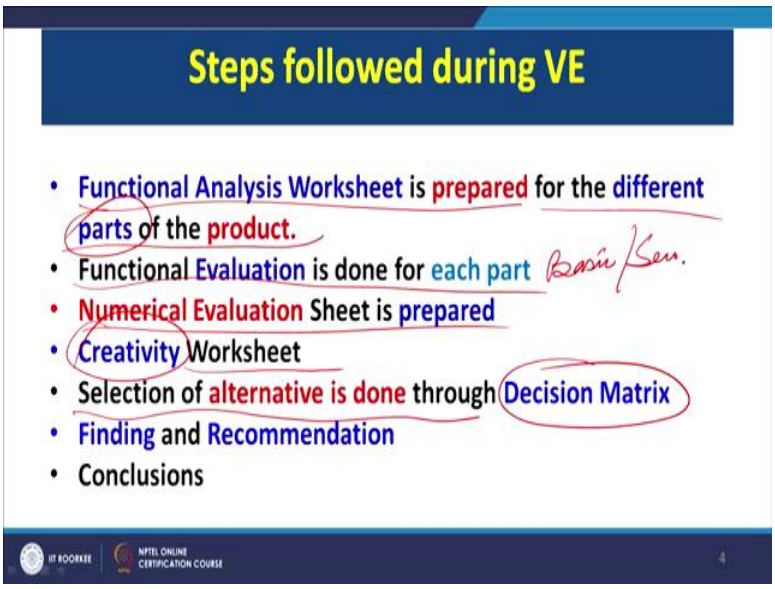

Quickly now, let us see that how we will be able to solve this problem. What we need to do? We need to blast this product into the individual components or the individual parts and then, write down the verb noun definition for each and every part and then

established the cost for each and every part. And finally, see that which all parts are contributing to the primary function of the product, which all parts are contributing to the secondary function of the product, what are the parts which can be eliminated, what are the alternative designs that are available with us, and how those designs can help us to get a better product at a reasonable cost.

So, first thing is functional analysis worksheet is prepared for the different parts of the product. Already, I have told this and we will see for divan, what is the functional analysis worksheet. Functional evaluation is done that is we say that what is the basic function being achieved by that part, what is the secondary function being achieved by that fought that is the functional evaluation. Then the numerical evaluation sheet is prepared where we write the cost for each and every part or the sub component.

Then comes the creativity. Already we have taken a session on creativity here. We already know now this is divan, this is existing product, these are the various parts of the product, this is the cost of each and every product. Now we will try to use our creative skills to find out the alternatives.

Alternatives maybe in terms of materials or alternate materials, it can be in terms of alternate manufacturing processes, it can be in terms of alternative designs of the product; maybe we change the overall look of the product. So, we would like to create a sheet where we would like to write all the alternatives, then selection of the alternative is done through the decision matrix.

Now, there can be number of approaches that you can use for finding out the best alternative among the existing alternatives. You may be having 5 different alternatives; out of that you may like to select the best alternative which is giving you the performance at the minimum cost. Then, we will report our finding and recommend our solution that we are found out or the best alternative and finally, the conclusion. Now this is the overall structure of this article, and quickly we would like to take the most important things.

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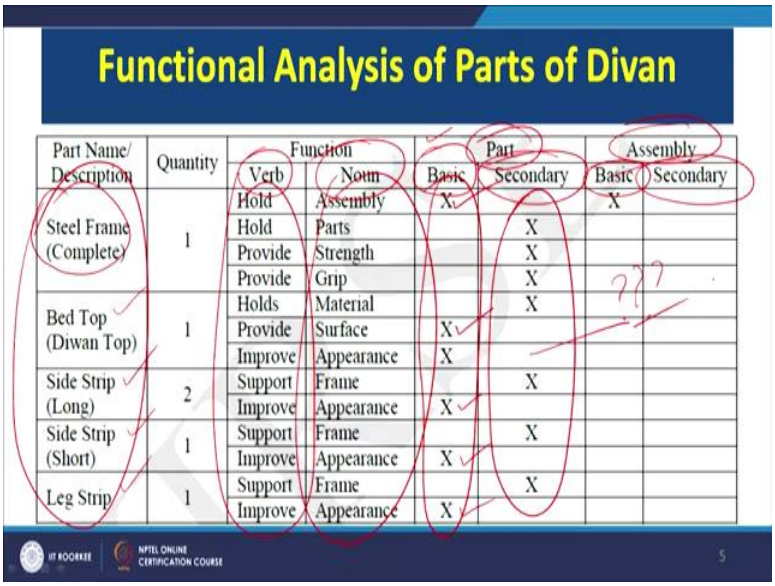

So, here we can see, we have a steel frame which is the basic assembly based on this steel frame the overall assembly will be done, bed top that I have told in the image the platform on which the customer is going to sleep, then side strip is there. Side strip long side strips are there, then shorter side strips are there, then the leg strips are there and you can see the verb and the noun definition for each and every part has been written. For example, if we say bed top holds the material, provide the surface for sleeping improve the appearance. So, we have basic and the secondary function.

Similarly for each part, we can do the functional evaluation as basic and secondary and for assembly also we can do the functional classification as basic and secondary. So, what are the basic functions? So, we can see that these are the parts which are satisfying the basic function. Steel frame, yes, it has got a basic function. Bed top also has got a basic function, side strip has also got a basic function, side strip short also has a got basic function and a leg strip as also got a basic function.

So, all these parts, whatever are listed out here for the divan have got the basic functions. But you can see from the functional evaluation point of view that there are number of secondary functions also which can be studied and these can be tried to be eliminated or these can be try to combined with each other. So, that we are now able to develop a better product. So, this is the first stage that is a functional analysis of the divan.

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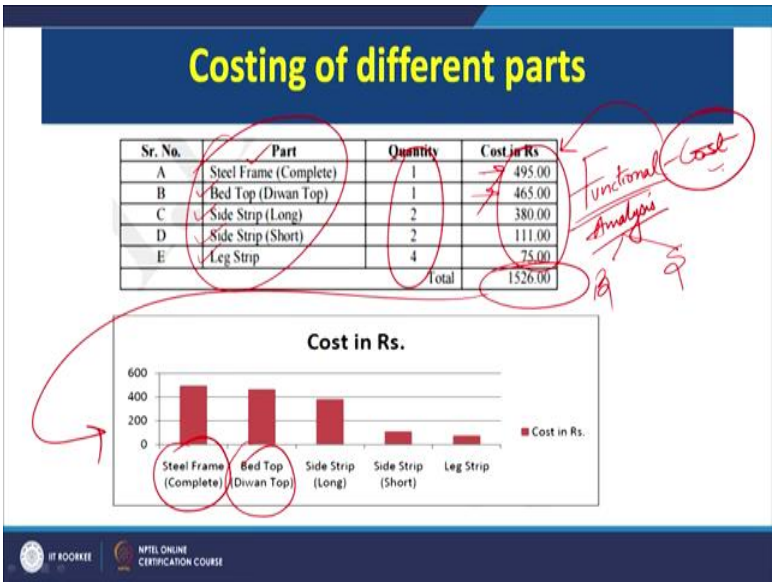

Then for each now, we have seen the title of our session is functional cost analysis. Now we have to from here on focus on the cost component also. So, you can see the cost component here. So, we have five components; steel frame, bed top, side strip, long side strip, short leg strip, and then the quantity is given for each one of these, at the costing is given and the overall cost is mentioned here. So, we can see that the distribution of the cost that the steel frame is contributing to the maximum that is rupees 495, then is the bed top that is the divan top 465. And similarly, we can see the cost for each and every component.

Now two things are known to us. We have done the functional analysis for each and every part we know that what are the functions and within the functions also we know, what are the basic functions being achieved, what are the secondary functions being achieved. And then for each component, we know, what is the cost. Now, we can find out the value gap that what can be the minimum cost with which the functions can be achieved. So, that is given here.

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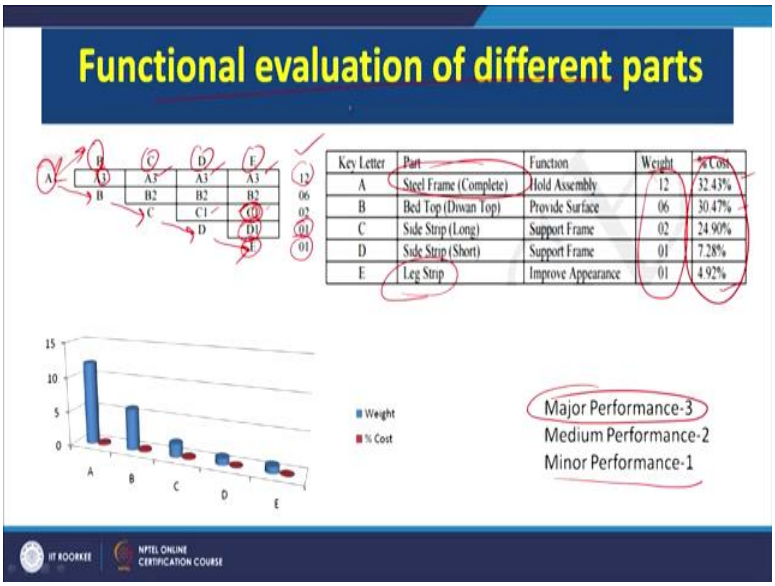

So, we can see that once we do this functional evaluation of the different parts, we can see hold the assembly the weight is also given, percentage cost contribution is also given. So, what we do? We do in context of B, C, D and E. So, if you go back, you can see. We have named these parts as A, B, C, D and E. So, in our analysis part we have tried to relate. So, three basically wherever we have written it means that A and B are strongly dependent; so major performance.

So, A 3 A and B so, what is A? A is steel frame and B is bed top. So, they are inter related in a better manner that is there influencing a major performance and minor performance is one. So, we can see here C, 1. So, we can see A and E. So, it is 1. So, performance is one only which is lesser. So, 3 means higher relationship, 1 means lower relationship.

We are in this direction, we are move A, B. C. D and E. So, accordingly we can see that D, how it is in relation to C, how is performance whether it is a major performance medium performance or minor performance. So, we can see the contribution of cost also in the overall product. So, steel frame maximum cost, then bed top next to that and the leg strips are having the minimum contribution to the cost.

So, here also we can get the rankings also A is the most important part because 3, 3, 3 and 3; so, 12 and whereas, D has or the D is our side strip which has got a less contribution and E has also got a lesser contribution. So, what we have found out here, is

that from the cost point of view also steel frame is contributing more, from the this decision matrix also A is our steel frame is an important part of our product. So, we have now focused on that what are the lesser important parts, what are the more important parts, what is their contribution, how they are going to influence the functional or the performance or the functional performance of the other parts.

So, main guiding principle or the guiding part here or the main important part here is our steel frame. So, now, we can decide that what we need to do and here we can see this information is represented here that is the weight contribution, and the cost contribution.

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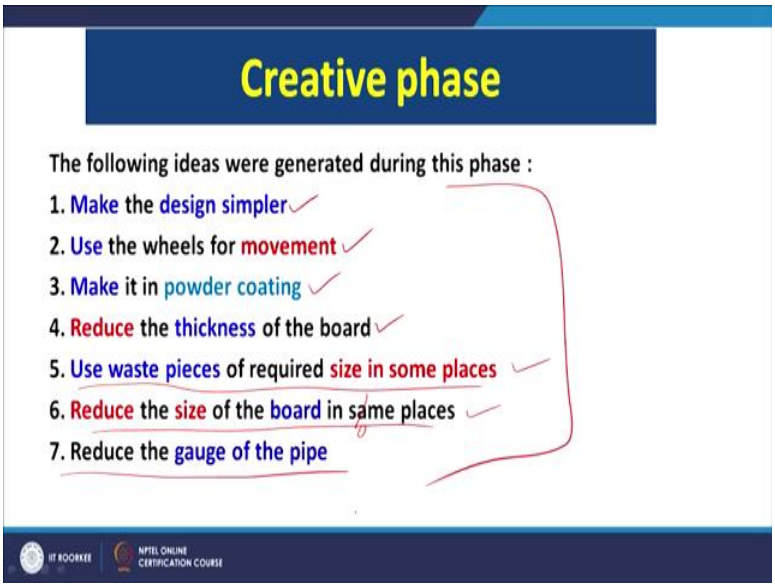

Now, why now we have try to understand the overall summary. Now what is the overall summary we now know that which part is contributing more cost, which part is contributing more weight to the product. Because in case of a divan, one of the criteria can be that it must be light in weight or we can put the rollers or the tires just below the four legs. So, that we can easily move it or make it portable from one place to another place. But once we put the wheels we have to ensure the stability also; once we want to place it at a particular location, we have to ensure that it is hinged or it is fastened at a particular place.

So, that it does not move when a person is climbing on the divan. So, there are additional functional requirements that arise once we make it light in weight as well as we make it portable by putting rollers under the legs. So, there are certain advantages of making it

portable and mobile, but then in the creative face we will try to find out how we can reduce the weight of our divan that can be one of the major criteria, how we can achieve the performance or the basic function of providing a comfortable bed or a comfortable resting place for other customer at a reasonable or the minimum cost. So, these are the things with which we go to the creative face, and try to find out that what can be the better of the alternative designs which can help us to get the product; the first fully functional product, but at a reasonable cost.

So, the following ideas are generated during the design phase, first make the design simpler that is very important Use the wheels for movement already I have told. Make it in powder coating maybe, to make it rust free or corrosion resistant. Reduce the thickness of the board may be that may also add up to making it lightweight.

Use the waste pieces of required size in some places to focus on the cost component of our product. Reduce the size of the board in some places; it is not same at some places. So, we can try to reduce maybe side strips; if they are not caring too much of load, we can try to reduce the thickness of the side stripes, reduce the gauge of the pipe.

So, we can try to reduce the gauge of the pipe, but without compromising the performance or we can see effectiveness and efficiency of the product. We can think of reducing the gauge of the pipe, but that must not influence the performance of our product. So, these are some of the creative ideas and if we give the similar problem to all of you, you can also come up with n number of additional ideas which can help us to make the product better.

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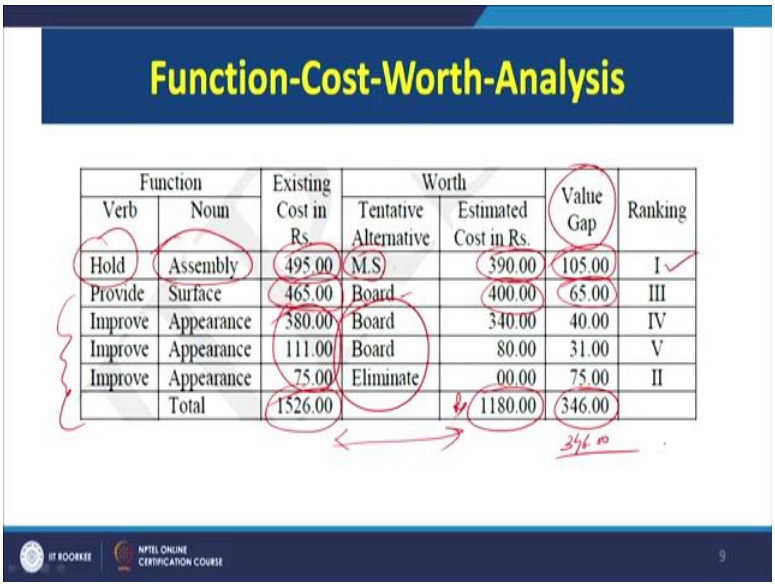

Now, we can see here the value gap which has been calculated. Now we can see the assembly. The first part or the component that is A the basic purpose is to hold the assembly. Now, what is the tentative alternative? It can be mild steel because currently if you go back, and try to see we have a steel frame A and the basic function is to hold the assembly. So, that is the basic function. So, the same thing, it can be made in existing cost is 495. If we make it in mild steel, it can be 390 and the value gap is 105 and the ranking is 1.

So, first alternative that we can try is changing the material of the frame from the existing steel to mild steel, and the basic function is hold the assembly. Then the bed surface or the bed top provide the surface. Current cost is 465, this is the board material is board. We can get that function at 400 rupees and the value gap is 65. Similarly, for the other parts or components of the divan, we can see that what is the existing cost, what can be the tentative alternatives and finally, what can be the value gap.

So, we can see that the estimated cost is 1180 rupees and the current cost is 1526. So, definitely there is the difference between the two and the difference being 346.00. So, which means, that the current design without compromising the performance of the product has the potential, to save certain cost certain elements of cost by changing to alternative materials, changing to alternative designs, changing to thickness of the gauge. So, basically we say change can always lead to better results.

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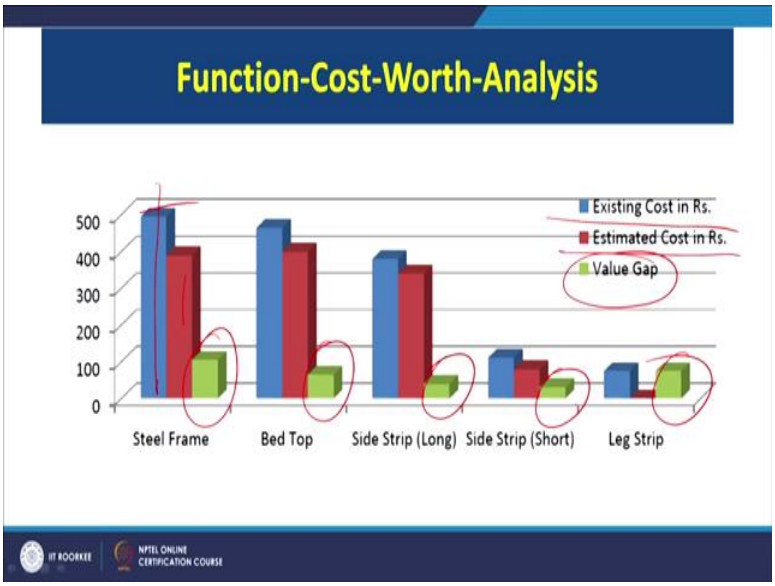

So, here we can see again this is the same information represented in the form of a bar. So, this is blue tower is showing the existing cost, the red one is showing the estimated cost and the green one is showing the value gap. So, we can see for each of the sub parts, we have a value gap. So, we can try to focus on this value gap, try to experiment with the alternatives, try to check the performance of the product with the alternative materials, alternative thickness of the board, alternative gauge of the pipe, and try to see whether the product is performing to the satisfaction.

It is able to pause all the desired tests that are required before launching the product in the market whether, it is able to get all the certificates that are required to launch the product in the market, whether, it is able to pass the tests and the guidelines specified for similar type of products.

So, by changing all these materials and gauge of the pipe, we have to find out that whether the material is able to perform up to the desired level of performance or not. So, without compromising on the effectiveness, efficiency, performance, reliability, durability, dependability of the product; if we are able to bring on this changing the case study is showing that we will be able to save some money.

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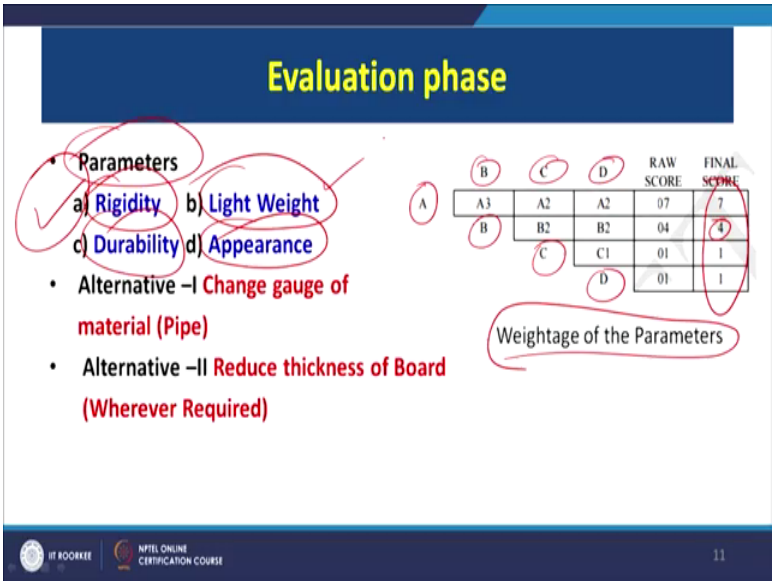

Now, here evaluation phase, what are the parameters here? The parameters decided for this case study is as published in the research article are rigidity; it must be lightweight, durable and the appearance must be good. So, these are the four parameters. So, weightage of the parameters is found out. So, we can see that out of these A, B, C and D parameters, again A, B, C and D parameter B, C and D, we find out that the final score is 7 4 1 and 1 which means A that is rigidity is one of the prime parameters and 4 is B that is lightweight.

So, the main parameters the durability is coming third and the parents is coming also again at the same ranking, but the main two important parameters. Why appearance? Because in most of the cases, you will see that the divan will be covered with bed sheet or the matrix. So, matrix will be covering the divan with the bed sheet. So, may not be the appearance may not be that significant parameter which can influence our decision also the durability definitely is, but as it is related to rigidity because if it is rigid it will be better.

So, it will be durable also. So, we can say as per this case study or within this domain, we can say rigidity and lightweight are two important parameters. It is not important to debate on the rigidity and durability, but it is important to understand the process that how we can analyze our product. So, we can see out of the two, now how we can achieve this. We can have a alternative one, change the gauge of the material that is the pipe. So, we can try to use a different gauge pipe for making the product or the assembly.

Now, as an alternative reduce the thickness of the board wherever required. So, based on the four parameters that we have identified, we finally, decided to alternatives, change the gauge of the material and reduce the thickness of the board.

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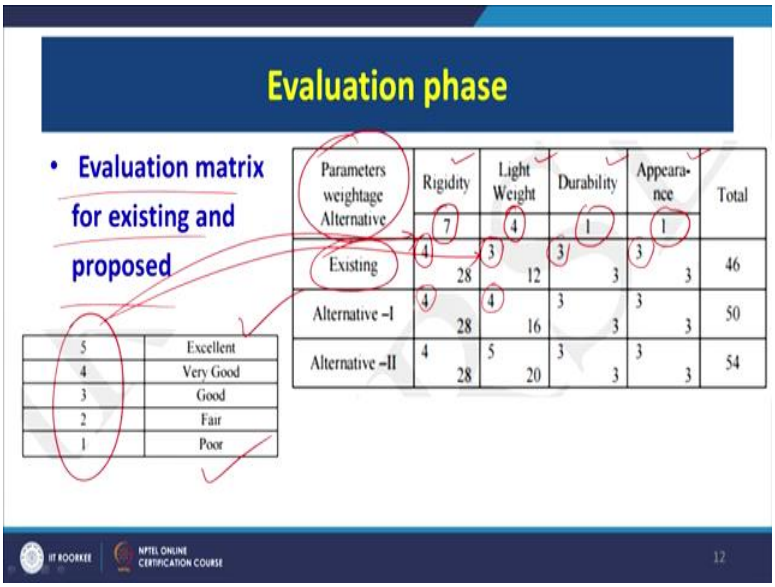

Now, here we can see the evaluation matrix for the existing and the proposed; this is the ranking 5, 4, 3, 2, 1; 5 is excellent, 1 is poor. So, we can see here, parameters weightage so, rigidity, lightweight, durability and appearance. So, this is the ranking 7, 4, 1 and 1 which we have found out in the previous slide. If you can go back to the previous slide and 7, 4, 1, so, existing we are giving the ranking rigidity is 4, lightweight is 3 ranking.

So, this ranking is based on this scale; 5 is excellent, 1 is poor. So, existing is 4 in terms of rigidity, 3 in terms of lightweight, 3 in terms of durability and 3 in terms of appearance. So, alternative one again 4, 4 it is lightweight; for alternative 1 and what is alternative one, change the thickness of the gauge.

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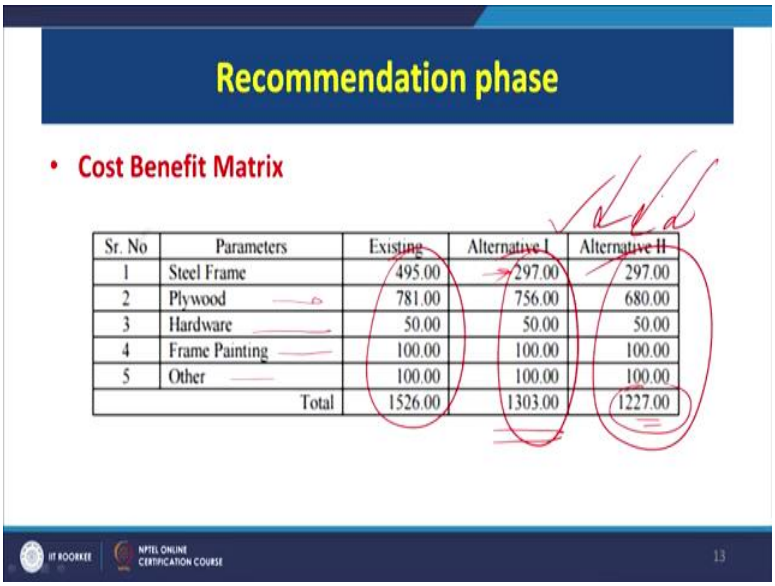

So, you can see, what is the alternative 1, change the gauge of the material. So, again it is lightweight because a gauge is going to change. So, the pipe we are going to uses different. So, it will make it lightweight and this is here 3 and 3. So, the overall ranking if you add this, this is going to come at 50. So, alternative 2 again 4 5 3 and 3; so, this is 54. So, we say that the overall ranking for parameter weightage, alternative. These are the parameters in this direction.

This is the weightage and these are the alternatives. So, we get that for alternative 2 we get a higher score. So, therefore, we can see that cost benefit matrix; steel, frame, change to gauge, then plywood, hardware frame printing other. So, with this is the existing design. This is alternative I; if we select, and this is with alternative II. So, if it select alternative I, 1303 is the cost. If we change alternative II, change to alternative II, 1227. So, even if we see that if we select alternative II that is use board with lesser thickness, our cost is going to reduce, and we are able to still focus on two important parameter that is lightweight and the rigidity.

So, we are not compromising on the rigidity of our product, we are not compromising on the weight, the weight is not increasing. In fact, it is reducing which is better for the functional requirement of our product.

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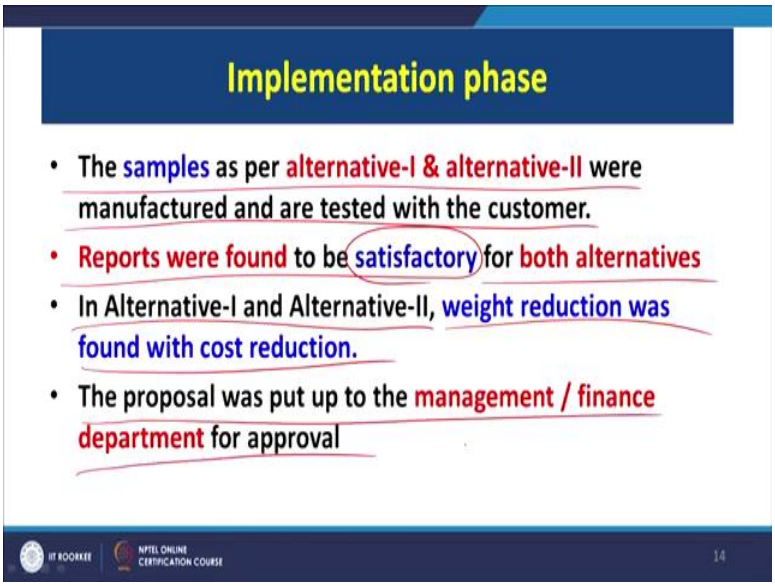

So, if with this, we can see that if we implement these samples as per alternative I and II were manufactured and tested with the customer reports were found to be satisfactory for both alternatives. In alternative I and alternative II weight reduction was found with cost reduction. The proposal was put to the management finance department for approval.

So, you can see that by changing the material and analyzing the cost implications of those two alternatives that is changing the pipe and changing the board, the performance was not compromise; the performance was better. The weight of the product also reduce that is divan, and the customers were also happy to have this product. So, we can see or we can conclude that value engineering was used for cost reduction without change in the product design and its value.

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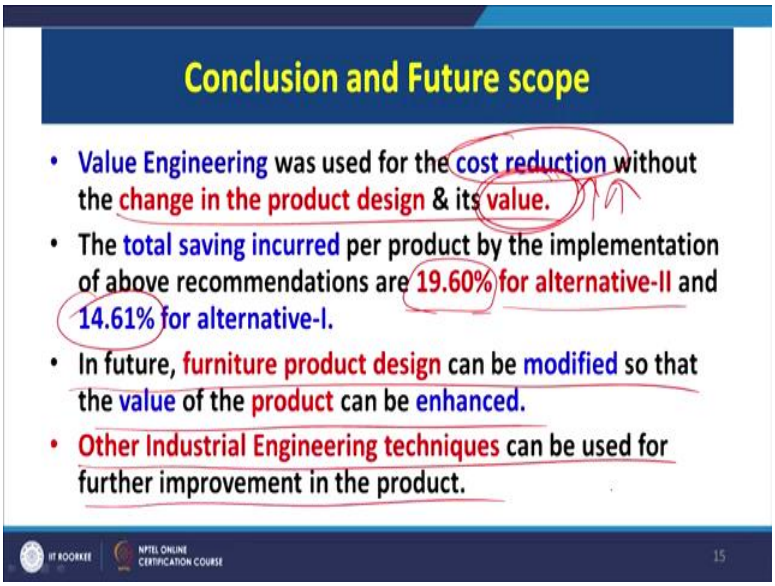

More important is that the value increased by as well as the cost also reduced. The total saving incurred per product by the implementation of the above recommendations was 19, approximate 20 percent for alternative II and 15 percent for alternative I. So, we can see that without compromising the performance of the product, the authors were able to save 20 percent cost in one alternative and 15 percent cost in another alternative. In future furniture power design can be modified so that the value of the product can be enhanced.

Other industrial engineering techniques can be used for further improvement in the product. So, we can conclude that if we do a systematic analysis of the functions of the product, we focus on the cost component of each and every part of the product. We will certainly be able to find out alternatives through the creativity or when we implement creative thinking approach in finding out the alternatives for satisfying the intended function of each and every part of the product and see its implication on the cost; obviously, we will be able to improve the value of the product by satisfying the desired function at a reasonable or the minimal cost.

So, this case study of divan has established that if we focus on each and every component, and try to link it with the cost of each and every component and find out the alternative ways for achieving the desired function of each and every component, we will be able to propose a new design which will give us better performance. So, with this we

come to the end of today's session. I have already shown the reference from where this case study was taken. So, we are thankful to the author who has publish this article which has helped us two understand the cost functional analysis or the financial cost analysis of a specific product in this case that is a divan.

We will try to do further study or a case study on functional cost evaluation of a different product in our next session.

Thank you.