Infrastructure Planning and Management
Risks and Challenges in Infrastructure - Part 3

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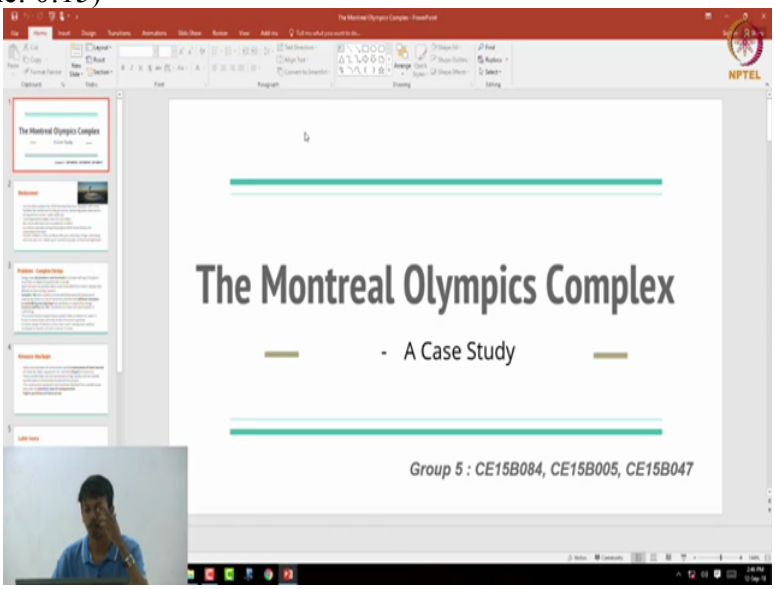

Hello guys. Now I am going to talk about Montreal Olympics Complex Case Study.

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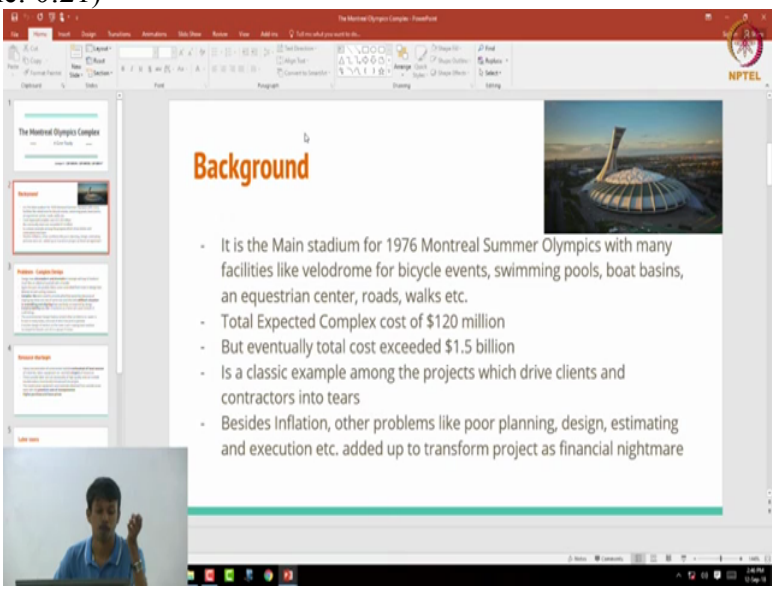

It is the main stadium for 1976 Olympics. It is built with, built for many facilities like bicycle events, swimming pools, I mean swimming events and many sporting events can be held in that main stadium. And the total expected cost of the Olympic Complex is 120 million but it ran over to 1.5 billion which is nearly 10 to 15 times of expected and there are many reasons for this spillover of cost. Like there are besides inflation there are other problems like design problems and planning problems, estimation problems and et cetera. So now we are going to look at each and every problem in detail.

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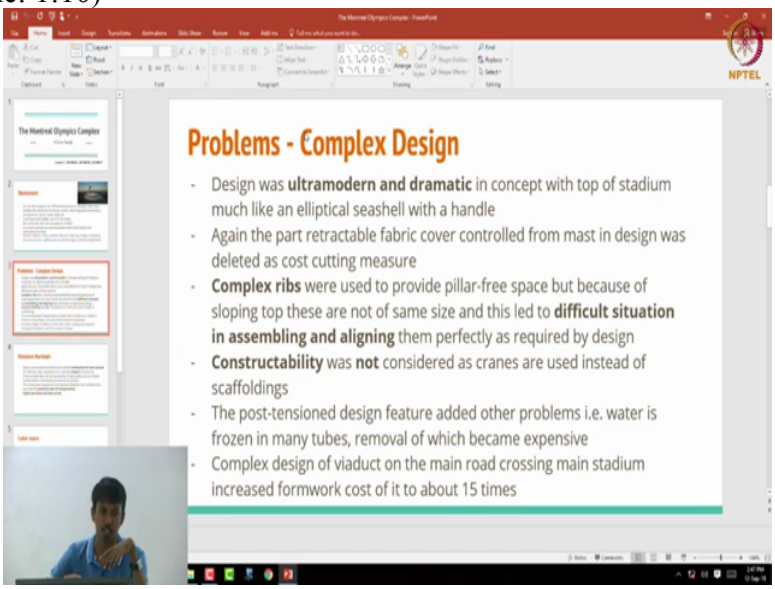

First of all, going to design problems, like the design was very ultra-modern and dramatic in concept. Like the top view of stadium will look like a elliptical seashell with a handle but due to overrun of cost they have cut down the most part of it and they deleted that cover part.

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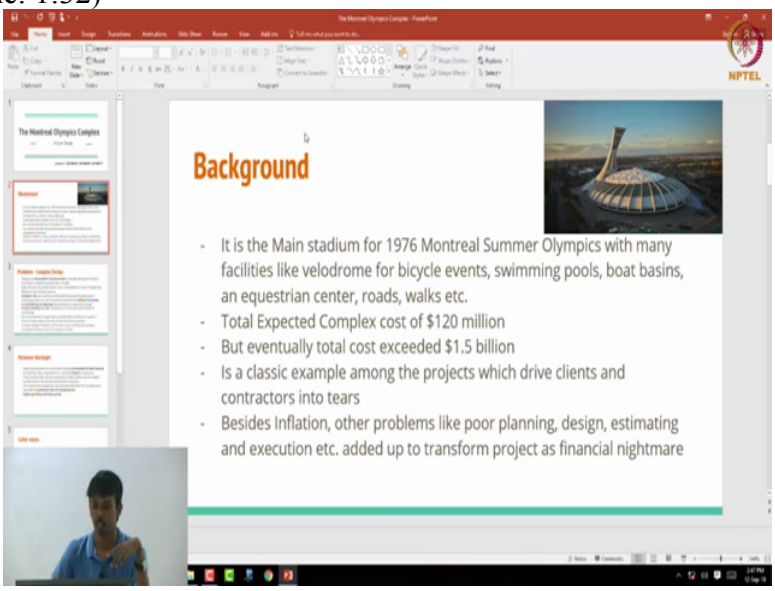

You can see that stadium at the top. Like they have deleted the cover part at first and it resulted in a top roof which is inclined.

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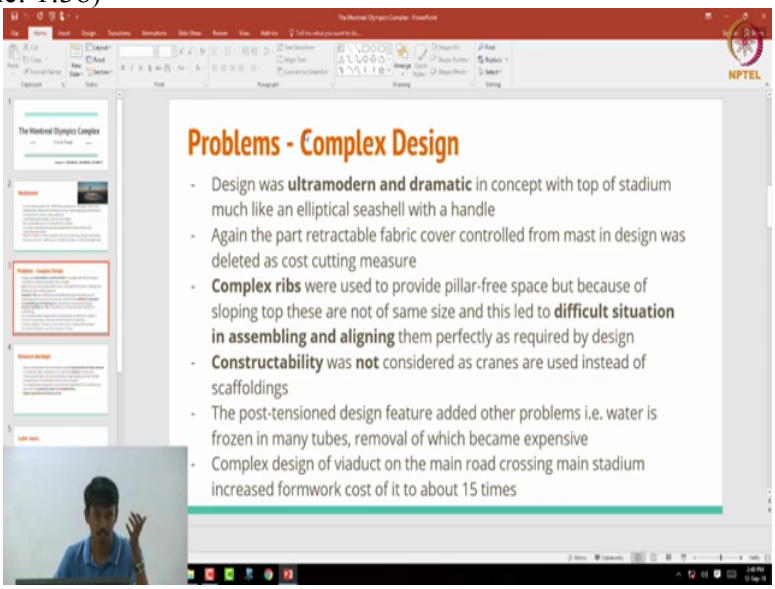

And to get the pillar free space, they have introduced a complex ribs instead of pillars. Like as the top view of the stadium is inclined, these ribs are not of same height which led to difficult situation in assembling and aligning. And one more thing, the constructability was not at all considered during the design. And the post-tensioned design feature which is used in this structure was one of the problem. Like in winter water entered into these tubes and it got frozen.

And removal of this water became very expensive. And they have constructed viaduct with a very complex design instead of directly constructing it. So it increased the cost to about 15 times of that viaduct.

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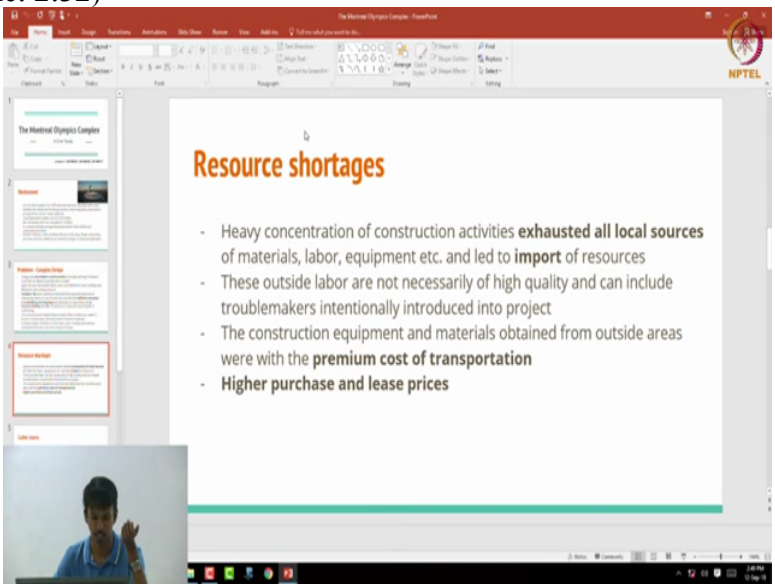

Next, coming to resource shortages, as the city is hosting Olympics, like there are heavy construction activities going on in that area which has exhausted all the local resources of materials, labor, equipment, et cetera. Like then they went to outside labor and importing of construction equipment and materials. Like it led to very high cost of transportation which again led to increase in prices and overall budget of the project. And these important materials are of very high cost and lease prices are also very high for equipment.

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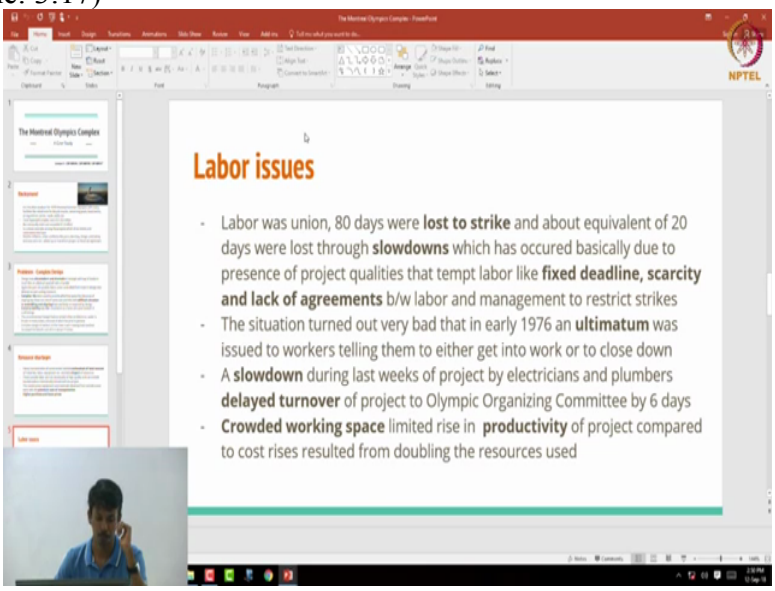

I am coming to labour issues. Nearly 80 days were lost to strike because the labour went on strike because it has the, the project has features like fixed deadline and scarcity of resources. So labour took it as an advantage and went to strikes which nearly 80 days were lost and even there was a situation like at the like nearly 2 months before the start of Olympics there was slowdown of work by electricians and plumbers, like which resulted in Olympics Organization Committee had delayed the turnover of project by 6 days.

And like they have increased the resources and labour resource but which resulted in crowding working space, which in turn does not increase the productivity to the required scale. It is also one of the problems.

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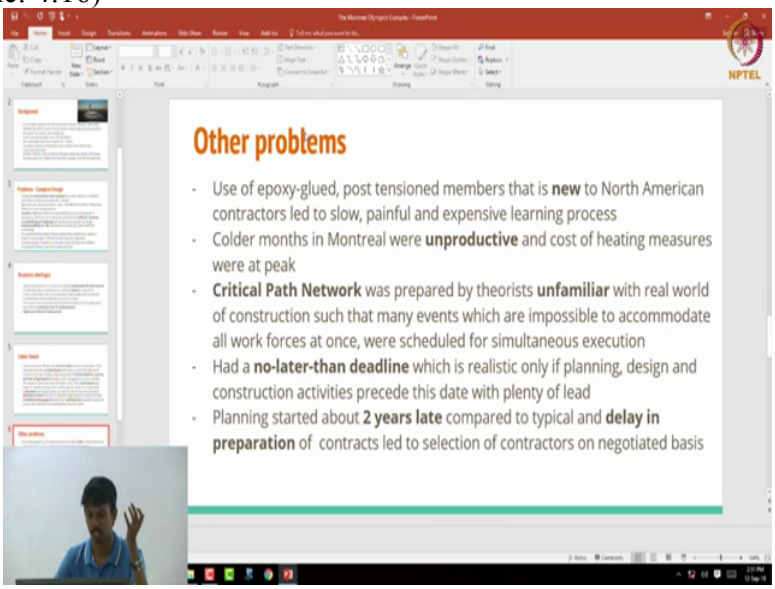

And there are other problems like, they have used epoxy-glued and post tensioned members that is new to North American contractors. So they had to learn the process. So it had led to very like waste of time and expensive also. And weather in the city is also one of the major problems. Like winter months were mostly unproductive, like and the cost of heating were, it also increased the cost. And one more important thing is during construction planning while making critical path network, it was made by the people who are unfamiliar with the real-world construction activities.

Like while they are developing this critical path network, it was bit like most of the activities were allocated simultaneously so that resources and labour cannot be accommodated between these. And there is delay in planning process which was started 2 years late.

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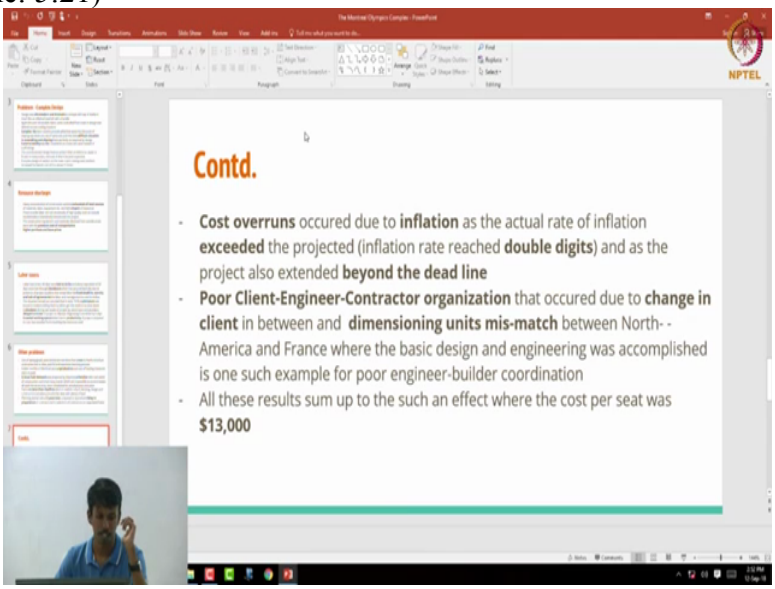

And inflation is one of the major project as the duration of project was also exceeded and inflation rate in addition to the, that inflation rate reached double digits. So it created add-on effect which increased the cost much. And there was poor client engineering contract relationships like there was a change in client in between, the project was handed over to like other authority that led to poor relations between them. And actually the design process was carried out by a French design and engineering firm.

There was mismatch between dimensioning units like they have to convert the dimensions. That also led to a problem. And all these results like the, at the end when the stadium has stared, the cost per sit is 13,000 dollars. Like we can see that everything went wrong in this project like there are problems related to labour, resources, constructability, design. Everything went wrong.

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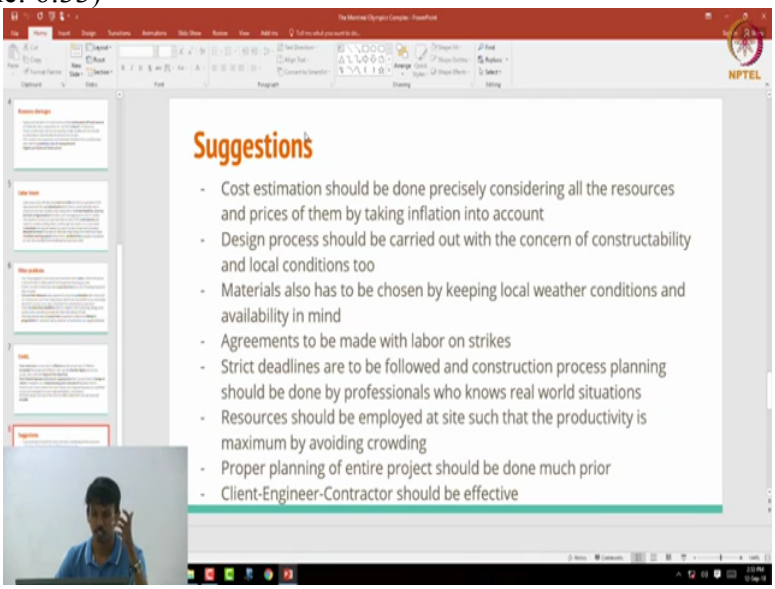

And these are the some suggestions like first of all, cost estimation, they had neglected the, they have underestimated the rate of inflation and rate of materials and some of the things. Like design process, we cannot construct the very complicated designs like it should be kept in concerned while designing. And materials has to be chosen by keeping local weather conditions and availability in mind. Like they have imported several materials from neighbouring countries and they have used post-tensioned members which aware them water entered and it got frozen, it also became problem. So we have to choose materials such that keeping these factors in mind.

And proper agreements to be made with labour regarding it was not made, so which eventually lead to delay of project and strict deadlines to be followed of course. And we have to avoid crowding like we cannot increase the resources like that it productivity decreases. And proper planning should be done which is not amenity, it is delayed in this case. And proper client-engineer contracts should be maintained. And these are some of the suggestions. Thank you.

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I am from Group B and the project is like Project From Hell.

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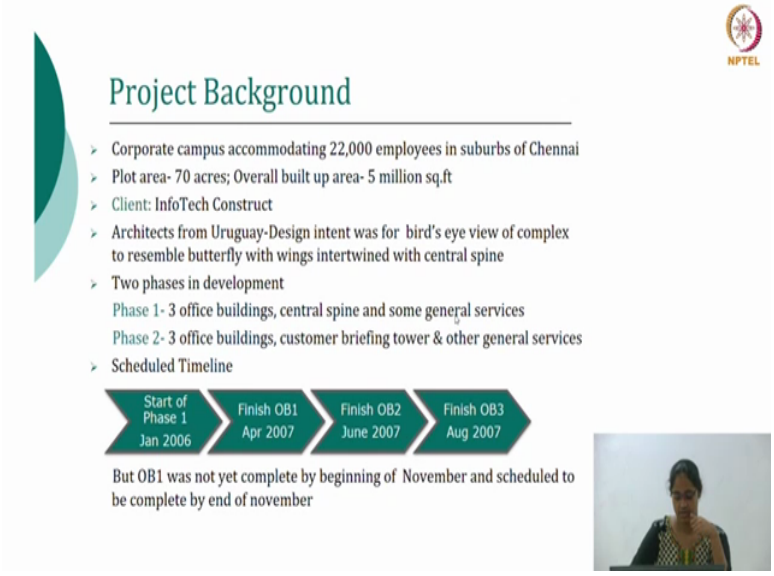

It is basically to build the corporate campus in the outskirts, I mean suburbs of Chennai. The client is InfoTech Construct. So there are like a software firm, so they could not, I mean they had other consultants to build this one. Then they took architects from Uruguay and the design was basically to like bird's eye view which resembles a butterfly with its central spine. So the project was planned in two phases, phase 1 with 3 office buildings, central spine and some general services.

Phase 2, the other three office buildings, customer briefing tower and other general services. Timeline was like the project they start in January 2006 and then finish the first building by

2007 April and in between two months the second building and within two months the third building. But even by the end of November, the first building itself is not completed.

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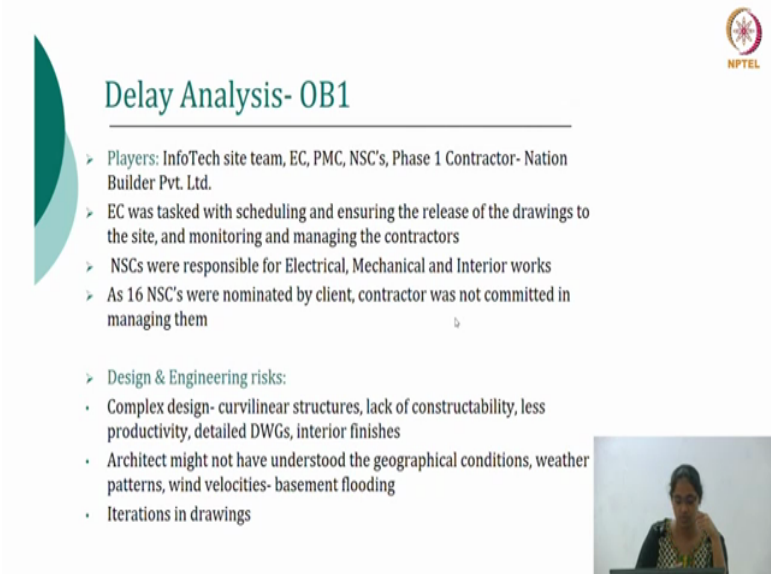

So the people involved were like engineering consultants, the site team from the InfoTech considered itself and then project management consultants and nominated subcontractors. The main contractor in phase 1 was Nation Builders. EC was again tasked with scheduling drawings, other works and then nominated subcontractors which took care of other works, electrical, mechanical and interior. So the nominated subcontractors were nominated by the client itself.

So the contractor was not happy with it like why should not I involve so that I could coordinate with them well, but so that the coordination was not well between the contractor and subcontractors. Then even at the end of delay like the project was delayed by around 7 months. Then the contractor took delay analysis and claimed only 45 days worth because of them. And other delays were because of non-subcontractors. So the risks involved were like it was a complex design, so the workers were not familiar with the work and they had to figure out how to do that. And it made, I mean it called delays.

And there was also like productivity was less and constructability also was less. Next, from architect's point of view it was like foreign architect, so during construction of superstructure, there were frequent rains so that shafts were like leading to the basement area, so it was frequently flooded. This was an issue because of the foreign architects. Drawings, they were like many changes made according to the plans and the schedule has to be updated again and again, so there was a delay because of that.

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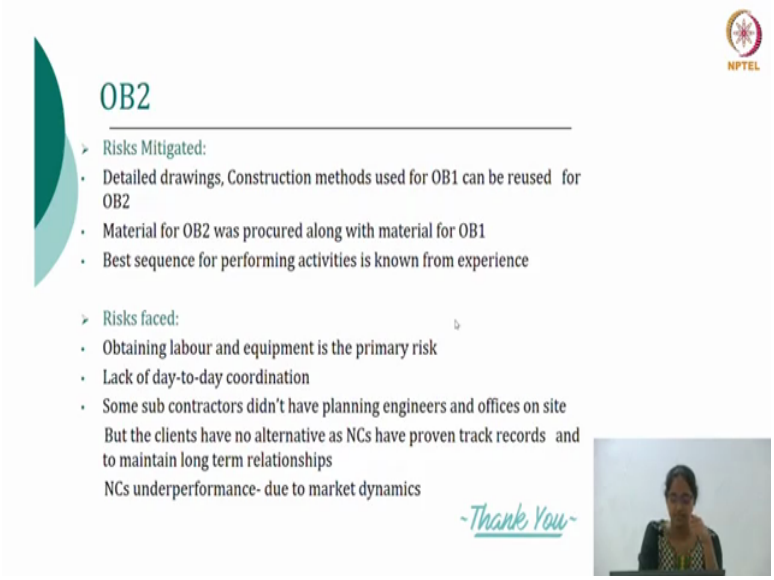

Procurement risks, resources were like some were obtained from foreign countries, so there were delays in procuring that. So they could not do the work that was scheduled that day. And labour was like because the construction site was away from the city, they could not, villagers near that area could not allocate the enough labour. And the prominent I mean normal labours cannot go there, like they are not willing to go. So at every point of time there was only 50 percent of labour available.

Construction risks, it was like the client will be, since the delay is going on, client will say like okay, we will move the deadline before. Contractor will say, okay but it will be as usual, there will be delays. And there will be miss-communication between the contractor and the client. And amount of free work, yeah, there was no optimal sequencing like for example there was a handrail and steel work going on. First, they put the handrail and then for the superstructure they had to do the welding work. So the handrail was damaged after doing that and again they had to do the work again.

This was like back of sequencing and then climate and rains caused productivity to decrease. Welding was done at a slower pace. They were last minute delays that client got to know the details about last minute. Then there was no clear documentation on why the delays occurred. So the client was like it was due to the inefficiency of the project management consultant. So in the second building, there were like, they planned in-house project management system. So primarily they will take care of the management itself.

Then to mitigate the risks that were in the first building, they are like using these single drawings for building 1 and building 2 and the construction methods also were quite similar.

Material was already procured along with the material for the first building, so there was some risk mitigated but they do face on the risk like obtaining labour and equipment. There was no coordination between the contractor and the subcontractor and that is it. Yeah, and since the underperformance was due to like market dynamics, there were lot of projects going on at that time.

So they were like already this project is delayed, so there are high risks, why to concentrate on this project, we can concentrate on other projects and gain some profits. So that is one reason for them.

What we have looked at are three projects, sorry two projects where the construction has gone horribly wrong. So in the Montreal case as these guys were saying, what was it? 120 million went to 1.5 billion, these are all small numbers. It is a huge and just imagine if that happens, if you think back to a few classes, your whole financial analysis is done based on some cost and some revenue. So you assumed a certain cost, you assumed a certain revenue stream, you have discounted it, et cetera and you have come up with IRR of, Internal Rate of Return of 15 percent or whatever it is.

Now imagine if your cost increased ten-fold, that is the end of the project. I mean you are definitely never going to make any kind of profit if you have these kinds of projects. So construction risks are very large and they can really affect the fundamental economics of the project. So the question then is, from the two cases that we have looked at, so we mentioned both presenters have mentioned specific risks. I mean specific problems; this was the challenge, that was the challenge. But what according to you are some risk categories that come out when you are doing construction? What are some categories of risks?

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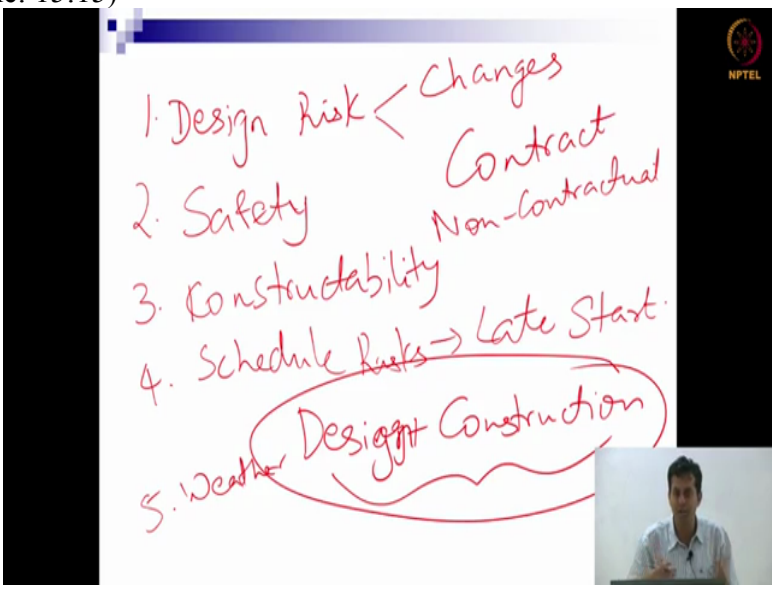

So design risk, what is design risk?

Student is answering: The design is not, the frequent changes they got with…

Okay. So one of the big risks is that designs keep on changing. Why do they keep on changing? Because clients obviously have requirements, it is very difficult for you to think of things right at the beginning. So over a period of time very often clients cannot picture what a facility will look like. Only when it starts coming up, they actually start realizing that this is what we wanted. It happens everywhere, in our own academic complexes does that everywhere, so there are changes.

Now what happens with changes is that cost might increase but I might have to go, get more resources, things get delayed. So there are certain risks that the design might not be complete. And again we will talk about solutions later on but this is where theoretically 3-D beam models and so on can play a role. So you can simulate 3-D, you can do walk-throughs. And we can sort of arrive on what the building should look like much ahead of time, rather than having the client see it midway and say wow, this is what I want, I want this change.

So that is one sort of category of risks. Any other category, Harsh? What is safety risk?

Student is answering: (())(16:34).

So safety again is a big risk in construction because you are dealing with a lot of heavy machinery, lot of heavy and very sharp implements. There are all kinds of there are places where you can just fall off, there are reinforcing steel bars that you can get impelled on. So lots of risks, large equipment that can literally crush you. So safety is a big risk during the

construction phase. And safety if you do not pay enough attention to safety, it might actually cost you lot of money. Because every time there is an accident, there is an injury, there is a direct cost. If a worker gets injured, then perhaps you have to pay their family or then if they get killed, then the amount you pay is higher.

But also there is a loss of productivity. Imagine it is a group of five labourers working. One or two of them if they are injured, there is a loss in productivity. You bring a new person in, that person might not gel with the team. Morale is lowered, think about it. The person next to you, just got his foot chopped off, it could have been you. So how excited are you to come and work productively? So safety risks have economic consequences in terms of cost and time. So that is another category or risks. One other, just staying with design for a second, what other kinds of design risks that, design related risks that we see on the cases? Yeah. One second, just one by one let us go. Let us go, Alexander first.

Student is answering: Technological risk.

Such as?

Student is answering: (())(18:01).

Okay, so I am going to give it a new term which I was going to put up anyway, it is called constructability which is, I can, it is clearly I want something iconic. So both of these projects were iconic. Montreal Olympics, you are making a statement to the world, it was also an organization that wanted an iconic building. Because you are iconic, you want things that may never have been done in that area. You might want building materials that might not be, it might not exist in India that need to be imported.

You might want fasads, shapes and so on which are very difficult to construct. And sometimes these then lead to extra costs and time. As we all know, if you want me to sort of pour a concrete wall, it is relatively easy. I get formwork, I pour it. If you want me to pour a curved surface, so it is bit more difficult, I got to create the formwork, I go to make sure that concrete flows, all of that. And that takes a little bit more time and effort. So constructability I think is a set of risks to look at. Something that came out in the Montreal, what was sort of, what else came out in the Montreal case?

Student is answering: Scheduling was bad.

Why was the scheduling really bad?

Student is answering: They started off very late, and there was like lot of sudden release and not enough proper work given.

Yeah, so again this is an issue. Because all of these projects are heavily time bound, the Olympics for instance, obviously the Olympics dates are announced years in advance and unlike any other facility where you can say yeah, please come back, I will delay it by three months, you cannot tell all the athletes in the world that sorry, we are not having the Olympics now, come back three months later.

So those are all set in stone and if you do not give yourself enough time to plan, then essentially you got very little time to actually come up with designs, with cost estimates, with schedules. And when you have little time, you often end up doing a sturdy job. Even in the second case if you look at the timeline, the timeline was barely 16 months, or 18 months. So from 2006 April or something up till 2007, that is a very short amount of time to develop something of the complexity that you wanted to develop. Did the case have a picture? Did it have a figure? It was not there in the case, okay.

Then I can circulate copy of the picture. But it is a very complex undertaking. And because you do not have enough time, that these risks start exaggerating. So again there is a clear risk mitigation measure there. So take more time in planning this out. You know for instance, Rio Olympics was what? 2 years ago, right? 2016. We already know who is, in 2020 we already know 2024. Do you know 2088? Probably not. But you know this far ahead of time and by the way these the winners of the 2024 Olympics were known couple of years ago.

So you have a long lead time. No point planning for 2-years before the games, you really need to start planning for this much ahead of time. Similarly with these corporate facilities. So I think there is a lot to be done in terms of timing. But here again one of the issues that comes up is to what extent is design and construction collaborating, because this could actually save time. If construction could tell design, what you are, so design in both these cases there are international architects.

They have been called in because they want to create something iconic. They want to create something iconic because it is going to go on their resume. They are going to show all of these pictures tomorrow of this stadium I built in Barbados, this office building I built in Chennai, et cetera. So they have an incentive to design something that is extremely complex. They also have an incentive to design something that is extremely complex because their fee

is a percentage of the total cost of the structure, which means the more complex and the more expensive it is, the more I get paid.

So it is fine. But the point is, and there is nothing wrong in expecting something that is unique. That sort of visionary go ahead. But at the same time you got time and cost implications. And if you just left, architects have a free hand, you will end up with something that is probably extremely complex and extremely costly. But if you bring contractors in, contractors are the exact opposite. The more complex it is, the more difficult it is for me to construct. And therefore I might be able to actually have a discussion saying look, these are specs, can you really make these a bit more normal, so I can construct them faster. Whereas certain fasads et cetera, you can actually make much more unique.

So I think design and construction end up talking to each other. Construction again has a very good idea, what is possible with regards to schedule because they know how long things take. They understand the kinds of resources that they might have. They might understand the practical challenges on site. So very often the fact that design and construction do not talk to each other is a big issue here. Another issue, I mean there are many issues but another issue here was the weather which I think is very important.

So Canada is really cold, you cannot build all way around. And I have made this point again, I was consulting on a project once in Mumbai where this large developer was going to build this big tower, residential apartments et cetera. And they were going to start construction in June. So what happens in Mumbai in June, it rains and of course it rains heavily. So the question is if you are going to excavate, are you building luxury apartments or you are building a swimming pool? Because you are not going to be able to work, you just going to fill up this excavated area with water, you will have to dewater etcetera.

So I think all of these considerations that will lead to cost and time overruns. So I think there are lots of, there are lot of things that can go wrong in construction. We have not even talked about labour which came up in the case, labour strikes. We have not talked about resources, material shortage. Yeah.

Student: Unavailable.

Yeah, unavailability of material resources, unavailability of machinery. Metro rail is struggling because you do not have enough tunnel boring machines available to build the tunnels the way you wanted. You have to wait a little bit for one stretch to be completed

before you can start another stretch and so on and so forth. All of these challenges that make it very difficult to build on time. So essentially you got to do a couple of things. One is, you got to try to figure out how you mitigate risk and one way of mitigating risk is getting design and construction to talk to each other, that sort of helps mitigate risk a little bit.

So essentially another way of looking at it is you can look at the contract and you can try to put things into the contract. Yes, there are a few. Larsen & Toubro for instance, does both design and construction. There is a certain form of contract called design and build contract where you go to somebody and say you design it and build it for me, turnkey contractors people call them. There are some firms across the world but by and large the industry tends to be specialized. So particularly in India you do not have that many of these kinds of players. You have a handful of people who can both design and build.

Although people say we can design and build, very often they are doing a joint venture with somebody for design or forbid. But it is possible. So one way is go to the contract and through the contract have mechanism. So contracts for instance, are things called price escalation clauses. For no fault of my own, the price of steel is increased by 10 percent, so can we do something about it? But also you will have to think non-contractually. We will have to sort of think how can the client, the contractor, the designer all be involved in decision making so that these projects do not have the kinds of cost and time overruns.

So it is somebody's responsibility to tell the client, it is great if you want your building to look like a butterfly or dragonfly or whatever it was from when an aircraft flies over head. It is not even on the flight path. I do not know if anyone ever seen the butterfly shapes but anyway. This is, but the point is it is going to, you either have to budget more time and more money and then you work out your economics in that fashion or if you want something in 16 months this is what can be done.

And unless you have that kind of constructive dialogue which today does not happen because the client puts a sack of money in the ground and says I want the facility in 16 months, the architect says sure, here is a pretty picture, get a contractor to build it for you. Contractors you under pressure to get business, so they outcompete everyone, they want to get projects. And sooner or later you are in the kind of mess that Montreal face during the Olympics or these guys face.

And by the way you can think of, you want sort of a Montrealish example, think Commonwealth Games. Commonwealth Games was very very similar. You had your hand up and then we will wind up in a minute. So did they underbid for it? See, the Olympics bid has nothing to do with the money. To get the Olympics bid, you are essentially showing proof that you can host the Olympics. So that has nothing to do with whether you bid the 120 million or 500 million. That something you do internally.

Student: Sir, to be able to run the…

You mean so, did they go back internally to their finance department and say allow us to bid for the Montreal Olympics because it only cost 120 million, maybe, there might be an element of that in it. Because if they are gone in and said it is going to cost 1.5 billion, Canada would have said look, forget it. We will do it 30 years down the line. It is called the Boston Big Dig, it is sort of been, yeah it was one of those, I mean there is a lot of literature you can read on the Big Dig on the web which I would encourage you to do. But a classic example of overruns.

Student: (())(27:24).

So some of these infrastructure projects in the Big Dig what happens is once you, it is like a metro rail, once you build 5 kilometers of tunnel, it does not make sense to stop the project because what you built is wasted. So sometimes there is this motivation to say look, let us keep going. People talk about it as putting good money after bad. But there are all kinds of dynamics. But I think the point here is that your infrastructure cost come down to the asset cost in many of these large cases.

The road projects economics are driven by the cost of construction of the road. The power plant's economics are driven by the cost of construction of the power plant. To the extent that you do not understand that there are these risks and you let the project go out of hand, you can have 100 you know, 1000 percent cost overruns and then your project is in huge tub. So construction risks are very real, there are all kinds of risks, design, safety, constructability, schedule, weather, labour, et cetera.

And we have got to figure out either decisioneering wise or managerially how we are going to manage those risks. Either you are going to bring people together or you are going to allocate the risk to somebody else, bring in new technology, use building information modelling. You really need to think about these risks, otherwise these projects go (())(28:35).

There is data and we will get back to it little bit later in the semester then. And I think maybe Swapnika it was in your presentation or somebody's presentation I saw today where, no sorry, it was an earlier session. 9 out of 10 projects typically run overbudget, 9 out of 10 infrastructure projects. That is a large percentage.

So this is a very real risk. And we have just seen some of these risks. We will talk again little bit later on how to mitigate them. Just one note on the Vadodara-Halol case, there is some data. I would like you guys to do some numerical analysis, do not just sort of qualitatively look at the case. They have got some traffic data, try to play with those numbers a little bit and when you come and present, justify it little bit rather than just waive your hands. Okay. All right, see you all.