Ergonomics Research Techniques

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Week 8: Lec 29- Cognitive task analysis methods

Critical decision method

Welcome back, we are again back for this class that is cognitive and behavioural method. At the initial days, we started with the general analysis, then we started with the cognitive task analysis where first we completed hierarchical task analysis and then we completed that allocation of functions right. So, today we will take up the last component of cognitive task analysis that is the critical decision method ok. So, let us understand what this method is all about. Here from this particular terminology critical decision, we understand that when we are having a particular system in place, the operators are working continuously, then what we need to understand that the whole event critically and what are the points critical events are happening and how the operators are taking decision on it right. So, once we understand the whole procedure impact of that critical decision on the whole process, we will be able to understand how to minimize the error or how to minimize the accidents further.

Critical decision method (CDM)

- It is an approach to cognitive task analysis.
- The method involves multiple-pass event retrospection guided by probe questions.
- The CDM has been used in the elicitation of expert knowledge in diverse domains and for applications including system development and instructional design.
- The CDM research illustrates the sorts of knowledge representation products that can be arise from cognitive task analysis:
  - Situation assessment records
  - Time lines
  - Decision requirements

So, first let us understand what this method all about and what are the process or procedure we should take up when we want to do this particular method. So, yes it is an approach to cognitive task analysis and this particular method involves you know multiple past events in retrospect, retrospection. So, once we have a particular event

already completed, we actually look back ok, retrospective guide by some kind of probe questions. So, the CDM we call it in short form that critical decision method CDM has been used in the elicitation of experts knowledge in diverse domain ok. So, in many cases we use this particular not only in design, not only in industrial management or occupational health or in you know ergonomics field or human factors engineering field. So, in many diverse field we use it and for applications in you know including system development and instructional design. So, the CDM research illustrates the short knowledge representation the you know the products that can be arise from cognitive task analysis. First is the situation assessment record, then timelines and the decision requirements. So, these are the three major component that we are going to work on.

Critical decision method (CDM)

- CDM was developed as an extension of the critical incident technique (CIT).
- CDM uses in depth interviews to gather retrospective accounts of challenging incidents.
- It is a semistructured interviewing technique for investigating phenomena that rely on subtle cues, knowledge, goals, expectancies, and expert strategies.

So, CDM actually was developed as an extension of the critical incident technique. This is also very old technique. However, there was a requirement to do some specific modification and then only this CDM has been evolved ok. So, CDM uses the depth in depth interviews to gather retrospective accounts for challenging incidents. Here it is very important that you know it is not for every event or it is not for every activities we do critical decision method. Wherever it is very challenging in nature ok it is very critically complicated ok it is very very important. Then only we go for this CDM method. It is very interesting. It is a semi-structured interviewing technique ok. It is not that we completely rely on the structured interview over here. It is a kind of semi-structured interview that we conduct for investigating the phenomena that rely on subtle cues, knowledge, goals. What are the expectancies are there that and the expert strategies? That is very very important. So, we take up some kind of not unstructured, semi-structured interviews to all these type of stakeholders ok mainly the operators.

Critical decision method (CDM)

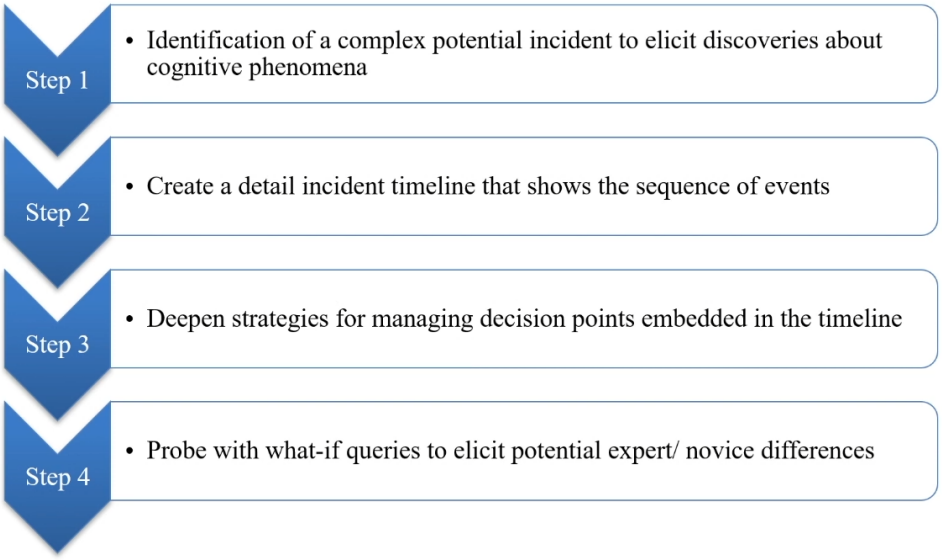
- CDM also shows how one can approach methodological issues surrounding cognitive task analysis, including questions about data quality and method reliability, efficiency and utility.
- CDM utilizes cognitive probes in semistructured interviews to elicit information about how experts formulate their decision-making strategies.
- CDM is used to
  - Generate knowledge for the development of expert systems
  - Develop training materials and identify requirements
  - Determine the effect of expert systems on task performance

CDM also shows how one can approach methodological issues surrounding the cognitive task analysis including questions about the data quality and method reliability, efficiency and utility ok. So, CDM utilizes cognitive probes very important over here that you know it is some kind of probes that we try to use in semi-structured interview to elicit the information about how experts formulate their decision making strategies. So here majorly we will be looking for the strategies ok, decision making strategies when there is a critical incidence. Whatever the critical incidences are there we are going to look back the steps to the process whole points in detail and then we will be discussing what are the critical decision making strategies has been followed by the experts. So, CDM is used to generate knowledge for the development of expert system, develop training materials and identify requirements, determine the effect of expert system on task performance. So, these are the things normally CDM use for their data.

Procedure

- CDM does not use a strict protocol of interview questions.
- It is a structured by a set of interview phases or "sweeps" that examine the incident in successively greater detail.
- A typical CDM session requires approximately 2 hours to move through each of the four interview sweep:

So, let us understand the procedure in detail. So, CDM does not use any strict protocol of interviewing questions ok. As I mentioned earlier it is a kind of semi-structure. So it is a structured by a set of interview phases or you know sweeps, small small components will be there that I will tell you in the next slide that examine the incident in successively generate you know greater detail. So what happens when we have a point, when we have small small probes we try to gather information in the surrounding areas ok. So that is the way how do we collect data for CDM. So a typical CDM session requires approximately 2 hours to move through each of 4 interviews. Normally there are 4 sweep that I am going to tell in the next. So it is like that kind of time consumption. So it is a huge involvement ok. So it is not that easy task. It is require lot of training first of all. It requires lot of time and it needs expertise ok. So that is why critical decision method it is very important in those cases where you know we are actually going to start or we are going to design a very new system taking influence from the old similar system. And we try to get information the know what were the drawbacks of those system and we try to improve upon it ok. So their critical decision method help us to improvise the whole system.



So these are the major 4 steps. So first identification of a complex potential incident to elicit know the discoveries about the cognitive phenomena. So what are the it is not when there is a system. It is not only the know cognitive right. So there are many other components or partially physical components also involved. So we really need to understand what are the cognitive phenomena are present in the whole system. In the second step what we do that create a detail incident timeline. So when we are talking about decision making or critical decision method right. So in that case where there is an incident and we try to understand step 1 what happened. In second what happened. Third what happened. So on a timeline we actually detail out the incident incidents. So different incidences what we try to do put it in a particular timeline and which shows the sequence of event. So once we have the sequence of event in a particular method we really know that where the problem started. So at the end definitely suppose there is an error or there is an accident. However it must have not started at the initial stage or it must have not started at the very end stage. Somewhere it must have started. So we try to do through this method we try to put all these events you know one by one in a particular timeline. And once we understand the timeline and we compare it with the standard then we understand where the problem started. So here it is very very important to detail out the incident on a particular timeline. Once this particular stage is over in the next stage what we do that we try to find out the whatever the strategies has been taken for managing those decision points which are already embedded in that particular timeline. So if there is an error so to overcome that error what are the decisions has been taken, what are the strategies has been you know formulated, how they have tried to, how the operators or the involved manpower has tried to you know discuss this or tried to control it. So these particular strategies we need to find out. Of course it is again retrospective right. So here once it is done something happened then only we go back and

try to understand those things. In the last stage what we do is the probe with what if varies. So we try to you know enquire with the stakeholders okay that what if it happened, what if this happened, that happened something like that. So probe with what if varies to elicit potential expert and novice differences. We try to understand, we try to find out. So once we know what are the type of people were involved in that particular situation and how these things happen then we will come to know that what is the difference between the experts opinion and the you know newcomers. So then we will understand where the training is required, where the you know design interventions are required. So through all these four steps we actually try to get information where the failure in a particular process or system and how critically someone can analyze it, how critically the decision could have taken or how the design intervention can help them to take such decision okay. So these are the steps. Now definitely it is a very important tool and it has lot of advantages. Of course there are disadvantages I am going to tell them.

Advantages

- Elicitation of real incidents.
  - Capturing incidents within an expert's experience that required complex cognitive behavior and thought allows the researcher to identify influences and strategies that might not be included in even very realistic task simulation.
- In-depth iterative structure
  - The four-sweep structure allows for an iterative approach to data collection.
  - So the final sweeps of the interview can deepen on the issues that surface during the initial detailing.

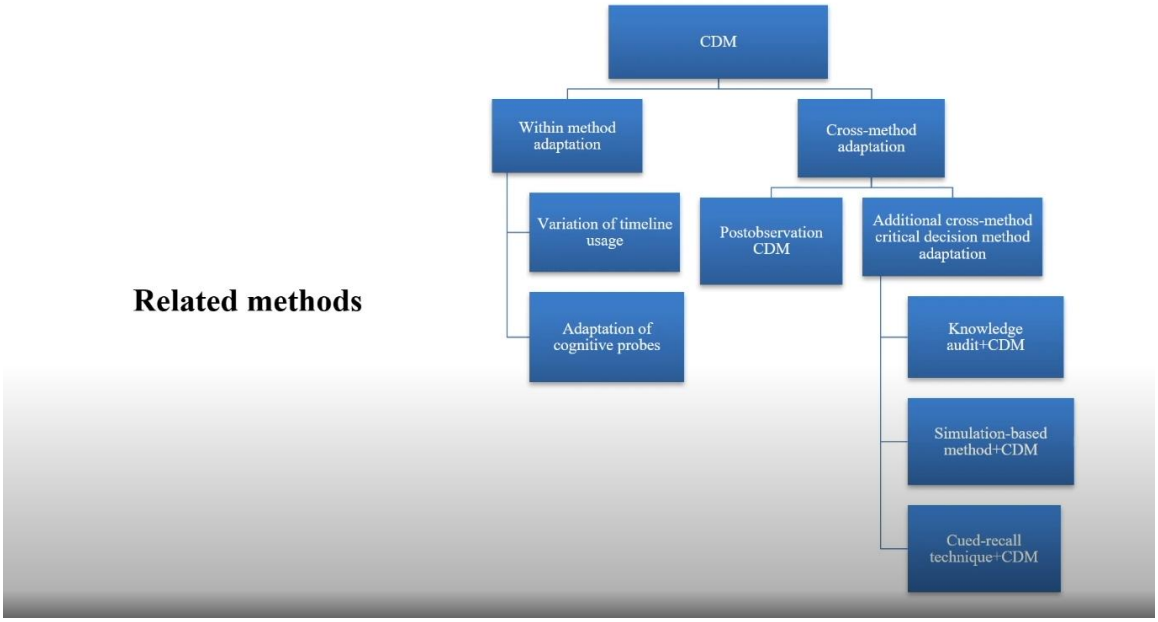
However it has lot of advantages. So very first advantage is elicitation of real incident. So what exactly it says? So you know capturing the incidents within an expert's experience that require complex cognitive behavior and thought allows the researcher to identify the influences and strategies, influences and strategies that might not be included in the very realistic task simulation. Although we have lot of task simulator like suppose I am talking about air traffic control. So we have pilot simulator right. There are, it is a very sophisticated in nature. However after getting training, after getting all these advantage you know all these type of technologies are available still there are accidents right. So when we try to understand those accidents how do we do? We try to analyze the real incident. It is not that we do not do in the simulation. So in simulator we

definitely do all those thing in a realistic manner. However real incident are definitely different than the simulation right. So what it does? So it capture those incidences within an expert's experience that requires complex cognitive behavior. Very important okay, complex cognitive behavior. And you know what you need to do is the thought allows the researcher to identify those influences and strategies. So influences and strategies that might not be included in even any realistic task simulation. So which is not possible in this task simulator? Those type of thing we can really analyze in through this particular method. Next is in depth interactive structure. So the four sweep structure that we discussed already allows for an interactive approach to data collection. So when there are iteration, so what happen that you know there are more number of information are coming. So as long we have an option to iterate that then you know always it is better that we have more options and we can have the comparison and we can choose best among them. So that is why this particular method help you to get more variety. So in the final sweep the interview can depend on the issues that surface you know during the initial detailing. Maybe in the initial phase it was not in detail. However, in the next last stage okay what we can do? We can go into detail and we can have more clarification or better clarification. So that whenever you are redesigning the whole thing you can avoid those elements, you know disturbing elements. Efficiency, the use of critical incident is highly efficient means of cognitive task analysis. It has been proved in different literature. Subtale aspects of expertise are brought into play along with the routine aspect of performance that serve as a background. So you know when you have more variety, so it is not only same thing, routine thing that you are actually doing. So you are actually analyzing those critical decisions okay. So inform the cognitive probes. The cognitive probes and what if queries that we do used in sweep 3 and 4 of CDM have been utilized for you know years and many years. So actually we are practicing it and deemed to be beautiful in research and development environment to capture the whole process okay. So if that happen then what will go? If this happen then what will go? How do you take care of this decision? So these types of probing questions, these types of you know queries from the experts actually help to improve the whole system. So then you can develop more number of designs to give better solution to that particular situation.

Disadvantages

- Uncertain reliability
  - CDM methodologies elicit retrospective incidents, concerns of data reliability have been raised due to evidence of memory degradation over time for critical events and details of those events.
- Resource intensive, small data set
  - The CDM interviews are more demanding than traditional surveys or structured interviews.
  - These cost appear to be more than balanced, however, by the richness of the data obtained from each interview.
- Sophisticated methodology requires training
  - Utilizing the CDM methodology requires a high level of expertise and training.
  - Effective use of CDM also requires knowledge of the cognitive processes/ phenomena being investigated

However, there are disadvantages as I mentioned initially. First I say it is very uncertain in terms of reliability. There are reasons right. When we are talking about uncertainty of reliability, why? Because CDM methodology elicit the retrospective incidence okay. So based on a particular variety we are actually trying to develop something new. So it may not happen that exactly similar thing happen in the new process right. So it is always there is a chance that we the same repeat will not be there right. So what happens that it concerns with the data reliability and have been raised due to the evidence of memory degradation over time because you know if it is a fresh incident the stakeholders can give better information whereas if it is not there may be a lapse of information okay. Then it is very much resource intensive okay. So you understand that you know you need to really collaborate with the all varieties of stakeholders or the operators who were associated with that particular event and the data is very small because you know you cannot have large set of database because one incident one data. It is like that. So the CDM interviews are more demanding than the traditional survey and structured interview as we mentioned and this no cost appear to be more than balanced however by the richness of the data obtained from each interview can somewhere save it okay. Because if there is an critical event and if we understand that really in terms of correct way then that information is definitely going to give you a very rich data which will help you to develop a good system further. However the whole process will take lot of time, lot of resource you know involvement of lot of resources and money. The next is the sophisticated methodologies which requires training. So utilizing the CDM methodology requires a high level of expertise and training and effective use of CDM also requires knowledge of cognitive process or phenomena being investigated. So you really need a skill and experience.



So let us understand what are the connected method and how do we actually take help from each other to conduct these the whole process. So mainly I will say within method adaptation and cross method adaptation. I will describe them in detail and within method we have two majorly variation of timeline uses because you know once we have specific timeline how do we change the timeline, how do we change the decision making and second is the adaptive of the cognitive probes. In the second component that is the cross method adaptation we mainly have the post observation CDM and additional cross method critical decision method adaptation okay. So under the second we have knowledge audit CDM in combination, simulation based method and CDM and cued recall technique plus CDM okay.

Related methods

- Adapting critical decision method to address critical needs:
  - There is two type of CDM methodological adaptations:
    - **With-in method adaptation**- Modify the way of interview conduction
    - **Cross method adaptation**- Synthesize the CDM with other related methods.

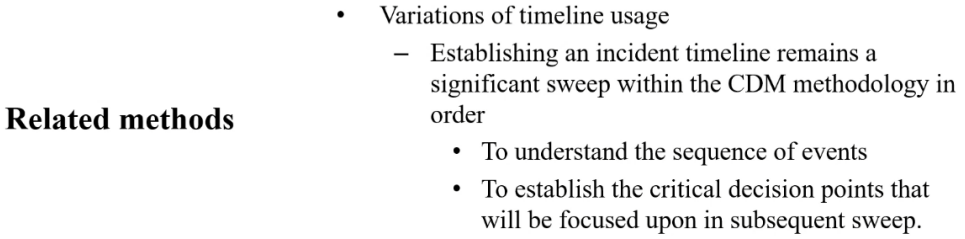
So let us understand all those things in little detail. So this is just the representation in sentences that within method and cross method adaptation. So within method it says the modify the way of interview conduction. In cross method synthesize the CDM in other related method.

Related methods

- **Within-method adaptation**
  - It is several adaptation of the traditional CDM; adaptation of four traditional CDM sweeps.
  - There are two sets of notable within-method variations
    - Variations of timeline usage
    - Adaptation of CDM cognitive probes.

So let us go into detail about the within method. So what it says that it is several adaptation of the traditional CDM okay. So traditionally how do we do from that it is adaptation. However, it is not that exactly same. So adaptation of four traditional sweeps so that we discuss 1, 2, 3, 4. So we are not following exactly but it is some kind of

adaptation. There are two sets of notable within method variation. So one is the variation in the timeline uses and the second is the adaptation of CDM of cognitive probes.



The first one which is related to timeline uses. So what we actually do over here so we establishing an incident timeline remains a significant sweep within the CDM methodology in specific order okay. So when there is a specific order from that order what we do to we try to understand the sequence of event and also we try to establish the critical decision point that will be focused upon the subsequent sweep okay. This we do in the variation of time uses okay. So this variation of time uses will give you some more variety okay. So if this particular incident is happening this time or if it happens in this time that how the whole process will change, how the whole sequence will change okay, where the decision strategies will change. So this will help you to make more iteratives, more alternate design okay.

Related methods

- Adaptations of Cognitive Probes
  - A set of cognitive probes that is effective for successfully focusing on critical incidents.
  - These probes elicit information about
    - Situation assessments
    - Situational cues
    - Expert strategies
    - Goals of incident players
    - Critical decisions and judgments.

So adaptation of cognitive probes, what it does? A set of cognitive probes that is effective for successfully you know focusing on the critical incident and these probe elicit information about situation assessment, situational cues, then expert strategies. Here it is very important when you are talking about expert strategies. So when we are actually doing it now you inquire with the novice people who are not really experienced in that field and then you get idea from the expert people. Now you really understand what are the basic differences are coming and can your design, can your intervention you know make up these differences. So it is very important. And then goals of incident players and the critical decision and judgment okay that we do in the cognitive probes.

Related methods

- **Cross-Method Adaptations**
  - There are two set of cross-method adaptation methodologies:
    - Postobservation CDM
    - Additional cross-method critical decision method adaptations

Whereas in the cross method adaptation there are two set of cross method adaptation, one is you know post observation CDM. So once you complete your CDM you do some kind of you know afterwards that observation and what you actually gaining out of it. And the second is the additional cross method critical decision method adaptation that is also possible.

Related methods

- Postobservation CDM
- The CDM in-depth interview is conducted immediately following an observed event.
- In this event it has to be observed the incident and the decision making during the incident.
- The time is needed

So in post observation CDM what is exactly we do? In depth interview you can conduct immediately following an observed event. So you just observed an event and immediately after that you start following up with the interview. In this type of event it has to be observed that incident and the decision making during that particular incident and of course you can use again the timeline and you can check what is the kind of required time for that and then you can compare it okay. So this way we use CDM and I suggest that we could not take up any you know example for this particular method because I was not having any data with me to represent. So you can practice taking up any particular event and then maybe we can if you have any query we can discuss it okay. Thank you. Thank you.