Cognitive Work Analysis to Comprehend Operations in Self Check-in Counter

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Abstract. Self service check-in is a new service that has been given by the airlines for passenger. This service is able to minimize the use of manpower in the airport and reduce the time consuming for passenger to do the requirement before flying. Cognitive Work Analysis (CWA) is expected to extract the phases and explore the parts that implied to the system. CWA is a method to analyse an industrial complex system which is useful for industrial design. CWA divided into five stages which outlined different function in each stages those are work domain analysis, control task analysis, strategies analysis, social organization and cooperation analysis, and worker competencies analysis. This research used brainstorming as qualitative method and got several results such as there are five categories that implied in the WDA, five categories involved on CTA, seven categories on SOCA, and nine categories implied on WCA.

1. Introduction
As technology become very sophisticated and human required to do their task as quick as possible, the system in public places should be improved to reduce waste time and increase the effectivity. Effectivity means reducing the variability of the process, simplify the action, and reduce several waste [1, 2]. Travelling by the airplane must be given enough spare time. Passengers should pass the x-ray inspection, baggage check, baggage storage, and check in. All the steps to enter the airplane is really takes time. The average time for doing all the stages is approximately 30 minutes when there will no long queuing. Moreover, check in process is a crucial part since it is the first operational step for passengers during their travel [3]. To reduce this critical situation, this paper will outline the developing of self-check in system to reduce the check in time by using cognitive work analysis. Check-in at the airport usually being long queuing because the limited of counter and customer services. By Cognitive Work Analysis, I will create self-check in system which able to use in a check-in machine which provide by the airlines company and any devices such as smartphone, tablet, and laptop a few hours before their flight will be due.

Cognitive work analysis (CWA) is a design, analyse, and evaluation from a complex sociotechnical. The aim of CWA is to improve the system design by exploring parts that implied with the function of it [4]. Sociotechnical is a theory for developing work system, moreover it has strong connection between human and machine [5, 6]. The output of CWA is to breakdown the support design rather than doing the design and the benefit of it in this case is the ability of CWA to generate some function to support developing the self-check in machine. To create a system which used by a human there should be many consideration such as, easy to use, safety, and efficient. The designer always needs developer team who has important role to succeed the system, and the developer team will need related stakeholder to collect some data and tools. All of these schemes will be connected together and will give impact to each other's.
Cognitive Work Analysis is a multi-phases process, it has five main stages which will be concern to their respective duties, those are work domain analysis, activity analysis, strategies analysis, social organisation and cooperation analysis, and worker competencies analysis. It would be hard to run the system when the designer does not have the complete supporting system to make it happen. However, some people might not accept the change of the system, it has high risk to refuse the improvement of the system. Due to this possibility of risk, the system should be planned as well as possible and also should involve the users as the main object of the cases.

2. Theory

2.1. Cognitive Work Analysis

The purpose of CWA is to analyse the parts of industrial complex system and divide them into five stages with specific level on each stages. Those stages are work domain control (WDA), control task, strategy, social organization and cooperation (SOCA), and Worker's competencies. Each level has the different methodology to interpret and collect the data with quantitative method used by experts in the field [4, 7].

2.1.1. Level 1: Work Domain Analysis (WDA)

General characteristics of Work Domain Analysis will be highlighted in this part. In this case, the objective is to unfold the system of self service check-in counter and explore the task of each stakeholders [7]. WDA is developed by five level such as the top level is domain purpose, the second level is domain value, the third level is domain function, the fourth level is technical functions and contextual effects, and the fifth level is physical resources and constraints [9]. The result of this level will give some details in the self service check-in system on the basis of the constrains affecting equipment and human behavior [8].

2.1.2. Level 2: Control Task Analysis (CTA)

Control task analysis will evaluate the essence of tasks, relevant to the functional purposes determined in the level above (WDA) so that every aspects of the technological design can be identified. The specific tasks are listed to accomplish the goals within a work domain. CAT is a good approach to show the personal involves in the control task [10].

2.1.3. Level 3: Strategies Analysis

This is the third level of CWA. The strategies analysis illustrates about specific factors which able to prevent task from completion and uncalculated management risks. This stage helps to find out alternative strategies by which the control tasks can be implemented [8, 10, 11].

2.1.4. Level 4: Social Organisation and Cooperation Analysis (SOCA)

The fourth level of WDA aims to identify of how individuals interact in the constraints on the mine site, and the overall team performance. It creates the interactions in the organizations to optimize the collaboration and communication. This stage mainly outlines the relationship of operators in the organization by verbal processes [11, 8, 10].

2.1.5. Level 5: Worker Competencies Analysis

At the final stage of WDA called by worker competencies analysis which gives some details of cognitive awareness of the individuals and their behaviors when having external situations coming from upper level. A specific tools from Rasmussen called skills, rules, and knowledges (SRK) will be implemented in this stage.

SRK tools categories the human behaviors within relationship of various restrictions in a workplace and the knowledge required for each strategic task. The final result of this stage is an extraction of cognitive processes, and it will be used for improvement in the system design.
3. Materials and Method

3.1. Study Design Overview
The researchers have done the brainstorming with people who have a great impact to the design of self-check-in counter. Obviously, the person who involved in the brainstorming should have experience related with airport system especially airlines system booking and check-in. The result of discussion has been recorded in voice and has been noted to be a consideration when creating Cognitive Work Analysis.

3.2. Brainstorming
Brainstorming is one of the most famous tools for creative thinking [12]. Creative thinking is needed for establish the industrial design which have a great contribution in the developing concepts and specifications for users and manufacturers. Industrial designers are the people who deliver the ideas to an engineer and they are not people who handle things by themselves on creating products so that in creativity has the big impact on industrial design. This is convinced also by Dorval that small group of brainstorming will contribute on a better result for many practitioners in the problem solving are [13]. Brainstorming is a rules which creates to maximize the productivity within the groups and generates some ideas by minimize the production loss. The main objectives of this tool is to improve the creativity in organization [14].

3.3. Participant
The participants that involve in this brainstorming activity are staff research and development facility of the airlines, a ticketing staff airline, and a consumer service staff.

3.4. Brainstorming Procedure
- Identification person in charge of development self-service check-in counter
- Creates an ethics form procedure before collecting the data
- Ask the person in charge to approve the ethics form
- Start the brainstorming in small group

4. Result

4.1. Work Domain Analysis

![Work domain analysis diagram](image-url)
The first stage of Cognitive Work Analysis is Work Domain Analysis (WDA). The WDA concept was developed by Rasmussen and colleagues as a way of structuring information in terms of the means ends links that form the relationships within a system and the representations organise information in a systematic fashion that will support system design. This stage is divided into 5 level of abstractions hierarchy (AH), those are domain purpose, domain values, domain function, physical function, and physical object. The five level of AH will be linked from previous level to the next level to get the interaction between them. The aims of this stage is to understand the environment of the system that will be developed and create some constrains to be focused on the parts that might influence the system.

The first level of Work Domain Analysis (WDA) in this case is to provide self check in system for airplane passengers. The first level will indicate the final goal of the cognitive work analysis. This is the overall system that will be conducted by this case, and it called as domain purpose of work domain analysis. The second level of WDA is domain values which dispatched into five parts. This level will judge the values that will be get from the first level as a domain purpose. Domain values also can be the priority measurement of successful from the system that will be created. By this case, the domain values are the easiness of use by the passengers, the saving time of using that system, could reduce worker or employer from the airport side, enjoyable user experience, and flexibility that users will achieve. The third level is the purpose related function on the second level. This level captures general function of the system necessary in order to achieve system purposes. The example in this case is the function of machine and app software will be provided in the check-in system. The second last level is object related process which have aims to describe the object that will be needed to develop the function. Moreover, the object related process is helpful to dispatched particular object in the last level. Physical object is the lowest level of WDA. It will outline several the objects that will be needed to support another level to make the final goal happen. The object should be physically things and does not suggest to be abstract. The example of the last level are personal computer, internet connection, ticket receipt and etc.

4.2. Control Task Analysis
The second stage of CWA is control task analysis (CTA). The aims of control task analysis is to give the possibility recurring activities that might happen in the complex system. The Figure 2 shows it divides into two part, the horizontal axis as a situation and the vertical axis as a function. The function in this CTA are taken from the purpose related function in the third level of work domain analysis.

![Figure 2. Control task analysis](image)

Inside the table of control task analysis shows the relationship between situation and function. The dashes mean “can be relevant”, the circle mean “usually relevant” and the blank box mean “impossible”. For example in the first row, there are four situation that might happen such as filling
the booking details, synchronise airline data, connecting to internet, and synchronise software. The four of this situation will be observed about their relationship with the first function, that is data source. The result is dashes and dots only located in the first and second situation. It means that the filling booking details and synchronise airline data usually relevant with data source. In the other side, the connecting to internet and synchronise software are impossible relevant with the data source.

4.3. Strategies Analysis

Strategies Analysis is the third stage of cognitive work analysis. The purpose of this stage is to know how the things can be done by several steps. There might be some different steps that possible to take in the same destination. In this case, I choose two different goals related to the check in system and connected to the network.

The purpose of strategies analysis in Figure 3 is to know the steps to check in and they got three different step. The first step is by using the counter check in, the second is by using the application in the devices such as smartphone, tablet, or passengers’ laptop, and the last step is using the self check in machine method. The longest step is using passengers’ devices, it is contain of 4 steps to get their self check in. However this step does not determine the time that will be spent.

![Figure 3. Strategies analysis for check in](image)

The second strategies is how to connect the network in order to access the app software to check in as can be seen at Figure 4. There are three different step to be connected with the network. The main differences is by using the Wi-fi installation, SIM card, and local area network. The longest step is using the LAN network which contains of four step to be connected.

![Figure 4. Strategies analysis for connected to network](image)

4.4. Social Organisation and Cooperation Analysis

This stage will show the staff that will be needed in each situation and function of the case. Sometimes there will be more than one staff in each situation and function. It will help to cooperate each other to succeed the system. In this case there are five different staff which been interpreted in five different colour as be seen at figure 6. There are airport officer, technician, IT controller, provider inspector, and airline ticketing staff. Each staff has their own responsibility, for example the airport officer has responsibility to control the passenger who will use the self check in system, sometimes passengers do...
not know how to use it and need some guidance from the staff. Technician is needed to provide the machine and also provide frequently maintenance the machine. IT controller will check the general problem about the app software in the device and report some problem related connection to provider inspector. However provider inspector should checked the connectivity frequently to prevent technical problem while passengers are using the system. The last one is airline ticketing staff who has responsibility to each data that will be used in the system. They should be cooperate each other and know the part of their responsibility to make the system running appropriately.

The diagram that used here is same with stages 2, the difference is only the interpretation of the colour in each box. If we have a look at the fourth row, the relationship between situation “filling the booking details” and the function “interesting user interface” created the colour red and yellow. This means airport officer and IT controller will be responsible in this part.

Figure 5. Social organisation and cooperation analysis (SOCA)

![Diagram showing social organisation and cooperation analysis (SOCA)](image)

| Situation          | Filling the booking details | Synchronise airline data | Connecting to the internet | Synchronise software |
|--------------------|-----------------------------|--------------------------|----------------------------|----------------------|
| Data source        |                             |                          |                            |                      |
| Provide machine    |                             |                          |                            |                      |
| Provide App Software |                            |                          |                            |                      |
| Interesting user interface |                 |                          |                            |                      |
| Connectivity       |                             |                          |                            |                      |

Figure 6. Interpretation staff of SOCA

4.5 Worker Competencies Analysis

The last stage of cognitive work analysis will outline the competencies for each worker that required by the system. In this phase, the purpose related function in the first stage will be used for the main consideration to create competencies of worker. The competencies divided into three part such as skill, rule, and knowledge. Skill is automatic performances to deal with their job and problems. Skill has strong relationship with experience, the more they solve the problem the more skill that will they gain.
Rule is procedures and guidance to do their job. The rule is made to guide the worker achieve the goals that has been define before the system running. Therefore knowledge is an understanding of situations or facts which have learned before.

Table 1. Worker competencies analysis

| Object Related Process | Skill                          | Rule                             | Knowledge                                           |
|------------------------|--------------------------------|----------------------------------|-----------------------------------------------------|
| Data Source            | Check the upcoming data of booking frequently | Update and synchronize every new booking flight ticket and remove the cancellation ticket, also re-create the new booking details for change time flight | Understand about creating the booking details and know how to change booking details into ticket receipt, so people could use their ticket to enter the gate |
| Provide Machine        | Assembly parts become a machine | Observe the drawing parts of machine, then create the parts correspond with their dimensions, therefore assembly it correctly | Understand about dimensions of machine in some projections and could install each part according to the draft so the machine runs properly |
| Provide App            | Make the programming language become a software design | Design the app based on the purpose, collecting the data that will be used in the app, and developing the software by the programming language | Understand data processing system which transferred from data sources for communicating the passengers with their flight |
| Interesting user interface | Designing the display of software | Observe users interaction with software interface, interpreting users desire to use the software, and create the comfortable design on it | Understand the necessary content on display and could simplify the content to make it feasible for users without ignoring any important details |
| Connectivity           | Connected the device to the network | Count on the numbers of devices and the numbers of possible passengers that might use the device, choose the broadband capacity and install the network into devices. | Understand the network capacity during pick hour and understand how to increase the speed to prevent long queuing |

5. Conclusion
The final result of this research is a model of cognitive work domain which has been outline in the result. The work domain analysis produced categories ease of use, saving time, reduce worker, enjoyable user experience, and flexibility. Control task analysis found out source of information, develop machine, develop app software, interesting user interface, and connectivity. SOCA produced several categories such as data transfer, user input, engineering team, IT support, graphic design, display textual, and fast response system. The last stage WCA which used SRK by Rasmussen taxonomy found out internet connection, wiring, power source, machine design, personal computer, ticket receipt, app software, big internal memory, and touch screen technology.

Acknowledgments
We would like to thank Directorate General of Learning and Student Affair, Ministry of Research Technology and Higher Education for giving us the financial support in this publication as implementation of grant program in the postgraduate improvement quality by the contract number (No.036/B4/PPK-SPK/VII/2019).
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