



UNIVERSITY OF GOTHENBURG



# A study on the improvement of the Bus driver's User interface

*Master of Science Thesis in Computer Science*

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## **Abstract**

*A bus driver performs several different tasks and receives lot of information during the work day. Located on the dashboard is a graphical screen which shows different kind of information to the drivers. This information includes route information and destination sign information. Although there are researches on the occupational health of the Bus drivers, on the driver's working environment. There are practically no studies on how the Intelligent Transport System helps the bus drivers in performing their daily work. A studied was therefore initiated by Volvo Bus Corporation in the Swedish city of Gothenburg with the aim to increase understanding and knowledge of the information used from the bus driver's point of view.*

*Screen, Drivers, Information and Daily*

## **Acknowledgement**

Special thanks to Volvo Bus Corporation for giving us the opportunity to do this study. And also many thank to two Bus companies Göteborgs Spårvägen, Veolia and their bus drivers for helping us carry out this study.

We would also like to thank the two supervisors Åse Lindström and Fang Chen for helping us accomplish this research.

## *Dictionary*

This dictionary contains words and expressions that have to be defined or explained more in detail to fully understand the content of the thesis.

<b>Expression In Swedish &amp; short word</b>	<b>Explanation</b>
ITID	Existing ITS system for bus drivers
ITS4mobility	The Traffic Management system used by Volvo Bus corporation
Omlopp	Paper binder on the Bus/ Block assignment for the particular bus(Journey)
Fordontjänst	Block Assignment for the particular bus
Slinga	Signal for priority signals(Loop)
Omväg	Route Change
Samtrafik	Inter-connection to the other buses
Nästa Linje	The next bus line for the particular bus
Linje	Bus Line
Tur	Turn
TID Indicator	Time Indicator
Visual indikator	Visual indicator
Inställd buss	Cancelled bus
Inre högtalare	Inside volume
Yttre högtalare	Outside volume
Tillbaka	Back
Avbryt	Cancel
Verkställ	Apply / ok
Komfram	Old version of ITID system with tangible buttons
ITID version 8	New Version of ITID system used in outskirts of Gothenburg
Clusuter Panel	Dash board

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# **1. Introduction**

This work has been initiated by with Volvo Bus Corporation. The paragraph below states the background for this particular study.

## **1.1 Background**

In Sweden, one of the important means of public transportation is bus oriented. Bus driver profession according to Dhar [1] is extremely stressful. It is an environment where the drivers have no control because of their schedules and it also impacts the social as well as personal wellbeing of the bus drivers. There have been many studies done in the field of occupational effects on the health of bus drivers and also many studies on the intelligent system in traffic coordination, but practically no work has been done in the field of intelligent systems which facilitates the bus drivers in their daily tasks. So this is a study initiated by Volvo Bus Corporation to investigate the different information displayed on the Graphical User Interface used by the different bus companies. And also how these information can be better displayed to increase the usability of the system.

So this study was done in the city of Gothenburg, which is the second largest city of Sweden. Public bus is one of the important means of transportation in the city of Gothenburg. For complete participation and the understanding, this study was done in Swedish language. In order to facilitate the bus drivers a touchscreen system is located on the dashboard showing different kind of information for the driver; such as route information and destination sign information. This screen is a part of the traffic management system and the ITS4Mobility platform, but is a custom adaptation for the Gothenburg City and is called ITID. Further details about the system will be explained in the coming chapter.

## **1.2 Purpose**

The focus of this study is divided into two main parts. Firstly to investigate the pros and cons of the information displayed in the current user interface of the ITID Screen. The second part of the study is to come up with a proposal of a conceptual design based on the knowledge. So the aim of the study is to gain knowledge of the different information displayed on the user Interface ITID. And also to understand the relevance of the information displayed and how this knowledge can be used with the help of Usability guidelines to improve the user Interface to that it can help the bus driver to perform their task more effectively.

For this study to be complete, this study was divided into 3 specific research questions:-

- What is the different information presented to the Bus driver?
- How useful are the information presented to the bus drivers?
- What improvement can be made on the driver screen?

## **1.3 Intended audience**

The intended audiences within academia are those researchers who are interested in Traffic Management as an improvement in the daily work of the bus drivers. Within the Industry, the intended audience is leading bus manufacturer like Volvo Bus Corporation who is interested in product development and planning. They are also interested providing better solutions and at the same time interested in finding the challenges that exist in present day solutions.

## **1.4 Disposition of the report**

The first part of report focuses on gathering all the different Information presented on the ITID user interface. And at the same time it focuses on the evaluating the information presented to the bus drivers. By evaluation the researchers gained knowledge on the advantages and disadvantages of the information presented on the ITID screen. The Second part of the report focuses on using these knowledge gained from the evaluation and with help of usability guide and to present a design proposal, so that this proposal can be used by the different bus companies.

The second chapter of this report will present the domain knowledge. The different tasks included in the occupation of the bus drivers and the difficulties faced by the drivers. This chapter also includes a description of the current system used by the bus companies, Göteborgs Spårvägen and the Veolia. It also includes the Usability criteria for this particular study. The Usability criteria form a basis to help evaluate the system and a guide on which the researchers developed a design proposal.

Chapter three describes the methodology used to help accomplish the study. The different methods used to gather information about the ITID screen. It also describes the method used for designing the conceptual proposal, as well as methods to evaluate the design proposal.

The fourth chapter describes the results from the different methods. It also includes the analysis of the results. Here the researchers showed what was important for the drivers and what could be improved or added in the conceptual design.

Lastly the discussion section explains the learning process of the researchers at the same time discusses the good and the bad points about the system. And also how the conceptual design was improved with the help of usability guidelines.

## **2. Domain knowledge and theoretical framework**

### **2.1 Working as a bus driver**

A number of studies have been carried out on the work and health of the bus driver especially in the urban cities. These studies tend to show that the job demand is high but yet it offers low control and low support. Bus drivers operate buses that carry passengers from place to place. No matter what the assignment is, they follow a predetermined schedule and travel specific routes. The bus drivers pick up and drop off passengers at different bus stations at regular interval based on time schedules. Bus drivers are not allowed to come to the bus stops too early or too late so that they miss the passengers.

According to Mård [2] while researching the working environment of the drivers has stated that the bus driver profession is a very sedentary, while their working environment is constantly moving. There are many things happening around them like stressful situations such as threats, violence and working alone.

Researcher like Kompier [3] says that a combination of stress and constant risk of physical and mental occupational ill health leads to absenteeism and decrease in productivity. According to Kompier, the bus driver's task is mentally demanding because the bus driver is under constant pressure due to conflicting demands. The bus companies as well as the public themselves expect the bus driver to maintain good contact with passengers and to be service-oriented, for example to travellers (providing information about timetables, routes, stops, fares, etc.). These are also important aspects for job satisfaction. These demands conflict with each other because if the driver's keep service in mind then there is always bound to be delays in the already tight schedule. Another demand to drive safely according to traffic regulation cannot also be kept due to delays while providing service to the passengers. Kompier [3] also says in his paper that these conflicts can be resolved by driving unduly fast and about 25 per cent of bus drivers report that schedules are so tight that traffic safety is endangered almost daily. It therefore seems that, whichever path the driver chooses, he or she will constantly have a conscious or subconscious feeling of inadequacy. Kompier [3] also recommends a solution to help the bus drivers. According to him a combination of the stress management both on an individual level as well as measures to adjust the work environment to individually fit the needs and the abilities of the bus drivers.

While researchers like Kompier [3] and Dhar [1] focuses on the occupational health hazard of the bus driver. Bailey & Hall [4] focused on how Intelligent Transport System can help the drivers in their daily work. According to Bailey & Hall [4] intelligent transport system (ITS) has the potential for improving the overall bus transit systems but also has small potential in increasing bus driver's effectiveness. If ITS can provide information of the about large number of passengers waiting to board the bus, then lateness can easily be managed by the drivers. Baily & Hall also says that ITS can provide information that would help the drivers to better pace their busses over their routes, but can only be realized with changes in work rules and enforcement. As stated earlier in this study the researchers will focus on the information displayed and how they can be further improved to provide better solution so that the bus driver can improve their daily work.



## 2.2 Description of ITS4mobility and ITID System

ITID system is a graphical user Interface for the bus driver, which is located either on or inside the dashboard, it is a small 6, 5 inches touch screen. As mentioned in the earlier paragraph that it is a part of ITS4Mobility platform which is a system for traffic control, passenger information and vehicle tracking. ITID screen is customer adaptations of ITS4Mobility platform and therefore does not include all information as in ITS4mobility. The information that is included in the ITID screen is Time table adherence, logical position along the line, next stop point, Vehicle signs, time, assignments etc. The information on the ITID is updated automatically via Telecom. And only in case of malfunction, the drivers manually update the system by navigating through the different menus.

The main reason for the ITID is that the traffic should flow smoothly both for the passengers as well as the bus drivers. It not only makes the public transport journey more reliable but also more safe and secure by providing more detailed information both to the drivers and the traffic management. The below picture [figure 1] shows the different components involved in the system. The scope of the study is highlighted in red, which is a part of the vehicle computer system called Advanced Information Center (AIC) which manages the resources and calculations to present the real time information to the drivers.

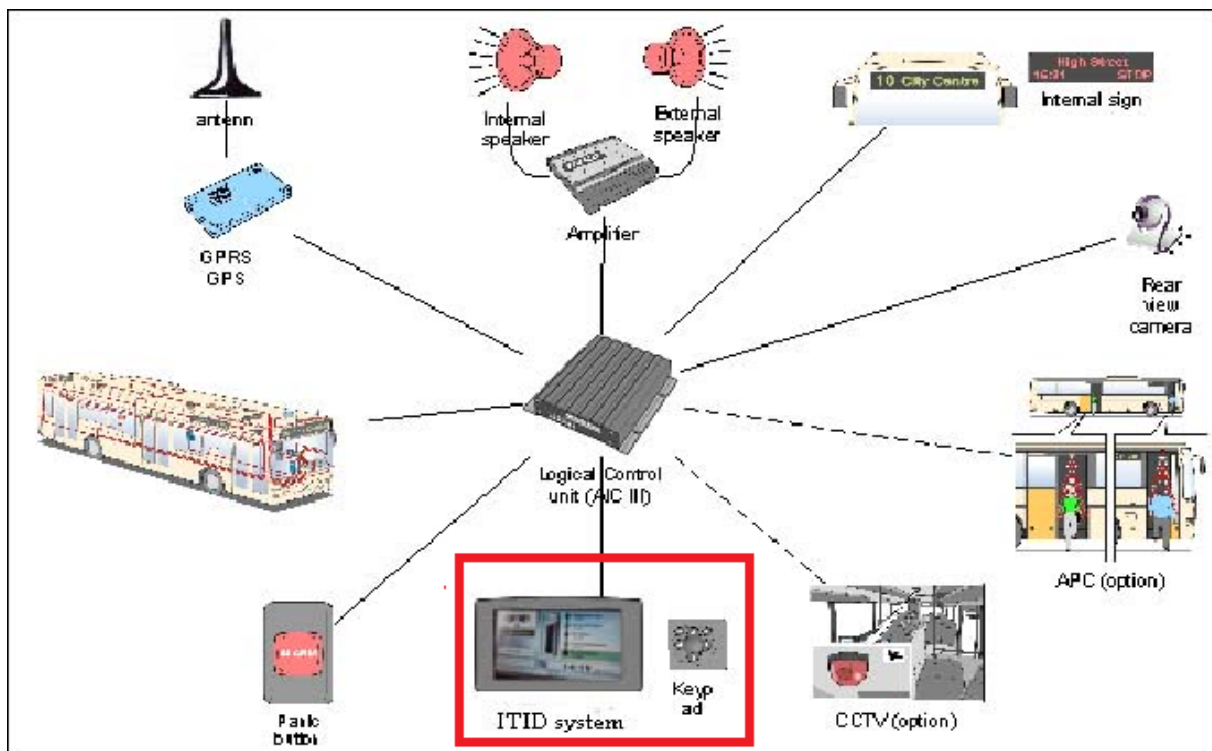
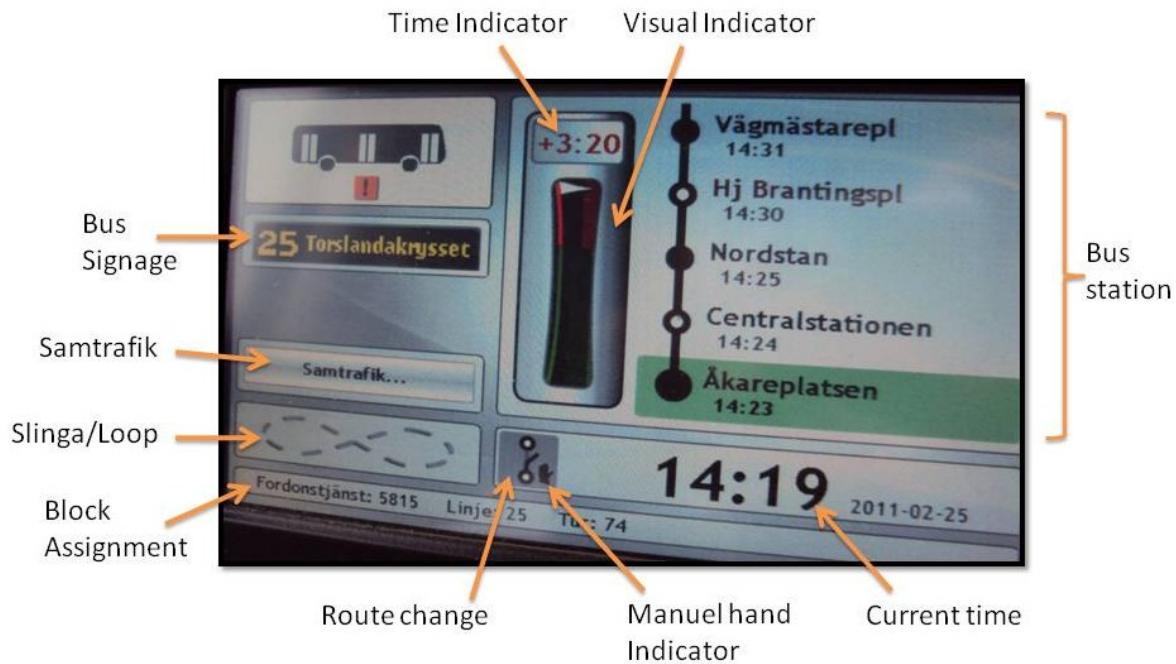


Figure 1: Traffic management system

Another fact about the ITID screen is that, the transport authority of Gothenburg does not give permission to the bus drivers to manually update the ITID screen when the bus is in motion. So the screen does not re-act when the bus is moving and the drivers try to make changes on the ITID. The list below will describe in detail the different information presented to the Bus drivers.



**Figure 2: Default page in Existing ITID system**

## Default Page

The main screen that is visible to the bus driver is the Default Page (figure 2). As the name suggest this is the default page and this page is always visible to the drivers. From this page or screen the drivers can manually navigate to other page or screen. On this default page different information is visible to the bus driver which will be listed and explained below in clockwise manner.

### **Time Indicator**

Time Indicator provides information about the delay or early arrival of the particular bus in relation to the time table/schedule. The '+' or positive sign as well as the numbers in red color means this particular bus is running earlier than its normal time schedule. It also states exactly how early the bus is in comparison to the particular the bus station. The '-' or negative sign as well as the number in green color means the particular bus is running later than it actual time schedule. It provides the drivers exact information in minutes and seconds.

### **Visual Indicator**

Visual Indicator is a red and green bar which provides a visual representation of the delay or early arrival of the particular bus in relation to the time table/schedule. If the white arrow is towards the red color it means that the bus is running early and if the white arrow is more towards the green it means the bus is running late, the more towards the lower green means the bus is running quite late in comparison to the time table.

### **Bus Stations**

Bus stations provide information about next 5 coming stations in the particular route of the bus. As the bus starts moving, it also provides information in meters, as to how many meter left to the next station. It also provides information in time, at which time the particular bus will arrive in the particular bus stations. The bus station is highlighted in green, this tell that

this is the 'current bus station'. Next to the bus station names there are round black symbol which is connected to each other with a thick black line. This states that the bus stations are connected to each other and the round symbol with a hole in the middle states that these are big stations and the bus must stop at these stations even if there are no passengers, waiting to either get off or on the bus stations.

### **Current Time/Date**

Current time and Date gives information about the present date as well as the present time.

### **Turn**

There buses which have the same bus number running the same route throughout the day. In order differentiate the direction, Turn or 'Tur' is displayed which means at which direction the bus is running.

### **Route Change**

Route change or 'Avvikelse' is usually used either manually or automatically when there is a deviation of the bus from the actual route. This usually takes place in case of Route change due to traffic problems. The hand indicator next to the route change means it can be changed manually.

### **Line**

Line or 'Linje' describe the bus number.

### **Block Assignment**

Block Assignment or '**Fordontjänst**' or '**Omlopp**' (Journey) provides information about the particular bus's assignment. Every bus has a unique number which is given unique assignments, this tell the drivers which route the bus will follow throughout the day. A hand indicator also can also be seen next to the Block assignment, when it is updated manually.

### **Loop**

Every time a bus passes a detector, the Loop or '**Slinga**' on the street/road a green light is highlighted on the loop. This is used to regulate the traffic signal giving the bus more priority.

### **Inter-connection**

Inter-connection is also known as '**Samtrafik**' and is used by buses travelling long distances. Inter-connections helps the driver be informed of the buses that await his/her bus. This makes it easier for the passenger to travel long distances in-order to catch the next bus to reach their ultimate destination.

### **Bus Signage**

Bus Signage or '**Skyltning**' states the bus number as well as the end destination of the bus.

### **Bus Icon**

This provides bus door information to the drivers. When the bus opens/closes, it is visible in the Bus Icon. Another function of the Bus Icon is also navigating to the Menu page (See figure 3).

## Menu Page

So with the touch of 'Bus Icon' on the default page, the menu page is visible to the drivers (figure 3). There are 7 icons visible to the drivers. Not all the icons can be used by the drivers. Description of the different Icons is listed below.

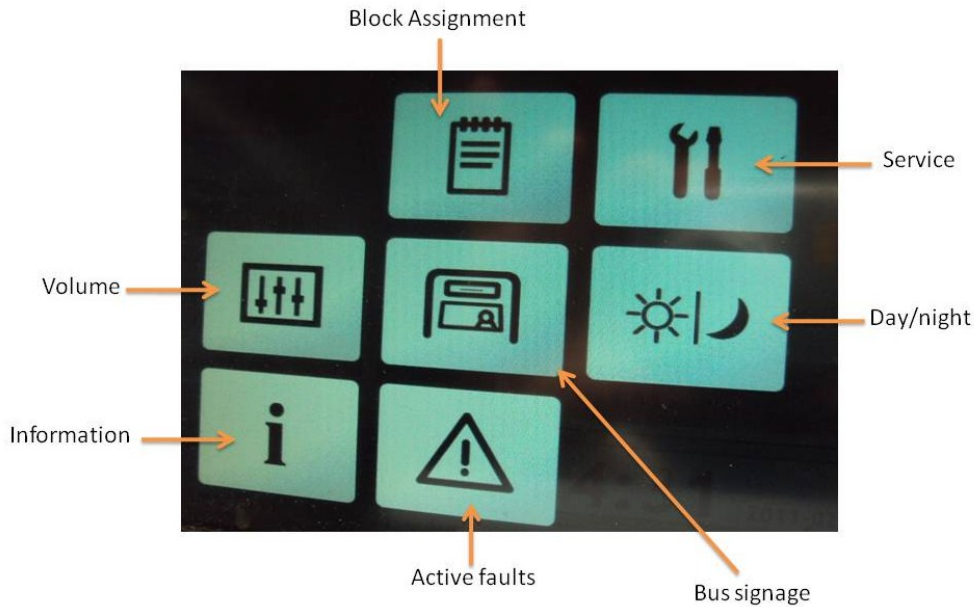


Figure 3: Menu page in Existing ITID system

### **Block Assignment**

Block Assignment is also known as 'Fordontjänst'. From this icon the Block Assignment of the bus can be updated. With the touch of the Block Assignment Icon the screen below is presented to the drivers (Figure 4). The drivers are given different options, like new assignments where he/she chooses different options available to the drivers. Detail on how exactly it is done is explained in the conceptual design section.



Figure 4: Sub Page of the Block Assignment/Fordontjänst/Omlopp in Existing ITID system

## Service

The Service Icon cannot be used by the bus drivers; this icon is for the service personal. The Icon requires you to have a code to log in to the system. This icon was not used by the researcher due to the fact that this was not applicable to the bus drivers.

## Day/Night

From this icon the drivers can manually set the background to either black or white. This can be chosen by the driver to suit their own needs.

## Bus Signage

Bus Signage is also known as ‘Skyltning’; from this icon the drivers can manually update the sign/Number/destination of the bus. The figure below shows the different options to the drivers. The drivers can either choose from “Automatisk Skyltning”, “Special Skyltning”, “Tidigare Skyltning” and “Manuell Skyltning”. Detail on how exactly it is done is explained in the conceptual design section.

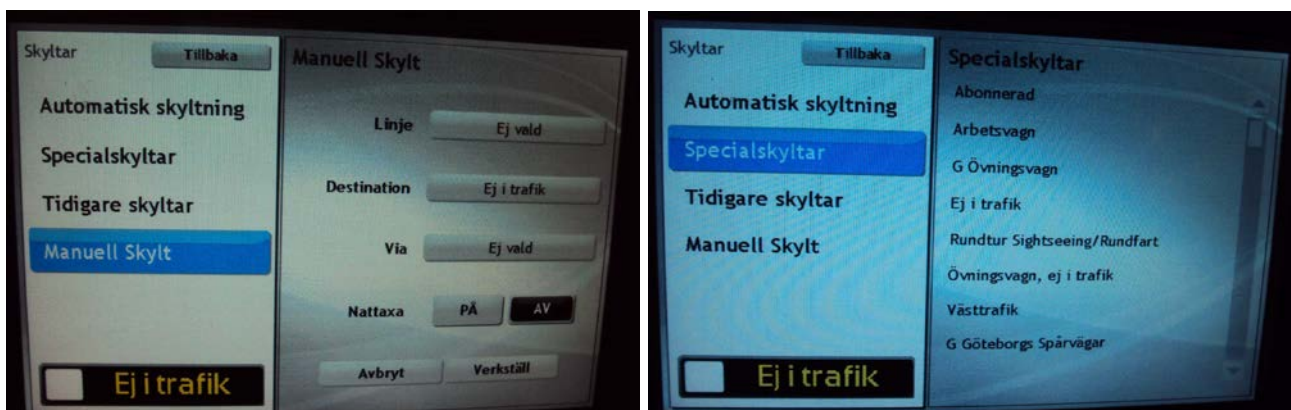


Figure 5: subpage in Bus Signage/Skytning in Existing ITID system

## Active faults

This Icon is used to display information about the bus, especially in case of some technical problem with the bus. An example of this could GPRS/GPS not able to send signal to the bus.

## Information

This is used to display traffic information to the bus drivers.

## Volume

Last but not the least the volume Icon, the drivers use this settings to manually adjust the volume in the bus. The control is connected to either speakers which is inside the bus or speakers outside the bus. The volume adjusted by pressing max or min on the screen. The volume can also test by pressing the ‘volyntest’ (see figure 6)



Figure 6: Subpage in Bus Volume in Existing ITID system

### 2.3 Usability theory

To develop a usable interactive product, is a main concern of interaction design. Having a better understand about the users in the environment where they live and work; can help designers to understand how to design a interactive product that help to carry out their activities in their everyday life. Yet another way to understand users, Preece [6], Nielsen [17] and other authors suggest term of usability and user experience goals to identify and get clear idea about the primary objectives of developing an interactive product. According to Preece [6] usability is “ensuring that interactive products are easy to learn, effective to use, and enjoyable from the user’s perspective”. Preece [6] and Nielsen [17] suggest 6 different usability goals (e.g. effectiveness, efficiency, safety, utility, learnability and memorability) which are presented as being concerned with meeting specific usability criteria. Usability criteria are specific objects “that enable the usability of a product to be assessed in terms of how it can improve a user’s performance” Preece [6]. For an example, time to complete specific task (efficiency), time to learn a new task (learnability).

The aim of this study is to investigate pros and cons about the given information in existing ITID display and improve the system. By the help of usability criteria, ITID system to be assessed in terms of how can improve the driver’s performance in ITID system. Effectiveness (is ITID existing system doing what it is supposed to do?), efficiency (Does ITID existing system support drivers to carry out their task?), learnability (is that easy to learn how to use IT ID existing system for first time user?) and memorability (How easy a ITID existing system is to remember how to use it, once learned?) are the main usability criteria that researchers use for this study. See [Discussion](#) section for the more details.

### 3. Methodology

The bus drivers have been highly involved in the whole study process because they are the actual users of the ITID system and their input and ideas are very valuable for this study to be successful and due to lack of sufficient research done around this area. All information gathered for this research was mainly through observation, interviews and empirical studies. According to Marshall& Rossman [4] these are some of the primary forms of information gathering. The method used to gather data in their pre-study phase was mainly observation. Interview was used to collect different information from the driver’s point of view. Lastly a concept was developed which was evaluated by a usability test actual users. The participants for this research were bus drivers from “Veolia” and “Göteborgs Spårvägen” bus companies. Figure 7 is the research process that has been used for the study. Each method that was used during this study is further described in the data collection section.

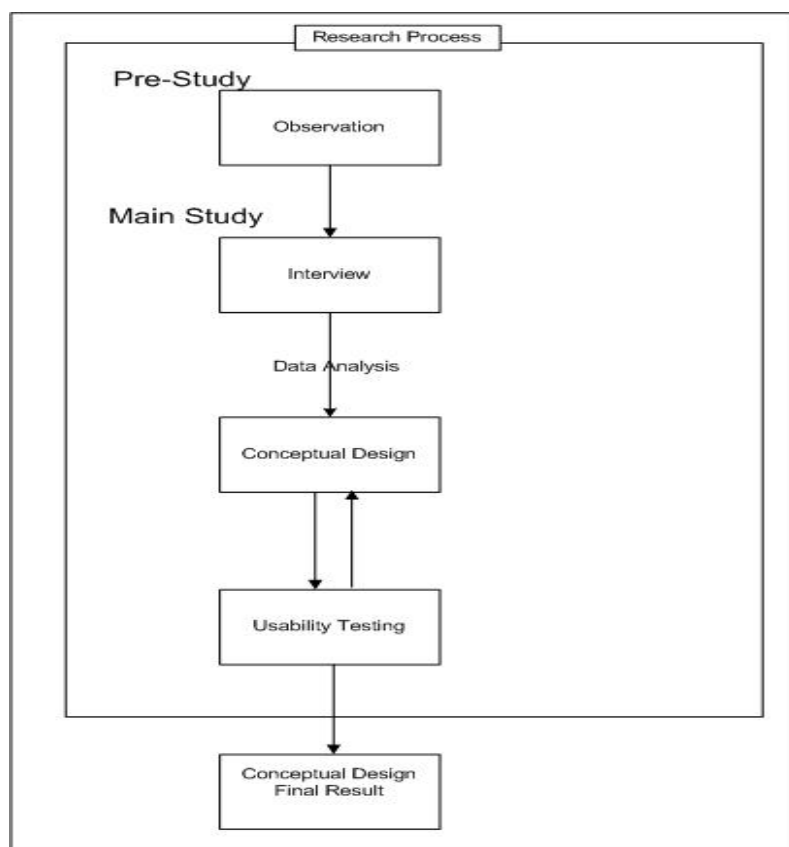


Figure 7: Research Process

#### 3.1 Pre- Study

This was an important phase in the study; this was the phase where the researchers needed to understand the context of use. By understanding the usage of the ITID system, questions for in-depth interview was formed. Pre-study took place within a span of 3 weeks where the bus drivers were observed and also how the ITS system was used by the bus drivers. Besides this, pre-study also included short interviews with the management levels for understanding the context of use.

### 3.2 Observation

Observation as a methodology is mainly inspired by ethnography in which observers actually observe in order to gain insight into people's lives and their problems [6]. Passive observation was one of the methods used to study the ITID system being used by the bus drivers. Similarly in this study the bus drivers were studied by the researchers in their buses. Passive observation allowed the researchers to study the people in their natural setting without affecting the bus driver's behavior. Some researcher like Baker [7] says that observation is a complex method, in collecting data the researchers are required to play different roles as well use all his/her senses. In spite of different levels of involvement with the study group, the researchers needed to remember the primary target at the same time remain unbiased to study. At the beginning of this study researcher needed to understand the system being used in the public transportation and in what context the ITID system was being used. So the study started with the researchers being non participants and complete observers, this was a starting point for future observations and interview. It was passive observation [7], where the drivers were not aware of the researchers observing the drivers in their working environment.

So, different bus drivers from two bus companies, Veolia and Göteborgs Spårvägen were observed for 3 weeks. Around 50 different bus drivers of both sexes were closely observed. The researchers observed the behavior of the drivers towards the ITID screen. The researchers also watched how often the drivers looked at the ITID screen and under what circumstances did they look at the Screen. And when they looked at the screen, did it affect their driving behavior. The researchers also observed if the drivers looked at other devices or tools that helped their driving. The buses that the drivers were observed in were bus number 16, 24, 25, 32 and 99. This way researcher got an understanding of how the system is being used in a public transport. Notes were kept on different drivers as a method for understanding the bus driver's behavior.

### 3.3 Interview

In-depth interview as a method was used to evaluate the ITID system presently used by the Gothenburg public transport. In-depth interviews is considered as good qualitative research technique where a small number of interviewees are interviewed intensively[8] This is a good way of finding out the bus drivers perspectives about the ITID system. It is better according to Boyce & Neale [8] because it might provide context to other data thereby bring a clearer picture. The aim of the interview was to find what the different information is presented to the bus drivers and in what way were their useful are for the drivers. The interview was also semi-structured interview where the drivers were also actively involved. This was because it included both open ended and close ended questions, as well as some probing question [9]. The interview questions can be found in the [Attachment](#).

15 bus drivers from 2 different transport companies Veolia and Göteborgs Spårvägen were involved in this research. Participants chosen for the interview were from different age and gender group, one importance that was common was that all had some experience of the usage of ITID system. All drivers experience ranged for 6 months up 35 years in driving public buses.

The basic way of structuring the interview was funnel shaped technique, where one started with open ended questions which was very detailed, sometimes probing and the interview ended with closed question [10].The funnel shaped structured allowed the researchers to provide an easy, friendly way to begin the interview [11]. Researcher's role during the



interview was to guide the interviewee through the different topics and make quick decision to probe which resulted in valuable inputs from the respondents. According to Charlsetn [11] Funnel shaped interview was useful by beginning broad general question to ending with narrowing questions. The tools used for recording was mainly in video sequence, pictures were also taken of the different ITID system.

Although, the bus drivers were the focus of this study, the researchers thought that it would be good to understand the higher management's expectancy of the ITID system that was being used by the drivers. So 2, short and unstructured interviews were conducted with the higher management levels. It included both with the company level as well as the municipal levels. In this way the researcher could understand that both the drivers and the management levels expected different things from this ITID system. Since this study was from the driver's view, the researchers did not focus on the management levels.

### **3.4 Usability Testing**

Usability testing was used to evaluate the new design proposal. This methodology was used to test the design on the end users of the system. There were 7 bus drivers from the bus company were chosen for the test. 5 of the drivers were participants of the in-depth Interview, while other 2 were completely new drivers. Using this method the researcher could unearth the problem areas, including those areas that could not be found during the subjective feedback.

First version of ITID conceptual design was paper prototypes, so usability testing was done on paper prototypes. This was also due to time limitation and according to Virzi, et al. [11], it is useful during the early design phase. Paper prototyping is an important part of the rapid iterative design process. It cost less both in terms of time and material and gets critical input from the users of the system [12]. At the same time it is easy to make changes on the design as not much time is spent in coding the system. And it also increases usability [12]. But the final version of the conceptual design was the simulator which was implemented in flash.

In the usability test the participants were tested individually in a normal room. Each session started with introduction and explanation on how the usability test would be conducted. One researcher acted as a facilitator while the other recorded the sessions. After a brief introduction, the paper prototype was introduced. Firstly, the drivers were asked to recognize and explain different features and their functionality. Secondly the drivers were asked to perform some sequence of tasks. Think aloud was also used in during usability testing as the drivers just performed the tasks, in this way the usability experts could understand the thinking process of the tester while performing the tasks. Each test was recorded, and the recordings were reviewed. When reviewing the tapes the usability problems were written down.

### **3.5 Conceptual Design methodology**

According to Preece [6] conceptual design is moving all requirements to first design, conceptual model. Conceptual design model can take any different forms such as paper prototype, simulator etc. Preece [6] presents conceptual model is "an outline of what people can do with a product and what concepts are needed to understand how to interact with it".

During this studies researcher followed Preece's [6] conceptual design principals such as keep an open mind but never forget the users and their context, discuss idea with other stakeholders, use low-fidelity prototyping to get rapid feedback and iterate.

The first step was to analyze the data which researchers gathered during pre study and interview by the help of usability criteria. From this stage, researchers got concrete picture about the all requirements and comments about existing ITID system from drivers. The process is helped by considering the issues area and experiment with prototype. During this stage researchers did several iterations in different forms to get concrete design suggestion. Paper prototype and computer base drawing by the help of Adobe Photoshop were different forms that researches used. The conceptual design was carried out based on the result of analysis but keeping in mind Nielsen's heuristic principles and Norman's usability principles.

At the beginning of the stage, when conceptual design was in paper prototype form, the design was tested with a usability testing. Based on the finding from the usability testing, the design was further improved and implemented in Flash simulator. And this can be found in the Conceptual design chapter.

## 4. Results

In this chapter results from Pre-study, Interview and Usability test will be presented.

### 4.1 Pre-Study results

Results from the pre-study showed the context of use and it was observed that ITID system is used to enhance the effectively of the drivers. ITID not only provided bus station information so that the drivers could follow the route information but also time table information as well as time schedules in terms of delay or early to the different bus stops. It was also observed that different parts of Gothenburg city used different versions of the ITID Screens. Volvo Bus Company had their own version of ITID system and it was called 'ITS4mobility'. There were two other systems used in the different routes in the city of Gothenburg. One was called 'Komfram', an old system and the other was newer, it was called 'ITID version eight'. All together there were about four system being used in the by the different bus companies. Since this study was performed in the city central of Gothenburg so only that system was included for this research and this was called ITID.

The researchers also noticed that on every bus's dashboard, there was a binder with number of papers. And at last bus station, the bus drivers always got up from their seats and took the binder and started looking through it. In speaking with the management levels as well as the drivers, the researcher were made known of the fact that the binder was called as 'Journey'(Omlopp) and carried similar information as the ITID system.

### 4.2 Interview Results

Results from the 15 Interviews showed that ITID system is seen as a help and support to the drivers, it not only informed the drivers the different bus stations in the route but also helped in the drivers stay align to the time schedule. There are different types of information present on the main screen of the ITID system. The results will present the different information from the driver point of view.

So the first part of the interview, questioned the interviewee's general idea about the ITID system itself. The questions related to this part of the interview were mostly related to daily usage of the ITID system. In order to better understand the respondent's response the researchers summarized the responses of the interviewee into categories and listed the responses of the bus drivers.

#### General Questions about the ITID system

##### **1. There are different versions of ITID systems existing**

- 72% of the bus drivers like the ITID system and the information presented on the screen.
- 14% of the bus drivers like the paper binder system called 'omlopp'
- 14% of the bus drivers like the old system called Komfram.(which was tangible button system)

## 2. When asked about the information on the ITID system

- 93 % of the drivers liked the information they received from the ITID system, these information was related to automatic updates on different bus stations, Automatic updates on Bus Signage on each Bus and time table's information on bus stations, at what time the bus must reach the particular station and also the distance in meters between different stations.
- While 7% of the driver did not have comments on the screen although used the ITID system but also took help from the 'omlopp'(thought the system was not that reliable) Driver number 05 said, *'It is a machine, I don't trust so much, I believe in Paper binder and my watch'*

## 3. When asked about the satisfaction whole of ITID system

53% drivers were satisfied by the overall ITID system. They were satisfied by the automatic updates of the bus stations, the time table's information and the time indicator which tell whether they have arrived early or late to the bus station. They trusted the Information on the ITID screen.

- According to the drivers, *'if the time indicator shows +1.25 in red it means that it is bad for us but if it show -1.25 in green then it is good for us, It is better to come late to the bus stop then to come early, then we would have not missed the passengers'*
- 47% drivers were not satisfied with the existing ITID system. This was due to many reasons this will listed in the '**Disliked the ITID System**' section below.

## 4. When asked about the 'touch screen'

- 74% did like the touch screen and would use it in the future.
- 26% had no comments about the touch screen.

## 5. When asked about the placement of the ITID System?

- 100% like the right hand side, inside the dash board.
  - Driver number 01 said, *"I like the right hand side as it is now especially in the Volvo buses, because it from this side the passenger come inside the bus. There is a red button signal which we use to open the door at the right hand side "*
  - Driver number 02 said that *"Some buses have the ITID screen on the left hand side, on the dash board. It is really hard to look at the Screen when sun is shining. It is much better to have on right hand side inside the dashboard"*

## Disliked the ITID System

- Cannot use the ITID system when the bus is in motion
  - 60% wanted to use the system when the bus is in motion, Driver 09 *'The old Volvo system with button was better, in case wrong bus station was called aloud. One could press the button to go to the actual bus station on the screen, In this if wrong bus station is called aloud, we cannot do anything, we have to wait until we stop'*

- 33% had no comments
- 7% said that it is right that they cannot use during driving.
- 60% of the drivers said that there were too many steps to make any manual changes to the ITID system.
  - Driver 03 ‘ *When I want to change the volume in the bus, I have few seconds waiting traffic in the traffic light, I want to do it quickly but there are many steps to follow and suddenly I get the green signal, and I have to follow all the steps all over again* ’
- Another reason for disliking the ITID screen was the reaction time being slow.

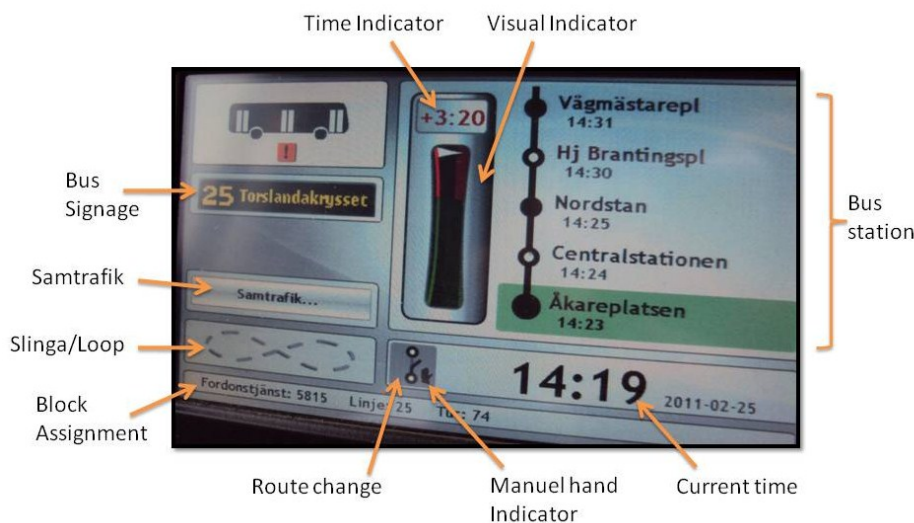
### Features that lacked in ITID System

- Lack of cancelled bus information- 80% of the drivers (there were times that earlier buses of similar bus number was cancelled and the drivers were not informed of this, which created problems for the bus drivers)
- Lack of stop symbol on ITID screen- 73% of the drivers (This feature was not present in ITID)
- Lack of information about connection between in/out sign- 27% of the drivers.(The drivers missed this features because there were times they did not know that the Bus signage was not visible outside to the passenger waiting on the bus stop)

The 2nd part of the interview discussed in detail, the different features and their functionality. It also provided an understanding of how the features helped the drivers accomplish their daily job. The Default Page is 1st screen visible to the bus drivers. It is from the first page that the drivers navigate to the other features. All 15 drivers explained the different features and its functionality based on their understanding. Below is the list of the different features which are list below:-

### Default Page

Different features and functionality on the menu page (see figure 8)



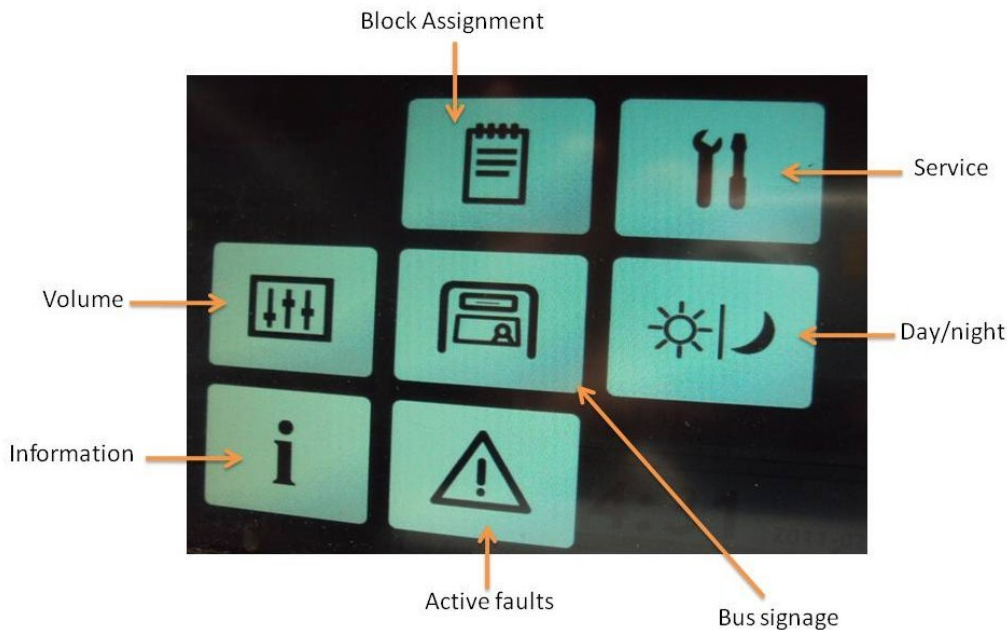
**Figur 8: Default Page in Existing ITID system**

<b>Descending order (Important to less)</b>
<b>Bus stations</b> <ul style="list-style-type: none"> <li>● 93% of drivers understand and use the function</li> <li>● 7% understand, but never use given information. Driver number 5 said '<i>I have many years of driving and I know my route better than the machine</i>'</li> </ul>
<b>Time indicator</b> <ul style="list-style-type: none"> <li>● 100% Understand and use the function</li> <li>● 40% people look at the color (green or red)</li> <li>● 34% people look at +/- symbol</li> <li>● 26 % look at both</li> </ul>
<b>Visual indicator</b> <ul style="list-style-type: none"> <li>● 60% understand and have used this functionality <ul style="list-style-type: none"> <li>○ 20% out of 60% says when look at this we will get stress</li> </ul> </li> <li>● 40% understand, but never use the given information.</li> </ul>
<b>Bus signage</b> <ul style="list-style-type: none"> <li>● 60% people believe there is connection between inside and outside. <ul style="list-style-type: none"> <li>○ 27% drivers out of 60% connection between in and out does not work properly</li> </ul> </li> <li>● 40% understand, but never use the given information.</li> </ul>
<b>Block assignment</b> <ul style="list-style-type: none"> <li>● 93% drivers understand and Use this function to match with the paper binder system 'Omlopp'</li> <li>● 7% understand, but never use the given information. Driver number 7 said '<i>I know my route well and I have been driving for many years</i>'</li> </ul>
<b>Route change</b> <ul style="list-style-type: none"> <li>● 66% Drivers understand what the function and used the function. They have seen this icon appear on ITID</li> <li>● 20% Drivers misunderstood about this function. <ul style="list-style-type: none"> <li>○ 7% out of 20% said '<i>By clicking this Icon we can go to Menu page</i>'</li> </ul> </li> </ul>

<ul style="list-style-type: none"> <li>○ 13% out of 20% said <i>'this is a Slinga'</i></li> <li>● 14% Driver donot understand.</li> </ul>
<p><b>Inter-connection</b></p> <ul style="list-style-type: none"> <li>● 40% drivers can understand this functionality, but have not used the functionality. Drivers <i>'This is city traffic and we do not have a Samtrafik'</i></li> <li>● 46% drivers do not know of this function</li> <li>● 14% ignore, had not comments</li> </ul>
<p><b>Loop</b></p> <ul style="list-style-type: none"> <li>● 33% drivers understand and have used this functionality.</li> <li>● 67% do not understand what is this functions is about.</li> </ul>
<p><b>Current time</b></p> <ul style="list-style-type: none"> <li>● 100% drivers understand and have used this functionality. Driver number 10 said <i>"I would like to have clock on this ITID. When passenger say my bus is late then I can show to them and say see this clock I am not late"</i></li> </ul>
<p><b>Bus Icon</b></p> <ul style="list-style-type: none"> <li>● 46% drivers have used and understand about the functionality.</li> <li>● "By clicking on the bus icon I can go to menu"</li> <li>● 56% drivers ignored</li> </ul>

## Menu Page

There are 7 main features in the Menu page; one feature cannot be adjusted by the drivers as they require special pin code. While 6 features can be used by the bus drivers, these are used in case of GPRS failure or other reason.



Figur 9: Menu page in existing ITID system

Descending order(Important to less)
<p><b>Block Assignment</b></p> <ul style="list-style-type: none"> <li>● 93% Understand the function <ul style="list-style-type: none"> <li>○ 67% Use the function</li> </ul> </li> <li>● 7% ignore</li> </ul>
<p><b>Day &amp; night</b></p> <ul style="list-style-type: none"> <li>● 100% Understand the function</li> <li>● 80% Use the function <ul style="list-style-type: none"> <li>○ 40% Use Night</li> <li>○ 40% Use day</li> </ul> </li> </ul>
<p><b>Bus signage</b></p> <ul style="list-style-type: none"> <li>● 93% understand <ul style="list-style-type: none"> <li>● 67% have used manual function</li> </ul> </li> <li>● 7% Ignore</li> </ul>
<p><b>Active faults</b></p> <ul style="list-style-type: none"> <li>● 7% Understand</li> <li>● 93% Ignore</li> </ul>
<p><b>Information</b></p> <ul style="list-style-type: none"> <li>● 7% understand</li> <li>● 93% Ignore</li> </ul>

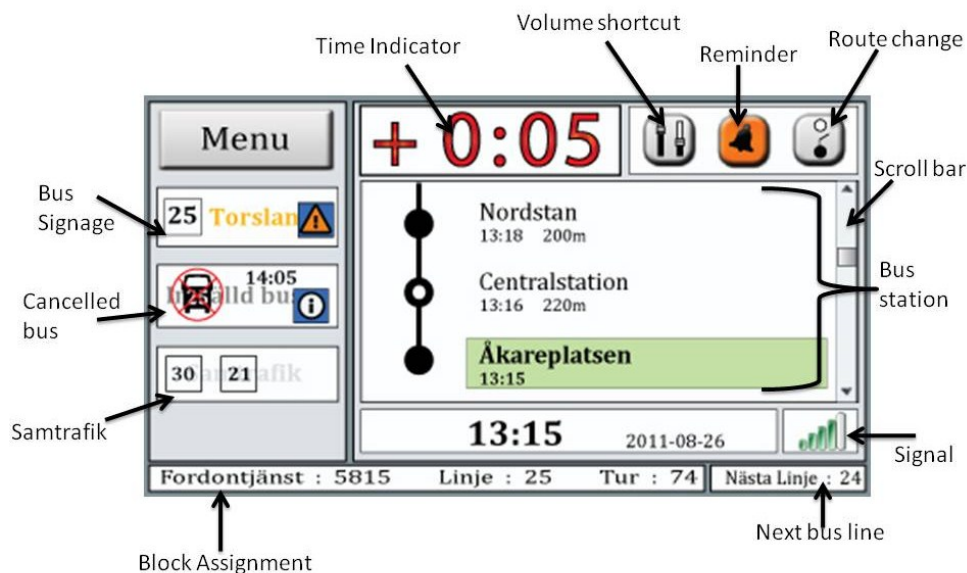


## Volume

- 93% understand
  - 93% Use the function
- 7% ignore

### 4.3 Usability test Results

Usability test results from 7 bus drivers, who participated for the interviews, showed that the most of the features and its functionalities were captured by the researcher. And this is visible in the ITID conceptual design. In the first part of the usability test the drivers got a chance to identify the different information presented in the conceptual design and in the second part of the usability test the drivers performed the different tasks on the paper prototype which given by researcher. The result is presented with different information from the driver's point of view. Figure 10 (Default page) and figure 11 (volume page) represent some of the prototype.



**Figure 10: Default Page Prototype**

On the Default page – prototype (figure 10) 100% drivers recognized and identify Time indicator, Stop button, Next bus line, Bus signage, Inter-connection and Menu button without any problems. 100% drivers recognized the canceled bus function. But they had some design suggestions, driver number 01 said *“I would like to have text format cancelled bus information rather than numbers.”* Driver number 02 said *“it will be more visible if you can change the text color for cancelled buss, then I can see well”*.

Only 85% driver could identify and understand the functionality of the Reminder without problem. There are 15% drivers could not recognized the Remainder. One of the drivers who could not understand the Remainder said *“What is this? I know I have never seen this in the ITID that I am using right now. This is a new function I do not know what this is doing. But I am sure this function is not dangerous to use.”* Around 85 % drivers indentify the volume shortcut without any problems and 15% drivers said volume shortcut icon is too small to recognize. Around 85% drivers agree about the design of bus station with scroll bar and 15 % drivers said *“I want to see more bus stations than 3”*

No drivers could identify the GPRS signal. They completely misunderstood it as a volume icon. Researchers got lot of design idea from the drivers on how to present the GPRS signal icon.

New volume page (figure 11) is totally different from volume page in existing ITID. Researchers had high expectation about the usability test with the actual users (bus drivers). Even though volume page is totally new design 100% drivers understood all functionality of the new volume page without any problems.

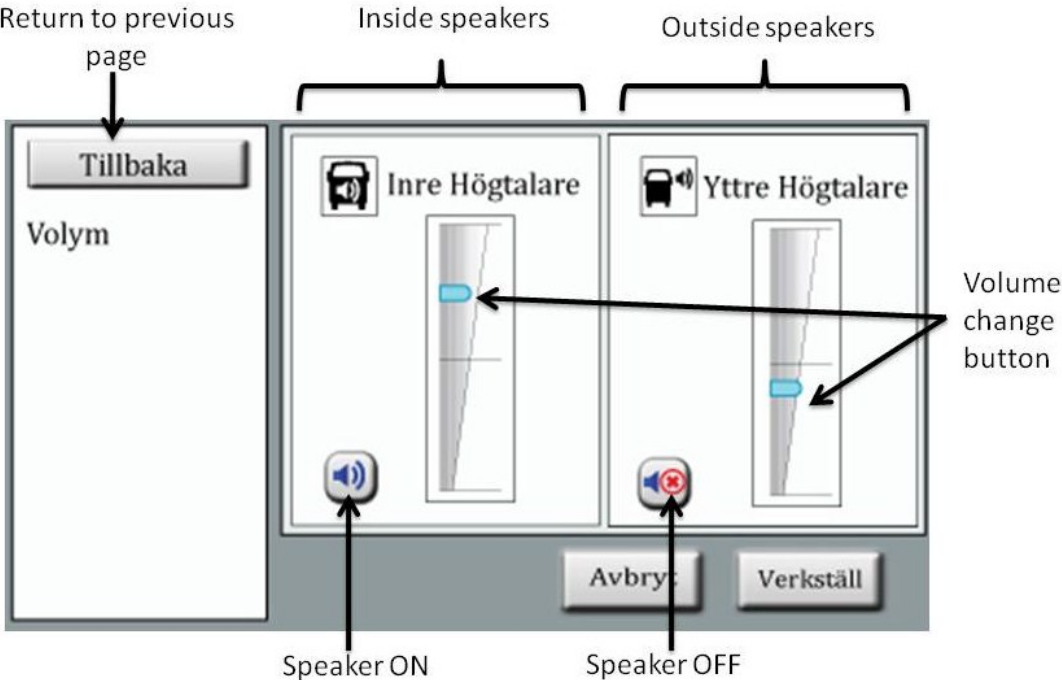


Figure 11: volume page – Prototype

## 5. Conclusions of Problem Analysis

The observation and the in-depth interview results highlighted few problems as well as importance of some information displayed on the existing ITID system.

The first problem, the drivers faced with the existing ITID user interface was that no manual changes could be made to the system as long as the bus was in motion. In order to make minor changes like simple volume adjustment, bus needed to stand still. According to the drivers time schedules for the buses are very tight and it is not often that they can test the volume in advance. It is usually during their journey that they realize that the volume inside or outside the bus needs to be adjusted.

Similarly the second problem with the existing user Interface (ITID) was also related to the volume, when making updates there were too many steps to follow. As stated earlier, time is precious for the drivers; they need uphold the time schedules. Since the existing system has too many steps, it took a lot of time to make simple changes to Volume.

The third problem that the drivers faced with the system was lack of consistency and lack of similarity with the windows presented to the drivers. In the case of making journey or bus signage changes, there is a point or a step within the system that confuses drivers. The drivers also find it confusing to choose something from the windows presented, as there is no cancel or ok buttons (Figure 25) which makes it difficult for the drivers to understand that changes has been done. Neither does it give the driver a chance to regret the decision by pressing cancel.

The fourth problem faced was that, the drivers thought there was a connection between the Bus signage that was displayed outside the bus and the Bus signage that was displayed on the user Interface (ITID). This led to a misunderstanding that if it showed the correct information on the user interface (ITID), it also displayed the correct information outside the bus. But it was not always the case and it was mostly the passengers who discovered that the outside information was not always correct.

The fifth problem that the drivers faced was not all the drivers understood that the Bus Icon is used as a menu to 'Menu Page' – this was due to the fact that all information on the ITID interfaces was automatically updated. It was seldom required by the drivers to manually make updates to the user Interface. So it was difficult for them to understand or remember it.

There was information on the User Interface which indicated more or less similar kind information to the drivers. The Visual and Time indicator provided somewhat same information to the drivers. The Visual Indicator was a graphical representation of how early or late the bus was running in comparison to the actual time schedule. But the drivers were more interested in the Time indicator than the Visual indicator, this is because the Time indicator provided accurate time in minutes and seconds as how late or early the bus is running in comparison to the time schedule. And Time is important for the drivers, as they can pace their driving in accordance, so that passengers are not missed when the bus arrives on the different bus stations.

According to the drivers, not all information that they considered important was displayed on the ITID. Although a stop signal when press by the passenger was visible on the cluster panel or dashboard of the bus. The drivers considered it important to have it on the ITID as well, the

reason being that not all buses have the stop signal within the eye level of the driver. So sometimes it could not be easily viewed. According to them it would be good to have it on the ITID because the drivers view the ITID constantly. There were some information that was displayed on the ITID was not considered important and similar information can be view elsewhere on the cluster panel/Dashboard. One such is the Loop/Slinga, which helps the Bus get priority in the traffic, thus helping to regulate the traffic. But this information can also be seen on the cluster panel.

Service to the passengers is also an important task of the driver. According to the drivers, answering questions related with the different stations is also service to the passenger. Helping the passengers get off at the right station is also considered service by the drivers. So if this information were displayed on the ITID, it would help them provide better service to the passengers.

Another point missing from this system was lack of knowledge of prior bus that has been cancelled. This causes the bus to be delayed even further due there a large number of passengers waiting to get on the bus.

These points needed to be considered when designing conceptual design, at the same time keeping usability in mind.

## 6. Conceptual Design

After analyzing the interview and the usability test results, researchers came up with a design called ITID Conceptual Design (figure 13). ITID Conceptual Design contains important as well as useful functionalities which are missing on existing ITID system (see figure 12). ITID Conceptual design was presented in flash simulator and it provides the user experience to the end user.

Although the drivers wanted to use the system when the bus was in motion, but this conflicted with the bus company's terms. The bus company considered the safety of the passengers, there did not want the drivers to use the system. About 60% still wanted to use the system, although the researchers do not recommend the use of this function. In the ITID conceptual design, driver can restart the system very easily by pressing on the black button at the right upper corner of the frame (see figure 13). This is another function which is not visible on existing ITID system. If there is no activity on the ITID Conceptual design interface within 30sec the system will automatically go back to the home page.

### 6.1 Default Page

Figure 13 shows the new ITID Conceptual Design interface. And figure 12 shows the existing ITID interface. The paragraphs below will detail the new functionalities or the improved functionalities one by one.

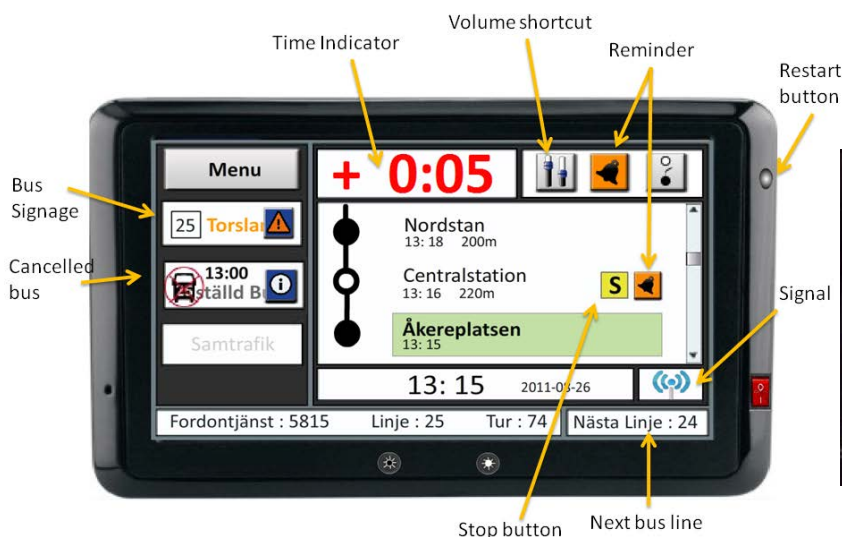


Figure 13: Default page in ITID Conceptual design



Figure 12: Default page in existing system

#### Time indicator

It is the most important function used by the drivers, since the drivers are bound by time and time schedules of the bus. Researcher looked at this function as one of the most important function for the drivers. So when compared with the existing ITID system, the Time Indicator is larger font size and more prominent red making it more visible and eye catching for the drivers.

### **Bus stations & stop button**

Real time updates of the different bus stations make it easier for the bus driver to easily drive the route without having to remember the different stations. Since not all drivers drive the same route through the day, it is very difficult for the driver to remember the different stations. Since the update takes place automatically as soon as the bus is near the stations. It also provided distance estimates in meters and at the same time estimates in minutes and seconds, for the next coming station. The researchers minimized the visibility of five bus stations to three bus stations. By minimizing the visible bus stations, the researcher tried to provide more visibility and clarity, so that the driver could easily see the bus stations. The researcher also provided a scrollbar indicating that the user can easily scroll up or down to see the other bus stations in their route.

### **Useful buttons**

As the problem analysis stated that there were many steps to making changes to simple adjustments like volume. So the researchers have added three short cut buttons on upper right corner of the window. (See figure 13). First button is Volume shortcut button. "Volume". By clicking or pressing the button driver is taken to volume adjustment windows. (See figure 17 for volume adjustment window).

The second button is called "Remainder" which is a new function that is introduced by researchers. When a passenger knows only the name of the bus station and he/she does not know where the bus station is. Then the passenger comes to the driver and says "I want to get off at 'central station' bus station. Could you please tell me where to get off?" In this scenario "central station" bus station will come after six bus stations. The driver makes a remainder or notice about the passenger request. It can also be possible that the driver gets similar requests from several passengers but with different end bus stations. It is not possible to keep all requests in mind while driving and at the same time fulfilling all secondary tasks which are related to driving. In the conceptual design a new function was introduced which was called "Remainder" which symbolized a black "Alarm clock" in an orange background. After such requests from the passenger the driver can find the bus station where the passenger wants to get off, by using the scrollbar. And then simply drags the "Remainder" icon and places it next to the particular bus station. When the bus is coming towards a particular bus station which was requested by the passenger, then the stop 'S' symbol will appear next to the bus stations on the system and at the same time the remainder symbol "flashes" which gives a message and reminds the driver that there is a passenger who wants to get off at this bus station (figure 13).

### **Next bus line**

As stated earlier not all the buses have the same bus number in their route. So the bus drivers must always keep in mind the next bus number. For his help there is a binder which states the next bus number. And it is not possible to look at the binder when the bus is in motion. Since the information displayed on the existing ITID is updated automatically, the bus does not change its bus number before it actually arrives at its destination. According to the drivers knowing the bus number in advance helps the driver remember its route more thoroughly. So the researcher has introduced this feature at the bottom right corner of the system called "Nästa Linje" (see figure 13). For example bus line 27 changes to bus line 32 at the end bus station and will continue as line 32. In the existing ITID system (figure 12), the driver does not know which bus line number he/she has to drive after it comes to the end bus station until he/she checks it out on "Omlopp". In the ITID conceptual design (figure 13) the driver can see the next bus line number in advance.

### **Current time and date**

No changes have been done to Current time and date concept as it is important for the drivers to know the date as well as the time, the only difference between existing ITID system (figure 12) and ITID conceptual design (figure 13) is the size and visibility of the date and time. It has been made larger to be more visible to the drivers.

### **Signal**

Another feature that has been introduced is the signal strength. Since the updates are done automatically via telecom. It not always clear to the drivers that the updates have been done. By providing the signal strength, the driver can be made aware when the telecom is working or not working properly. So at the right side below the “bus stations” and above the “Nästa Linje” one can also see “Signal”. This symbol represent of GPRS signal (figure 13).

### **Menu button**

In the existing ITID system (figure 12), there is a Bus Icon at the left top corner. As the interview result presents that only 46% of drivers can understand this function as navigational button to go to Menu page. To avoid this problem researcher added a text to the button which is called “Menu”. Menu button is visible at the left top corner of the interface (figure 13). By clicking on the menu button, driver can open menu page where driver can change functionality manually. (See figure 15).

### **Bus signage**

Just below the menu button, Bus Signage can be visible. In existing ITID system (figure 12) driver can see only bus line number and destination. The ITID conceptual design (figure 13) has several advance functionality for “bus signage” than existing ITID system. Passengers outside the bus can see bus signage at the in front of the bus or side of the bus. It is possible that bus signage does not work sometimes. In such situation the driver does not have any knowledge that the signage is not working until passenger come and inform about it. On the other hand around 27% drivers want have a technical solution for this problem. To avoid this problem, researchers introduce new functionality on ITID conceptual design. If outside signage is wrong or has error, then driver get a notice on ITID conceptual design system (figure 13) “Orange icon” with blue background catches the driver’s eyes very easily and driver can see for detailed information by clicking on the “Exclamation icon”.

### **Cancelled bus**

Cancelled bus or “Inställd buss” is a new function that can be visible on ITID conceptual design (figure 13). Around 80% drivers complained and discussed about lack of cancelled bus information and the kind of problem they faced when they were not aware of earlier bus being cancelled. As a solution, the researchers introduce a new function called “Inställd buss”. When the previous bus is cancelled, driver can see cancelled bus number and time on the ITID conceptual design interface. If driver want for the more information regarding cancellation, driver can click on information icon. (See figure 13).

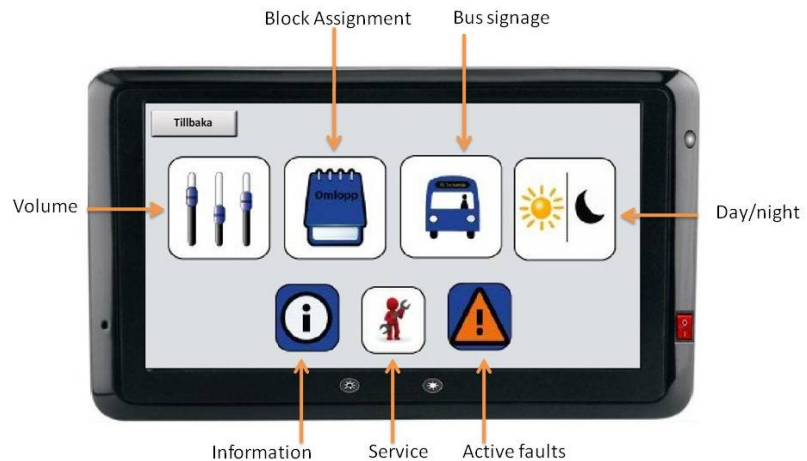
## **6.2 Menu page**

When driver click on the menu button on the Default Page (figure 13), menu page will appear (see figure 15). Form here the driver can manually updates functionalities. The 4 large buttons are more useful and important functions. The difference between existing ITID system (figure 14) and ITID conceptual design (figure 15) is that ITID conceptual design has large button with colorful icon which will more realistic and recognizable. By clicking on “Tillbaka”

button on the ITID conceptual design user can always go back to previous page. This functionality is totally missing on the existing ITID system (figure 14).

**Figure 14: Menu page in existing ITID system**

**Figure 15: Menu page in ITID Conceptual design**



### 6.3 Volume

If driver wants to change volume level in the existing ITID system, driver has to press on the bus icon on the default page (figure 13) then they will come to Menu page (figure 15) then press on the Volume icon to open volume page (figure 17). In the existing ITID system there are too many steps to follow to change the volume. There are two ways to this volume level change, firstly by clicking “Volume” button on Menu page (figure 15), driver can go to “Volume page” or by using the shortcut “Volume button” which is present on the Default page(figure 13), driver can go to “Volume page” also. In this page driver can control the both inside and outside volume. Figure 17 represent the volume page of ITID conceptual design.



**Figure 17: Volume page – ITID conceptual design**



**Figure 16: Volume page - existing ITID system**

In the existing ITID system volume page (figure 16) driver has to press several times on the max button to increase the volume level. The driver does not have time to perform so many steps for a simple task. To avoid such problem, researchers introduce drag and drop button to change volume level. ITID system is built on the touch screen and driver can easily perform task without wasting time. In figure 17 is a volume page for ITID conceptual design and in this scenario “Inre Högtalare” is ON and “Yttre Högtalare” is OFF. Driver can switch on “Yttre Högtalare” by clicking on “Speaker off” icon which can find at the bottom of the “Yttre Högtalare” square. If driver want to increase the outside volume, driver can drag the small blue button and drop near to end line.

Driver can click on “Verkställ” button to apply he/her changes or Driver can cancel all changes by clicking “Avbryt” button, then system will go back to menu page. Driver can always click on the “Tillbaka” button to go back to previous page. After click on the “Verkställ” system will save all applied data and go back to the Home page. Above three



buttons (Verkställ, Avbryt and Tillbaka) have similar functionality and user can see those buttons in different places in the system.

## 6.4 Block Assignment

By clicking on the Block Assignment also known in Swedish as “Fordontjänst” button on the Menu page (Figure 15) driver can open the “Fordontjänst” page where driver can change their bus assignment manually (Figure 19). Figure 18 represent existing ITID system Block Assignment page.

Driver can fill data by pressing on the text field. When driver press on “Fordontjänst” then system will open a new window (Figure 20) and driver can find the data by scroll up and down or search on the search field which place on middle of the interface. After select particular data driver can click on “Verkställ” to apply his/her choice, or driver can click on “Avbryt” go back to Menu page or Driver can go back to previous page by clicking on go back to previous page by clicking on “Tillbaka”.

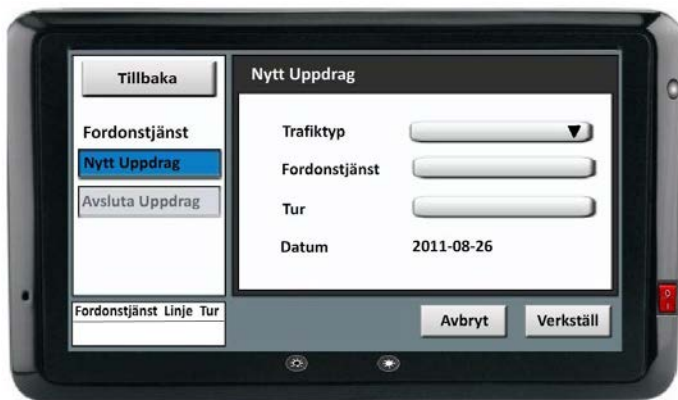


Figure 19: Omlopp /fordontjänst - ITID conceptual design



Figure 18: Omlopp / Fordontjänst - existing ITID system



Figure 20: Omlopp/ fordontjäsnt sub page – ITID conceptual design

## 6.5 Bus Signage

By clicking Bus Signage button on Menu page (figure 15) driver can open the Bus Signage page where driver can change bus signage manually. In this scenario system is in “automatic mode” and manual button on the left side of the picture is inactive. By pressing the “AV” button driver can change the mode to manual. In the bus signage – Manual (figure 24) can see bus signage in manual mode and driver can add new signage or used signage which is already saved in the system or use a special signage. When user presses the sub menu under the Manual, the result will appear at the right side of the page.



Figure 22: Bus signage Automatic - ITID conceptual design

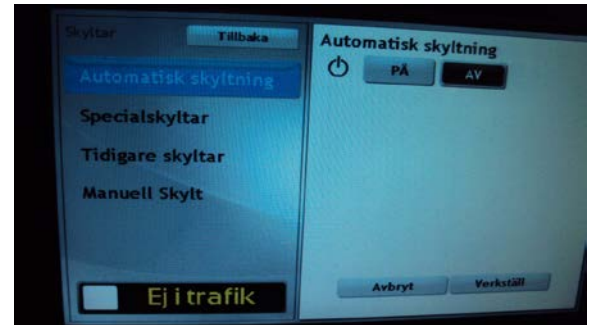


Figure 21: Bus signage Automatic - existing ITID system



Figure 24: Bus Signage – Manual – ITID conceptual design

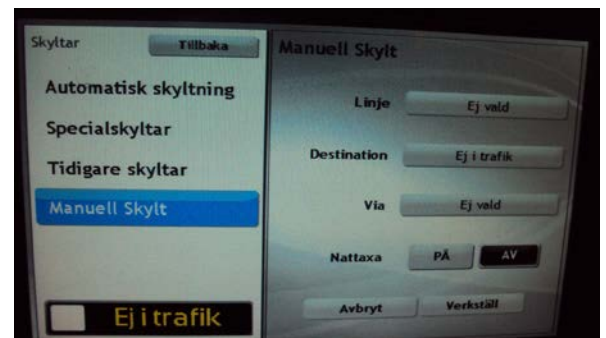


Figure 23: Bus signage Manual - existing ITID system



Figure 26: Bus signage - Manual sub page – ITID Conceptual design



Figure 25: Bus signage sub page - existing system

Figure 24 shows interface for how to add new bus signage. By clicking on the text field driver can open the new window where he/she can find data. (Figure 26) This is having same functionality as Block Assignment/Fordontjänst subpage (figure 20). User can click on “Verkställ” to apply the selected data or click on “Avbryt” to cancel the changes. Use always can go back to previous page by clicking “Tillbaka”.

The clear different between existing ITID system and conceptual design are when the system is automatic mode driver can see only Automatisk and Manuell (see figure 22) where ITID existing system (figure 21) driver can see all options. When system is in Manual mode driver can see all option that he can do manually in the ITID conceptual design (see figure 24). Main different between existing ITID sub page (figure 25) and ITID conceptual design (figure 26) is on the ITID conceptual design driver can search his/ destination or able to cancel and go back to pervious page while existing ITID system (figure 25) driver must choose some destination or press on ”EJ vald”. In this case there are no buttons and system force to driver to do some performance which drivers does not want.

## 6.6 Information



Figure 28: Information – ITID conceptual design

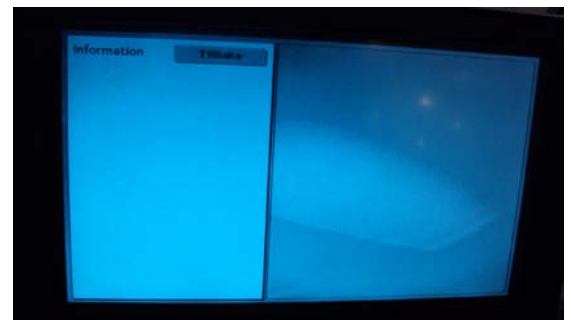


Figure 27: information – existing ITID

By clicking on the “Information” button on the Menu page (figure 15) driver can see information about cancelled bus or traffic information (figure 28). There is a connection between “Cancelled bus” function on Default Page (figure 13) and Information page. User can get detailed information about particular cancelled bus from Information page. This is a missing functionality from existing ITID system’s information page (figure 27).

## 6.7 Active faults

By pressing on the “Exclamation” button on the menu (figure 15) page, drivers can get “Aktiva fel” page (figure 30). In this driver can see technical problem with the bus. In this page driver can find details information about signage fail. This functionality is missing on existing ITID system’s Aktiva fel page (figure 29).



**Figure 30: Active faults– ITID conceptual Design**



**Figure 29: Active faults– existing ITID**

## 7. Discussion

The researcher looked into the usage of ITID system through observation and direct interviews. Results showed that the ITID system improves the effectiveness of the bus drivers [4]. Time indicator in the ITID system helped the bus drivers keep the time schedule of the Bus. Easily interpreted real-time information on timetable means the driver can concentrate on smooth safe driving. Information that helped the drivers improve effectiveness was the presentation of the five different stations. This helped the driver keep themselves updated with the next bus stations; it also helped answers bus station questions from the passengers. Besides bus station information, the ITID also provided help with current time and date. The findings also showed that the automatic updates of the bus signage, the bus routes, time indicator and others seemed very helpful for the drivers. All information is automatically updated via GPRS/Telecom. And all these information helped the bus drivers facilitate his/her job.

The finding from the results also showed that some of the features were inapplicable; one such example is “Slinga”. The functionality of the “Slinga” is to provide information about different signal points. These signal points are placed on different location on the road, at the junctions and at the bus/tram stations. As soon as the bus passes over these signal points, the signal information is relayed on the dashboard and on the ITID screen. Therefore drivers look at the dashboard to get signal information and the information on the ITID system is ignored. The researchers have therefore removed “Slinga” from conceptual design. Hartmut Obendorf [14] dictates Jacob Nielson in his book ‘less is more’ in Usability Engineering, every extra elements or features adds more work for the users to use the features. According to Nielson [16] fewer options provides better usability.

Another feature that was replaced was the “bus” icon (figure 2). It was replaced with the new icon called “Menu”. According to drivers the functionality of the “bus” icon was similar to the menu. The “bus” icon and its functionality are not recognizable by the new drivers or first time user. At the same time this “bus” icon provides the driver with other information or functionality such as visualizing door opening. This door opening and close function can also be visible on the dashboard and the drivers preferred to have it so. Therefore drivers would rather use the dashboard for door information than ITID system. Due to this reason researchers have replace “bus” icon with “Menu” icon and removed the bus door functionality from the ITID because this was repetitive information. One of the important design principles is visibility and affordance [15] The ‘Menu’ icon is easily visible and at the same time presented as a button which gives a clue to how this icon can be used.

According to Dhar [1] bus profession is extremely stressful. Bailey. et. al says ITS system can help the drivers perform their job effectively. Similarly ITID system helps and fulfills drivers need. ITID is a special system, it was developed to cater to the needs of the bus drivers in the city of Gothenburg and therefore it requires bus drivers for go for special training to use and understand the System. According to the Preece et al [6] in order to introduce a new system, researchers have to consider target user group and in context it will be used. Similarly, when designing conceptual design the researcher focused on the functionality which drivers found important and helpful. At the same time the researchers removed those functions that were not used by drivers. New function was added in to the conceptual design which is useful to the driver such as “*Remainder, Cancelled bus and other*” (see figure 13). Another principle of design that was used was Recognition; the driver should be able to recognize the alarm icon/Symbol which is a very common symbol for Alarm to remind

something. Similarly this concept was used for ITID conceptual design to remind the drivers to help passenger get off the bus on the requested bus station [7][15][16].

Consistency was another principle that was considered when designing the concept design. According to Norman [15], when designing interface to perform similar operation, similar elements should be used to achieve similar task. This way it is easily for the user to learn the actions and also form an understanding of the system. And the users quickly transfer prior knowledge to new context and focus on relevant task. Similarly the researchers have used this principle on adding a cancel/Ok button to regret/validate a choice which was not consistently used in existing ITID system (see attachment A). Another form of consistency was that the researcher have added is similar layout to the different setting pages so that the user should easily recognize the layout than to recalling on how to perform the task.

Flexibility and efficiency of use was also added to the ITID conceptual design. According to Nielsen [16] accelerators should be used to speed up the interaction. Similarly Short cuts to the feature like Volume was added, this was due to the fact that navigation to the different settings could only be done when the bus is not in motion. Volume is one of the features that the drivers considered as important and often use this feature. Due to lack of time at a traffic signal, navigation through the volume setting made it difficult to adjust the volume. Therefore the researchers added a shortcut to the volume. Another point that adds flexibility and efficiency to the design is the fact that the drivers can do same task in two different ways, therefore providing more control to the user.

One fact that the researchers had to consider was that, the ITID system is local system, developed for the drivers of Gothenburg. This point was highlighted during usability test, where the researchers introduced a new icon for GPS / GPRS signal (see figure 10). The result was that, it was misunderstood by the drivers as volume icon. The icon introduced by the researchers was similar to common network symbol which can be found on any computer or the mobiles. The researchers considered it to be a common and easily recognizable by normal user. As mentioned earlier that the drivers look at the icon and symbol in ITID in different perspective. Therefore the researchers managed to change the design according to the driver suggestion of GPS/GPRS icon (See figure 13).

Another factor that the researchers had to consider was the fact that although there were differences of opinions between the bus drivers and the management level (Västtrafik) with regards to the safety issue. Although the company did not allow the use of the ITID system when the bus was in motion, but the bus drivers still wanted to use the ITID system when in motion. Since this study focuses on the driver's opinion, keeping them in mind, a tangible button was introduced on the side of the ITID conceptual design system (see figure 13). This gave the drivers the freedom as well as the responsibility to choose whether to have the switch on or not.

Interview and observation used as data collection methods. Because of data collection methods researchers got both disadvantages as well as advantages, in another word pros and cons.

### **Advantages**

Some of the advantages of this study was that researchers got a chance to study the real users of the system, existing ITID system. Bus driver or interviewee as a real user, has some years or months experience about the system and he/she exactly knows how the system works, how

it should work, what are the functionality missing from the system. Because of this reason researchers receive trustable, valid inputs from the interview. Researchers got a chance to interview with management level. Although it is not within the scope of this study, researchers see clear differences between management level and bus drivers in relation to the views and requirement about the ITID future design. The management levels are interested in removing all control from the bus driver and making everything on the ITID automatic. Since this study is based on driver's point of view, researchers had presented the result only from bus drivers' side.

Another advantage of this study was the researchers got a chance to try the existing system in the real time and visited the traffic control system in Gothenburg. That experiences and knowledge helped researchers during interview with bus drivers.

### **Disadvantages or problems**

For then interviews, the researchers had used printed photos to represent the existing ITID system. During the Interview the Interviewee said aloud "*When I press bus icon in home page I can open menu page*" and the researchers put menu page printed paper on the top of the home page. These printed papers help drivers to remember the existing ITID system. So there was a lack of the real system which might have given a better result.

Another disadvantage was that, researchers did not get chance to choose participants for the interviews. These participants were provided by the different bus companies. At the same time researchers could not push the bus companies to get better interviewees. This was the reason as why the researchers could not categorized collected data under different categories such as gender, different age groups. Researchers interviewed 3 female drivers and 11 male drivers. Another problem faced by the researchers was that the room where the interview took place was not always empty or available due to which others there were huge amount of disturbances. In some case researchers did not get individual answers without getting common answer from drivers who were sitting in the rest room. As an example if the given question is very interested or does not have concrete answer for that, then interviewee turn to his/her colleagues who are sitting in the rest room and asked about their opinions. This scenario happened several times during interview phase.

Finally as a contribution for this paper, researchers wanted to highlight, what are the requirements from end users. Drivers are the actual users of the ITID system and they have better idea about what type of functionality they want or not in the ITID system. Understanding the user and their work environment, help designer to develop high usability product. 888

## **8. Conclusion**

In this study, the researchers investigated the ITID system showing different information to the bus drivers in the city of Gothenburg. The researchers evaluated the current system from the bus driver's point of view. The information was gathered and analyzed, and then sorted and prioritized. Results from findings helped in shaping a conceptual design. The design was developed based on the different principles of usability. The participants of this study responded positively to the conceptual design, as this design was a result of driver's participant. So In conclusion we can say that by understanding the actual end user of the system, their needs to carry on their daily work. At the same time understanding the information displayed on the ITID Screen and adding the usability design guides, a better product concept can be developed.

For future works, more studies can be done from the drivers and the management point of view. The management concerned with digitalizing all device leaving very little control for the drivers, while drivers still want to use tangible buttons.



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## **Attachment A – Interview Questions (Swedish)**

### **Alla Frågor är värsta fall (Scenario)**

Mål grupp: 15-20 bussförarna (Veolia & GS Buss)

#### **Bussförarnas bakgrunds information**

- Kan du presentera dig själv för oss?
  - Namn -
  - Ålder -
  - Kön - (M/F)
  - Företag - (Veolia / GS buss)
  - Hur många års erfarenhet har du som bussförare
  - Vilket pass jobbar du mest, Morgon/ Kvällpass?
- Bakgrunds information (linking Ques)
  - Ursprungligen från -
  - Hur länge har du bott här i Sverige -

#### **Information till och Från förarna (Miljö runt hannom/henne allt annat)**

- Vad är Omlopp? Kan du förklara mer? Hur ofta tittar du på Omlopp?
- Vilken typ av information ser eller hör du när du kör buss? tex, Instrumentpanel, ITID(AIC Display), och knappar? Kan du förklara mera?
  - Vilka information behöver du?
  - Varifrån får du det?
  - Finns det någon information du inte vill ha eller saknar?

#### **Stoppknappen**

- När passagerare trycker på stoppknappen, hur känner du till det? ( uppföljning frågor) är det bara ett ställe eller? Tycker du att placering är bra eller vill du ha den på ITID?
- Hur känner du till när det är bara en dörr som är öppen, finns det något meddelandet eller visual grej som informerar om det?

#### **Information till Passagerarna**

- Hur ofta passagerarna har kommit fram och frågat dig information ?
  - Vilken slagsinformation?
  - Ha du alltid svar för för dem? finns det nån slags hjälp från systemet som hjälper dig att besvara på de frågor som passagerar har ställt?(ITID system)
- Har det hänt nångång att passagerar ha kommit fram till dig och frågat dig om tidigare buss som inte ha kommit. Hur informeras ni om det(tidigare buss inställt)? Bilr ni

informerad av olika situationer, typ om olyckshändelse som ha skett i din rutt(resrutt) och av konsekvenser att bussar ha blivit inställda på grund av det.

- Vilken sammanhang behöver du prata med andra förarna när ni kör ? I dags läge hur kör ni samtrafik?
- Under bussens färd, kan bussförarna prata med varandra eller är det möjligt att prata med varandra ? Hur gör man det och vad använder man (både mellan förarna och mellan TL och förarna)? är det radio eller? Vilken typ av information skickas till o från varandra?

### **ACI Display**

- Vilken typ av information får du från ITID(ACI display)? kan du berätta lite om detta?
- Hur använder man ITID(AIC display)-Vardagligt användning av ITID system (AIC display)?
- Vad är den viktigaste informationen som du kan hitta på ITID (ACI displayen)? Vilken typ av information brukar du kolla mest? I vilken ordning burkar du kollar på informationen?
- Behöver du all information som du ser på ITID (ACI display)? Saknar du någon information som du behöver ? eller skulle vilja du ha någonting som du tycker är viktigt och du använder (information från en annan källa) från nån annanstan som du ville hellre se på i ITID (AIC displayen)?
- Fick ni någonslags utbildning för ITID(AIC Display) system? Hur lång tid tog det att lära sig?

### **Användare scenario med hjälp av bilder**

- Kan du förstå allt som presenteras på displayen? tex Ikon, symbol, text
- (Tid indicator and tidtabel) Är du du nöjd om storleken på ikonerna eller text på den här sidan? Vill du ha stora bokstäver eller tvätom?
- Du har nämnt omlopp finns det någon samband mellan dem två(tid tabell and Omlopp)?
- Det finns 8 Menyerna på den här sidan (Menyer sidan). Kan du visa oss hur den här ikonerna fungera? (point out one by one icon)
- Använder du alla menyerna? Vilken typ av manuell inställning brukar du göra? Var för använder du inte andra menyerna?

- Använder du den här iKon? (Day/night icon). När använder du den? Använder du bara dag-version hela tiden eller tvärtom? Vilken version är det bäst att använda?
- Finns det någonting du skulle vilja ha eller förändra på ITID skärmen som du tycker är ganska viktigt eller gör ingenting för dig som bussförare?

### **Display Information**

- När du gör förändringar eller inställningar, Känns det lätt att använda pekskärm för att göra förändringar eller föredrar du knappar?
- Du ha berättat lite om informationer om inställda bussar, olyckhändelser i din reserutt, sådana enkla updateringar om trafik informationer skulle du vilja se dem på ITID display? Tycker du att det är bra idé att ha den informationen här?(Information icon i meny). Färg?
- Nu under körning du kan inte förändra någonting, har det hänt dig nångång att du behövde göra förändringar och du behövde stanna bussen för det?

### **Placement of display**

- När du sitter på din förarareplats och tittar på ITID, syns allting ordentligt eller ville du ha det högre eller lägre. Vad tycker du om placering av ITID på väntra sidan eller höger, vilken är bästa sidan?