# USABILITY ASSESSMENT ON EXISTING ALERTING DESIGNS FOR EMERGENCY COMMUNICATION BETWEEN PASSENGERS AND CABIN CREWS

E. Manikath*, W.-C. Li*, P. Piotrowski†
* Cranfield University, Safety & Accident Investigation Center, Bedfordshire, Cranfield, United Kingdom
† Lufthansa Technik AG, Hamburg, Germany

**Abstract**

Since the deregulation of commercial air travel after World War II, airlines are forced to differentiate their product in competition with each other. Whereas providing enhanced service during flight is the only way how airlines can fight for passengers. Unfortunately, this need for competition reduces flight attendants' main responsibility in public perception as serving refreshments and keeping the cabin tidy. However, the key role of cabin crew is to ensure safety and security. Flight attendants need to handle multiple unexpected situations in a professional manner. A mean for communicating with cabin crew is the Passenger Call Button. The button is not solely used by passengers, but also commonly used by flight attendants in their routine. **Research question.** This paper explores how the current design is being used by passengers and cabin crew and its limitations during daily operations. **Methodology.** Two separate questionnaires were distributed to passengers and cabin crew to assess how the PCB is being used and what the limitations of the current design are. **Results.** The Passenger Call Button is mainly used for service requests. There is an association between travel duration and use of the PCB, as well as there is an association between travel class and the use of the PCB. Passengers as well as cabin crew stated that the existing design is not enabling discreet communication. **Discussion.** The results highlight the design flaws of the existing alerting design. Passengers as well as cabin crew use the PCB for their own communication practices. Training on how to use the device are missing. The results stress the need for an improved design and training needs. **Conclusion.** It is necessary to decouple the emergency alerting function from the service function to improve delayed response times. To support cabin crew during emergencies it is important to include an emergency alerting device.

**Keywords**

passenger call button; cabin crew; inflight emergencies; emergency communication; passenger safety; emergency alerting

## NOMENCLATURE

### Formula Sign

| | |
|---|---|
| $\alpha$ | significance level |
| $\chi^2$ | Chi-Square Test |
| $df$ | degree of freedom |
| $n$ | number of samples |
| $p$ | p-value, calculated probability |
| $\varphi_C$ | Cramer's-V Test |

### Abbreviations

| | |
|---|---|
| AI | Artificial Intelligence |
| BA | British Airways |
| BS | British Standard |
| CRM | Crew Resource Management |
| CS | Certification Specification |
| EASA | European Union Aviation Safety Agency |
| H | Hypothesis |
| IFE | In-Flight Entertainment |
| ISO | International Organization for Standardization |
| LCC | Low-Cost Carrier |
| PA | Passenger Address |
| PCB | Passenger Call Button |
| RQ | Research Question |
| SD | Standard Deviation |

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## 1. INTRODUCTION

In 2022 the total number of air travellers was approximately 7 billion [1]. After the Covid-19 pandemic air travel is regaining its popularity with nearly 68.5% of the pre-pandemic passenger volume [2]. The increasing amount of passengers also increases the workload on cabin crew. Flight attendants need to handle unexpected situations requiring immediate actions [3]. Good communication skills are essential and important to effectively manage these situations. Cabin crew needs to interact with different stakeholders such as passengers, flight crew, other crew members and ground staff. There are different systems available inside the aircraft cabin as a communication aid. The intercom system is used for calls between the cockpit and the cabin crew work stations, the cabin interphone is used for communication between cabin attendants. Flight attendants can use the Passenger Address (PA) system to make announcements to the passengers. The Passenger Call Button (PCB), as the name states, is primarily used by passengers to call flight attendants for assistance. However, there are also reports where the button is used commonly by flight attendants to communicate and collaborate with other crew members [4]. During e. g. service tasks or routine checks the PCB can be pressed by cabin crews to call other colleagues who are either in the front or back of the cabin for assistance. The illuminated button and a chime sound indicate where help is needed. Despite its benefits there are some challenges with this practice. Firstly, it is difficult to distinguish the chime sound in the noisy aircraft cabin. If there is an urgency cabin crew reported to press the button multiple times to indicate the seriousness. Secondly, in some cases the Passenger Call Button is not easily accessible e. g. in the armrest of a seat or else usually for widebody aircraft which makes it difficult for the flight attendants to use the button without asking passengers for help. Lastly, cabin attendants cannot distinguish who used the PCB: passengers or fellow crew members. Especially during emergencies it is an “extra cognitive step” for crew members to remember the location or any specific code of the button [4]. In these situations flight attendants might tend to call out loudly to draw the attention of fellow crew members. However, this practice could cause panic among passengers and would be contrary to the content in CRM trainings [4]. Furthermore, according to Manikath et al. [5], there are from a passenger’s perspective “controversies” when to use the button [5], [6]. There are reports where passengers were reprimanded when using the PCB for service requests [7]. Some flight attendants insisted on utilizing the call button only in case of emergencies. However, the symbol on the button itself is misleading (ref. Fig 1). The icon on some aircraft is depicting a person with a tray table or a cup, which indicates that it can be used for service requests [5].



**FIG 1. Different icons used on the PCB [5]**

Previous research has shown that the use of symbols depends on the cultural environment and could therefore lead to misunderstandings [8]. ISO 7010 suggest e. g. to use exclamation marks or a telephone headset with a cross to indicate warnings or help. In case of flight BA762 passengers used the Passenger Call Button and shouted to inform the flight attendants about a technical problem occurring during take-off [9]. Shouting could create panic amongst passengers. According to Le Bon [10], emotions in crowds can be as “contagious as that of microbes”. Moreover, panic in individuals can spread quickly to a group [10]. To avoid panic in critical situations it is necessary that passengers have a possibility to discreetly inform the cabin crew. Emergency alerting devices are commonly found in mass transportation vehicles such as trains, busses and since 2015 even in cars. After the Delhi Gang rape, India introduced so called panic buttons which are mandatory in public transportation vehicles such as trains, taxis, and busses [5].

Commonly found emergency buttons can fulfill different functionalities:

1) Provide communication connection with an operator or emergency center [11],
2) Emergency stop especially for trains or machines [12].

However, in an aircraft environment the existing Passenger Call Button fulfills several functionalities and can be used by passengers as well as cabin crew in practice. The following research questions will be explored in this research to gain a basic understanding on how the existing Passenger Call Button is used by passengers and cabin crew.

RQ1: What are the primary use cases for the existing PCB?

RQ2: What are the limitations of the current PCB design?

RQ3: How is communication between passengers and cabin crew affected by the current design?

RQ4: How can the existing design be improved to enable discreet communication between passengers and cabin crew?

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## 2. METHODOLOGY

The main motivation for this study is to identify and close the existing communication gap between passengers and cabin crew. This study aims to gain a basic understanding on the use of the existing Passenger Call Button by both focus groups passengers and cabin crew in order to improve communications between passengers and cabin crew. Furthermore, to enhance situation awareness of cabin crew.

### 2.1. Material

As a starting point a qualitative survey study was chosen. Two separate online questionnaires were distributed to passengers and cabin crew. Both questionnaires started with basic demographic questions. The second section assessed the details on how and for what reasons the Passenger Call Button is being used and further on how communication can be improved between passengers and cabin crew.

### 2.2. Research Design

The survey was created using the online software Qualtrics (http://www.qualtrics.com). Participants needed to be over the age of 18 years, read and sign the consent form to be able to participate in the study. The institutional research ethics committee has granted the ethics approval (CURES/19329/2023). It took less than 10 minutes to complete the survey.

## 3. RESULTS

### 3.1. Basic Demographics

In total 201 passengers completed the study. The median age of the participants was 39.0 years ($SD = 10.8$). Passengers of four different ethnicities participated in the study with the majority being Europeans (88%), whereas the minority were of Asian, North or South American ethnicity. Further detailed information on the demographics can be found in Tab. 1
54 active and former cabin crew with a median age of 44.0 years ($SD = 11.0$) participated in the study. The average tenure was 15.75 years ($SD = 10.7$). Further details are shown in Tab. 2.

| Category | | Count | Percent |
|---|---|---|---|
| Position | Passenger | 201 | 100% |
| Gender | male | 123 | 61% |
| | female | 74 | 37% |
| | others | 4 | 2% |
| Ethnicity | European | 176 | 88% |
| | Asian | 14 | 7% |
| | African | 2 | 1% |
| | North American | 5 | 2% |
| | South American | 4 | 2% |
| Travel Type | leisure | 122 | 61% |
| | business | 79 | 39% |
| Travel Class | Economy | 127 | 63% |
| | Business/First | 74 | 37% |

**TAB 1. Basic demographics passengers**

| Category | | Count | Percent |
|---|---|---|---|
| Position | active cabin crew | 26 | 46% |
| | former cabin crew | 30 | 54% |
| Gender | male | 23 | 41% |
| | female | 29 | 52% |
| | others | 4 | 7% |
| Ethnicity | European | 39 | 70% |
| | Asian | 8 | 14% |
| | African | 2 | 4% |
| | North American | 1 | 2% |
| | South American | 2 | 4% |
| | Oceanic | 1 | 2% |
| Contractual Base | full-time employee | 44 | 79% |
| | part-time employee | 12 | 21% |

**TAB 2. Basic demographics cabin crew**

### 3.2. Use of the Passenger Call Button

The participants were asked several questions to understand how the current design is being used. The categories could be grouped into three major categories: Service, Emergency, and “No Use”. Multiple answers were allowed for this question. The majority (66%, $n = 201$) indicated that they mainly used the Passenger Call Button for Service purposes. A third of the participants have never used the PCB. The details can be found in Tab. 3.

Looking at the different travel classes (Economy, Business / Premier Class) 38% ($n = 68$) in Economy Class stated that they have never used the Call Button. In Business Class the results were similar with 21% ($n = 29$) not having used the Button. In Business Class the passengers main objective was for beverage or food services (23%, $n = 32$), whereas the majority in Economy class stated that they have never used the Button, succeeded by food and beverage service requests (22%, $n = 40$). A Chi-Square test for independence has been performed to analyze the association between travel class and use case. Therefore, some of the use-cases were grouped (“duty free services” and “paid services on board” to “inflight-shopping” and “socializing (e. g. chit-chat, complaints)”, “asking for information (e. g. connecting flights, arrival/local time)” to “talking”) to reduce the complexity of the calculation and to gain more statistical relevant data due to low count.

Following hypotheses were tested:

H0: There is no association between travel class and use of the PCB

H1: There is an association between travel class and use of the PCB

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| Category | Amount | Percent |
|---|---|---|
| **Service** | **201** | **66%** |
| Comfort requests (e. g. adjustment of temperature, pillows/blankets) | 49 | 24% |
| Beverage or food service (incl. information about food) | 72 | 36% |
| Technical user assistance (e. g. seat adjustment, Entertainment System) | 36 | 18% |
| Asking for information (e. g. connecting flights, arrival/local time) | 29 | 14% |
| Duty free services | 7 | 3% |
| Paid services on board (e. g. Internet, Telephone) | 6 | 3% |
| Socializing (e. g. chit-chat, complaints) | 1 | 0% |
| Assistance with luggage | 1 | 0% |
| **No use** | **97** | **30%** |
| I have never used the passenger call button | 97 | 30% |
| **Emergency** | **21** | **7%** |
| Emergency (e. g. medical, technical, criminal) | 21 | 7% |

**TAB 3. Passengers use of PCB**

| Category | Amount | Percent |
|---|---|---|
| **Service** | **115** | **86%** |
| Comfort requests (e. g. adjustment of temperature, pillows/blankets) | 18 | 16% |
| Beverage or food service (incl. information about food) | 41 | 36% |
| Technical user assistance (e. g. seat adjustment, Entertainment System) | 18 | 16% |
| Asking for information (e. g. connecting flights, arrival/local time) | 28 | 24% |
| Duty free services | 2 | 2% |
| Paid services on board (e. g. Internet, Telephone) | 2 | 2% |
| Socializing (e. g. chit-chat, complaints) | 2 | 2% |
| Assistance with luggage | 4 | 3% |
| **No use** | **0** | **0%** |
| I have never used the passenger call button | 0 | 0% |
| **Emergency** | **18** | **14%** |
| Emergency (e. g. medical, technical, criminal) | 18 | 14% |

**TAB 4. Cabin crew called by the PCB**

Since the calculated p–value is less than the chosen significance level of $\alpha = 0.005$ , the null hypothesis can be rejected and the alternate hypothesis accepted $\chi^2(9, n = 201) = 26.98$, $p = 0.001$. Hence, there is an association between travel class and use of the Passenger Call Button. Furthermore, cabin crew were asked for what top three reasons they have been called via the Passenger Call Button. Participants needed to choose three options from the same list of use cases which were also presented to the passenger target group. The results are similar to the passenger study, cabin crew also indicated that the main reason they have been called by passengers where because of service requests (86%, $n = 115$). Only in 14% of the cases the call was due to an emergency. Details can be found in the following Tab. 4.

Subsequently, passengers needed to answer what they think is the main purpose of the Passenger Call Button. The options to choose from were “calling cabin crew for service requests”, “alerting cabin crew in case of emergencies”, “asking for information” and “else”. 85% ($n = 170$) answered that “asking for information” is the main reason to use the PCB. In the cabin crew study 67% ($n = 35$) stated “else” as the main objective for the button, where “else” was not specified further and could also include “asking for information”. Only 33% ($n = 17$) of the cabin crew mentioned “alerting cabin crew in case of emergencies” as a main aim for using the call button. A Chi–Square test of independence has been calculated to analyze the association between the cabin crew and the passengers perception of the purpose of the PCB.

The tested hypothesis are as follows:

H0: There is no association between target group and perception of main purpose of the PCB

H1: There is an association between target group and perception of main purpose of the PCB

The calculated value for chi square were $\chi^2(3, n = 253) = 154.07$, $p < 0.001$. Therefore, the alternate hypothesis can be accepted and there is an association between cabin crews’ and passengers view of the main purpose of the PCB. Results from the Cramer’s-V Test $\varphi c = 0.78$ signify a strong association between the two variables. To evaluate the association between the travel duration and the use of the button Chi-Square statistics have been calculated. The value for $\chi^2(14, n = 201) = 14.42$, $p = 0.42$. Since the calculated p-value is greater than the significance level of $\alpha = 0.005$ the null hypothesis cannot be rejected. Therefore for this study population there is an association between travel duration and use of the Passenger Call Button. Details of the calculations can be found in the Tab. 5.

Lastly, participants were asked whether the existing call button enables discreet communication between passengers and cabin crew. 77% ($n = 143$) of the passengers stated that it is not supporting discreet communication. Similarly, 73% ($n = 36$) of cabin crew highlighted that discreet communication is not enabled with the existing design.

### 3.3. General Communication

This section of both questionnaires aimed to understand preferences of passengers and cabin crew in communication methods. Passengers as well as cabin crew answered to questions like “What

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| Use-Case | Short-haul (<2h) | Medium-haul (>2h) | Long-haul (>6h) |
|---|---|---|---|
| Emergency | 7 | 9 | 5 |
| Inflight shopping (duty free, paid services) | 2 | 5 | 4 |
| I have never used the PCB | 44 | 32 | 22 |
| Beverage or food services | 26 | 25 | 21 |
| Comfort requests | 16 | 18 | 15 |
| Technical / user assistance | 10 | 12 | 14 |
| Talking (socializing, asking for information) | 10 | 12 | 7 |

**TAB 5. Dependence travel duration.**

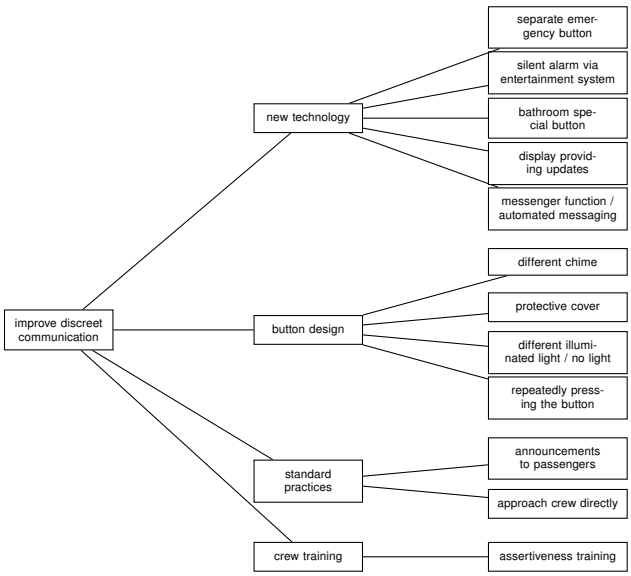



**FIG 2. Results of content analysis**

is your preferred way of communication" and how communication can be improved during emergencies. Passengers (82%, $n = 155$) stated that they prefer face to face communication with cabin crew. The minority preferred using either an interface e. g. embedded in the Inflight Entertainment screen (9%, $n = 17$) or no communication at all (8%, $n = 15$). A Chi-Square test was calculated to determine the association between travel class and preferred communication method.

The null hypothesis is:

H0: There is no association between travel class and preferred way of communication between passengers and cabin crew

H1: There is an association between travel class and preferred way of communication

The results for the Chi-Square calculation are as follows: $\chi^2(3, n = 187) = 6.40$, $p = 0.068$. Since the p–value is greater than the chosen significance level of $\alpha = 0.005$ the null hypothesis cannot be rejected. Almost 50% more male travellers ($n = 94$) indicated their preference on face to face communication than females ($n = 57$). Lastly, passengers as well as cabin crews were asked how discreet communication could be improved. The passenger answers could be grouped into four clusters:

1) "enhanced button design",
2) new technology,
3) process adjustments / improvements and
4) crew training.

Looking at the "enhanced button design" participants stated e. g. pressing repeatedly, with a specific call-sign (long-press, short repeats) or that the illuminated light is not shown openly in the aircraft cabin could improve discreet communication. As new technological approaches e. g. integrated messaging functions (incl. audio messages) for every seat, flight specific text messaging numbers or sending silent alarms via the entertainment system were mentioned. Some participants also mentioned approaching flight attendants directly in the galley area as an option and regarding crew training that cabin crew should approach with "curiosity and not exasperation". Cabin crew were asked the same question and the results were similar to the traveller study. Regarding "enhanced button design" pressing repeatedly, different lights, chimes, protective cover to avoid unintended use were mentioned. Separate buttons for emergency and service or automated messaging via the IFE screen were presented solutions. One participant suggested an "assertiveness training" for cabin crew training. Details can be found in Fig 2.

### 3.4. Use of the PCB by Cabin Crew

Flight attendants were asked whether they have used the Call Button and for which reason (multiple answers were allowed). 63% ($n = 30$) of the crew members used the button to ask colleagues for support and in 50% ($n = 24$) of the cases it has been used to communicate with other flight attendants. Other reasons such as "getting attention of crew when replenishing or special drinks service" or emergency were also mentioned.

## 4. DISCUSSION

This is the first study which aims to understand how the Passenger Call Button is currently being used and which improvements are needed to enable discreet communication in emergency situations. The first finding is that the button is used for multiple reasons with an emphasis on service requests by passengers. Cabin crews results underlined this fact: in 86% of the cases they were alerted due to a service request. Some of the participating flight attendants indicated that the missing distinct functionality is a design flaw and leading to either prolonged response times ("no

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information regarding reason for call (loosing time in case of emergency, health issue)", "It is used almost exclusively for non-emergency purposes which also leads to longer response times (because if you constantly assume it is service related, you don't immediately jump into action)") or no reaction ("the crew is often not reacting to the call button; often used by mistake") which could lead to passenger frustration. Delayed response of the lead flight attendant was also mentioned in the Air Accident Investigation Report of flight BA762 [9]. The lead cabin crew member stated that she was alerted due to the "highly unusual" behaviour of the passengers trying to alert the cabin crew of a technical problem by pushing the call button multiple times [9]. An experienced flight attendant (experience level 7.5 years on short-haul and long-haul) participant confirmed that during the boarding process there are usually no passenger calls and while being on ground there are only a few calls which could indicate a problem.

Around 40 years ago, after World War II air travel and service on board were highly regulated. Since air travel is mostly an international affair it was and still is, nationally as well as internationally strongly regulated and strictly monitored [13]. This is necessary to avoid disadvantages for any countries or airlines participating in air traffic [13]. In 1978 the deregulation concluded in the USA and 1984 in the European Union. In Europe the competitive environment changed with the rise of the Low-Cost Carriers (LCC) in 1992 and their aggressive pricing [14]. Since then airlines are forced to compete with their offerings, especially the aircraft cabin product. Therefore, the deregulation of air travel can be seen as the starting point for the increased focus on service, since the onboard travel experience is how airlines can differentiate from each other [13]. Passengers are buying a comprehensive service where the aircraft is one component [13]. Air travel can be considered as pure service [13] with products and services complementing the travel experience before and after. People are not only asking for "sophisticated services" but also for a bigger choice [15]. Airlines on the other hand are offering more refined and diverse services to improve the flight experience and attract more travellers [15]. Airlines are the primary customers for the aircraft, however passengers are the actual users [13]. Consequently, in aircraft design and the airline service product it is important to know and satisfy the traveller requirements [13]. During air travel people are separated from their familiar environment [13]. Passengers tend to express general discontent in cases where only a single need has been fulfilled [13]. In the beginnings of air travel, where affluent business men were the target group of airlines, flight attendants main duty was to make the travellers "feel at home" [5]. This becomes also evident in the results of the study. Looking at the different service requests comfort requests (e. g. adjustment of temperature, pillows/blankets), food and beverage service and technical user assistance (e. g. adjustment of seat / IFE system) accounted for 78% ($n = 157$) of the service requests. According to Maslow's hierarchy of needs (1943) the mentioned service request can be categorized as basic physiological needs which must be satisfied (see Fig 3) [16]. Referring to Maslow's theory safety needs would be secondary, which could also be an explanation for the results passengers using the call button in 7% of the cases [16].

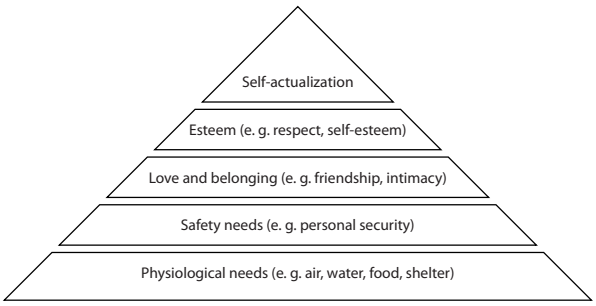



**FIG 3. According to Maslow's hierarchy of needs [16]**

Furthermore, passengers as well as cabin crew where asked what would be the main purpose of the PCB. Whereas 85% of the passengers stated that "asking for information" is the main purpose, cabin crew stated "else" which could be everything excluding service and emergency. The contrary results emphasize the ambiguity on the use of the PCB. It is unusual that passengers did not choose the option "Calling Crew for Service". An explanation could be the ambiguity on when to use the button. Cabin crew mentioned that "nobody is informed on how to use it". For other equipment on the aircraft there is an instruction or it is self-explanatory (e. g. demonstration of oxygen masks and life vests, IFE screens usually with a training video, use of gasper air outlets / light switches), however there is no clear instruction and the icon on the button itself is not self-explaining (see Fig 1).

Because of the ambiguity flight attendants face a dilemma on deciding between safety and security tasks [17]. This conflict is even intensified due to the "trivialization" of the safety role of cabin crew [18] and the public perception of "feminine accommodation and deference" [19]. After the Air Ontario accident, the only surviving cabin crew Sonia Hartwick confirmed the emphasis on the service role "[...] you have a front-end crew and a back-end crew, and we are looked upon as serving coffee and lunch and things like that", Air Ontario accident, Dryden [20], [18].

According to Damos et. al. [17], some airlines set performance standards for service tasks e. g. certain activities need to be completed at a specific time stamp. This practice puts additional stress on cabin crew and increases the conflict between safety and

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service tasks [17]. Flight attendants need to trade off between service, safety, and security duties [17]. This can have an adverse effect on their performance on safety and security tasks [17]. Longer response times could also result from desensitization to alarms [21]. Especially in healthcare settings “alarm fatigue” is a major concern since healthcare professionals are exposed to beeping sounds for a prolonged period of time. Occasionally, these alarms are either “disabled, ignored or silenced” which could lead to fatal errors such as the death of a heart-patient in 2010, where the nurse could not remember the alarm sound [21].

Participants in this study also mentioned the false alarms due to unintentional use (“often mistaken for the light switch”) and that a service request is expected instead of an emergency. Furthermore, the results on when the PCB is used to alert the cabin crew in emergencies (7% of the passengers and 14% for cabin crew) are in line with what has been found in the literature [18]. According to Murphy [19], 80% of flight attendants’ main duty are safety and 20% service related. However, for passengers it is 80% service and 20% safety [19]. This becomes also evident looking at the results for the different travel classes (Business / Premier class and Economy class). There is an association between travel class and the use of the PCB. Whereas, typically the service needs in Business / Premier class are higher and the focus of cabin crew is on providing enhanced and personalized service [15]. Usually, the passenger to flight attendant ratio is lower in Business class than in Economy. One flight attendant mentioned that if there is a call from Business class, there was more “excitement” to attend the call whereas in Economy class it is “mass processing”. It was also highlighted that the way of communication regarding politeness of passengers has been perceived differently between the two classes. Approximately one third of the passengers stated that they have never used the call button. This could be due to the lower service requirement of Economy class passengers. One cabin crew member compared his experience of working in Economy class like “running the gauntlet”. When one passenger is pressing the call button, the flight attendant will be approached by several other passengers in the proximity of the initial one. In Business or Premier class this is different: one passenger is calling and the maximum another one would approach the flight attendant. Looking at the association between travel duration and the use of the PCB it is evident that most passengers (38%, $n = 44$) on short-haul ($< 2h$) have not used the call button. This could be due to the nature of short-haul flights usually being commuter flights with limited focus on service. Furthermore, the time spend on board is also short and passengers are usually not willing to pay for any service upgrades [15]. Secondly, food and beverage services on Low Cost Airlines, which are typically operating on short-haul flights are only available for purchase. The high number of food and beverage service requests could be linked to LCC operations [14]. Reducing meal services is reducing the operations complexity and therefore rooted in the operation model of LCCs [14]. However, many airlines are offering meal services again in order to e. g. reduce negative image [14]. According to one participating flight attendant the main passenger requests on short- and medium-haul flights were asking for pain medication (head-ache or ear-ache) and comfort requests such as pillows and adjustment of cabin temperature. These issues will usually be resolved during the service rounds. On medium-haul flights (<6h) the results are comparable to short-haul. Medium-haul flights can also be operated by charter airlines with a lower focus on service which could explain the higher number on food and beverage services or no use at all. Another explanation could also be the longer time which is spent by passengers on board requiring more comfort and services [15]. The lower amounts of no use of the call button (25%, $n = 22$) can be explained because of the nature of long-haul flights, people are usually sleeping or resting in the aircraft [18]. This becomes also evident in the results for “talking” (socializing, asking for information) which is the lowest on long-haul flights (8%, $n = 7$).

As expected, both passengers and cabin crew confirmed that the existing design of the Passenger Call Button is not supporting discreet communication. Another factor contributing to the inefficient design of the PCB is that cabin crew are also using it for their own communication practices although not being the primary users. Over 60% of the participating cabin crew mentioned that they either used the call button to communicate with colleagues or ask for support. According to Wong and Neustaedter [4], the collaboration tools found in aircraft are the cabin interphone, audio alerts, visual signs e. g. No Smoking / Fasten Seat Belt signs and the call button. The button is “routinely” being used either to ask for assistance or indicate the position in the aircraft [4]. Although the button is commonly used by the crew members, there are also challenges with this practice. In the literature three challenges are mentioned. Firstly, the chime can be easily overheard in the noisy aircraft cabin [4]. Secondly, on narrow body aircraft the button is easily accessible for cabin crew in the overhead panel, however on widebody aircraft the button is usually integrated into the aircraft seat which makes it more difficult to reach it [4]. Lastly, it is not evident for the cabin crew who activated the button – passengers or cabin crew. Flight attendants also developed different practices such as pressing multiple times for emergencies, or two times to indicate it is a crew call. However, these methods vary from user to user and carry the risk of misunderstandings. This highlights the inefficient design of the Passenger Call Button.

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### 4.1. Proposals for Improvement

To resolve the insufficient situation design and training improvements are suggested. In order to keep the effort of implementation as low as possible, a design improvement on the existing button shall be pursued. Based on the findings of this study, passengers suggested to include an additional functionality into the existing button design such as either repeated or prolonged pressing to activate the emergency function or a different illumination of the button (e. g. preferably yellow for warning or red for danger according to ISO7010) [22]. In an emergency situation the different push of the button (e. g. prolonged or repeated pressing) would be an additional "cognitive step" which could lead to additional stress and is therefore increasing mental workload [4]. The resulting consequence would be that the code cannot be remembered or will be executed faulty, especially in distress situation. Introducing a new chime specifically for emergencies could improve situation awareness of cabin crew. In previous studies it was mentioned by cabin crew that it is difficult to distinguish the sounds and it would be necessary to recognize whether it is an urgent call [4]. A good example for an auditory alarm is the smoke detection in the lavatory. A repetitive chime can be heard through all cabin loudspeakers and flight attendant stations [23]. Cabin crew are usually highly aware of this type of sound and immediately recognize the urgency of the situation.

### 4.2. Introduction of New Technology

Providing a separate emergency button as proposed by Manikath and Li, 2022 would have several advantages compared to changes in the existing design such as clear separate functionality. Additionally, if designed in accordance with established design principles for e. g. passenger alarm systems in railways (see BS-EN16334) unintentional use shall be avoided. Depending whether a physical or a virtual emergency button will be incorporated additional weight for the equipment could be an issue. The implementation of an automated Chat-Bot could be an option to reduce workload with regards to "asking for information". Frequently asked questions such as e. g. arrival information, local time, on-board menu could be programmed into an automated messaging system and therefore reduce workload of cabin crew. Collins Aerospace has presented a similar approach using deep learning AI and sensor technology to support cabin crew and maintenance technicians optimize operations and in-flight service [24]. Collins' InteliSence observes passenger's interactions with objects in the cabin (e. g. electronics, glasses, plates) to predict and recommend actions to cabin crew and maintenance technicians. The aim is to reduce e. g. waiting times for passengers to get a drink refill or a faulty equipment being removed quicker and therefore provide more personalized service [24].

### 4.3. Prospect Studies

This study provides initial insights on how the Passenger Call Button is used and its limitations in daily operation. Future studies should focus on how trainings of cabin crew can be improved in order to avoid "alarm fatigue" and to improve task response. Additionally, since cabin crew need to collaborate with flight crew, passengers and ground staff, enhanced communication skills are essential [3]. Future studies could evaluate whether there are technical solutions (e. g. automated messaging) which could aid flight attendants with this task. Moreover, the implementation of an emergency button as proposed by Manikath and Li, 2022 could improve situation awareness and response times of cabin crew in case of emergencies [25]. Further usability studies are necessary for a virtual but also physical emergency button [25].

## 5. CONCLUSION

Aviation has very high safety standards. In the EASA Certification Specification for large aeroplanes (CS-25) the important design principles which need to be followed, are described to ensure flight safety. For instance, in CS25.1302 Installed systems and equipment for use by the flight crew it is clearly mentioned that information for flight crew shall "be presented in a clear and unambiguous form" [26]. However, looking at the Passenger Call Button as a communication mean, this is an example of an inefficient design. This paper investigated passengers but also cabin crews' user behaviour of the Passenger Call Button. The button itself might seem like an inconsiderable and negligible feature inside the aircraft cabin. However, this research highlights firstly its importance as a communication mean between passengers and cabin crew (as initially designed) and also between crew members. Secondly, this study emphasizes the inefficient design resulting from:

- misleading graphical symbols on the button
- insufficient training on the use of the button
- misuse / convenience-driven practices of passengers and cabin crew
- ambiguous use

of the existing Passenger Call Button. Resulting from this design flaw are "alarm fatigue", delayed or no response and confusion which could lead to potential fatal errors in case of emergencies, increased stress levels for cabin crew and lower passenger satisfaction. Cabin crew are expected to handle unexpected situations immediately [3].

The results of this study emphasize firstly, which kind of diverse tasks flight attendants need to take care of (e. g. handling emergencies, technical / user assistance, in-flight sales, serving meals and beverages etc.), and secondly the constant trade-off between safety, security, and service tasks. The findings of this study are the foundation to develop an effective communication technology which shall improve cabin

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crews' situation awareness for emergencies, but also have an implication on future crew training standards in terms of emergency and assertiveness.

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# Usability assessment on existing alerting designs for emergency communication between passengers and cabin crews

**Manikath, Elizabeth; Li, Wen-Chin; Piotrowski, Pawel**

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