Cruise cabin as a home: smart approaches to improve cabin comfort

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Abstract. Information and Communications Technology (ICT) has an impact on nearly every aspect of people lives – from working or learning to socializing – and makes people lives easier and more comfortable. In particular, smart home devices can handle environmental characteristics (lighting, temperature, etc.) that can increase people comfort and can also help in reducing costs. In order to increase passenger comfort in the cruise ship cabins, this study proposes the design of an App that provides high quality products and services. Smart Home, Ambient Intelligence and IoT are the starting knowledge to create a smart space without re-designing all the cabin environments. The App brings real added value compared with existing domotic systems, because it does not consider only environmental characteristics but also personal features of the passengers and their activities. The aim of the proposed system is to improve passenger comfort in order to increase perceived quality, acting as a real time Decision Making System. The application receives information from various sensors and actuators and decides how to create a suitable environment and healthy space, according to the passenger preference and activity. The App follows both the necessity of the ship owner to increase passenger satisfaction and to reduce costs.

Keywords. smart cabin; application; comfort; IoT device.

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1. Introduction

According to the Cruise Lines International Association (CLIA 2018), the cruise sector is becoming a major part of the U.S. travel and tourism industry. The increase in cruise ship vacations is the result of more attractive and accessible cruise ships to a wider range of target markets. Indeed, since 2010, Brida and Zapata revealed that the cruise industry had evolved from a means of transportation into a complex travel destination that offers luxury and entertainment to tourists. The year 2018 is predicted to see a rise in traveller-friendly on-board technologies that enhance travel experiences. The Cruise Operators have to provide high quality products and services to be competitive and to satisfy their customers.

The passenger cruise experience is influenced by various key attributes. These attributes encompass both tangible and intangible features of cruise line [1]. The comfort perception is considered by Cruise operators as a key quality attribute to increase the cruise attractiveness, to guarantee passenger enjoyment of the travel experience and therefore increase revenues.

In the cruise business environment, the growing demand for high-value cruising has led to the continuous creation of new increasingly innovative ships.

However, cruise ships have a longer life cycle than that of the on-going fast economic, social, environmental, and technological innovations. This paper proposes to enhance the comfort of a cruise cabin by using a novel domotic platform system that requires a moderately low-cost intervention on the cruise ship. The platform proposes an App that provides high quality products and services in order to increase passenger comfort in the cruise ship cabins.

2. Holistic experience in cruise ship cabin

The cruise industry is founded on the following basic principle: provide customers what they want in terms of products, services and experiences. Thus, the cruise vacation has to be a holistic experience, pertaining to cabins, restaurants, entertainment programs, on-board activities, miscellaneous services (e.g., Wi-Fi, Internet café and laundry) and cruise ship atmospherics [2].

This study addresses the holistic experience from the point of view of the cruise ship cabins. Cruise ship operators transport passengers by sea for pleasure, and passenger comfort is one of their main priorities [3]. Thus, the Cruise operators have to take care of the passenger comfort perception to minimize the uncomfortable feelings in order to increase the attractiveness of the cruise ship. Nowadays, on the fleet already in use, passengers spend a significant amount of time in the cabin even if it is mostly small and with a generalized microclimate set-up. The proposed application adds to the optimal existent microclimate of the cabin the possibility of a personalized configuration. This study has been based on the Fincantieri cruise ships as a case study for the cabin space.

In this Cruise Ship scenario, Smart Home, Ambient Intelligence and IoT are the starting knowledge to create a smart space without re-designing all the cabin environments. Thus, the passenger comfort perception can increase via the collaboration of technology and services through a network. IoT devices are part of the cabin network in which every device is connected to every other related device within the cruise ship ecosystem and communicates more and more usable data to users

through the Decision Support System (DSS). Automatic systems in the smart cabin could not only provide optimum comfort to people, but also reduce energy consumption (including electric energy and heat from the heating plant), offer control and oversight of all technical devices and allow the printing of necessary reports on the status of the indoor environment.

The majority of domotic and Smart home systems available on the market have focused on the importance of the environmental characteristics, on controlling lighting, heating, ventilation and security features also by leading to energy savings. The proposed App brings real added value compared to existing domotic systems [4] [5][6][7], because it not only considers environmental characteristics but also the personal features of the passengers and their activities.

In order to include personal features of the passengers and their activities within the system, it is important to ensure a certain level of hotel comfort and suitable living conditions to the majority of passengers. Passengers present various variables, including age, gender, disability and different cultural, economic and social backgrounds; therefore, life space in the cabin and its uses provide a base to study the holistic experience in the cruise ship.

3. Use case: reading

To fulfill the objectives of this study, the "reading" example was used. The requirement is that the passenger is in the cabin and the App is running. The passenger, after choosing the purpose of reading (study, work, hobby) and the type of support for reading (book, magazine, newspaper, digital book), chooses where to read (chair, sofa, bad).

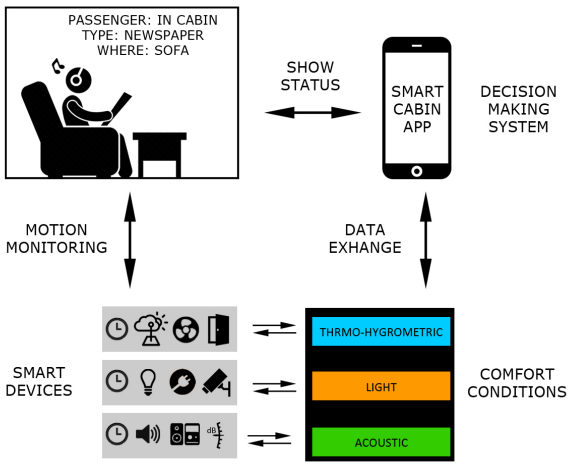

Figure 1. Functional interaction among living space, smart devices, smart app and the passenger: comfort of passengers is managed taking into account personal features and current activities.

The passenger position, monitored by video cameras, influences the following App evaluation:

- Thermo-hygrometric comfort conditions (internal and external temperature, relative humidity level, CO2 level, set point temperature and air conditioning system characteristics, thermal contributions of artificial lighting, natural ventilation, solar radiation)
- Magnetization as a function of applied field. Note how the caption is centered in the column
- Light comfort conditions (internal illumination level, light tones, light direction, glare, shadow distribution, luminance distribution)
- Acoustic comfort conditions (internal noise level).

If the passenger perceives discomfort, probably his comfort parameters are out of the standard comfort ranges and he/she can communicate his/her own welfare level to the app (very comfortable, quite comfortable, comfortable, uncomfortable and not comfortable at all). In this way, the App restarts the customized comfort setup, setting the various parameters of the devices installed in the cabin and changing their status in order to maximize user comfort.

4. Smart cabin device

The smart cabin is an area where all subsystems interact with each other, thus creating an environment friendly to people, with the ability of automatically reacting to any kind of danger or change in the environment, with minimum input from the passenger.

In the App implementation, the devices and the components of the system, the reliability of their work and their ease of use are of primary importance, thus allowing the user to configure the system and to program its tasks according to his own needs in a simple way. The devices, for indoor and outdoor use, monitor the environment. For example, they identify the status of doors and windows, the presence of people and provide environmental information. Moreover, the real-time monitoring allows the user to check the trends of the environmental quality parameters.

The devices are classified as ambient and as energy-saving; the first ones are installed to monitor the cabin environment and the second ones are installed to reduce energy waste.

Table 1. Cruise cabin selected smart device

Type	Device	Number
Ambient	Weather station	1
Ambient	Door and window sensor/actuator	2
Energy-saving	Motion sensor	1
Energy-saving	Air conditioning	1
Ambient and Energy-saving	Time and date sensor	1
Ambient	Audio system and speaker	2
Ambient	Flood sensor	1
Ambient	Webcam	2
Ambient and Energy-saving	Lights (diffuse and punctual)	12
Ambient and Energy-saving	Video camera	2

The selected devices are the starting blocks for creating the Cabin App that improves passenger comfort performance inside the cruise ship cabins during different activities (read, change, wake up, etc.).

4.1. Weather station

The weather station gives real-time weather information in two separate modules: outdoor and indoor modules.

- Outdoor module outputs: outdoor temperature, outdoor relative humidity, outdoor air quality, barometric pressure and weather forecast.
- Indoor module outputs: indoor temperature, indoor relative humidity, indoor air quality, sound meter and ventilation warning (measure indoor pollution levels through a CO2 sensor).

4.2. Door and window sensor/actuator

The door and window sensors produce the status of the door or window. The actuator is equipped to automate the door and window opening/closing mechanisms; in case of an open status, the actuator can close the door or window in order to change and improve the internal microclimate of the cabin.

4.3. Motion sensor

The motion sensor observes the movements of the passengers within the cabin and triggers the lights when motion is detected, e.g. it automatically turns on the lights when the person enters in the cabin. The lights will be turned off automatically, when motion is no longer detected.

4.4. Air conditioning

An air conditioning device, especially used during the summer, can provide optimal temperature within the cabin when the temperature is high. An air conditioning controller considerably reduces energy consumption without affecting the comfort levels of the passengers.

4.5. Time and Date sensor

The time and date sensor set the correct system time/date.

4.6. Audio system and speaker

The audio system and speakers create a pleasant environment, a special personalized acoustic atmosphere for the passenger activity.

4.7. Flood sensor

Flood sensor is much more than just a leak sensor; it combines several useful features that ensure safety through a light indicator and a sound sensor. After detecting a leak, the system immediately alerts the central unit and closes off the water supply to minimize damage.

4.8. Smart lights

Light bulbs have grown exponentially smarter in recent years. The incandescent bulbs are being replaced by a variety of connected solutions controlled via smartphone or tablet. This light network changes the look and atmosphere of the cabin into an extraordinary experience with coloured and white lights. The App combines the different lights, turns them on or off, changes the warmth of their glow and synchronizes the lights to music, TV and games to create immersive effects and increase comfort in the cabin.

4.9. Video camera

A video camera is a device devised to monitor the movements of the passenger in the cabin and light conditions in the cabin. It does not send or store images but it is used to derive aggregated features regarding movement and lighting conditions in the environment.

5. APP Architecture

The Smart Cabin APP is an application that works as a DSS (Decision Support System) for passengers. The APP interfaces with the users by means of the graphic interface GUI - Graphical User Interface, with the reasoner and with the smart devices by utilizing the E-Cabin platform. The APP architecture involves the following elements:

- DSS module
- Data Base
- Graphic interface (GUI)
- Interface with the E-Cabin platform by the Topic and Message definition of the E-Cabin Publisher Subscriber platform for:
    - Interfacing with the sensors
    - Interfacing with the actuators
    - Interfacing with the reasoner

The logic architecture of Smart Cabin is described in Figure 2. The blue block and the blue interconnections are APP specific In detail, the DSS module is going to be implemented as an always active service. The red blocks are the components included in the E-Cabin platform. The green block is the database where all the passenger data, obtained during the check in, are collected.

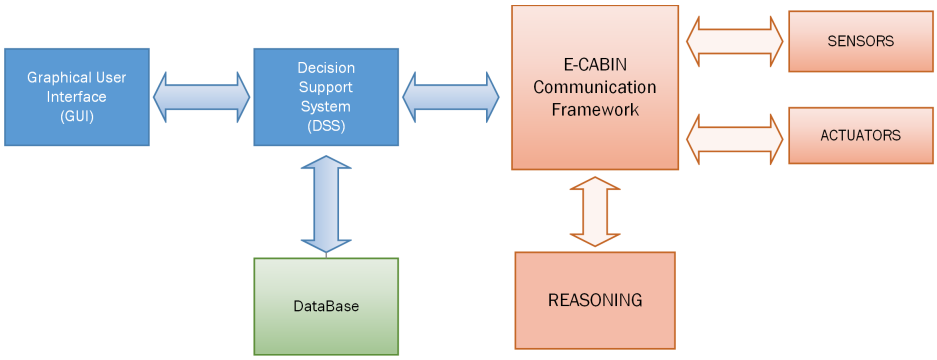

Figure 2. E-Cabin APP Architecture

5.1. Graphic interface

The aim of the APP graphic interface is to be interactive and easily usable by all the passengers of the cruise ship. Usability makes the product useful, which is the first step in creating a desirable experience.

The user interface is designed in such a way that the app is fully usable on multiple devices and mobile operating systems. The design, created to improve comfort perception, makes common tasks easy, clear and simple, communicating in the user own language.

At first access, the app requests the passenger cabin number. In this way, the system recovers all the information previously indicated by the user during the check-in boarding. The useful information for the functioning of the APP are: personal data (name, surname, date of birth, sex) and disability (hearing, visual or dexterity disabilities, etc.).

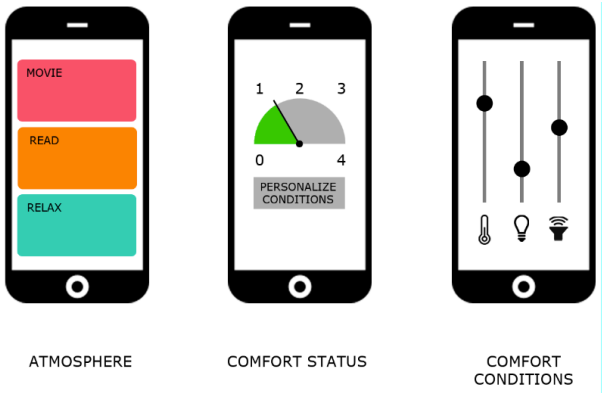

Figure 3. Graphic interface of the E-Cabin APP.

The App has four main functions: atmosphere, smart devices, activity and cabin statistics.

- Atmosphere: The App creates the right ambiance for any moment; the passengers, in accordance to their mood and desired activity, can select from different atmosphere presets. For example, the App can wakeup the user naturally, help him to reinvigorate, read, concentrate, relax and could even

help him fall asleep. Moreover, the atmosphere preset turns the environment into an extraordinary experience by playing with colors or syncing the smart lights with audio and video content.

- Smart Devices: The passenger has access to the characteristics of the devices.
- Activity: The passenger can select the activity e.g. reading, sleeping, cinema etc. After the selection, the App sets the smart devices to create a personalized environment, which influences and increases the user performance.
- Cabin statistics: The passenger can see what works better and increases perceived comfort.

6. Conclusions

To increase the passenger comfort perception and consequently minimize uncomfortable feelings, the cruise ship is designed as a sequence of various public and private spaces. In detail, this study proposes a novel infrastructure that increases passenger comfort in cruise ship cabins already in use. The proposed App works as a DSS (Decision Support System), utilises smart devices and also considers the user activity through a holistic approach.
Further developments should be aimed at ensuring a new project approach that takes into account the design and the proposed infrastructure since the first phases of a cruise ship design and production.

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