

IncarWellbeing:
Innovations from Healthcare
for the Automotive Industry

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1. Introduction	1
2. Definition of Incar Wellbeing	1
3. Technologies	1
3.1 Automatic Air Conditioning (AC)	1
3.2 Air Balance Package	3
3.3 Multicontour seats and massage function	4
3.4 Seat climate control.....	6
3.6 Further Technologies	7
3.7 Future Technologies.....	10
4. Market	12
4.1 Healthcare market	12
4.2 Wellness Market	19
4.3 Incar Wellbeing market.....	23
4.3.1 Existing Technologies	23
4.3.2 Concept Cars.....	25
4.3.3 Conclusion	28
5. Economic Benefits	29
5.1 Car Accidents.....	29
5.1.1 Microsleep	31
5.1.2 Drunk driving	33
5.1.3 General Health Condition	34
5.2 Health Problems	35
5.2.1 Diabetes	35
5.2.2 Heart Problems	37
5.2.3 Allergies.....	38
5.3 Conclusion	39
6. Summary.....	40
7. Bibliography	42

1. Introduction

Health and well-being are basic needs of people. Good health, fitness, diets and wellness are aspects of life which are important for many people today. Everybody wants to create a better version of themselves. This need has created a trillion dollar industry. As an increasing number of people have chronic diseases, the healthcare industry is continuously growing and developing aids in order to help them. Then there is also the wellness industry which tries to sustain the physical and mental health of people. There is an increasing number of innovations and products in these industries every year. Incar Wellbeing is the idea to implement these innovations into a car. The majority of people spend a lot of time in their cars. It makes sense to implement innovations in the area of healthcare and wellness into a car.

2. Definition of Incar Wellbeing

Incar Wellness, Health and Comfort are used to describe the innovation process of Incar Wellbeing in the automobile industry. A definition for Incar Wellbeing could be: implementation of technologies in a car to maximize the well-being of the driver. For this reason it is not possible to clearly define which technologies are connected with Incar Wellbeing. Most of the technologies are innovations stemming from the healthcare and wellness industry, such as, for example, a heart rate monitor or an air humidifier. Since there is no official definition of Incar Wellbeing, car manufacturers are free to define what they see as being part of Incar Wellbeing technology. The ongoing innovation process in the industry will determine how Incar Wellbeing will look like in future and what technologies are connected with it.

3. Technologies

The review of the Incar Wellbeing technologies includes existing technologies and technologies which are in the phase of conceptualization.

3.1 Automatic Air Conditioning (AC)

AC is a standard feature in every car today. However, many aspects have changed since its introduction in the 60s. The innovation of automated AC in the premium segment has made

it into Incar Wellbeing technology. An example of it in the premium segment is the Thermotronic by Mercedes Benz. A similar technology also exists in cars made by Audi¹ and BMW², for example. The Thermotronic system is an automated AC which keeps the temperature at the level set by the user. Another feature is that the car can be divided into different climate zones, which makes it possible to choose individual climates for driver and front passenger and also for the rear passengers. Furthermore it is possible to select an individual higher or lower temperature for the foot area. Several sensors measure the temperature inside and outside the car in order to keep the temperature at the selected level in the different climate zones. The system features a high level of effectiveness, low noise emission, without any unpleasant air draft.

Another important aspect is the control of air quality. The system includes an activated carbon filter which filters fine dust, pollen, etc. and smell. A sensor measures the outside air quality and checks for airborne impurities. The system automatically switches to internal air circulation if the level of airborne impurities is unsafe.³

Thermotronic System (Mercedes Benz)



¹ Audi, Komfortklimaautomatik 4-Zonen

² BMW, 4-Zonen-Klimaautomatik

³ Mercedes Benz, Klimatisierungsautomatik Thermotronic

Thermotronic System (Mercedes Benz)



3.2 Air Balance Package

The Air Balance Package is a combination of three innovations which are offered in the current S-Class of Mercedes Benz. A similar system exists in the BMW's Model 7.⁵ The package consists of an improved filter, ionizer and fragrancier. The improved filter works with two combined activated carbon filters. In contrast to normal filters it is possible to reduce airborne impurities to such a level that passengers don't recognize them. Furthermore it includes an improved filter especially for pollen, which is helpful for people with allergies. Another aspect is ionization: before the filtered air from the AC is channeled into the cabin it passes through an ionizer. Here it is cleansed and viruses, bacteria and spores are eliminated. Another benefit is a relaxing effect because the concentration of negative ion will be increased by the ionizer. This can improve concentration and wellbeing of the passengers. The fragrance is not permanent and does not affect clothes or the instruments of the car. Four different fragrances are offered in small jars which can be placed in the glove compartment according to the mood of the user. The liquid fragrance evaporates by itself and is then diffused into the cabin. The intensity of the diffusion can be adjusted and also be turned on and off.⁶

⁴ Mercedes Benz, Image 1

⁵ BMW, Ambient Air Paket

⁶ Daimler AG, Die Klimatisierung: Viele Neuheiten für ein behagliches Klima, Stuttgart, March 26, 2013

Fragrance jar (Mercedes Benz S-Class)



3.3 Multicontour seats and massage function

Multicontour seats and massage functions already exist in cars from different car manufacturers in the premium segment, like Audi⁸ or BMW⁹. The modern multicontour seat of Mercedes Benz, for example, has several functions that provide comfort and improve conditions while driving. The seat has several air chambers that adapt to the anatomy of the passenger. A four-way adjustable lumbar support supports the spine in the loin area. The forming and position of the air chambers can be individually adjusted to a passenger's contour through air pressure. The side and seat bolsters are also adjustable to give stability while driving. The seat can be adjusted through the Command System (on-board computer) or the controller in the central console. A separate feature automatically adjusts the air in the side bolsters while driving. This gives the driver perfect stability while driving in curves.¹⁰

Another function that will help the driver find the best position to be seated remains to be developed: the on-board computer would analyze the position of the passengers and give advice on a healthy seat position.¹¹

⁷ Mercedes Benz, Image 2

⁸ Audi, Komfortsitze

⁹ BMW, Komfortsitze vorn, elektrisch verstellbar

¹⁰ Mercedes Benz, Multikontursitz

¹¹ Innovationen Institut, Incar Wellbeing, 2015

The massage function is effected by seven air chambers which are built into the seat and work with fast-switching magnetic valves. Through inflating and deflating the air chambers a wave-like massage effect is achieved. The massage lasts up to 20 minutes and has two levels of intensity.¹² Another program gives a massage comparable to a hot-stone-massage. The passenger could relax under the effect of heat and pressure in the area of the spine. Additional movement in this area improves the blood circulation of the muscles.¹³ The massage function is also operated through the command system.

Also waiting to enter the market are technologies that individually massage the neck. A device massaging the neck with the help of heat would be an innovation. Furthermore a massage which uses music in the form of acoustic waves which pass through the body would be an innovation as well. This would give the possibility to intensify the perception of music and reduce stress.¹⁴

Multicontour seat (Mercedes Benz)



15

¹² Mercedes Benz, Multikontursitz

¹³ Mercedes Benz, Sitzkomfort Paket

¹⁴ Innovationen Institut, Incar Wellbeing, 2015

¹⁵ Mercedes Benz, Multikontursitz,

Massage function (Mercedes Benz)



3.4 Seat climate control

Seat heating has become a standard feature in the premium segment. There are, however, some innovations that qualify them for being included in Incar Wellbeing technology. An example is once again the technology of Mercedes Benz. Their seat heating has three different levels and automatically switches to a lower level after a certain time. Seat ventilation is a further option: air is directed through small perforations in the seat to the back of the occupant for increased comfort. This ventilation also has three levels and works also in combination with the seat heating. It can therefore also be used on cold days to dry the clothes of passengers faster.¹⁷

Another feature in this context is the heating of surfaces in the car. All the surfaces a passenger comes in contact with can be heated at three levels. This includes the steering wheel, armrests and other surfaces.¹⁸ BMW offers this technology as well.¹⁹

A new innovation which does not yet exist in the market would be an automatic adjustment of the climate to the body temperature of the passenger. Normally, according to whether passengers feel cold or warm, they have to adjust the temperature. An infrared camera can monitor the temperature of the passenger and prompt an increase or decrease of the

¹⁶ Mercedes Benz, Image 3

¹⁷ Mercedes Benz, Sitzklimatisierung

¹⁸ Mercedes Benz, Wärme-Komfort-Paket

¹⁹ BMW, Wärmekomfort Paket vorne

temperature in the car. This system would always keep the optimal temperature suited to maximize passenger well-being.²⁰

Surface Heating (Mercedes Benz)



21

3.6 Further Technologies

Innovative Glass

The glass of cars in the premium segment has also undergone innovation allowing the glass to decrease the effects of heat from the sun and also to shield passengers from outside noise. It can also reflect infrared light.²²

Ambient lighting

Ambient lighting is an Incar Wellbeing technology available in the premium segment. BMW, for example, offers light in six different colors with different intensity levels. It is automatically activated when the headlamps are on, but can be turned off manually.²³ An innovation in this area would be the option of natural light (sunlight). This would increase the comfort and wellbeing of the passengers.²⁴

²⁰ Innovationen Institut, Incar Wellbeing, 2015

²¹ Mercedes Benz, Wärme-Komfort-Paket

²² E.g. Audi, Dämm-/Akustikglas

²³ BMW, Ambientes Licht

²⁴ Innovationen Institut, Incar Wellbeing, 2015

Ambient Lightning (BMW)



25

Eye Monitor and Attention Assist

Systems like Toyota's Eye Monitor or Attention Assist by Mercedes are safety features as well as Incar Wellbeing features. The Eye Monitor uses cameras to monitor the upper and lower eyelids. If the camera detects signs of tiredness, it suggests to the driver to take a break. Also, if the external cameras detect signs of a collision, an alarm is triggered.²⁶ The Attention Assist analyzes the performance of the driver: data like the handling of the car, speed and small mistakes of the driver are collected in order to determine whether there is a decline in concentration. In case the driver shows signs of not being focused, the car activates an alarm and suggests a break.²⁷ The invention also increases the well-being of the driver because it suggests rest periods which make long journeys more comfortable in general.

Keyless Go

Some car producers also see technologies like a Keyless Go function as an Incar Wellbeing technology.²⁸ Keyless Go is a common feature of premium car producers. Touchpads in the handle of the door allow the driver to open and close the car without using the key. The key has to be in the pocket of the driver so the integrated chip can communicate with the integrated aerial of the car. If the key is inside the car, the driver can the engine turn on and

²⁵ BMW, Ambientes Licht

²⁶ Toyota, Toyota Enhances Pre-crash Safety System with Eye Monitor, 2008

²⁷ Daimler, Der Aufmerksamkeitsassistent ATTENTION ASSIST warnt rechtzeitig vor dem gefährlichen Sekundenschlaf

²⁸ BMW, Komfortzugang

off by pushing a button. In the broader sense this technology can be an In-car Wellbeing feature. It also increases the comfort of the driver.

Hands-Free Access (BMW)



Start-Stop Button (BMW)



Electric adjustable seats and Memory Function

Electric adjustable seats and the memory function can be seen as In-car Wellbeing functions in a broader sense. The technology is available in the premium segment. The electric adjustable seats give the passenger the opportunity to change the seat height and slope of the back and seat cushion. Furthermore the Memory Function can save the settings and after a change of drivers the original settings are automatically re-established by pressing the button for the Memory Function. Additionally, the memory function also saves the position of the steering column and the exterior mirrors. It is possible to save up to three different profiles.³¹



²⁹ BMW, Komfortzugang

³⁰ BMW, Start-/Stop-Knopf

³¹ Mercedes Benz, Memory Paket

³² Ibid

3.7 Future Technologies

Most of the future technologies are implementations from the healthcare and wellness market. The presented innovations are still in the phase of conceptualization.

Heart-Rate Assistant

Heart rate monitor in a car works with sensors in the seat and in the steering wheel which measure the heart rate. The board computer of the car can analyze the data and warn the driver concerning health problems.

Blood Glucose Monitor

The blood glucose monitor would work with a glucose meter in the steering wheel. The board computer would warn the driver concerning low blood sugar levels and suggest stops in restaurants or fuel stations. Furthermore, patients with diabetes could use this technology to monitor their current condition in the car.

Air humidifier and oxygen monitor

An air humidifier in a car would increase the comfort for the driver and the condition of the mucosa. A sensor in the car measures the humidity and keeps it at a healthy level. Furthermore, an oxygen monitor in the steering wheel could measure the blood oxygen levels of the driver. The board computer can then increase the oxygen level. The result is an increased concentration and overall wellbeing.

Electromagnetic shielding

The car with its antennas and other electric devices can eventually cause electromagnetic pollution. The idea is to implement a device which helps reduce this pollution in order to keep the passenger healthy. The harm of electromagnetic pollution to the human health is not clear yet and there might be no negative effect.

Headrest with ionizer

The headrest with ionizer should strengthen the nervous system. If the body has an insufficient supply of negative ions, the person is feeling uncomfortable. The headrest should supply the body with negative ions in order to increase the wellbeing of the driver.

Water dispenser

The water dispenser in a car can bring comfort to passengers because they do not have to keep additional water with them. Furthermore the water dispenser has a filter. Additionally, the board computer also can remind passengers to drink. Putting gemstones into the water dispenser can also increase the quality of the water. The water dispenser can also use powder which increases nutrient and vitamins in the water.

Autonomous Driving Technologies

In the future cars will drive autonomously. The driver would concentrate on other things than driving the car. In-car Wellbeing technologies can help use time in the car efficiently. The implementation of fitness devices like expanders or spinning bikes could help the passenger stay fit. Also the implementation of a bio swing platform which trains the skeletal muscles could be possible. Furthermore, the board computer could show a training like yoga which is possible to perform in a seated position.

Connected Health

Connected health is of importance for car producers as well. This innovation from the healthcare industry could be implemented in cars as well. Further details under point 4.1.

Remote applications

Remote applications for cars already exist in the market. It is possible to check the fuel level, consumption, route information and other diagnostic information with a smartphone. For In-car Wellbeing remote applications could be used also. One example is the preconditioning of the air quality in the car. Sensors measure the quality of the air. The data will be transmitted to the smartphone and give users the opportunity to precondition the air before using their car.

4. Market

Concerning Incar Wellbeing and the market there are two main questions:

1. Is there a market for Incar Wellbeing technologies?
2. How does this market look like?

A market exists if there is a demand for and a supply of products. There are technologies like multicontour seats already produced and sold by car manufactures. Therefore there is a market for Incar Wellbeing technologies. Nevertheless the Incar Wellbeing market is in an early stage of development due to the fact that many technologies are still in the phase of conceptualization. Thus it makes sense to look at existing markets with technologies that could be built into an automobile. Two main markets are connected with Incar Wellbeing. These are the healthcare market with technologies to monitor health functions and the wellness market with technologies to enhance the comfort in a car. In order to assess which technologies are associated with the corresponding market there exists a definition by the US Food and Drug Administration. Wellness products are defined by their function to maintain a general state of health. They are associated with the role of a healthy lifestyle and may reduce the risk of certain chronic diseases.³³ Wellness products underlie lower standards than healthcare products. The latter have to guarantee higher standards for the purpose to treat or assist people with diseases. Before taking a look at the Incar Wellbeing market and answering the question of how this market looks like, it is helpful to look at the established healthcare market as well as the wellness market.

4.1 Healthcare market

General

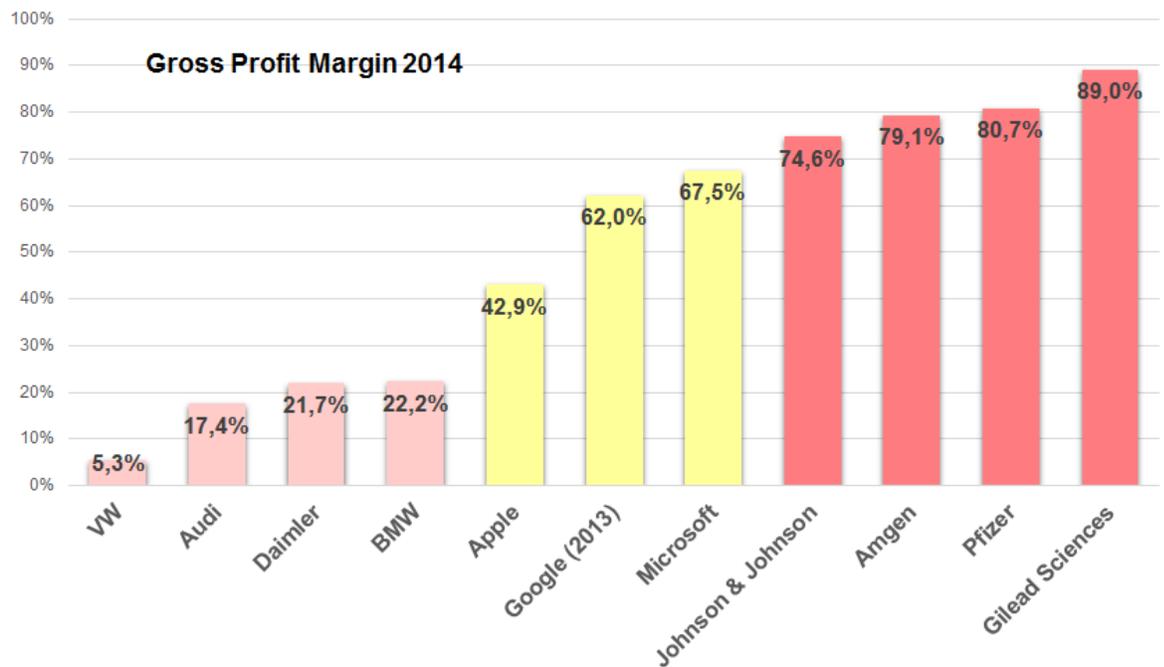
Future technologies in the Incar Wellbeing market are coming from the healthcare market. The general condition and future of the healthcare market may show trends for the Incar Wellbeing market. The global healthcare market is a continuously growing sector worldwide. The Economist Intelligence Unit estimates an average growth of 5.3 % a year between 2014 and 2018. Today an average of 10.3 % (2014) of the Gross Domestic Product

³³ U.S. Department of Health and Human Services, General Wellness: Policy for Low Risk Devices, January 20, 2015, p. 3

(GDP) is spent on healthcare.³⁴ Regional 17.4 % of the GDP is spent in North America, 10.7 % in Western Europe, 8.0 % in Latin America, 6.6 % in Asia/Australasia, and 6.4 % in the Middle East/Africa.³⁵

Furthermore, the global healthcare market faces challenges concerning aging population and increasing spread of chronic diseases. The life expectancy is going to increase from 65 years in 1990 to 77 years in 2050.³⁶ The number of high-income households is also going to increase, which is also creating demand. Concentrating on Europe, the demographic changes will be tremendous. By 2050 37 % of the European population will be over 60 years. Consequently age-related diseases will increase. Additionally, sedentary behavior and rising obesity levels will increase the spread of chronic diseases.³⁷

Additional compared to the automotive and IT sector the profit margins are very high in the healthcare market:



Sources: Annual Reports 2014 VWAG, Audi AG, Daimler AG, BMWAG, Innovationen Institut 2015

³⁴ Economist Intelligence Unit, Global outlook: Healthcare, March 2014, p. 6

³⁵ Health expenditure, total (% of GDP) data, World Bank

³⁶ United Nations, UN projects world population to reach 8.5 billion by 2030, driven by growth in developing countries, July 29, 2015

³⁷ Deloitte, Global health care outlook, 2014, p. 1-7

Medical Technology

Important for Incar Wellbeing technologies is the sub-market medical technology. Many technologies from the area of medical technology can be implemented in a car. Therefore it is important to take a look at the market for medical technology.

Medical technology is used to ensure the health of individuals. It is used in the entire range from diagnosis to cure. The aim is to extend life by curing symptoms of diseases or preventing diseases. Billions of patients worldwide depend on medical technologies in their life. Today more than 500.000 products exist in this area with a huge variety, e.g. wheelchairs, insulin pens, dental floss etc.³⁸

Concentrating on Europe, the medical technology market is estimated to have a volume of 100 billion Euros. It is the second largest medical technology market covering 30 percent of the world market (based on manufacturer prices). Of the 10.4 percent of GDP spent on healthcare in Europe, 7.5 percent is attributed to medical technologies. Over the past 6 years the market has been growing by 4 percent per annum and has created a trade surplus in the medical technology area of 15.5 billion Euros (2012). Due to a high level of research and development, medical technology is characterized by a frequent flow of innovation. More than 10.000 patent applications in the field of medical technology were filed with the European Patent Office (EPO) in 2012 alone. This is equivalent to 7 percent of the total number of applications, which is more than in any other technical field. European companies filed 38 percent of these patents. With more than 575.000 people employed, the medical technology industry is an important part of the European economy. There exist around 25.000 medical technology companies in Europe. 95 percent of these companies are small and medium-sized companies (SMEs), meaning they employ fewer than 250 persons and their annual turnover does not exceed 50 million Euros.³⁹

Medical Device

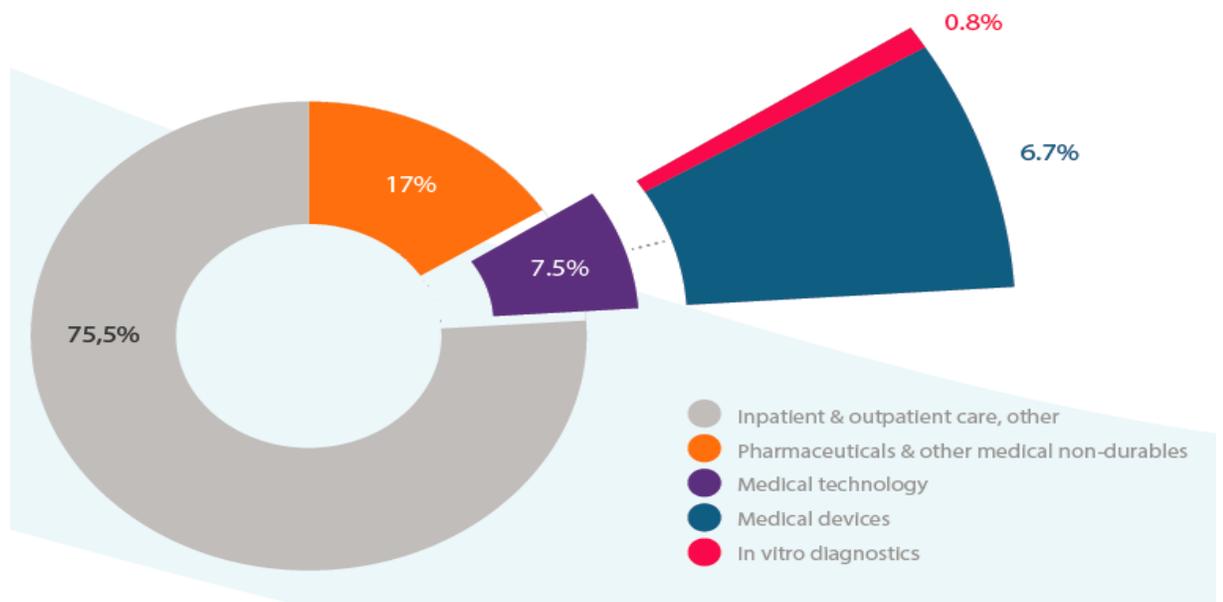
Especially important for the future of Incar Wellbeing are existing technologies in the medical device area. There are existing personal medical devices which are portable and consumers can monitor their health with them during the day. The market outlook is

³⁸ MedTech Europe, The European Medical Technology industry in figures, January 2014, p. 2-30

³⁹ Ibid

positive for these devices. Self-Care medical devices like heart rate monitors, pulse oximeters or blood glucose meters have an increasing demand. 220 million people are affected by chronic diseases like diabetes, asthma or blood pressure, and 85 per cent need personal medical devices at home to monitor their condition. In 2012 the global self-care medical devices market was valued at 10.5 billion USD. It is expected that this figure will reach 16.9 billion USD in 2019. This makes an annual growth rate of 7 percent from 2013 to 2019.⁴⁰

Breakdown of total healthcare expenditure in Europe



41

Technologies

The following technologies already exist in the healthcare market and have the potential to be built into a car. However, ongoing innovation in the healthcare market will also affect the technologies in the In-car Wellbeing market.

⁴⁰ Transparency market research, Self-care medical devices market expected to reach USD 16.9 billion globally in 2019, Jan 07, 2014, PR Newswire

⁴¹ MedTech Europe, The European Medical Technology industry in figures, January 2014, p. 2-30

Heart rate monitor

One product is the heart rate monitor. Heart rate monitors exist in many forms with many features. They are implemented in watches, fitness machines and other devices. Besides monitoring the heart rate, these devices also provide information about calories burned and the breathing rate. Today the main market for this product is in the fitness area and for people with chronic diseases. The prices for most these devices lie between 20 Euro and 200 Euro.

Heart rate monitor (Garmin Forerunner 225)



42

Pulse oximeter

Another technology is the pulse oximeter. The technology of pulse oximetry is used to measure the oxygen level in the blood. A clip on the finger measures the oxygen level using red and infrared light. People suffering from obstructive lung disease, asthma, heart failure or other diseases need this device to monitor their condition. In a hospital and a doctor's office this device is common. However, there is an increasing number of customers who use these personal medical devices at home. The prices for these devices lie between 20 Euro and 50 Euro.

⁴² Garmin, Forerunner® 225

Pulse oximeter (MD 300D C2)



43

Blood glucose monitoring

Blood glucose monitoring is a technology to test the blood for its glucose level. It is used by patients with diabetes in order to adjust their insulin dose. The common blood glucose test uses a small sample of blood from the finger which is then put on a test strip. The blood is analyzed by a blood glucose meter, a small electric device. In recent years there came up a new development of non-invasive blood glucose monitoring. The idea is to use near infrared spectroscopy to analyze the blood glucose level.⁴⁴ This technology is not yet on the market and just a concept. Nevertheless, this technology could be used in Incar Wellbeing in the future. The prices for the existing devices lie between 20 Euro and 100 Euro.

Blood glucose meter (OneTouch Ultra®2)



45

⁴³ Oxigeno healthcare, Fingerpulsoximeter MD 300D C2

⁴⁴ Masab Ahmad , Awais Kamboh & Ahmed Khan, Non-invasive blood glucose monitoring using near-infrared spectroscopy, October 16, 2013 , EDN Network

⁴⁵ Onetouch, OneTouch Ultra®2

Personal Electrocardiography (ECG)

Personal Electrocardiography (ECG) monitors record the heart rate using electrodes, like a normal ECG used in hospital for example. The difference lies in the compact size. Whereas normal ECG monitors use 12 electrodes, mobile ECG monitors use dry-contact skin contacts where the subject is pressing his thumbs on the device.⁴⁶ Such a device could also be implemented in a car. Many people with diseases like coronary artery disease have a use for such a device. The prices for these personal ECGs lie between 200 Euro and 300 Euro.

Personal ECG monitor (Instant Check)



Connected Health

Implementing medical devices in cars also generates the need to connect them. Therefore the development in the area of connected health is also important for Incar Wellbeing. Connected health is a relatively new topic in the healthcare market. The idea is to link patients and providers through telecommunication even if they are geographically separated.⁴⁸ Especially important is the field of telemedicine which uses technologies to remotely diagnose, monitor, and treat patients. One example is a program for patients with congestive heart failure (CHF) at Partners HealthCare. 3000 CHF patients used in-home monitoring of weight, blood pressure, heart rate and pulse oximetry. The data was uploaded and analyzed in order to filter patients who need attention. The result was that hospital

⁴⁶ James W Grier, Comparison of three handheld 1-lead ECG / EKG recorders, North Dakota State University

⁴⁷ Dcbiomed, Instant Check

⁴⁸ Iglehart, J. K., Connected health: Emerging disruptive technologies, 2014, Health Affairs, 33(2), p. 190

readmissions dropped by 44 percent and cost savings of more than 10 million USD were generated.⁴⁹The advantage of cost savings will help develop this technology even further in the next years. With the implementation of connected health devices into a car passengers can use the collected data to complete their medical records.

Another important aspect concerning connected health is telehealth. Telehealth deals with giving people access to health education through the internet.⁵⁰ The idea is to provide consumers with information about a healthy lifestyle or general health issues. Furthermore, it supports them in managing their health and lifestyle. In the Incar Wellbeing market this information can be delivered via the board computer of the car to the passenger. Through the connection between the medical devices and the car it is possible to analyze the health and give advice about improving actions and behavior.

Also relevant is the development of mhealth. mhealth or mobile health deals with the development of mobile applications in order to provide health services. There is an increasing trend of health applications in the market. These applications support the customer with their diet, fitness program or general health tips. The development of these applications is in an early stage at the moment. In future there will probably also be health applications in order to support people with chronic diseases and in other areas. Health applications will become important for Incar Wellbeing as they may be connected to the medical devices in the car.

4.2 Wellness Market

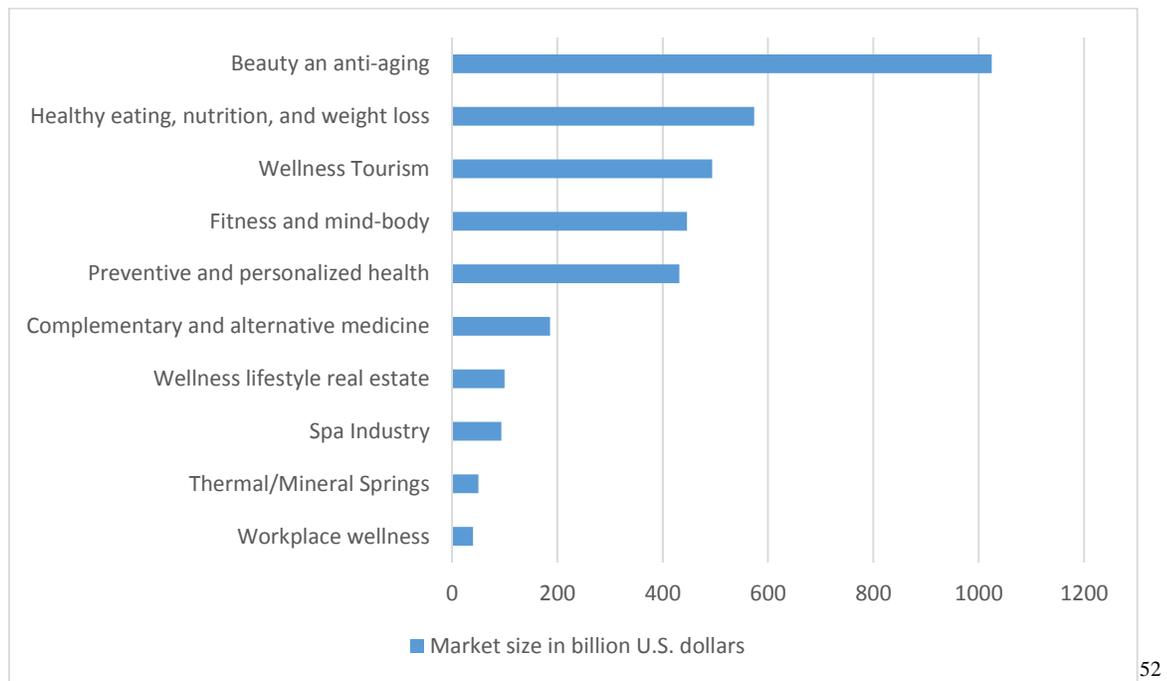
The global wellness market is a 3.4 trillion (2013) dollar industry with a growth rate of 7.7 percent between 2007 and 2013. Due to the aging population and the increasing prosperity in the emerging markets, the wellness market is constantly growing. People are becoming more interested in how to stay healthy and relaxed. Today many diseases are the consequence of lifestyle, sedentary behavior and stressful living. The wellness market offers products to act preventively in this area. The aim is to reduce stress, prevent diseases,

⁴⁹ Kvedar, J., Coye, M. J., & Everett, W., Connected health: A review of technologies and strategies to improve patient care with telemedicine and telehealth, 2014, *Health Affairs*, 33(2), p. 194-9

⁵⁰ Ibid

and live well.⁵¹ Many sub-markets are collected under the wellness market as shown in the graphic below.

Market size of the global wellness industry in 2013, by segment (in billion U.S. dollars)



52

Important for the Incar Wellbeing market are technologies that can potentially be built into cars. This includes fitness devices which will become even more important for Incar Wellbeing due to the fact that autonomous driving will provide the driver with the opportunity to more intensively use fitness devices built into the car.

The following technologies already exist in the Wellness market and are capable to be built into a car.

Air purifiers

Air purifiers can improve the air quality in many ways. Some aspects of these devices are already implemented into cars, like active carbon filters. Modern air purifiers are able to do more than just clean the air. It is possible to help people with allergies or asthma by filtering pollen, mold, dust, bacteria, odor and smoke from the air. High Efficiency

⁵¹ Global Wellness Institute, Global Spa & Wellness Economy Monitor, 2014, p. i-ii

⁵² Global Spa Summit @ Statista, Market size of the global wellness industry in 2013 by segment

Particulate Air (HEPA) technology is a filter system which can absorb up to 99.97 percent of all particles. This technology coming from the medical cleanrooms can absorb bacteria, dust and pollen. Another technology is electrostaticity, which uses electric charge to trap particles traveling in the air. The latter works very efficient in the combination with a HEPA filter. Further technologies are activated carbon filter which can filter smoke, gases or odors, and ultraviolet light (UV) which can neutralize viruses and bacteria. All the mentioned technologies can be combined in air purifiers.⁵³ Furthermore, these technologies can be integrated into a car to improve the existing filter systems. The price for air purifiers depend on the technologies used and the size of the area for which it is used. The prices lie between 200 Euro and 1000 Euro.

Air purifier (Blueair Classic 403)



54

Air humidifier

Air humidifier use several technologies to increase the humidity. Important for In-car Wellbeing are technologies that can potentially be built into a car. Vaporization is a technique where heat is used to vaporize water in order to channel it into the air. This technique uses a lot of energy but also eliminates germs in the water. Another technique is nebulization which uses high pressure pumps with nozzles or ultrasound to nebulize the water. Air humidifiers are often used in areas with low atmospheric humidity in order to prevent drying out of the mucous membrane of people. The prices lie between 80 Euro and 500 Euro.

⁵³ Airpurifiers.com, Understanding Air Purifier Technology

⁵⁴ Blueair AB, Blueair Classic 403

Air humidifier (Phillips HU 4803)



55

Water dispenser

Water dispenser are widely spread in homes and offices. They can filter tap water and are sometimes already implemented in refrigerators. Due to modern technologies like carbon filters, UF membranes and UV light, the water is free of germs and pollution. Furthermore, they can use an existing water tank filled with mineral water. Premium products can also heat or cool down the water. The prices for water dispenser lie between 50 Euro and 250 Euro.

Water dispenser (Waterlogic 4 Firewall)



56

⁵⁵ Philips, Air Humidifier HU 4803

⁵⁶ Waterlogic, Waterlogic 4 Firewall

4.3 Incar Wellbeing market

Some existing car technologies can be assigned to the Incar Wellbeing. These technologies are offered by almost all car producers and find their purchasers, at least in the premium segment. In addition, the car industry has discovered the potential of health or wellness technologies feasible to be implemented into a car. Some of these technologies are already implemented in concept cars.

4.3.1 Existing Technologies

Existing Incar Wellbeing technologies are: Automatic Air Conditioning, Multicontour Seats, Electric Seats, Memory Function, Massage Seats, Seat heating, Seat air conditioning, Ambient Lightening, Keyless Go and Innovative Glass. The following comparison of existing technologies is limited to German car manufacturers in the premium segment. As Surface Heating and Air Balance Package are only offered by BMW and Mercedes, these are excluded from the comparison.

The following table shows the prices for the technologies. Naturally, the technologies slightly differ between the car producers. The quality and the functions of each technology also has an impact on the price. The technologies are offered in many models of the car manufacturers. The information used comes from the official websites of the car manufacturers.

Car Producer	Audi (Model: A8)	BMW (Model: 7)	Mercedes-Benz (Model: S)	Porsche (Model: Panamera)	Volkswagen (Model: Phaeton)
Technology	Price	Price	Price	Price	Price
Automatic Air Conditioning	1.200 EUR	870 EUR	1356,60 EUR	1178,10 EUR	885 EUR
Multicontour Seats	5670 EUR ⁽¹⁾	2200 EUR ⁽²⁾	2023 EUR ⁽²⁾	Standard Equipment	3070 EUR ⁽²⁾
Electric Seats				1796.90 EUR	
Memory Function			892,50 EUR		
Massage Seats			1610 EUR ⁽²⁾	2023 EUR ⁽²⁾	
Seat heating	440 EUR	450 EUR	487,90 EUR	487.90 EUR	
Seat air conditioning	1610 EUR ⁽²⁾	740 EUR	1255,45 EUR	1059,10 EUR	
Ambient Lightening	530 EUR	890 EUR ⁽²⁾	440,30 EUR	737,80 EUR	Standard Equipment
Keyless Go	950 EUR	990 EUR	1779,05 EUR	1094,80 EUR	1410 EUR
Innovative Glass	950 EUR	1200 EUR	1368,50 EUR	1332.80 EUR	470 EUR

(1) Price for the package that includes the technologies, it also includes seat heating among other things

(2) Price of the package that includes the technology

The prices shown and the availability of the technologies are for the premium model of the corresponding car manufacturer. The prices for the technologies are relatively similar between the car producers. Often, the customer has to buy a package with multiple technologies combined. Therefore he/she loses the freedom to choose what technology he/she wants to be implemented in his/her car. There is a huge similarity in the technologies. The functionality of the technologies is often not different between the car producers. In the premium model of the corresponding car producers all Incar Wellbeing technologies are offered. The only exception is massage seats which are not offered in Porsche cars due to the fact of the sportive image of the brand.

4.3.2 Concept Cars

Various car producers have published ideas, concepts and innovations concerning Incar Wellbeing.

Ford

Ford has entered into cooperation with Medtronic. Medtronic is a leading manufacturer of medical devices. They have developed a prototype to connect a continuous glucose monitoring device by Medtronic with the Ford SYNC board computer. Via Bluetooth the device can be paired to the vehicle and a smartphone. The driver has the ability to use voice commands or the steering wheel controls in order to display trends related to his/her blood glucose levels. Furthermore he/she can receive audible alerts.⁵⁷

Another innovation is the Allergy Alert app. Ford has a cooperation with SDI Health in order to enable communication between the app and Ford SYNC. Through voice controls the driver can access information about location-based index levels for pollen, asthma, cold and ultraviolet sensitivity. Furthermore the app can show allergy alerts on the car display.⁵⁸

Ford and WellDoc also work on in-car accessibility in the field of mHealth. The idea is to access the Ford SYNC app via voice controls. Systems like Asthma Manager or Diabetes

⁵⁷ Ford Motor Company, Ford In-Car Health and Wellness Solutions, 2011

⁵⁸ Ibid

Manager can be accessed. The idea is to receive real-time patient coaching, behavioral education and medication adherence support while driving.⁵⁹

Ford also produced the first ECG car seat in cooperation with German universities. The seat ECG works similar to a normal ECG. Six sensors in the car seat can measure the electric impulses from the body. The sensors sense through clothes and performed satisfactorily with 95 percent of the test subjects. The seat is just a prototype but it could potentially be also connected to Ford SYNC or smartphones. The driver could be warned in case of a concerning medical condition. Furthermore, the car could send an emergency signal in case of a heart attack and use a driver assist system to stop the care carefully. The advantages of connected health like telediagnosis will become more and more important.⁶⁰

Ford ECG Seat



61

PSA Peugeot Citroen

PSA Peugeot Citroen has published the Chrysalide concept. The concept tries to interact with the four senses: sight, touch, hearing and smell. The idea is to make the car to a relaxation oasis. The car uses fragrances, cabin light, massage seats and 3D acoustic treatment. The concept introduces two well-being programs: relaxing and energy. The relaxing program offers the driver to pre-set the temperature in the car via smartphone. When the passenger enters the car, the seat is tilted back and a fragrance in combination with soft light and ambient music would generate a relaxing atmosphere. The energy program has the function to support the driver while driving. A camera analyzes the face

⁵⁹ Ibid

⁶⁰ Ford, ECG Driver heart monitoring, 2011

⁶¹ Medgadget, Ford Unveils Contactless ECG Sensing Driver Seat, 2011

and identifies signs of tiredness. The energizing program starts if it recognizes the need. It straightens the seat back, drops the temperature slightly, the cabin light becomes brighter and rousing ambient music is played.⁶²

Chrysalide Concept (PSA Peugeot Citroen)



Another innovation from PSA used in the Chrysalide Concept is the Cielo Magic light. The light comes from a sticker on the sunroof which displays a desired pattern of reflection on the inside. This technique gives the impression of a real light source.⁶⁴

Audi

Audi, in cooperation with Technogym, a leading fitness company, has presented the first wellness concept car called GEA. They have presented their concept at the Geneva International Motor Show in March 2015. The idea is to implement fitness devices into the car and generate a wellness ambience especially for long journeys. When the driver starts the wellness function, the ambient lighting is changing to an amber colored light which generates a warm and calming atmosphere. In the back seats two aluminum handles are integrated which extend when the program is started. They can be used to train the torso and the upper part of the body. Two boards from Technogym are integrated in the floor, which can be automatically lifted. The passenger can then do step exercises in order to train the lower limbs. The monitor assists the training with Technogym training videos.

⁶² PSA Peugeot Citroen, Chrysalide concept, a new experience in well-being for driver and passengers

⁶³ Ibid

⁶⁴ PSA Peugeot Citroen, Innovative ambient lighting, a source of onboard well-being

Furthermore, a refrigerated shelf between the seats offers space for drinks and juice. There is also a small box with cosmetic products and a fragrance bag for aroma therapy.⁶⁵

GEA Concept Audi



4.3.3 Conclusion

The answer to the question of how the Incar Wellbeing market looks like is that it is probably a combination of trends which can be seen in the healthcare market, the wellness market and the already existing Incar Wellbeing market.

Both the healthcare market and the wellness market are big markets with an increasing volume. There are technologies in these markets which can be implemented into a car as described in more detail above. As the time spent in the car is significant, 2 years and 6 months during a lifetime⁶⁷, it is likely that consumers would like to use this time more efficiently for their wellbeing. They already spend significant time and money for their health and wellness. It can be expected that the positive forecasts for these markets will also push the development of the Incar Wellbeing market if the respective technologies are developed and adopted.

The existing Incar Wellbeing technologies are solidly established in the premium segment. The prices for existing Incar Wellbeing technologies are high, especially if the customer is forced to buy packages. However, these technologies will probably come to mass market after a certain time. This development can be observed when looking at the massage seats

⁶⁵ Technogym, Technogym und Audi präsentieren Gea – das erste Wellness Concept Car

⁶⁶ Ibid

⁶⁷ Gruner+Jahr, Womit verbringen wir unser Leben?, January 3, 2014, P.M. Magazin

which are already offered in the Citroen C4. If Incar Wellbeing technologies currently tested in concept cars will prove to be truly beneficial for the health and/or wellbeing of customers, they will soon make their way into the premium segment and, over time, into the mass market.

Another aspect of the Incar Wellbeing market is that the existing technologies are part of the optional supplementary equipment for a car. It is easy to spend 70.000 Euro or more for supplementary equipment in a premium segment car. The trend of increasing prices for cars is basically driven by supplementary equipment. It can be expected that customers will consider more carefully what supplementary equipment they really need. Therefore, the development of the Incar Wellbeing market will depend significantly on the value customers will attribute to healthcare and wellness. In any event, the future of the Incar Wellbeing market will be determined by the level and quality of ongoing innovations by the automobile industry.

5. Economic Benefits

The economic benefits of Incar Wellbeing technologies consists in reducing car accidents and improving health and comfort of the driver and the other passengers. Therefore it makes sense to look at statistics of car accidents and health problems in order to evaluate the overall benefit of Incar Wellbeing technologies.

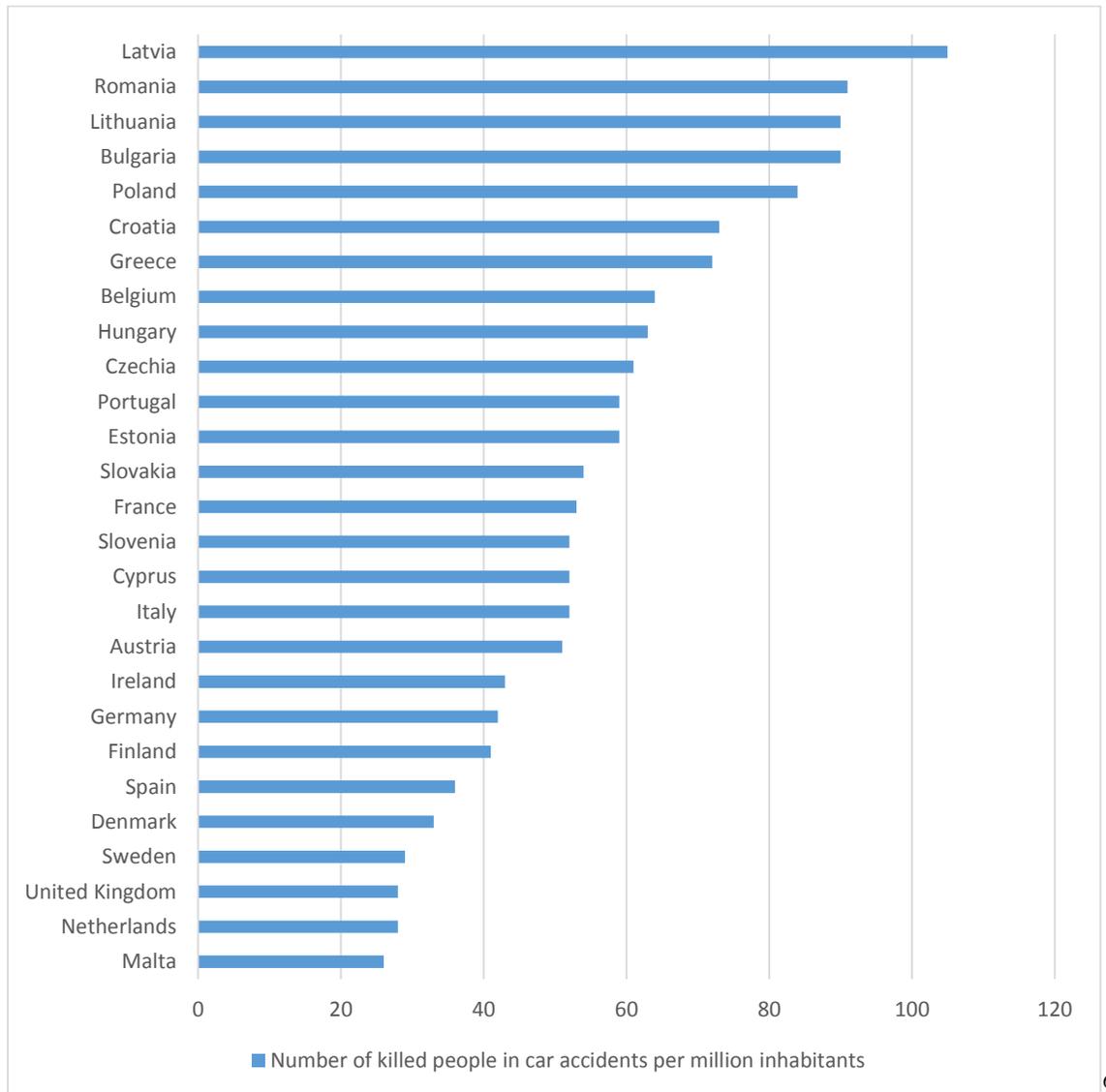
5.1 Car Accidents

Today, car accidents can be prevented by modern technologies built into cars. Important for Incar Wellbeing are those accidents that could have been prevented due to implementation of Incar Wellbeing technologies. The causes of accidents potentially avoidable with Incar Wellbeing technologies are: Microsleep, drunk driving and general health condition.

The distinction between safety and Incar Wellbeing technologies in general is not clear. Technologies like the Attention Assist which prevents microsleep or a breath analyzer which measures the alcohol level of the driver are primarily safety features. However, these systems also determine the wellbeing of the driver and alert the driver when he/she is no

longer able to drive safely. This enhances the comfort of all passengers in the car. Most safety technologies can therefore also be seen as In-car Wellbeing technologies.

Number of killed people in car accidents in the EU-28-countries for the year 2014



Concentrating on Europe, 25,845 people lost their lives in car accidents in 2014. Between 2010 and 2014 there was an 18 percent decrease in fatal accidents. This development is positive, but the figure is still high. The value of preventing one road fatality is estimated to be 1.94 million Euro (2014). The total monetary value of deaths prevented in the 28 EU countries between 2011 and 2014 is estimated to be 30 billion Euro. The high value of

⁶⁸ European Commission @ Statista, Verkehrstote in den Ländern Europas in 2014

social costs saved make road safety an important field for further research and development.⁶⁹

Furthermore, there are accidents without fatality which also produce costs every year. Concentrating on Germany, 3,377⁷⁰ people lost their lives in car accidents in 2014. Subtracting this number from the total number of car accidents in 2014 which is 2,397,080⁷¹, there are still 2,393,702 car accidents without fatality. The average damage sum per accident in Germany is 3,485⁷² Euro (2011). This amounts to over 8 billion (8,342,051,470) in the year 2014.

Key Facts

Fatality Europe 2014 (EU 28)	Fatality Germany 2014	Value of Preventing one road Fatality (VPF)	Number of Accidents without Fatality (Germany 2014)	Average damage sum per accident (Germany)
25,845	3,377	1.94 million Euro	2,393,702	3,485 Euro

The calculation of the benefit of Incar Wellbeing technologies will be based on the statistics mentioned above. However, the percentage due to which each cause of a potential accident leads to an actual accident is based on assumptions of experts and comparable statistics. Therefore, the presented fatalities and the corresponding social costs are estimations and no substantiated figures.

5.1.1 Microsleep

Microsleep is caused by tiredness. The driver closes the eyes for a few seconds and does not pay attention to the traffic and to the road. If the driver closes his eyes at a speed of 130

⁶⁹ European Transport Safety Council, 9th Road Safety Performance Index Report, June 2015, p.7-13

⁷⁰ Statistisches Bundesamt, Fachserie 8 Reihe 7 Verkehrsunfälle 2014, 9. July 2015, p.61

⁷¹ Statista, Unfälle im deutschen Straßenverkehr bis 2014

⁷² Statista, Durchschnittlicher Schadenaufwand je Pkw-Unfall bis 2011

km/h for 5 seconds he covers a distance of 180 meters without control. Often after waking up, the driver takes wrong actions like hard breaking or fitful steering. The indications of tiredness are recognizable like increasing steering corrections or movements of eyelids.⁷³ Technologies like Attention Assist can recognize these symptoms. The system can then send an alarm in order to prevent microsleep and suggests to the driver to take a break. Often a small break of 20 minutes can prevent microsleep.

Experts assume that 25 percent⁷⁴ of fatalities on highways in Germany and 4 percent⁷⁵ of all car accidents are caused by microsleep and its consequences. Probably, the number of unreported cases is even higher. In 2014 375⁷⁶ people died on federal highways and 2,019⁷⁷ on regional highways in Germany. Under the assumption that also on regional highways 25 per cent of fatalities are caused by microsleep, 598 people have died in 2014 in Germany because of this. This amounts to 17.7 percent of all fatalities in car accidents in Germany. Assuming that this percentage is similar in the other EU States, 4,575 people have died in Europe because of microsleep in 2014.

Under the assumption that technologies like Attention Assist are built into all cars and work with a 100 percent reliability, 4,575 fatalities could have been prevented in Europe 2014, which means savings in terms of social costs in the order of 9 billion (8,875.5 million) Euro. Furthermore, in Germany alone 95,748 accidents without fatality and damage of over 300 million (333,683,059) Euro could have been prevented in 2014.

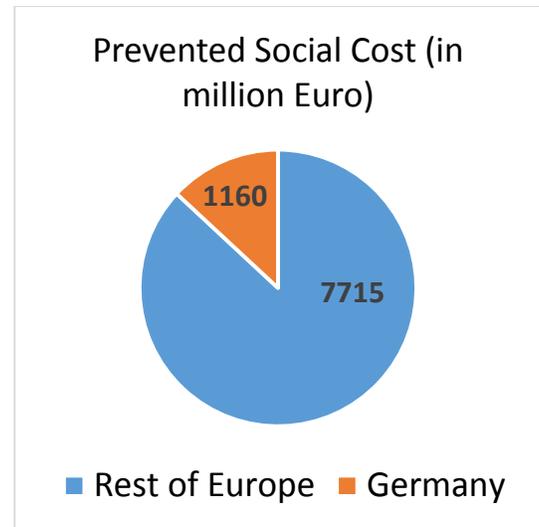
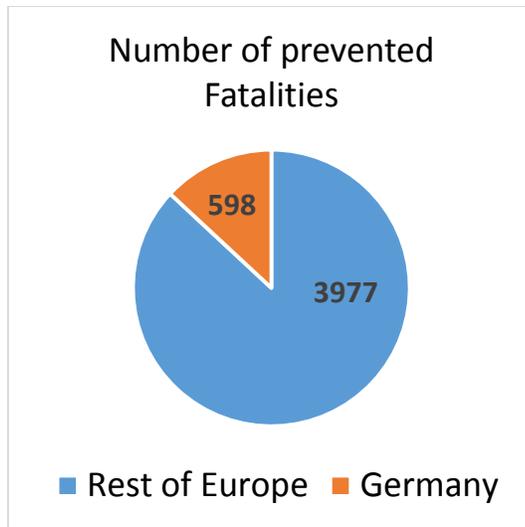
⁷³ Deutscher Verkehrssicherheitsrat (DVR), Sekunden, die über Leben und Tod entscheiden, February 4, 2010

⁷⁴ Ibid

⁷⁵ Statistisches Bundesamt, Fachserie 8 Reihe 7 Verkehrsunfälle 2014, July 9, 2015, p. 272-278

⁷⁶ Statistisches Bundesamt, Fachserie 8 Reihe 7 Verkehrsunfälle 2014, July 9, 2015, p. 61

⁷⁷ Ibid



5.1.2 Drunk driving

Drunk driving is still also an important cause of accidents with fatal consequences. In order to prevent the driver from driving under the influence of alcohol there are existing technologies to achieve this. These technologies can also be seen as an Incar Wellbeing technology due to the fact that the driver can check his/her physical condition and can be comfortable that although having consumed alcohol he/she is still capable to drive. In the United States breath analyzers in cars are more common than in Europe. They test for the alcohol level and inform the driver whether he/she is still capable of driving or not. In some cases the breath analyzer is connected with the ignition of the car, preventing the driver to start the car, when his/her alcohol level is too high.⁷⁸

In Germany 9.4 percent⁷⁹ of fatalities in car accidents are connected with an elevated alcohol level. This caused 317 fatalities in Germany in 2014. On the European level the rate is even higher, with 25 percent estimated by the European Commission.⁸⁰ This translates into approximately 6,461 fatalities due to accidents connected with alcohol in 2014.

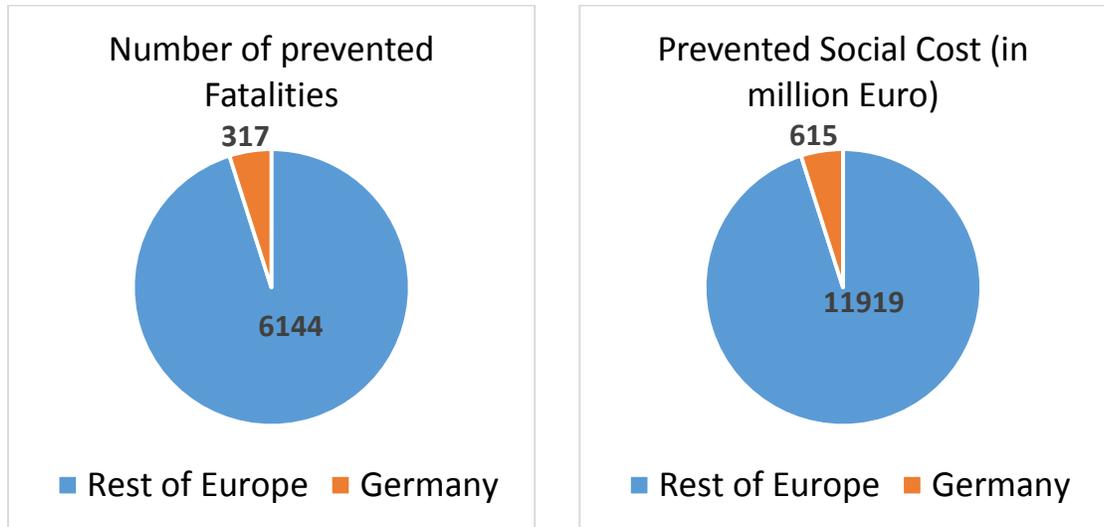
Assuming that the implementation of technologies like a breath analyzer could have prevented 100 percent of the accidents, 6,461 fatalities in Europe could have been avoided. This means savings in terms of social costs of 12.5 billion (12,534.34 million) Euro.

⁷⁸ California Department of Motor Vehicles, Ignition Interlock Devices (FFDL 31)

⁷⁹ Statistisches Bundesamt, Unfälle unter dem Einfluss von Alkohol oder anderen berauschenden Mitteln im Straßenverkehr, 2013, p.8

⁸⁰ European Transport Safety Council, 9th Road Safety Performance Index Report, June 2015, p. 16

Furthermore 8.76 percent⁸¹ of accidents without fatality in Germany are related to alcohol abuse which generated damage of over 730 million (730.763.708) Euro in 2014 which could have been avoided.



5.1.3 General Health Condition

The general health condition is also an aspect which leads to car accidents. Incar Wellbeing technologies from the healthcare market are able to monitor the health condition of the driver. In case the driver is physically not able to drive, the system can alert him/her. Furthermore, in case of a critical medical situation like a heart attack or stroke the car can take measures to safely stop the car and call for help.

In 2014 2.5 percent⁸² of car accidents with fatality and 0.89 percent⁸³ of all car accidents in Germany were caused by insufficient general health of the driver. This led to 84 fatalities in Germany 2014. Assuming the same rate for Europe, 646 people died in Europe due to this cause in 2014.

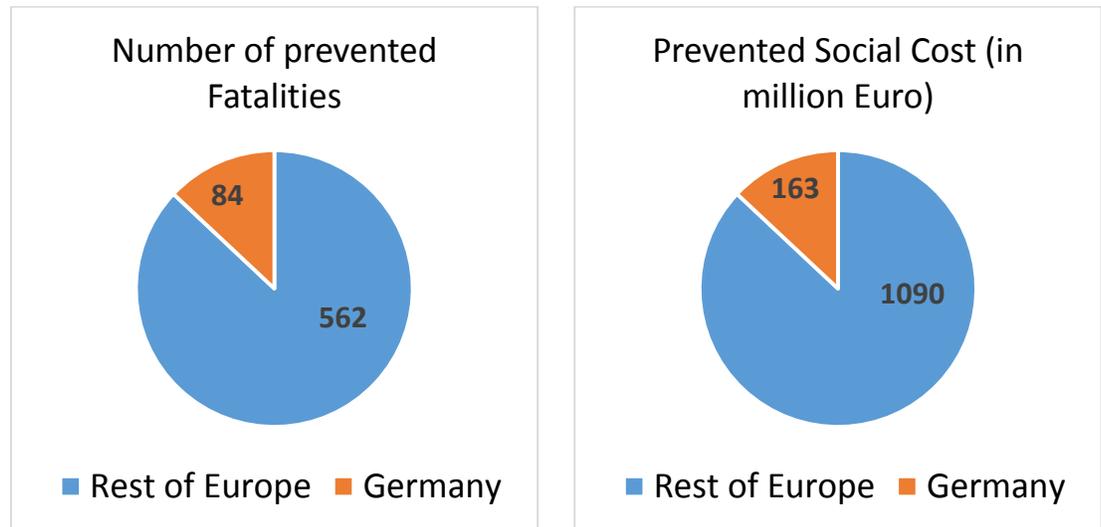
Under the assumption that 100 percent of these car accidents could have been prevented, 646 fatalities could have been avoided in Europe in 2014, which translates into savings in terms of social cost in the order of 1.2 billion (1253.24 million) Euro being spent in Europe.

⁸¹ Statistisches Bundesamt, Fachserie 8 Reihe 7 Verkehrsunfälle 2014, July 9, 2015, p. 272-278

⁸² Ibid

⁸³ Ibid

Furthermore, 21,304 accidents without fatality caused costs of 74 million (74,244,258) Euro which could have been saved in Germany in 2014.



5.2 Health Problems

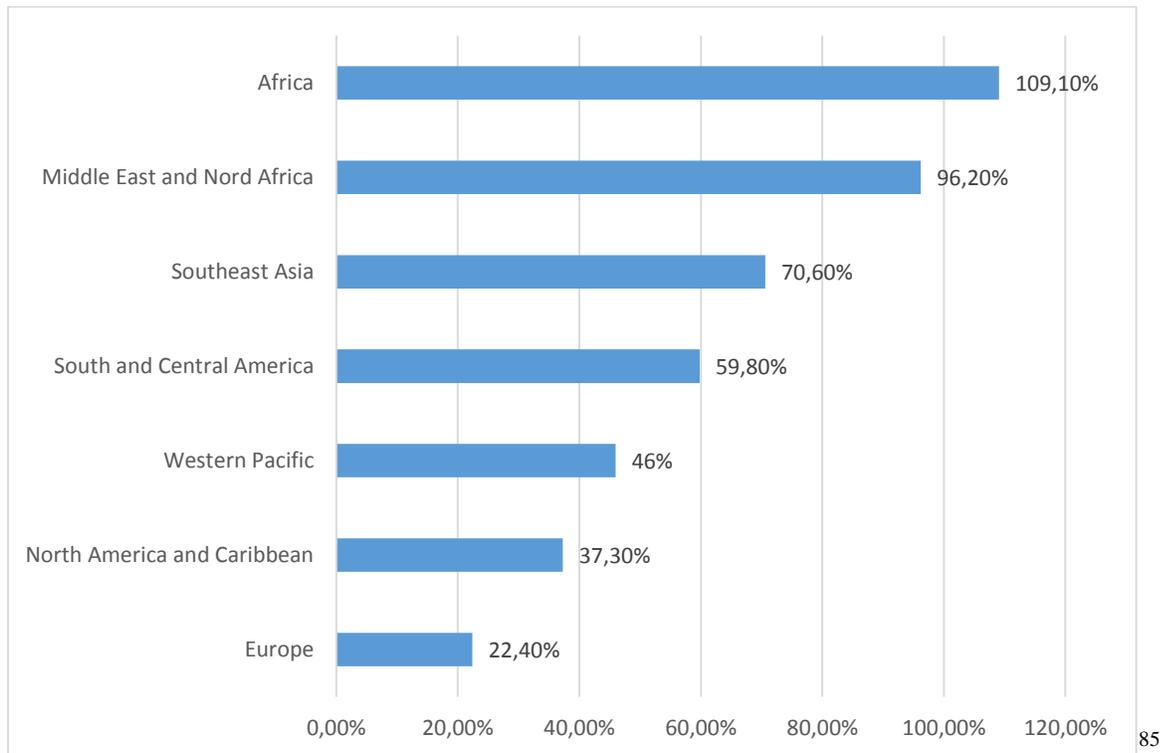
Besides preventing car accidents Incar Wellbeing technologies also provide a benefit for the health of people. On the one hand, wellness and fitness technologies provide passengers with the opportunity to stay healthy in a physical as well as in a mental way. Furthermore, health technologies built into a car are able to assist people with certain medical pre-conditions like diabetes, heart problems or allergies.

5.2.1 Diabetes

Diabetes is a disease increasing worldwide: 382 million people are diagnosed with diabetes. This number is going to increase to 592 million people by 2030. The costs associated with diabetes will rise to 741.3 billion US-Dollar worldwide by 2030.⁸⁴

⁸⁴ Statista, Diabetes mellitus - Statista-Dossier, May 2015, p. 7-37

Forecast of increase in number of people with diabetes by world regions between 2013 and 2035



Incar Wellbeing technologies cannot cure diabetes, but they can assist the patient in living healthy with this disease. Through the implementation of health devices like a glucose monitor into a car, the driver can constantly monitor his/her glucose level while driving. Patients with diabetes need to adjust their glucose level with insulin injections every day. If the glucose level is in the normal range, the diabetes has no impact on the physical capabilities of the patient. If the patient is able to nearly always bring the glucose level to within the normal range, diabetes will have no impact on his/her life expectation or general health condition. A glucose monitor can ensure that at least during the daily time spent in a car the blood glucose level is monitored and adjusted if necessary. Furthermore, the car can alert the driver if the glucose level is abnormal and may impact his bodily functions while driving and may cause an accident.

In combination with a diabetes application for the smartphone like in the concept car of Ford, the user can collect more data concerning his glucose levels from the car. This creates

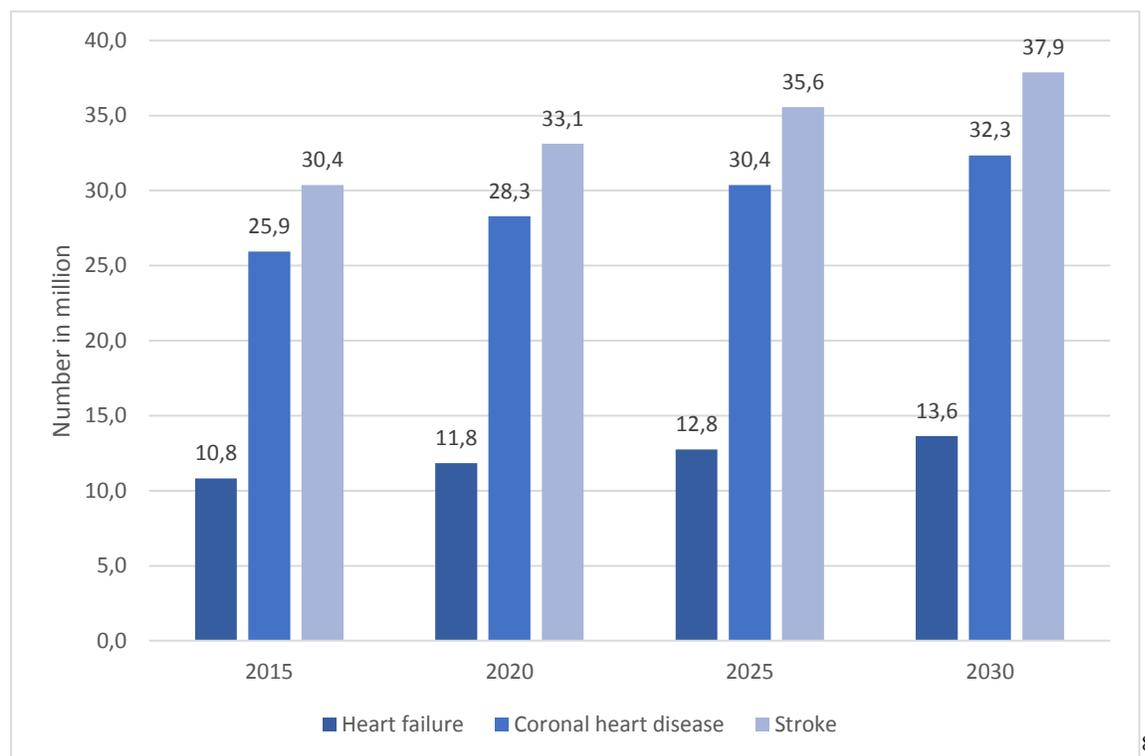
⁸⁵ Statista, Diabetes mellitus - Statista-Dossier, May 2015, p. 34

a more concrete disease pattern which helps also more generally to adjust the individual insulin dosis. Even if it is difficult to calculate a monetary value to this benefit, a well-adjusted glucose level of diabetes patients is constantly improving their lives.

5.2.2 Heart Problems

Cardiovascular diseases like heart failure, coronal heart disease or stroke are in the increase worldwide: 67 million people were diagnosed with one of these diseases in 2015. This number is going to increase to over 83 million by 2030.⁸⁶ This leads to costs of over one trillion US-Dollar (1,044 billion) in 2030 worldwide.⁸⁷

Number of cardiovascular diseases worldwide between 2015 and 2030 (in million)



88

Incar Wellbeing technologies like the ECG seat by Ford can help people with this kind of disease. One aspect is the constant monitoring through an ECG in the car. This allows to

⁸⁶ WEF, Havard School of Public Health @ Statista, Anzahl kardiovaskulärer Krankheiten weltweit im Zeitraum von 2010 bis 2030

⁸⁷ World Economic Forum; Harvard University @ Statista, Kosten kardiovaskulärer Krankheiten weltweit im Zeitraum von 2010 bis 2030

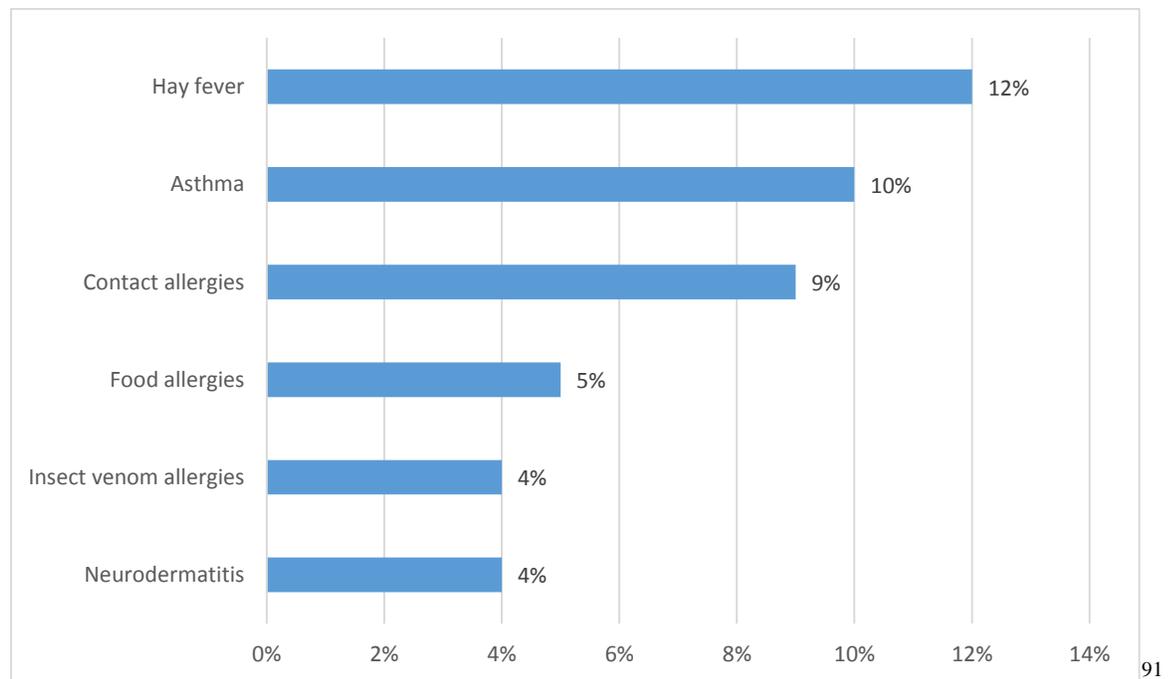
⁸⁸ WEF, Havard School of Public Health @ Statista, Anzahl kardiovaskulärer Krankheiten weltweit im Zeitraum von 2010 bis 2030

improve the medical record of already diagnosed patients, due to monitoring in the car. The data can be collected and sent to the supervising doctor. Through a better medical record changes in the condition of the patient can be early identified and measures to help the patient can be initiated. Another aspect is the first identification of cardiovascular disease. Abnormalities in the condition of the driver can be recognized by the ECG. The car can then alert the driver and suggest a medical checkup. Furthermore, in case of heart failure or stroke the car can take emergency measures like contacting an ambulance or securely stop the car. Therefore, the benefit of this Incar Wellbeing technology can be seen in improving the medical condition of patients and the prevention of a fatal heart failure or stroke.

5.2.3 Allergies

Allergies are an increasing problem worldwide. Especially in developed countries allergies are common. In Germany every fifth person has an allergy.⁸⁹The most common allergies are hay fever with 12 percent and asthma with 10 percent worldwide (2008).⁹⁰

Estimated worldwide spread of allergies



⁸⁹ Walter Willems, Heuschnupfen wird zur Volkskrankheit, Stern

⁹⁰ ISAAC study @ Statista, Estimated worldwide spread of allergies, 2008

⁹¹ Ibid

Incar Wellbeing technologies can improve the life of people with allergies when they use their car. Currently, the technologies concentrate on allergies like hay fever and asthma. Technologies like the Allergy Alert by Ford inform the passengers about the concentration of pollen in their area. Another aspect are improved filters in the air condition of cars. These filters can eliminate pollen and clean the air. Therefore, people with allergies or asthma are provided with clean air in the car. This increases their wellbeing during the journey and can be seen as the benefit from these Incar Wellbeing technologies. However, it is difficult to financially measure this benefit.

5.3 Conclusion

The prevention of car accidents through Incar Wellbeing technologies shows a potentially high benefit. Of course, it is not realistic that 100 percent of cars will be equipped with this kind of technology in future and that all the accidents will be prevented thereby. However, if only a certain percentage of fatalities and the associated social costs can be prevented, the benefit is still high.

The implementation of Incar Wellbeing technologies in order to assist with health problems shows various benefits. The technologies can improve the life of the customers dealing with certain diseases. Furthermore, it has the potential to prevent fatalities due to heart attack or stroke.

The presented benefit of Incar Wellbeing is just a part of the potential that lies in these technologies. The GEA concept of Audi for example can help the passengers improve their fitness in the car. This has a positive effect on the widespread sedentary behavior in society, which leads to many chronic diseases. Furthermore, big cities like Beijing have an increasing air pollution problem which also affects the health of citizens. Improved filters in the air conditioning of cars can reduce the effect of air pollution on the passengers. Air humidifiers in cars can also bring a benefit to people living in areas with dry air like the East Coast of the USA. The future benefit of Incar Wellbeing technologies will be determined by ongoing innovations. At present it can only be roughly estimated and not substantiated with reliable figures.

6. Summary

Incar Wellness, Health and Comfort are other terms used to describe the concept of Incar Wellbeing in the automobile industry. A definition for Incar Wellbeing could be: implementation of technologies in a car to maximize the well-being of the driver and/or other passengers. It is not possible to clearly define which technologies are Incar Wellbeing technologies. Each car producer understands the term differently and summarizes different technologies as Incar Wellbeing technologies. There are existing technologies that can be seen as Incar Wellbeing technologies like multicontour seats or air conditioning and future technologies stemming from the healthcare and wellness industry.

The review of Incar Wellbeing technologies in this thesis focuses on the important existing technologies and on future technologies which are in the phase of conceptualization. The information used for the review of existing technologies comes from the websites of car producers offering these technologies. There might be more existing technologies that can be categorized as Incar Wellbeing technologies due to the wide definition of the term. However, the technologies selected herein are characteristic for Incar Wellbeing. Concerning Incar Wellbeing and the market there are technologies like multicontour seats already produced and sold by car manufacturers. Therefore there is already a market for Incar Wellbeing technologies. The second question is how does this market look like. As the vast majority of the technologies are in the phase of conceptualization the Incar Wellbeing market is still in an early stage of development. Therefore it makes sense to look at existing markets with technologies that could be built into an automobile like the healthcare market and the wellness market. Both the healthcare and the wellness market are big markets with an increasing volume. There are technologies in these markets like a glucose meter or an air humidifier which can be implemented into cars. Due to the significant time spent in cars it is likely that consumers would like to use this time more efficiently for their wellbeing. They already invest significant time and money for their health and wellness. It can be expected that the positive forecasts for these markets will also push the development of the Incar Wellbeing market if the respective technologies are developed and adopted. Nevertheless the forecasts for these markets depend on the accuracy of the used sources. Furthermore, it cannot be measured to what extent these markets will support the development of the Incar Wellbeing market.

The existing Incar Wellbeing technologies are solidly established in the premium segment and will probably come to the mass market after a certain time. If the Incar Wellbeing technologies currently tested in concept cars prove to be truly beneficial for the health and/or wellbeing of customers, they will soon make their way into the premium segment and, over time, into the mass market. Therefore the development of the Incar Wellbeing market will depend significantly on the value customers will attribute to healthcare and wellness, especially due to the trend of increasing prices for supplementary equipment in cars. In any event the future of the Incar Wellbeing market will be determined by the level and quality of ongoing innovations by the automobile industry.

The economic use of Incar Wellbeing technologies consists of reducing car accidents and improving health and comfort of the driver and the other passengers. The statistics for car accidents and health problems are used to evaluate the overall benefit of Incar Wellbeing technologies. The prevention of car accidents through Incar Wellbeing technologies shows a potentially high benefit if only a certain percentage of fatality and the associated social costs could be avoided thereby. The calculations of fatality and social costs are limited by the fact that the percentage of potential causes of an accident leading to an actual accident is based on assumptions of experts and comparable statistics. Therefore the presented fatality and the corresponding social costs are estimations and not proven concrete figures. The implementation of Incar Wellbeing technologies in order to assist with health problems shows various benefits. The technologies can improve the life of the customers dealing with certain diseases. Furthermore it has the potential to prevent fatality due to heart attack or stroke. However, as these technologies are not yet on the market, it is difficult to number the benefit.

This thesis provides an introduction to the topic of Incar Wellbeing. To evaluate the success of certain Incar Wellbeing technologies one should conduct a representative customer survey. Only successful technologies purchased and used by the customers will have the chance to generate an economic benefit.

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