

# Changing Business Models with Affective computing

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University of Zagreb

Faculty of Economics and Business

Bachelor Degree in Business

## Changing Business Models with Affective Computing

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30<sup>th</sup> June 2021

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## ABSTRACT

In paper we will investigate how affective computing could be implemented into business models and what advantages affective computing would bring to the company. The paper firstly introduces the reader with basics of affective computing, some plain definitions with a touch of historical aspect. General overview of business models is also illustrated in introduction to give a reader a chance to compare usual business models and business models with high-technology. In the main part of the paper models of affective computing for collecting data are presented. Each of three models are detailly explained together with all of their sub-tools. Continuing with the most important part of the seminar which presents how affective computing would be implemented and affect certain industries. In this part paper illustrates how affective computing would be used in retail industry, wholesale industry and public sector. Additionally, two companies with different business models are used as an example how affective computing could be implemented into their operations. The last section is related to the future of affective computing and emotional recognition overall. Market and predictions for the future years is stated and predicted, together with its main challenges including ethical and technical issues, and development of affective computing overall. Lastly, conclusion of the paper summarizes all of the observed information and closes the subject with final opinion.

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# 1. INTRODUCTION

## 1.1 Definition of affective computing

Affective computing is a complex system which can identify, detect, interpret, process and occasionally even respond to one's emotional state. It is a multidisciplinary field which simultaneously engages a number of at the first sight diverse industries, such as: information technologies, psychology, engineering, education, neuroscience, and others. (RA Calvo, S D'Mello, JM Gratch, A Kappas, 2015) Affective computing can be obtained through several technologies. Three main ways division of collecting data for affective computing are physical methods, physiological methods and lastly questionnaires. Each of three models of data collection has several data collection activity variations under its name. Hence, physical model represents facial expression, speech, gesture and body posture. Secondly, physiological model represents EEG, temperature, ECG, GSR and Respiration. Lastly, questionnaire model represents PANAS, SAM, PAM and ESM. Each of these three types of obtaining data functions on a different way and with help of different tools. Therefore, some ways turn out to be better regarding certain segments than others. Different kinds of affective computing programmes use different combinations of three main types of data collection. Those programmes use computer software to precisely analyse all the information the programme collected with combination of earlier mentioned collection techniques. After the analysing part is finished, software estimates one's emotional state, and lastly provides fitting feedback. (TJ Brigham - Medical reference services quarterly, 2017). Although, affective computing is still a new thing on the market and there is a wide space for further development and upgrades, the predictions of market value of affective computing industry indicate affective computing will be crucial for businesses.

## 1.2 History of affective computing

Although, affective computing is often related to the year 1997, the truth is its foundation dates two years earlier. In 1995, Rosalind Picard combined computer science and emotion investigation for the first time and presented that in her technical report. Two years later, Rosalind Picard launched a book where the overall concept and meaning of affective computing got a lot more clearly to the public. However, according to some number expertise study of emotions as a scientific goal dates all the way back to great inventors like Bell, Duchenne and Darwin. (RA Calvo, et. Al, 2015) Nevertheless, Picard besides explaining the concept of affective computing in her book through theory, also proposed fitting models and practical procedures. Furthermore, Picard outlined three models of affective computing applications. First one was, systems that detect the emotions of the user, followed by systems that express what a human would perceive as an emotion, and lastly systems that actually feel the motion in applicable way. Later, the public got more interested in affective computing since it combined a wide range of potential disciplines and their mixtures, such as computer science, psychology, engineering, sociology, ethics, education and neuroscience. (TJ Brigham - Medical reference services quarterly, 2017)

## 1.3 General overview of business models

The term business model is getting more and more popular over the years. It is most frequently use in a board-meetings, ownership deals, strategic management and start-ups. But what is the real purpose of business model and for what does the term stands. Before presenting definitions of business model by some of the expertise I would like to explain it in my own words. If we look at the term business model, there are two words. Business and model. The word business represents the organization which generates certain revenue, while model represent the way something is functioning. Therefore, the plainest explanation of the term business model would be illustration and interaction of specific activities a company provides in order to make money. Meaning, business model represents the way a firm is doing business. It represents their core mission, through strategic management, delivery of products, logistic, interaction with customers and so on.

However, here are few examples how some other people described business model. “Architecture for the product, service and information flows, including a description of the potential benefits for the various business actors; and a description of the sources of revenues”. (Timmers, 1998) Furthermore (Henderson, 1998), describes business model “as a co-ordinated plan to design strategy along three vectors (customer interaction, asset configuration and knowledge leverage)”. Lastly, according to (Magretta, 2002) “business models are kinds of stories that explain how companies work and that contain specific characters, a plausible motivation and a plot that describes how value is delivered”. (L Schweizer - Journal of General Management, 2005)

Furthermore, if we take a look at the historical aspect of business models we can see how business models developed and evolved through years. As the times and trends were changing business models kept the step with them. Therefore, if we take a look at the Figure 1, we can clearly see an example of development of business models with an emphasis on actual trends at specific time. For example, the first point is guild system which took place at the mediaeval time. At that specific timeframe goods were produced by the groups of guilds. In other words, at the time people were producing items which were of a high quality, but very expensive. Those items were usually made by people implementing craft skills to produce them and sell them in their workshops. That was small-scale production, because there was no division of labour. One individual usually produced the item from beginning until the end. Second headline under Cohort label in the Figure 1 is Factory system. With the beginning of the first industrial revolution there was a major turn in the world of business. Factories replaced small workshops and the gap between small and big companies was never bigger at the time. Factory system business model, felt like a huge success. Firms started to divide specific tasks and labour inside the factory. With the division of labour the whole development process got much quicker and individuals became more specialized in the field they were operating. Furthermore, with industrialization came mass production, where economies of scale and other factors played a huge role, thanks to them with lower production costs there were lower prices. One of the first innovators of the factory system or as we may call it “model factories”, such as textile mills as well as settlements of UK’s New Lanark and USA’s Lowell, offered a so-called brand-new concept for company’s success which got everyone’s attention at the moment and everyone blindly followed. (C Baden-Fuller, MS Morgan - Long range planning, 2010) However, with the beginning of second industrial revolution large companies replaced cheap labour force with the heavy machinery. Great example of that is Ford’s moving production line,



which was able to make large number of goods, at a cheap price available for mass consumption. Here again, we can see change in the business model of the factories, because their core operations, all from how the product is produced, in what time and how the product is presented and sold to the public. After “American system of manufactures”, on the scene came and mostly still are “Network firms”. Examples of companies that use network firms, business model are Bennetton and Nike, as we can see in the table, together with most of today’s clothing and retail brands. These firms have complex business model which consist of a number of fields. They heavily implement technology in their business model regarding customer service, online stores, logistic, marketing, partners, sponsorships and so on. However, according to some scientist third industrial revolution is right in front us. “Chinese system of manufacturing” represent a completely new business model. Instead of compensating obsolete technology with cheap labour, they managed to provide high level technology at low cost. Meaning from the two sides, good is taken and that what was once bad was replaced and upgraded.

Figure 1: Historical development of business model

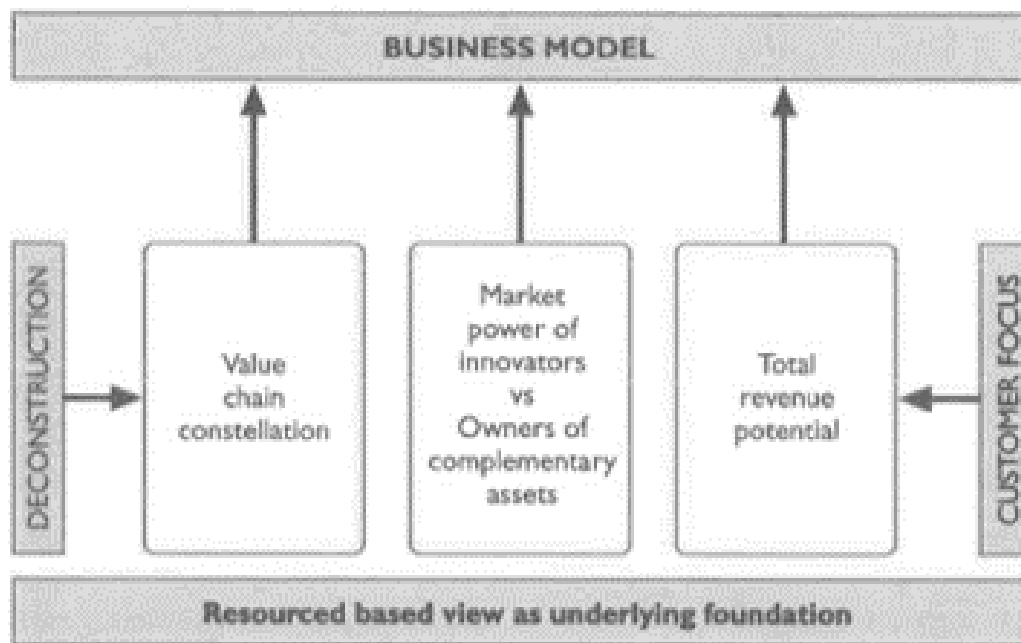
Cohort label (and arrival)	Examples
Guild system (mediaeval)	Goldsmith's workshop
Factory system (18th/19th centuries)	Textiles factory with automatic loom & Spinning Jenny
American system of manufactures (19th/20th centuries)	Model-T Ford production line system;
Network firms (20th/21st centuries)	Bennetton; Nike;
Chinese low cost (21st century)	Shanghai Zhenzua port machinery company

Source: Baden-Fuller, C., & Morgan, M. S. (2010). Business models as models. *Long range planning*, 43(2-3), 156-171.

It is clear that Figure 1 is just a sharp overview of business model development. Since, in each industry business model varies by certain characteristics. For instance, business model of BMW Group differs quite a lot from the Facebooks's business model. That is because wide range of

factors can affect how a business model should look like, such as: the size of the company, partners of the company (how the company produces its goods and services), how the product value is created and looked at, in what branch the company operates and so on. In order to understand more clearly how one business model works and what are the main functions one business model has to cover we will observe a sketch of business model concept.

Figure 2: Dimensions of business model



Source: Schweizer, L. (2005). Concept and evolution of business models. *Journal of General Management*, 31(2), 37-56.

As we can see in the Figure 2, business model generally consists of three main areas; value chain constellation, market power of innovators vs owners of complementary assets and lastly total revenue potential. First asset, which is value chain constellation, points out to company's position in a industry one operates and also to creation of value. Second area determines what is company's main competitive advantage. Meaning, in what way the company is different or „special“. Does the firm operates on a completely different way with the newest technology and innovations, is there a completely new market in which one operates or one has all the complementary assets, so

that it can easily obtain some level of economies of scale at the very beginning. Lastly total revenue potential defines how the company should gain revenue. This step also includes customer relation and product distribution. (L Schweizer - Journal of General Management, 2005)

These business model steps could easily be transforms into three questions every business should know answer for. Firstly, how is the value chain of the composed with the respect of industry's? What is company's competitive advantage compared to others? Finally, how will company make money and what is its revenue potential?

#### 1.4 Aim of the paper

The main purpose of this paper is to illustrate how it would be beneficial to companies to implement affective computing in their business models. However, because affective computing is still a relatively new term, this paper also tries to explain how affective computing functions, in order to make public more familiar with it. Furthermore, the paper tries to point out how there is a time for next generation and development of business models and technologies they are using. Many companies especially small and medium ones still use obsolete business models, which are slowing down company's operations and overall growth. Therefore, the paper reveals how affective computing collects, measures and generates information. In other words, how such systems can enhance and speed-up the production, delivery and customer relation of a certain company. With affective computing a company would in every moment know customers opinion and feeling regarding service delivered or product produced. Since, the system would greatly improve efficiency and effectiveness of majority of companies, the paper shows how such tool can be implemented in a range of business models.

## 2. MODELS OF AFFECTIVE COMPUTING DATA COLLECTING

There are three main models of collecting data for affective computing. Those are Physical method, physiological method and questionnaire method. Each of these three methods have a unique set of tools with which one can collect the information on a specific way. Furthermore, each of the data collecting models differs greatly from one another. Meaning, some models are better than others in certain segments. Of course, each data collecting method has its advantages and disadvantages. Therefore, the person conducting the research should be introduced and informed to each pro or con of a method or a tool one is using. Because of that, we will detailly explain basic characteristics of each model and go through the tools they are representing.

### 2.1 Physical method

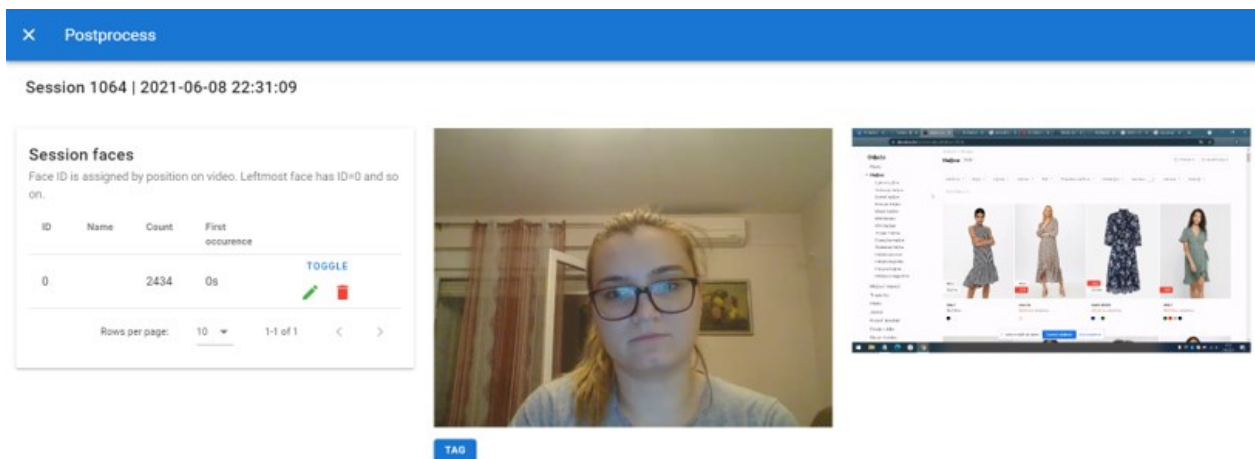
Physical method of collecting data for affective computing is by some the most popular model of collecting information. The tools or ways of collecting information physical model represents are: facial expression, speech, gestures and body posture. Each model has its advantages and disadvantages hence we will try to get to know each tool at least partly in this paper.

The first tool and probably the flagship of physical method is facial expression. In facial expression the most of the data could be collected with the usage of a camera where the algorithm responds to certain data and sorts out the data collected into categories divided by emotions and emotional states. The program would notice micro movements in the face. In the main focus are eyes, eyebrows, nose and mouth. However, in the facial expression tool the camera is taking the whole picture. Facial expression makes a great tool because it collects sincere data that person cannot control. Meaning, the data cannot be manipulated by the person who is being investigated. There are several programs which are providing affective computing services based on facial expressions. Furthermore, another pro is that it doesn't demand a large amount of money and the result are provided immediately. On the other hand, facial expression has some downfalls as well. For example, if the person wears a mask or something that unnaturally covers majority of the face, the program wouldn't be capable to provide precise information. Secondly, if the camera is dirty or blurred, again the system wouldn't be reliable. Another problem with this tool is the lightning, if

the lighting of the room where person is conducting “survey” has too much or not enough lighting, the results aren’t going to be valid.

In the Figure 3, we can see the procedure of facial expression survey. The data has been collected with a program named Tacit. The person is being recorded, while it looks a certain website. Furthermore, the person on an unconscious level reacts to certain information on the website and programme collects it.

Figure 3: Facial expression procedure



When the procedure is over, the results came out on a chart. The example of such a chart can be seen in a Figure 4. There are several lines in different colours each representing certain emotion of the person who has been recorded. The chart illustrates when each emotion triggers in a specific time period. Although most of the time emotions are neutral, occasionally other emotion triggers. For example, if we take a look at the Figure 4, we could see that person was surprised at 42<sup>nd</sup> second of the video, because there is a jump in the blue line. Then, we could easily play the video and see what question or image caused the subject to change its feelings.

Figure 4: Facial expression chart



Secondly, another tool important for physical method would be speech. With it, the scientists can also recognize emotional state the subject currently is. There are three main components of a speech emotional recognition system, those are emotion labelling or annotation, normalization of acoustic features and robust acoustic feature normalization. Emotion labelling specifies and brings out the initial truth for evaluating emotional recognition system. Furthermore, the system evaluates basic categories of how a person is feelings such as happy, angry, sad or neutral it also divides other emotional categories such as arousal, valence or dominance. Additionally, the system has been upgraded to identify the sense of ambiguity in human's voice. Next, normalization of acoustic features helps system to direct the attention on the person's voice by zoning out other factors which could influence one's speech. Lastly, machine learning algorithms help the system to successfully sort out and divide the speech that has already been extracted and observed and new wanted emotional labels. (Lee, Chi-Chun, et al. 2014.)

Another physical tool that easily collect information from the observing subject are gestures. Gestures are basically movements people do unconsciously. Majority of the gestures involve contact between hand and head. Since, there was a number of studies investigating meaning and definition of gestures it was easy to use that as affective computing tool. The system is coded and react to specific gestures which it automatically defines as emotion. In the Figure 5 we can see what gesture represent which affective state. However, all gestures aren't entirely reliable. For

example, eye rub indicates that a person is tired, but it can also be the case that something got in one's eye and it is irritating the eye. That is why eye rub gesture is only 81% precise. The confidence level percentages vary among the gestures, however there are some gestures that are 100 percent confident such as head scratch and lip zip.

Figure 5: Examples of gestures indicating certain emotions

<b>Gesture</b>	<b>Reported Affective State</b>	<b>Confidence Level in Reporting</b>
Head Scratch	Recalling	100 %
Nose Itch	Satisfied	77.5%
Lip Touch	Thinking	88.75 %
Eye Rub	Tired	81 %
Chin Rest	Thinking	90 %
Lip Zip	Bored	100 %
Ear Scratch	Concentrating	83.33%

Source: Or, J. (Ed.). (2008). *Affective computing*. BoD–Books on Demand.

The last tool of collecting data which goes under physical group is body posture. In a number of experiments and surveys people investigated how body posture mimics our emotions. Therefore, people came in conclusion that most of the people are expressing certain emotions by doing the same body movements and postures. Furthermore, our body movement are much quicker and sharper when we are expressing anger than when we are expressing happiness. Additionally, as the study gone forward it has also been proved that people use left and right hand by different purposes depending whether they are left or right-handed. For example, there was a study where several right-handed actors were all expressing anger with their right hand and more relaxed feelings with their left hand. (Calvo, et al. 2015) Since, most of the body posture movements are quite frequent in a general talk, the algorithm easily detects when a certain emotion is expressed and connect it with a suitable definition. If we take a look in a Figure 6, we will see what emotion some of the posture features represent. So, when the system detects for example: head backward, no chest backward, no abdominal twist it automatically connects it with anger.

Figure 6: Elements of body posture expressing specific emotions

Emotion	Frequent Posture Features
Anger	Head backward, no chest backward, no abdominal twist, arms raised forward and upward, shoulders lifted
Joy	Head backward, no chest forward, arms raised above shoulder and straight at the elbow, shoulders lifted
Sadness	Head forward, chest forward, no abdominal twist, arms at the side of the trunk, collapsed posture
Surprise	Head backward, chest backward, abdominal twist, arms raised with straight forearms
Pride	Head backward or lightly tilted, expanded posture, hands on the hips or raised above the head
Fear	Head backward, no abdominal twist, arms are raised forward, shoulders forward
Disgust	Shoulders forward, head downward
Boredom	Collapsed posture, head backward, not facing the interlocutor

Source: Calvo, R. A., D'Mello, S., Gratch, J. M., & Kappas, A. (Eds.). (2015). The Oxford handbook of affective computing. Oxford Library of Psychology.

## 2.2 Physiological model

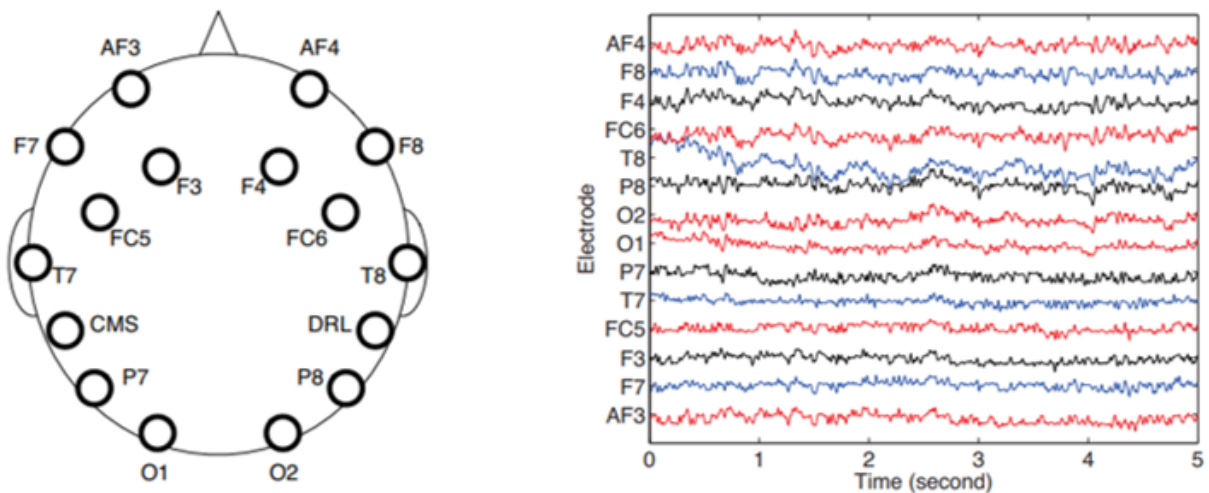
The physiological model of affective computing is becoming more and more popular through recent years. It overcomes the problem of whether the subject that is observed and examined being sincere. Furthermore, it also generated longer timeframe of emotions and not just expression in current timeframe. Some of the tools for collecting information which are in the physiological model basket are electroencephalogram (EEG), skin temperature (T), electrocardiogram (ECG), galvanic skin response (GSR) and respiration (RSP).

The first physiological tool we will observe is electroencephalogram or EEG. The EEG is gaining popularity because it has a good ratio of scientific investigation and practical usage. Firstly, one of the main advantages of EEG is that it has a strong base of scientific researches of neural systems. (Hu, X., Chen, J., Wang, F., & Zhang, D. 2019) Therefore, that strong base of neural system studies could easily be implemented in affective computing, or in other words observation of one's emotional state. Second advantage of EEG is that results are obtained quickly and the operational costs are respectably low. EEG initially struggled with procedure, since the wires had to be wet, the subject skin has to be prepared appropriately as well as other factors that needed to be done in



order to carry the procedure. Furthermore, because of high cost of high-tech equipment, it was hard to bring EEG out of laboratory to general public. However, in the early past new EEG head-sets are coming to market. They are compact, under reasonable price and relatively easy to use. There also were couple of experiments where scientists tried to use EEG head-sets on a daily basis and afterwards observe how their emotions change through the day, and allegedly the results came out surprisingly good. Meaning, if this could become a customer produced product affective computing, i.e. this way of capturing emotional stages would become much more popular. In the Figure 7, we can see how electrodes are positioned on a headset and example of a raw information electrodes collected. As we can see each electrode is has a specific purpose and collect the information from a certain point of the brain. Furthermore, information from each electrode is collected and presented in the chart. With assignable fluctuations in the chart we know certain electrode picked up some reaction or increased activity of the brain in a specific point of time.

Figure 7: Electrode positions on the headset and their raw data



Source: Campbell, A., Choudhury, T., Hu, S., Lu, H., Mukerjee, M. K., Rabbi, M., & Raizada, R. D. (2010, August). NeuroPhone: brain-mobile phone interface using a wireless EEG headset. In *Proceedings of the second ACM SIGCOMM workshop on Networking, systems, and applications on mobile handhelds* (pp. 3-8).

Although this skin temperature (T) tool seems quite simple it actually greatly contributes to affective computing data collection and analysis. Scientist use skin temperature in order to value

the percentage of presence of certain emotion. Skin temperature tool usually measures the temperature of the core or upper torso, however there are certain tool which also measure temperature of the finger. Skin temperature tool is fast and easy tool with whom additional information for affective computing could be collected.

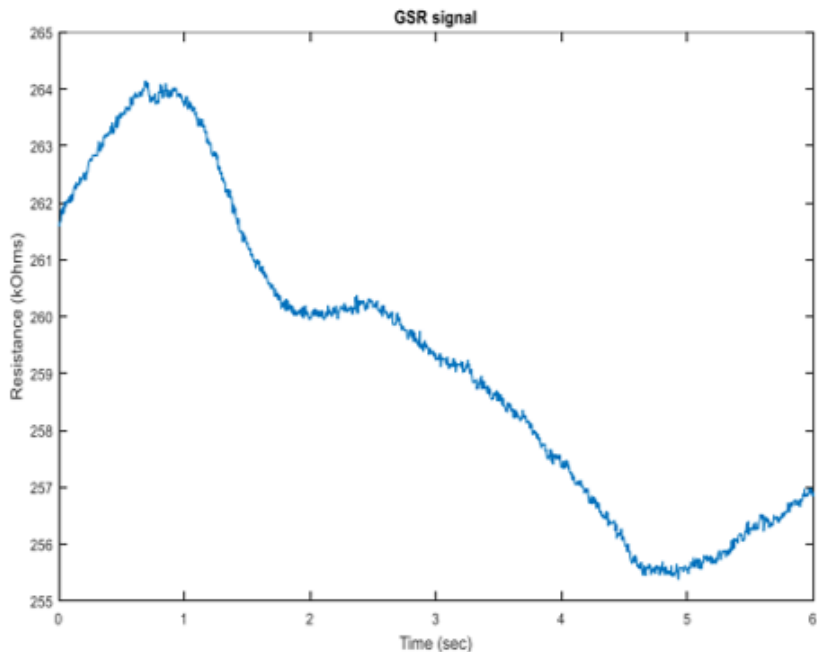
Another physiological tool that is frequently used is electrocardiogram (ECG). ECG represent a great tool because it can measure waves and emotional stimulations through a number of gadgets which are commercialized. The ECG system functions by following four steps when it is measuring emotional state. Those steps are affective data acquisition, affective feature extraction, affective feature subset selection and lastly classifier design. (Y. Xu and G. Liu, 2009) These steps are being followed to acquire, sort out and measure data precisely and effectively. Because otherwise too much information would be extracted and it would be almost impossible to evaluate observed data efficiently. The types of such gadgets are Polar H10, Apple Watch 5, Zio XT patch, VivaLNK, and so on. This typed of gadgets are frequently used in sports and training. For example, Polar H10 is widely known and used by athletes because it measures their hearth rate and based on that data it provides feedback about how their body is dealing with specific exercise and training overall. Based on that information athletes doze their trainings and plan future training programs.

Furthermore, the galvanic skin response (GSR) is also great tool for collecting information for affective computing. The gadgets which are practicing GSR are lightweight, small and practical. However, that kind of tools are not commercialized and used on daily basis, because they do not offer simple and practical everyday functions as for example Apple watch does. On the other hand, GSR tools collect the information from person's subconscious level. As most of the tools, GSR tools receive one's emotional feedback regarding feeling based on external factors, what the subject sees, hears or does. Because of the fact that for GSR measurement of emotional state only two fingers of less dominant hand are needed, some researchers state that GRS is the most suggestive way of collecting emotions based on the balance between its preciseness and practicality. (G. Udovičić, J Derek, M. Roso & M. Sikora, 2017)

One research has been conducted, where applicants were looking at certain images and GSR has been measured to capture their emotional state. The emotion on which the researches were focused at was excitement. Each applicant was presented with an image for five seconds. The Figure 8, illustrates how one of the applicants who was observed reacted to a certain picture. We can clearly

see that the biggest deviation in one's emotion occurred at the first second when the picture was presented. Afterwards the line gradually falls with minor fluctuations, meaning one's excitement was the biggest at first and sharply reduced right after.

Figure 8: Example of GSR emotion recognition



Source: Udovičić, G., Đerek, J., Russo, M., & Sikora, M. (2017, October). Wearable emotion recognition system based on GSR and PPG signals. In *Proceedings of the 2nd International Workshop on Multimedia for Personal Health and Health Care* (pp. 53-59).

Last physiological tool for collecting data we will mention is respiration (RSP). What gives respiration the greatest advantage compared to other physiological tools is that respiration can collect data in motion. Meaning, it will precisely collect the given information even if the subject is doing heavy physical work. This tool works on the way that collects the information as respiratory patterns change between affective states. (Wu, Chi-Keng, Pau-Choo Chung, and Chi-Jen Wang. 2012) This could be obtained because there is a relation between respiration and emotion. Therefore, as the respirational state changes it triggers the emotional state as well. Due to that wanted information can be extracted and used in affective computing analysis.

## 2.3 Questionnaire model

Our third model of data collection for affective computing is questionnaire model. This model could be called the simplest out of three. However, on the other side, for most applicants this model is also the most practical one. It is probably the easiest to develop and obtain the information. The participants could solve the surveys on any device they have including their phone. However, this model's biggest strength is also its biggest weakness. Because the surveys (questionnaires) are so simple they lack the preciseness. Additionally, the participants can be subjective and insincere while solving the questionnaires.

The first out of four questionnaire model tools we will observe is Positive and Negative Affective Schedule or PANAS. Basically, Positive and Negative Affective Schedule is used to evaluate at which affective state individual is. PANAS tool measures and provides two main measures. Firstly, to which extent does a person feel happy, cheerful and enthusiastic and on the other hand to which extent a person feels sad, stressed and obnoxious. The first measurement is presented in the vertical axes while second measurement is presented in horizontal axes. (Politou, Eugenia & Alepis, 2017) In other words, in the xy chart, vertical axis represents the extent of a happiness illustrated from lowest to highest, while horizontal axis represents sad feeling also illustrated from lowest to highest amount. However, as the years were passing, original inventors of this technique decided the results should not be illustrated in the xy chart and each positive and negative segment should be represented on its own.

In the Figure 9, we can see how one Positive and Negative Affective Schedule survey looks like. In this specific PANAS survey there is twenty moods (feelings). Each feeling an examinee evaluates. There are five choices an examinee could choose. The choices are sorted from the lowest (Very slightly or not at all) to the highest (Extremely). According to examinee's choices his emotional state will be displayed in the chart afterwards.

Figure 9: Positive and Negative Affective Schedule survey

Indicate the extent you have felt this way over the past week.		Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
PANAS 1	Interested	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 2	Distressed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 3	Excited	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 4	Upset	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 5	Strong	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 6	Guilt	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 7	Scared	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 8	Hostile	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 9	Enthusiastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 10	Proud	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 11	Irritable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 12	Alert	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 13	Ashamed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 14	Inspired	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 15	Nervous	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 16	Determined	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 17	Attentive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 18	Jittery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 19	Active	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PANAS 20	Afraid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Source: Thompson, E. R. (2007). Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS). *Journal of cross-cultural psychology*, 38(2), 227-242.

Second questionnaire tool we will take a look is Self-Assessment Manikin or SAM. Self-Assessment Manikin gained more and more popularity through the years. However, it never become the most popular tool of questionnaire model. Self-Assessment Manikin is type of questionnaire that is picture oriented in purpose to measure emotional responses. (Bradly and Lang, 1994) It basically, measures even three features of emotional responses that have been considered as connection to the main emotion. Those, three features are all single-item scales each collection certain type of information. Hence the first scale measures the amount of valence or pleasure (measuring from positive to negative). The second scale is perceived arousal measuring in levels, also ranging from high to low. Lastly, the only scale which measures from the low to the high levels is actually measuring perceptions of dominance/control. Lastly, SAM bases its practice on a dimensional-models of emotion, because of that SAM measures key parts of emotional responding.

As I have already stated, questionnaire model could vary sometimes regarding preciseness. Hence, after scientist asked themselves certain questions, such as is this model reliable enough, could the

survey be put that briefly that it could be solved on daily basis and could it be used for collecting data in situ. The scientist came up with the Photographic Affect Meter (PAM) tool. In the Photographic Affective Meter tool the examinees are presented several pictures on the same page, each representing different state. (J.P.Polak, P. Adams, G. Gay, 2011) It has been proved that people could connect with pictures more easily. Hence, when an individual is presented several emotional states that are illustrated by pictures it instantly connects its current mood with a certain image. There have been conducted several surveys about effectiveness and practicality of photographic Affective Meter, and it was concluded that PAM is even more efficient in practical use than majority of other questionnaire tools. Additionally, this is a big step for evaluating emotional states by using questionnaires, because examinees could easily be evaluated, because they can solve the surveys by using only their mobile phone.

As I have already stated PAM tool matches practicality with effectiveness. Therefore, PAM survey can be solved by using any kind of device. However, the main achievement of the PAM was implementation of easily solvable and transparent surveys on a mobile phone. Figure 10 represents how the Photographic Affect Meter survey looks like on an android smartphone. In the observed Figure 10, several types of emotions are presented. Depending on examinee choices the algorithm will value result and after picking several photos on several image-maps the precise results of the individual's emotional state could be provided.

Figure 10: Example of Photographic Affect Meter survey

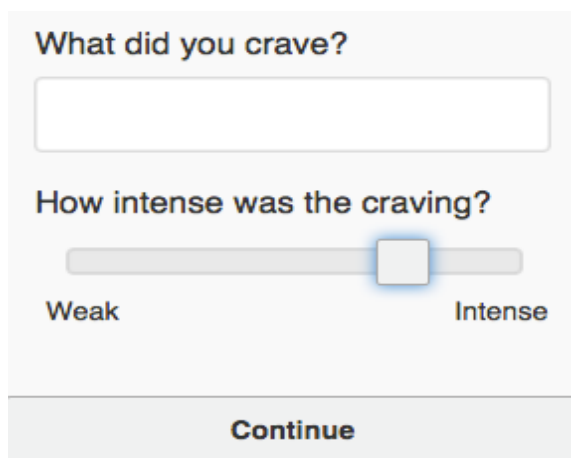


Source: Bin Morshed, Mehrab & Saha, Koustuv & Li, Richard & D'Mello, Sidney & Choudhury, Munmun & Abowd, Gregory & Ploetz, Thomas. (2019).

Last tool of questionnaires model we will learn about in this paper is called Experience Sampling Method or ESM. What differentiates most Experience Sampling Method from other questionnaire tools is what kind of information this tool collects. While other models and tools focus on an aspect of emotional state individual is currently into, Experience Sampling Method focuses towards experiences one lived in a specific timeframe, mostly daily. In other words, Experience Sampling Method collects daily information of examines for both context and content. (JM Hektner, JA Schmidt, M Csikszentmihalyi, 2007) Therefore, ESM gains an edge and competitive advantage compared to other models. ESM captures daily life situations and moments as the moments are captured and recognized, from one to another. Meaning, since ESM tool can collect the information of the affective state at the moment and captures several of that single-sample moments and evaluates them. It also can connect those moments and show us in which context those questions were asked and their relations. Therefore, it can bring the picture about the overall experience.

If we take a look at the figure 11, we will notice that this simple-survey has two main parts. The first asks the question What, where the examine describes the specific item or situation. Because of the first question ESM is getting a brief overview of the overall situation, or in other words it extracts the general context. The other part of this survey asks the question How, in a sense of measuring (how much, how intense). With this part ESM is capable of determining the intensity or the level of the emotional state.

Figure 11: Experience Sampling Method sample



What did you crave?

How intense was the craving?

Weak Intense

Continue

### 3. IMPLEMENTATION OF AFFECTIVE COMPUTING IN BUSINESS MODELS

By now, we have learned what is affective computing, how affective computing is used and what are models of affective computing for collecting data. Furthermore, we have also learned what are business models, how they developed over the years and why business models are important for the companies. In this part of the essay, we will learn how affective computing could be implemented in business models, and what would be benefits for implementing affective computing into firm's activities.

Generally, everything evolves, from animals to technologies. The same is with business models. Market, today is very fast and strict regarding mistakes and missed opportunities. The customers are both more educated and more demanding than ever. Therefore, firms in order to surpass certain level must operate on a ripping level. On the other hand, competition is enormous and every mistake might cost a company losing customers, since they will simply switch brand. That is why affective computing has such a great perspective. With affective computing, the person cannot misunderstand the customer, there is no more wrong judgement and bad social skills. It would offer companies to sort out, classify and read their customers like an open book. The whole operational system would get much faster and consequently the revenue would be larger. The main problem is that not many people know about affective computing, and the ones who do, they do not understand it. However, looking it from another perspective affective computing's main flaw could also be its biggest advantage for the people who do understand it and see the opportunity.

This section will illustrate how affective computing could be used in a retail, wholesale, public sector and at the end do the example on some specific companies. For each subtitle we will look at a certain example, however that doesn't mean that the same principle would work at some other industry or that it works only in mentioned one. Affective computing is variable, meaning it has a number of models and tools. Indicating, that it could be implemented in every business model, and we will discuss some of them.



### 3.1 Retail industry

Before we start describing how would affective computing change generally business model of retail industry, we have to get comfortable with certain features and theory. Three features important to us regarding retail industry are UI, UX and CX. The meaning of UI is user interface which is part of UX or user experience which is part of CX or customer experience. In other words, customer experience is the overall sum of all factors. It indicates all touchpoints one has with the brand, which can differ in all sorts of ways. Finally, we have a user interface or UI which illustrates the interface with which a user interacts with a brand at a particular point of time. Since, in retail industry consumers are the most important the whole focus here will be on them. Hence the three main UX questions that can be addressed to affective computing are: which emotional journey is truly experienced by consumers, what generates cognitive and emotional reactions on our interface and lastly which of my personal interface generates the best UX. The first one illustrates the changes in emotional intensity through some period of time on a chart. Second one indicates the amount of difficulty or other similar emotion and a scale from low to high. The last one measures which prototype indicates the best results, using xy chart.

Furthermore, if we want to take a look in a wider picture, we can analyse the overall CX. The elements of the customer journey map are: awareness, research, selection, delivery and lastly follow up. Awareness presents recognizing a need and where customers tend to learn about possible new and better solutions to their problems. Research stage is when the customers are researching potential solutions, and this stage differs highly in time depending on the type of the product. Selection stage is when the customer makes decision, to buy a certain product. Delivery stage describes how the customer should receive a certain product after choosing one. Lastly, the follow up stage is after the customer has bought the product, working on maintaining and making loyalty among customers.

Meaning, if the company can influence these stages of CX it will simultaneously retain more customers and gain a number of new ones. It would also enhance its operational system and build up a revenue. Lastly, since the company would see which things and operations aren't preferred by the customers it could cut it out and consequently lower the costs.

If we take Konzum as an example of a retail store and implement affective computing into its business model, there would be some significant changes. By now, we figured affective computing has a number of models and tools with which it operates. Furthermore, affective computing could bring the company on the next level. But the question is how to do that. If we start to be a little more creative, we will see that even supermarkets selling house products would benefit from affective computing. Konzum has an extremely wide range of products, moreover it has a number of brands of the same product, such as mayo, beer, meat, etc. Because of that people prefer to shop in it since they have a wider choice of selection. However, having a number of different brands of the same product requires a complex logistic and storage system oftentimes hard to remain stable. Furthermore, frequently storage stays half full with certain product and lacks of another. On the other hand, if Konzum used affective computing system and conducted several surveys, based on customers' average emotional reaction towards something they would easily sort out the quantity of their stored products. Furthermore, measuring customer's CX the company would get to know what their flaws are and how to correct them. In other words, customer relationship system would be significantly improved. Since, the customer service would be much more improved and updated, Konzum could make a data base of their customers. With the strict classification and division of their customer base on a certain categories Konzum could make promo codes and sales according to the percentages of each category. For example, if 60% of customers do not eat meat and 40% of them do, it would be a better strategic move for the company to make promotional sales about vegan products. Because if they do that, in theory more people would come to the physical store that in case certain meat was on sale. Furthermore, after the customers are divided into certain layers, Konzum could send a notification letter on their emails when the products they usually buy and prefer are on sale.

Moving on to retail stores where selling and social skills, plays a bigger role in daily business practice. An example of such industry would be automotive. If we concentrate on car stores, where the cars are presented in show rooms and the major part is done by an employee affective computing could also play a great role. Currently, everything depends on employee. Depending of employee's social skills and ability to read the customers emotion the purchase might happen. Moreover, even if the customer and employee have a great vibe and they are both relaxed and happy while talking, if the right product is not proposed there would hardly be any sale. On the other hand, if customers were obliged to conduct an informative affective computing survey on the

entrance, the situation would be quite different. In that case, according to survey's result the seller would instantly know at what emotional stage the buyer currently is, meaning what is the percentage one is willing to make the purchase. Furthermore, the results would sort out key features the buyer likes. Therefore, according to that and the price the system could suggest a several possible automobiles the buyer might like. Then after the customer conducts obligatory survey at the entrance, the employee already knows what is the percentage the customer is willing to take the purchase, i.e. in what emotional stage one is, and which product one might actually like. From that point on it is like playing a video game with cheats.

### 3.2 Wholesale industry

Apart from retail industry the main opportunity for affective computing and its implementation into business models would be the wholesale industry. Business to business is proved by several sources to be the largest customer segment for emotion recognition models. The main industries affective computing and its models could operate would be automobile, healthcare and to some education. Many of these industries already use certain AI tools and components of affective computing regarding emotional recognition, such as IoT, robotic, operational automatization, customer relation assistant, etc.

Many people aren't aware of the benefits affective computing could provide for their industry. Of course, different industries and different business models would differently benefit from affective computing implementation. Since, affective computing has a wide variety of possibilities it also offers a wide range of value proposition. If we take marketing for an example, we will notice that with emotional recognition it would be much easier to connect and interact with the potential customers, rather than just "shoot blindly". If companies do apply the emotional recognition model, understanding their customers needs and believes and them generally would probably result with a higher customer loyalty. A thing with which nowadays many companies have great problems with. Furthermore, as I have already mentioned in the Konzum example of retail industry, gathering emotional recognized data, would allow companies to classify and sort out their customers. Making both operational and product related decisions much easier. In other words, commercialization

would be decreased what many expect and the largest group of customers could be detected and targeted. Therefore, product customisation would be much simpler and faster to achieve. Additionally, companies could passively decrease their costs, increase performance by adding up efficiency and effectiveness and finally build up additional revenue. However, marketing is just one of many channels affective computing can operate at. It really depends how creating one is with it in a company. Hence, besides marketing affective computing could be used in sales, websites, data collecting, social network, blogs, conferences, press, webinars, podcasts and so on. Since this is still quite new technology, which is not familiar to the public, the best way of implementation is through wholesale, where businesses get more familiar with it and consequently introduce it to the public. There are a number of strategies companies could do such thing. For example, offering free trial periods to their customers where public could get to know this technology by themselves, step by step. On the other hand, customers will simultaneously familiarize themselves with affective computing through customer support. Furthermore, since customer support is often a problems and neglected pillars in company's business model, improving this would make competitive advantage by increasing loyalty of their customers and speeding up the process.

To get a bit more specific about channels of income regarding wholesale industry, we will mention some of the revenue stream types for affective computing. First of all, we have to mention Software-as-a-Service, which represent the greatest revenue stream. Meaning, companies do not have to implement affective computing into their business model directly, they can hire a company which will provide them a service of emotional recognition. That is done, because it is hard for large corporations to change their core business model. It is a lot easier for smaller companies and start-ups to implement affective computing into their business model, since they still aren't recognized on the market and do not have settled operational system yet. Second revenue stream we have to mention is technology licensing. Technology licensing offers both supervision and directing of the provision of the final good as well as mediator technologies such as SDKs and APIs. (Ignatyeva, O., Sokolov, D., Lukashenko, O., Shalakitskaia, A., Denev, S., & Samsonowa, T., 2019) A variation of technology licensing is also Emotion-as-a-Service (API). Where one party pays for a processing of certain product or survey. For example, one company pays affective computing company for a certain number of images and videos analysed. Lastly, product sale which is actually selling of finished goods in one hand. The affective computing companies sell

the emotional recognition systems that are implemented in watches or bracelets and other products to the companies which then brand the product but use these technologies. It is also possible to create its own final product (for example, smart-watch) all launch it on the market. However, this is more related to retail than it is to wholesale.

Lastly, emotional recognition is of great importance for research and development. It become very frequent that companies hire professionals, companies who provide artificial intelligence services. However, using artificial intelligence can get very expensive and it lasts quite long to detect the problem or the opportunity. Emotional recognition functions of the similar way while its results are a lot cheaper and much faster. Because research and development are of great importance, where huge amount of revenue goes in almost every big corporation emotional recognition service could be much more efficient.

### 3.3 Public sector

The public sector is always the trickiest to influence. First of all, the public sector is not the same in all the countries, consequently in differentiates quite a lot in certain countries. However, if we take some generally accepted rules and their average, we would be shocked how many possibilities there are for improving public sector by implementing an affective computing models.

Since, I am currently still a student and am highly introduced in the education system and it flows, the first industry that could benefit from affective computing that came into my mind was education. We have to take into consideration that I am from Croatia and the education is free in Croatia. Meaning, this implementation method might vary in some countries. However, I am sure even countries with different education system would benefit from certain affective computing implementations.

First of all, it is often thought that the education system is obsolete and that some major improvements should be implemented. Furthermore, teachers' subjective opinion can sometimes cause inequality regarding assessment and approach towards students. However, when the situation with the COVID-19 came, education had to make a step forward and include technology in its operations. Both middle, high schools and colleges accepted this practice and started to adapt to

learning online. On the other hand, it is often hard for teachers to get the sense of students' feelings and knowledge on the other side of the screen. Students often do not understand the task and feel unmotivated to try to ask for additional explanation. Therefore, affective computing could help teachers get the sense of every student in the class, since a student's gestures and motions would reveal one's feelings regarding the assignment, chapter or exam.

In the work project on the faculty we had an assignment and a case study regarding how did IBM constituted and implemented emotional recognition tools into its business model. While reading the case study I concluded that IBM's compassionate and personalized conversational system is a great example of a system which could provide all the necessary data for the implementation of affective computing in the educational system. System's three parts are people, interaction and lastly naturally gives present. In other words, understanding people at a deeper level, understanding styles of human interaction and optimize human-computer interaction and lastly understand and respond in various mediums in which interactions can occur. With these functions the system can determine various numbers of actual feelings, such as anger, motivation, interest, understanding... The data would be collected through three main channels, those are text, speech and gestures. On the other hand, mediums for the gathering of the data would be computers, mobile devices, displays, tablets, etc. I believe that would help teachers learn to interpret better student's feelings and understanding. Furthermore, when the students are solving computer tasks, the system could detect the level of students' confidence or knowledge and provide additional explanations and similar tasks if needed. Contrary, if a student's confidence and knowledge levels are high, the program could immediately provide students with tasks which are more demanding and make the task explanations brief. In that way students would also benefit because their learning would be more personalized and self-adaptive. In other words, they would save time and gain additional explanations by focusing mostly on tasks which they don't understand.

Ironically, research schools and universities should be an important factor for affective computing's success. However, it is hard to implement that kind of revolutionary technology to something that barely changer in the last 20 years, before COVID-19. Instead they should play the role of the partner and conduct researches regarding computer science, artificial intelligence and emotional recognition systems.

Furthermore, there are also other industries in a public sector where affective computing could be implemented. One of those industries is healthcare. Once again this does not refer to every country in the world. We are currently basing on a system which majority of European countries have. One of the main problems of the public healthcare system is waiting time. Because of long waiting lists and slow execution, the job is usually done poorly. However, if the affective computing is used, not only operational system would be improved but the quality of the service and consequently general healthcare system. With collecting information about each patient regarding emotional reactions, implementing that information and compacting it into big data which would store individual's information more precisely and efficiently the operational system would be much faster. Furthermore, with emotional recognition, certain expressions and gestures could easily be connected with specific diseases or physical injuries. Therefore, doctors would initially have a certain base regarding patient's condition, and they would narrow the range of possible causes at the very beginning. Additionally, if the patients don't know how to express themselves or the pain they feel, in a case where patients have some mental disease, doctors would much more easily detect the cause of the pain. This would easily be conducted with physical model, where a facial expression, speech and body movement is being observed. With this technology and approach the patients could see the doctor from the comfort of their own home, what would mean smaller waiting lines in the hospital's hallways and faster execution.

### 3.4 Specific companies

In this section I will point out possible event when the companies implement affective computing, or emotional recognition into their business model. Again, these are only possible outcomes that may occur. Meaning, the outcome could go the other way around, however based on the models we investigated and examples we observed I find these solutions to be highly competitive regarding high-tech implementation and plain business solutions.

The first company we will mention is ABOUT YOU. ABOUT YOU is an online clothing shop which experienced its boom in recent months, thanks to brilliant marketing move including enormous sales. However, after the company experienced its peak it immediately started to fall. The customers weren't happy with the products they got and the initial hype dropped instantly. However, ABOUT YOU remained very popular in the fashion world. The problem is that the company is trying to make its best and get rid of the bad product reputation, but that is very demanding, long and hard process. There are a lot of people who are expressing different feelings about their clothing, site, delivery and so on. It is just too hard to make everyone happy at the moment and that is why ABOUT YOU took the mark of a company who has products of bad quality but cheap prices. On the other hand, ABOUT YOU invested in research and development department, by purchasing affective computing systems, the story could be significantly different. The company could use emotional recognition models to make a professional and trustworthy study regarding what do customers like the most and dislike the most about their company. By adjusting to the largest group of people according certain specifications, ABOUT YOU could have the "perfect-site" or a "perfect-delivery" or also "perfect-offers". In other words, if they used affective computing as a model which will tell them what is the largest portion of their customers and what do they prefer, the site could easily create its loyalty group of customers. On that way, about you could maximize its profit compared to costs. Right now, the costs for marketing and other departments are huge, however affective computing would point at which groups of people the company should focus and at which it would be simply waste of time and money. Furthermore, by creating a certain data base of customers, the program could easily be coded to list the items the customer should be most interested at, according to its emotion reactions. This could be obtained with physical method, using just a facial recognition and body posture tools and with questionnaires which could be masked into promotions, games or discount offers.

Second company affective computing could make a huge difference in is Pauza.hr. Pauza.hr is a food delivery company which delivers food for restaurants so that they don't need to have their own delivery department. It has a list of a number of different restaurant and their offers. The customer uses its device whether that is mobile phone, table or laptop to make a delivery. Pauza.hr had a massive boom during the lockdown in Croatia when most of the restaurant had only delivery. However, the competition in this specific branch quickly got very strong. Now there are a number of companies which operate on the same way as pauza.hr does. Frequent promotional codes,



discounts and offers “+1” made very hard to stand out nowadays. However, in a case where Pauza.hr would implement affective computing to their business model they would get an edge over competition. For example, let’s say that pauza.hr already has a certain customer base. By implementing emotional recognition models, they could quickly get all the valuable information regarding each and every customer. Moreover, if the customer allows the camera option while one is ordering food, emotional recognition could be based on its previous orders and current emotional state offer best current option for a customer. In other words, the program could offer a dish a customer loves and needs at the moment, even if the customer maybe would not think of that dish at that moment. That would have a huge surprise factor with customers. I personally am also a customer of Pauza.hr and oftentimes don’t know what to order. However, if the application could offer my favourite chocolate meal when I am sad, or a “homemade” soup when I am feeling sick or weak that would be a game changing step. This could easily be obtained with just a facial recognition tool. With that option, offering something people subconsciously want, the company would surely increase its customer base and consequently profit as well.

## 4. FUTURE OF AFFECTIVE COMPUTING

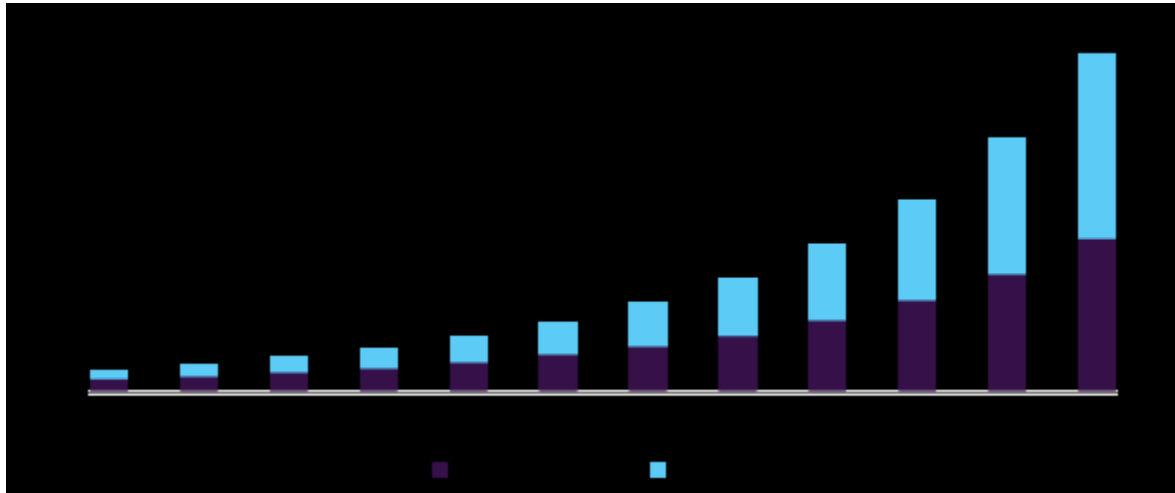
Although, on the first sight affective computing has a respectable future in the business world there are several factors which could easily change the outcome of the industry. In this section we will discuss how affective computing could succeed and what could stop it. Even now, the business world is being highly oscillate, hence even a brilliant idea with a bad execution would fall. Therefore, we will observe what are the main threats the industry could face and simultaneously what could be its potential growth.

### 4.1 Market

There is a rapidly growing demand for the technology which would assist humans generally. Therefore, affective computing has a great perspective in both personal usage and business. Affective computing market was valued at USD 20.23 billion in 2019 and is expected to

additionally increase at a compound annual growth rate of 33% from 2020 to 2027. As we can see in the Figure 12.

Figure 12: U.S affective computing market size (USD Billion)



Source: Size, G. M. (2020). Share & Trends Analysis Report By Application (Electronics, Composites, Energy), By Product (Graphene Nanoplatelets, Graphene Oxide), By Region, And Segment Forecasts, 2020–2027.

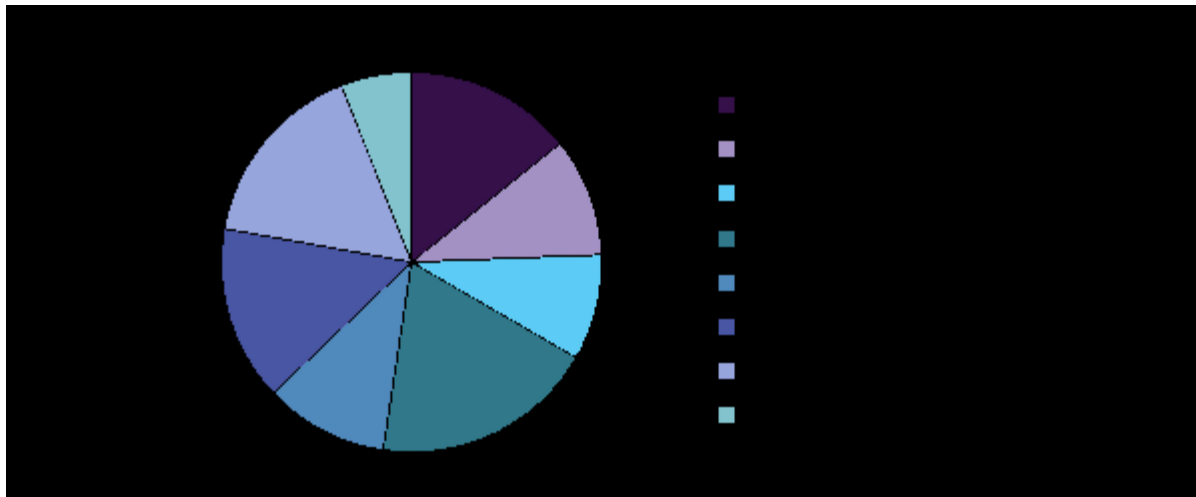
With the outbreak of COVID-19 most of the businesses had to change the way they operate their activities. Physical contact was strictly avoided. However, COVID-19 actually helped affective computing to spread its wings. With the high-technology processing every move of the individual, a number of physical actions can be avoided and consequently suspended. Therefore, companies are implementing gestures, speech, and facial recognition software for operations as attendance purpose and replacement of all the operations which are using biometric parameters.

However, one of the major problems for growth of affective computing market is technological compatibility and high implementation costs. Although, affective computing would definitely help companies to understand how purchase and marketing decisions are influencing customer's emotions and connect operational activities with triggered emotions, the major part of the data is collected and observed in complex lab environment. Furthermore, some models of affective computing such as wearable computing or gesture recognition demand enormous development

costs. Consequently, high development cost and hard implementation are the main threats for affective computing's market growth.

Lastly, it is important to mention that in 2019 touch-based segment was the most dominated affective computing segment with a revenue share of more than 50%. Additionally, this particular model is expected to have a compelling growth as the market gets larger.

Figure 13: Europe affective computing market share, by-end-use, 2019 (%)



Source: Size, G. M. (2020). Share & Trends Analysis Report By Application (Electronics, Composites, Energy), By Product (Graphene Nanoplatelets, Graphene Oxide), By Region, And Segment Forecasts, 2020–2027.

In the Figure 13, we can see a pie chart illustrating the market share of certain industries regarding affective computing market share. Currently, healthcare industry has the largest market share, occupying around one-fourth, of the all market. The affective computing tool healthcare industry is using the most at the moment is facial recognition. They are using facial recognition tools to order detect which patient needs the help most and to detect the scale of pain. Additionally, they can detect certain diseases according to facial recognition.

Another industry worth mentioning in the context of affective computing and its market share is automotive industry. Automotive industry is expected to have a huge growth in the future years as it constantly desire for a new and better technology in the next-generation automobiles. Since, the competition in automotive industry is extremely big, there is no room for saving on technological developments.

## 4.2 Main challenges

The first challenge for affective computing and overall emotional recognition is accuracy. Without accuracy, everything falls apart. Nobody would rely and pay millions for the technology that is sometimes wrong. Moreover, in this specific case, the technology is representing something what will finally give businesses a true information how the customer feels and thinks. Because of that talking about accuracy as one of the main challenges is a bit contradictory. However, there are more factors influencing the overall outcome. In other words, problems is that people can fake emotions, and can experience feelings without moving their faces. Furthermore, people sometimes in politeness smile to welcome someone. Since people can express emotions without feeling the emotion, that questions the whole theory of accessing emotions based on facial expressions. Furthermore, one can also fake the emotion without the program recognizing it. Moreover, many scientists claim it is almost impossible to detect one's knowledge based only on facial expressions. They think a wider range of factors should be included in defining the emotion, such as surrounding, ambient, personality, tone of voice, posture, body language, etc. Another two scientists claim, rather than considering happiness as a single emotion, emotional categories should be separated into their components. Meaning, happiness should present joy, pleasure, compassion, pride and so on. Expressions for each emotion could differ or overlap. Taking everything above into consideration, the accuracy in affective computing is crucial because in some events the stakes are too high for mistakes. Meaning, if the affective computing is being used in job interviews or at borders, the slightest change could affect one's life. For example, is when Hungary, Latvia and Greece piloted a system for pre-screening travellers that aims to detect deception by analysing micro-expressions in the face or to detect deception in courtroom videos.

Another great problem of affective computing is connected to ethical issues. Collecting data of customers and general people has become very "thin-ice" to walk on. Each country has different laws and regulations, regarding how data can be collected, managed and exploited. Therefore, affective computing, i.e. emotional recognition models which are entirely based on obtaining individuals information is standing on a very shaky ground. Furthermore, the procedure must be strictly planned and executed without any deviations. Additionally, all the information collected can only be used for specific project that is meant to. The information cannot be reused in other

activities nor issued or sold to some other institution or company. Meaning, if the data of the individual is processed in one survey and experiment. It can be stored but technically that data shouldn't be used in further investigations and business actions. What leads affective computing into a grey area of the economy. It would be extremely hard to prove guilty in using the information of previously stored data, because it can always be a lucky guess. Secondly, reselling the collected information about individuals and business practices is again hard to prove (Zuckerberg case). (Ignatyeva, O., Sokolov, D., Lukashenko, O., Shalakitskaia, A., Deneff, S., & Samsonowa, T. 2019)

### 4.3 Development

More and more researches and people in general are nowadays talking about affective computing and their projects. However, only small amount of that projects is actually implemented into businesses or some practice. A downfall regarding creating a concrete categorization of applications is that the potential influence of affective computing is unknown. Meaning, it is hard to detect specific cause of creation of certain application, or connect it to affective computing itself. A figure that plays an enormous role regarding this is actually general success and complexity of the affective computing systems. In other words, affective computing market will face great increase if the people from both sides like the system, that is customer and company and that resulting a huge popularity in industry implementation. Simultaneously, that complexity of affective computing is not too big, so that people can easily use in on daily basis. Furthermore, there are two possible outcomes depending on the construction of affective computing systems. If the systems are small and inflexible with very narrow scopes, affective computing will probably be used for a finite number of domains and only for extremely specific reasons. On the other hand, if a technology simultaneously supports affective computing systems and consequently make them large and adaptive, there is a great possibility that affective computing will be present in nearly every aspect of human's daily life. (Schwark, J. D., 2015). Therefore, the development of affective computing could go in either way. I personally think that it would go in both ways, but the question is which type will develop more. In either way, right technology is needed for implementation of the affective computing systems.

## 5. CONCLUSION

The paper learned, us everything from the basics of affective computing, its data collecting methods, implementation into business models in different industries to market and future of affective computing. Taking all of the information observed in the paper, affective computing has a potential to make it, in business world. Contrary, we also know there are several challenges for its success and that affective computing depends on several external factors. Such as, general development of the technology and public opinion towards data collection methods. However, affective computing provides a variety of methods and tools data could be collected, giving affective computing opportunity to make into every aspect of the business and personalization. Taking into consideration, market predictions, affective computing will from this point go only up. Meaning, although it is risky at the moment, this is the perfect time to get into it and get the edge off the competition later. Even now, in the early time of the affecting computing system companies would get extraordinary advantage with the usage of such system. With basing on a small and medium companies and start-ups affective computing could provide service crucial for the company's growth. Furthermore, it could be entirely implemented in business models which are completely new as well as in the old obsolete business models. Changing major part of activities to electronic way and precisely collecting and processing information about target market, customers and products. With affective computing each employee whether one is in marketing, HR or sales department would instantly have an edge. Workers knowledge would be ameliorated, because the worker would know how the person on the other side of the desk feels about product, deal or the worker itself. Large amount of the resources would be saved and directed towards right direction. The company's automatization would improve significantly, meaning the operational costs and total salaries of the workers would drop. I personally, think that affective computing can be implemented into every company in one way or another, and think that the company will always benefit at the end if it implements the system. In other words, I think affective computing is the future of business models.

## 6. REFERENCES

- Baden-Fuller, C., & Morgan, M. S. (2010). Business models as models. *Long range planning*, 43(2-3), 156-171.
- Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of behavior therapy and experimental psychiatry*, 25(1), 49-59.
- Brigham, T. J. (2017). Merging technology and emotions: introduction to affective computing. *Medical reference services quarterly*, 36(4), 399-407.
- Calvo, R. A., D'Mello, S., Gratch, J. M., & Kappas, A. (Eds.). (2015). *The Oxford handbook of affective computing*. Oxford Library of Psychology.
- Campbell, A., Choudhury, T., Hu, S., Lu, H., Mukerjee, M. K., Rabbi, M., & Raizada, R. D. (2010, August). NeuroPhone: brain-mobile phone interface using a wireless EEG headset. In *Proceedings of the second ACM SIGCOMM workshop on Networking, systems, and applications on mobile handhelds* (pp. 3-8).
- Cheung, E. O., Addington, E. L., Bassett, S. M., Schuette, S. A., Shiu, E. W., Cohn, M. A., ... & Moskowitz, J. T. (2018). A self-paced, web-based, positive emotion skills intervention for reducing symptoms of depression: protocol for development and pilot testing of MARIGOLD. *JMIR research protocols*, 7(6), e10494.
- Hektner, J. M., Schmidt, J. A., & Csikszentmihalyi, M. (2007). *Experience sampling method: Measuring the quality of everyday life*. Sage.
- Hu, X., Chen, J., Wang, F., & Zhang, D. (2019). Ten challenges for EEG-based affective computing. *Brain Science Advances*, 5(1), 1–20.
- Ignatyeva, O., Sokolov, D., Lukashenko, O., Shalakitkaia, A., Deneff, S., & Samsonowa, T. (2019, September). Business Models for Emerging Technologies: The Case of Affective Computing. In *2019 8th International Conference on Affective Computing and Intelligent Interaction Workshops and Demos (ACIIW)* (pp. 350-355). IEEE.
- Lee, C. C., Kim, J., Metallinou, A., Busso, C., Lee, S., & Narayanan, S. S. (2014). Speech in affective computing. In *The Oxford Handbook of Affective Computing* (pp. 170-183). Oxford University Press.
- Politou, E., Alepis, E., & Patsakis, C. (2017). A survey on mobile affective computing. *Computer Science Review*, 25, 79-100.
- Pollak, J. P., Adams, P., & Gay, G. (2011, May). PAM: a photographic affect meter for frequent, in situ measurement of affect. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 725-734).

- Poria, S., Cambria, E., Bajpai, R., & Hussain, A. (2017). A review of affective computing: From unimodal analysis to multimodal fusion. *Information Fusion*, 37, 98-125.
- Schwark, J. D. (2015). Toward a taxonomy of affective computing. *International Journal of Human-Computer Interaction*, 31(11), 761-768.
- Schweizer, L. (2005). Concept and Evolution of Business Models. *Journal of General Management*, 31(2), 37-56.
- Udovičić, G., Đerek, J., Russo, M., & Sikora, M. (2017, October). Wearable emotion recognition system based on GSR and PPG signals. In *Proceedings of the 2nd International Workshop on Multimedia for Personal Health and Health Care* (pp. 53-59).
- Wu, C. K., Chung, P. C., & Wang, C. J. (2012). Representative segment-based emotion analysis and classification with automatic respiration signal segmentation. *IEEE Transactions on Affective Computing*, 3(4), 482-495.
- Xu, Y., & Liu, G. Y. (2009, June). A method of emotion recognition based on ECG signal. In *2009 International Conference on Computational Intelligence and Natural Computing* (Vol. 1, pp. 202-205). IEEE.