Use of Emotion in Designing BI Dashboards

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**Abstract:** Due to increased focus on user experience and user interface optimization for users and customers, this trend leads to new methods for UX improvements. One of the methods is the use of emotion for getting additional feedback for UX designers. In this paper, we focused on finding relations among emotions, appearance, clarity, time, and a number of elements to improve Business Intelligence dashboards.

**Keywords:** UX – User Experience, UI – User Interface, BI – Business Intelligence, Designing BI dashboards, BI dashboards

1. INTRODUCTION

Using emotion in improving UX (user-experience) and adding value to development was proven [3] [13] [14]. By nature, emotion drives human actions and decisions [15]. Using emotion in UX also contributes to the trend of using emotion in marketing [12]. UX is also considered as part of the marketing discipline. Improving UX of any product is proven to increase customer satisfaction and user satisfaction, leading to increased revenue, lower marketing costs, and justifying the return of the investments into better UX [9]. Better UX can increase efficiency of employees [6].

Trends as data analysis are booming not just Business Intelligence (BI) but also process mining, AI data automation, and others. This trend is booming due to the exponential growth of data, which can be related to Moore's law.[1]

Emotions are complex phenomena. Emotions are characterized by their high sensitivity and variability. The sensitivity of emotions to changes in personal, situational circumstances is reflected in the fact that emotions themselves can change without apparent changes in objective circumstances (based on a subjective assessment of the situation). In one situation, the emotions may be aroused, but not in another. [8]

Research supposes companies want to improve the UX of their BI dashboards to increase the efficiency of their employees or customers. Companies can use general UX designing methods for improving the UX, which was already demonstrated in previous research [4]. Nevertheless, the traditional methods of measuring UX, such as eye-tracking, focus on measuring rather the manifestative effects of UX than the actual sentiment the system triggers. Therefore, in this paper, we focus on the sentimental analysis of UX. We believe that using emotion recognition software may help to speed up the process of software interface testing and, moreover, bring more precise results than other UX methods.

Most scientific articles focus on using emotions to express whether the user liked the product or not and whether the user is keen to use it further. [10] However, these studies do not mention how these emotions change in relation to the interface features such as the number of components, the use of white space or layout. In this paper, using FaceReader, the software for emotion recognition, we analyse how emotions can be used to formulate general design rules for Business Intelligence software. FaceReader is the most cited software worldwide for emotion recognition [18]. FaceReader recognizes Ekman's basic emotions. Ekman's basic emotions include happiness, sadness, anger, surprise, fear, disgust, contempt [5]. FaceReader recognizes just the first six emotions from Ekman's seven basic emotions.

This paper aims to explore the possibility of using emotion recognition software to test user-friendliness during software development. To verify our hypotheses, we analyze the relationships between the User Experience and User Interface heuristics such as the number of elements, appearance, clarity, emotions and time necessary to complete defined tasks when testing various designs of the business intelligence dashboard. This study assumes that better UX & UI design is related to positive emotions as happiness. Also, we suppose that confusing and ugly UX & UI designs can trigger negative emotions like sadness, anger, fear and disgust.

1. METHODOLOGY

This research is focused on revealing the dependencies among the number of elements, appearance, clarity, emotions, time, and various designs of business intelligence dashboards. Six different drafts (business intelligence dashboards) were selected with different designs, the number of elements, colours, and indicators in the draft. It was most often a combination of tables, graphs, and numerical indicators. Two of the six images were specific in that they were drafts designed in spreadsheet software. The drafts are different in design (draft 2) was a cleaned spreadsheet without colours, bold text, and italics, or other graphic elements. The second table (draft 3) had precisely the same data, but graphic elements were used, such as bold text for headings and colours to separate the size of values. The number of elements in the draft was calculated for each draft. Numerical, graphic, and textual elements from the design were included in the elements.

The participants' tasks were to find two numerical values ​​in all six drafts and say them aloud after finding them. The participants had never seen the drafts before, so the experiment results are coherent. Also, due to the coherence of the data, each participant had a randomly generated sequence of drafts. Because with the increasing number of repetitions, due to the "Law of Exercise"[[1]](#footnote-1) participants can improve in finding values in the draft [7].

All research was conducted remotely due to the covid-19 pandemic. The whole experiment took place via the ZOOM platform. The experiment was recorded using an OBS studio for recorded computer areas and a webcam shot of each participant. Each participant's face was recorded for emotion analysis. The FaceReader software analysed manifestations of the participant's emotions from the recording. For the experiment, 20 participants from the study field of management informatics across the bachelor's and master's degree studies were randomly selected. The population of all possible participants was 92 students. The age range of students was from 19 to 26 years.

The process of the experiment: A date for the experiment interview was agreed on with every participant. The interviews were conducted online on the ZOOM platform. At the beginning of the interview, each participant was asked about age, gender, and questions that were not related to the experiment to put them at ease, so that each participant's emotions were as coherent as possible. It was also checked whether the participant had an adequately set up webcam that captured the entire face. Subsequently, a link to dashboard drafts was sent to the participant. Then the participant started sharing his screen and was instructed to open the first draft. Then the first question was read after answering the first question, a second question was asked. This process was repeated for all drafts. The participant was timed for each draft, and time started after reading the first question and turned off after the second answer was heard. All six proposals were examined in this way. The last part of the interview was to score the appearance and clarity of the drafts. Every participant in the last part was asked to rate the appearance and clarity of each draft. Participants rated the drafts on a scale from 1-10, where 10 was the best score.

Subsequently, recorded images of participants' faces were analysed by FaceReader software. Data analysis was performed in JupyterLab. The correlation function in the Jupyter environment was used for the analysis of dependencies.

1. RESULTS

Table 1 shows the measured data for each BI dashboard draft from the experiment. The metrics of appearance, time, and clarity are the average of all values from all participants. The values of emotions are the average of all values measured by FaceReader software from all participants. Finally, the number of elements says how many elements are in the design.

Table 1: Collected data from participants

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Draft* | *Number of elements* | *Time*  *⌀* | *Appearance*  *⌀* | *Clarity*  *⌀* | *Happy ⌀* | *Sad*  *⌀* | *Angry ⌀* | *Surprised ⌀* | *Scared*  *⌀* | *Disgusted ⌀* |
| Draft 1 | 223 | 33.25 | 4.9 | 4.35 | 0.104 | 0.049 | 0.100 | 0.028 | 0.011 | 0.039 |
| Draft 2 | 215 | 22.55 | 3.45 | 5.75 | 0.094 | 0.059 | 0.080 | 0.021 | 0.024 | 0.043 |
| Draft 3 | 215 | 17.4 | 5.1 | 6.7 | 0.079 | 0.054 | 0.116 | 0.020 | 0.025 | 0.024 |
| Draft 4 | 159 | 18 | 7.2 | 7.3 | 0.074 | 0.049 | 0.055 | 0.028 | 0.014 | 0.027 |
| Draft 5 | 42 | 14 | 8.925 | 8.85 | 0.152 | 0.038 | 0.067 | 0.019 | 0.016 | 0.037 |
| Draft 6 | 173 | 22 | 7.1 | 6.7 | 0.060 | 0.058 | 0.074 | 0.029 | 0.020 | 0.026 |

A correlation matrix was created from the data in Table 1. Pearson correlation was used for the calculation. The results of the experiment are presented in Figure 1, where the individual dependencies of the metrics between each other can be seen. It can be seen from Figure 1 that the dependence between appearance and clarity is a high dependence with a correlation coefficient of 0.81. Furthermore, a very strong negative dependence between clarity and time was measured with a correlation coefficient of -0.93.

This means that poorer clarity correlates with a longer time to find the indicator in the proposal. A strong negative dependence was measured between clarity and the number of elements with a correlation coefficient of -0.87. Also, the number of elements negatively correlates with the appearance. The correlation coefficient is -0.88, where a higher number of elements negatively affects the appearance and also the clarity.

Dependencies between emotions and other metrics:

The emotion happiness is negatively correlated with the number of elements and the coefficient -0.67. A higher number of elements reduces user happiness. The dependence between happiness and appearance is weak, with a coefficient of 0.35. Between happiness and clarity, there is also a weak dependence with a value of 0.37. The relationship between time and happiness has not been measured.

The emotion sad is strongly correlated with the number of elements with a coefficient value of 0.78. The dependence between the sad emotion and appearance is high and negative with a coefficient of -0.7. Between sadness and clarity, the dependence is negative and is moderately strong with a coefficient of -0.53. The relationship between sadness and time has not been measured.

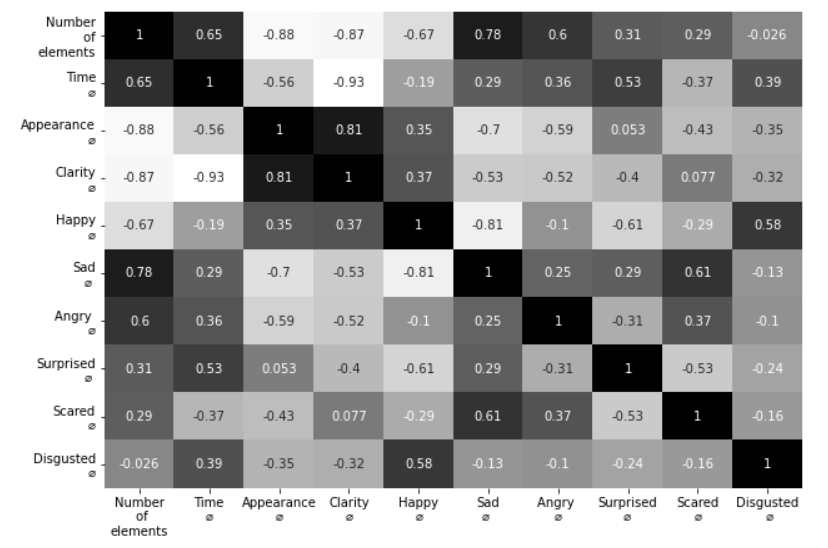


Figure 1: Results of experiment in the correlation matrix

The emotion angry correlates with the number of elements, and the dependence is moderate with a value of 0.6. The angry emotion is negatively correlated with appearance and clarity. The strength of the dependence is medium, and the values are -0.59 and -0.52. A weak relationship between anger and time was measured with a value of 0.36.

The emotion surprised correlates with time, and the value of correlation is 0.53. Surprised correlates with the number of elements with a value of 0.31. Furthermore, a negative dependence between surprise and clarity was found. The strength of the dependence is weak, with a value of -0.4. The relationship between surprise and appearance has not been measured.

The emotion scared negatively correlates with time, and the strength of dependence is weak with a value of -0.37. Scared negatively correlates with appearance. The value is -0.43. The relationships between scared, number of elements, and clarity were not measured.

The emotion disgusted correlates with time, and the dependence is weak with a value of 0.39. Disgusted negatively correlates with appearance, and the size of the dependency is weak with a value of -0.35. Disgusted further negatively correlates with clarity. The strength of the dependence is weak, with a value of -0.32. The relationship between disgust and the number of elements has not been measured.

1. DISCUSSION

In the research, we analyzed the relationships between the User Experience and User Interface

heuristics such as the number of elements, appearance, clarity, emotions and time necessary to complete defined tasks when testing various designs of business intelligence dashboard. The experiment confirmed the assumption that good UX & UI design corallites with positive emotions and confusing and ugly UX & UI designs correlate with negative emotions. A similar hypothesis was tested in [16] they analyzed if completing complex tasks on websites can trigger anger via FaceReader. Results of their research were similar complicated websites trigger the anger of users. Research results [3] show that difficult and complex UI are hard to use and negatively influence the users' emotions. This provides another evidence to prove the results of this paper that a higher number of elements, lower clarity triggers users' negative emotions like anger, sadness, disgust or scared.

Face recognition of emotion was reviewed and conducted studies to validate if the results of face recognition software are reliable. Research papers focused on FaceReader indicate some limitations on the side of FaceReader and the side of the environment's set-up, which can influence the results. The results in [11] point out the importance of the priming of participate because priming influences measurement by FaceReader. Nevertheless, results from FaceReader in most cases match with participants feeling during self-assessment. Similar conclusions are reported in [2]. Research [17] shows that FaceReader has a statistically significant deviation compared to other methods of tracking emotion like EMC, but in self- assessment comparison were no statistically significant differences in results compared to FaceReader. These papers show there can be inaccuracies in measuring emotions. However, none of the research does prove high inaccuracy and, in most cases, FaceReader provides reliable results. Minor inaccuracies are also eliminated by higher number of participants. In conducted research participated 20 participants, which we consider as reputable to mitigate inaccuracies caused by priming of participant or FaceReader.

1. CONCLUSION

Results confirmed that metrics connect with good UX & UI positively influence the emotion of the user. On the other hand, metrics connect with confusing and ugly UX & UI negatively influence the users. There is the correlation among metrics such as number of elements, appearance, clarity, and time to complete certain tasks and emotions.

Research conducted to a similar topic confirmed analogous results to this research.

Thanks to these findings, it is possible to make a few recommendations for designing and optimizing BI dashboards. If people say that a proposal is nice, then it is very likely that it is also clear. This logic also holds true the other way around – if the design is not nice, then it is most likely not clear. Another recommendation is to eliminate unnecessary indicators because a higher number of elements increases the time and reduces the clarity of the BI dashboard. Reduced clarity leads to lower appearance. A higher number of elements reduces user happiness. Also, if the designs are nice and clear, the user will be happier. The opposite is also true – if the designs are ugly and confusing, it makes the user unhappy. Ugly and confusing designs make users angry. Also, nicer designs and clearer designs make users less disgusted.

Research of the experiment was conducted during the covid-19 pandemic, and all data gathering was done through online interviews. This may lead to minor distortion between participants' results. However, despite the effort to ensure that all participants have the most similar conditions possible, it has not been possible to ensure that all participants have a high-speed internet connection and a quality webcam for the best possible emotion analysis record. Also, the environment in which the participants were located could affect the results of individual participants. Drafts of individual BI dashboards are sorted according to Table 1 and can be seen here[[2]](#footnote-2).

Further challenges will be to replicate these results on other applications like websites, software application, mobile app and provide general recommendations for designing UX & UI. Further research also can lead to finding more indicators that can influence user's emotions.

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1. Law of Exercise – people get better with every repetition of some activity. [↑](#footnote-ref-1)
2. https://drive.google.com/drive/folders/1YkhtxDRI6IdcQ0vLFBJeCK91FBCgieDE?usp=sharing [↑](#footnote-ref-2)