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Master Information Systems

Sustainable Digital Innovation Lab

WS 2021/2022

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1. Introduction

With MoodPod we want to help people in an office-related environment to track their work stress and in a broader image to raise the general awareness of work stress. Furthermore, we aim to target and if possible, relieve the stress if necessary. Our solution achieves this by pushing work stress targeting questions to the user in fixed intervals and receiving a simple “yes” or “no” button input. Tracking this feedback from the user allows us to make assumptions about whether the user is stressed, or his situation gets worse over time. As the name suggests our solution first and foremost represents the mood or in a more detailed approach the stress of its users. However, since aesthetic aspects play a big part in using an object like this, we also included a “Pod” which represents a plant and is intended to decorate one's workplace simultaneously with its intentional purpose, besides the stress relieving property of plants of course.

1.1. Motivation

Even though stress is normal and an important part of life, high and continuous levels of stress have a significant impact on physical and mental health. Therefore, keeping stress in check and knowing when to address it as a problem is a key to healthiness and wellbeing (Scott 2020). Stress is and can become a big issue amongst all people regardless of age, occupancy, religion or gender. Stress can occur in all lifestyles and every situation in life. This in mind our sustainable design solution aims to track stress, raise awareness where possible and assist the user in lowering his stress levels by himself or with the help of others (e.g., his superior or colleagues).

Especially in a corporate context the term “burnout” has become synonymous with being overloaded with work or not being able to grasp the situation at hand. Stress is very individual and depends on workers characteristics. Those characteristics are responsible for reactions to working conditions, with stress as one possible result (Centres for Disease Control and Prevention 1999). We want to address work-related stress, as this is the most experienced form of stress in society.

Especially in times where the pandemic has forced workers to conduct their work from home the possibility of becoming burned out has increased even more. More than 255 million full-time jobs were lost during the pandemic which is about 4 times higher than during the global financial crisis from 2007 to 2009 (United Nations 2021). This often resulted in employees having an increase in their workload or different circumstances in which they must conduct their work. Following a study from Indeed more than half of the interviewed employees felt burnout with 67% also stating that the issues they had with stress worsened over the course of the pandemic (Threlkeld 2021). This not only leads to a decline in the workload achieved but also directly affects the mental and even physical health of oneself. While the World Health Organization recognizes burnout as an occupational health issue since 2019, employers are only now realising that mental health should be more of a priority especially when working from home (Doniger 2021).

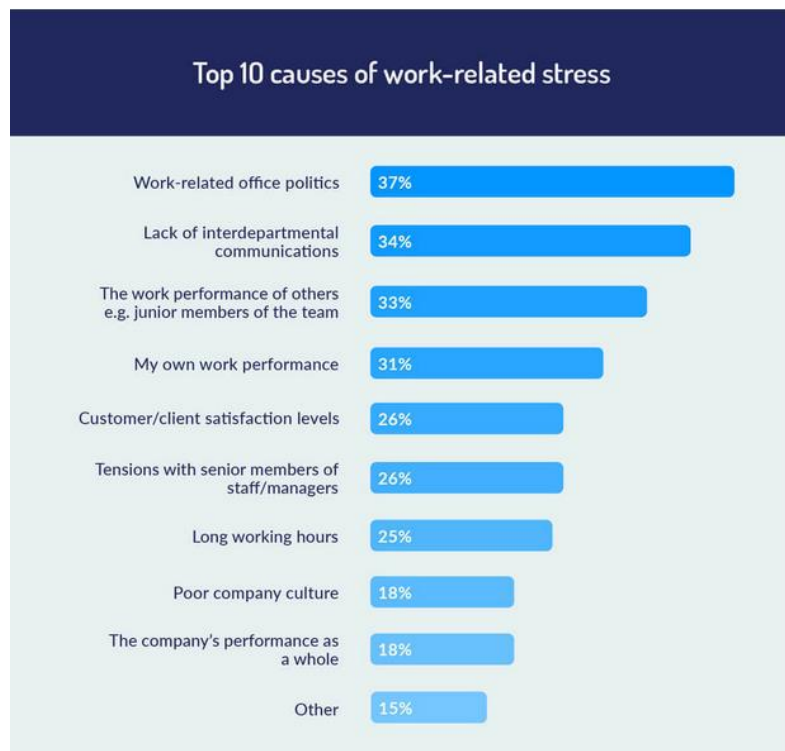


Figure 1 : Top 10 causes of work-related stress

As you can see in Figure 1 most work-related stress results from office politics as well as lack of communication between departments. After examining all Top 10 causes for stress we choose to tackle politics, communication as well as poor company culture with the MoodPod and its implications for the issues at hand. In order to protect those who still work or new employees who tend to do more than they should or can, we came up with an innovation to raise awareness for the described topics.

As we discussed the 17 Sustainability Goals (SDGs) defined by the UN during our studies in the Sustainable Digital Innovation Lab we believe that the 3rd "good health and well-being" and 8th "decent work and economic growth" goals fit our solution and the problems we are trying to address.

1.2. Objectives

With MoodPod we want to provide an affordable, handy, easy to build and easy to use device to track and monitor one's stress level. Furthermore, MoodPod is intended to raise awareness and to relieve work stress. Moreover, it can include several extra features like weather, calendar or even small games. However, since these functions are out of scope we decided not to implement them yet (more information in chapter 4). Our target is to deliver a cheap and simple solution that can be well integrated into the workday and find application by as many employees as possible. By providing blueprints and code basis of the entire solution on GitHub we want to encourage others to build upon our work and improve or adapt it.

2. Design Solution

2.1. Physical artifact

In this chapter we will guide you through our design process focusing especially on how and why we decided to make it a “Pod” as well as why some functions made the cut while others didn’t. This should help to better understand the solution and design itself while giving insights about which issues, we had to face during our design phase.

During the early stage we quickly decided on tackling work-related stress and the in chapter 1 described common causes. However, as we identified there are several possible ways to identify and track stress – some of them are:

1. Tracking Heart Rate
2. Tracking Work speed
3. Regular 1 on 1 with a trusted person
4. Regular questionnaires
5. ...

Therefore, we checked possible up- and downsides for each of them. Not only did these include obvious things like requirements to build it, required code or all-around difficulty in executing the project. One of two key requirements we identified however is the time which a user must invest in order to get feasible results. The other key requirement is getting the user to use the solution. These requirements further shrink the pool of options. In the End we had to make a choice between a wearable like an apple watch or a standalone device which could be setup somewhere. We decided against a wearable on three main reasons:

- Wearables are quite advanced in technology which would increase the time spent on coding
- Heart Rates which would be tracked by a wearable do not have to correlate to one’s stress (e.g., taking a walk, going to the gym, running up stairs at work) directly impacting the feasibility of the data
- Security might be a problem for some as the data collected can directly link to other health conditions (e.g., heart issues, overall fitness)

While there were certainly other challenges with a standalone device, we decided to pursue this endeavour as it seemed like a better fit than wearables. Also, as to this date we have not found a similar standalone solution while wearables sometimes feature stress tracking already.

2.2. Identifying user needs

When we designed the first prototype of our solution, we had many potential functions in mind. However, we had to cut off most of them due to time or technical limitation. Nevertheless, there were some functions which seemed more suitable to the cause than others. To further iterate on the process of finding the right functions for our solution as well as get general feedback about whether people would use the solution, we conducted a user survey consisting of the following 10 questions (Notice: We conducted the survey in German to make it easier for the users):

- Wie stressig ist dein Arbeitsalltag?
 - Ranking 1-10

- Welche dieser Antworten sind in deinen Augen Auslöser für Stress im Arbeitsalltag?
 - Workload / Umfang der Aufgaben
 - Fehlende Kommunikation mit Kollegen
 - Fehlende Kommunikation mit Vorgesetzten
 - Fehlende Mittel oder Hilfestellung, um die Aufgaben zu erledigen
 - Stress im privaten Umfeld
 - Keine der genannten Antworten
- Gibt es für dich weitere Auslöser für Stress im Arbeitsalltag?
 - Freitextantwort
- Kennst du den Begriff "Burnout" im Kontext von Stress
- Kannst du dein Stress-Level so gut einschätzen, dass du einem bevorstehenden Burnout vorbeugen könntest?
 - Ja
 - Nein
 - Vielleicht
- Würdest du eine Möglichkeit nutzen deinen Stress zu tracken, sodass du (oder dein Vorgesetzter) frühzeitig einschreiten kann um Burnout o.ä. zu verhindern?
 - Ja
 - Nein
 - Vielleicht
- Welche Funktionen wären für dich essenziell, um das Tracken von Stress zu nutzen?
 - Unkomplizierte Eingabe
 - Ästhetik des Devices
 - Rückmeldungen
 - Benachrichtigungen
 - Zusatzfunktionen (Wetteranzeige, Stifthalter, etc.)
 - Routinen, um Stress zu reduzieren
 - Keine der genannten Antworten
- Welche Funktionen würdest du dir darüber hinaus wünschen?
 - Freitextantwort
- Welche Möglichkeit gestellte Fragen zu beantworten, gefällt dir am besten?
 - Unkomplizierte Ja-Nein Eingabe
 - Ranking 1-10
 - Mindestens 4 Auswahlmöglichkeiten
- Ist es dir wichtig, dass du deine Ergebnisse (anonym) mit deinen Kollegen vergleichen kannst?
 - Ja
 - Nein

We did decide to conduct this survey **only** after pitching the idea and potential solution to users. Therefore, we had 31 participants of which 19 completed the survey providing data. This means we had a dropout rate of about 39%. A full breakdown of our results can be found in the project GitHub as a .csv file. If you choose to participate in the survey as well please find the survey through this link: <https://www.empirio.de/s/9vHWxBCZHx>.

The following subchapters will discuss certain insights we got through our survey.

2.2.1. Overall Stress

Wie stressig ist dein Arbeitsalltag? (1=kaum, 10=extrem)

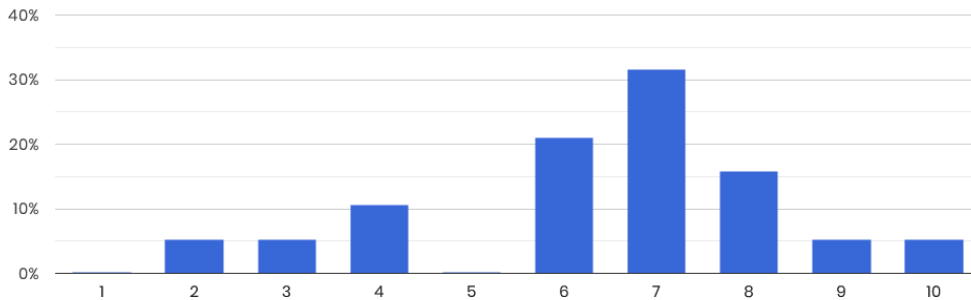


Figure 2: Stress in daily work

As you can see in the above figure roughly 50% of the questioned users would describe their daily work with a Ranking of 7 or 6 as stressful. If we look further 25% percent of the questioned users describes their work with a Ranking of 8 to 10 as extremely stressful. However, there were also about 20% of the participants who described their work as not too stressful with their Rankings of 2 to 4.

This proved to us that Stress in a daily work context certainly is an issue for most participants with most of them answering in the upper 50% of the ranking. This further solidified our thoughts that stress at work is an issue worthwhile to take on.

2.2.2. Triggers

Welche dieser Antworten sind in deinen Augen Auslöser für Stress im Arbeitsalltag?

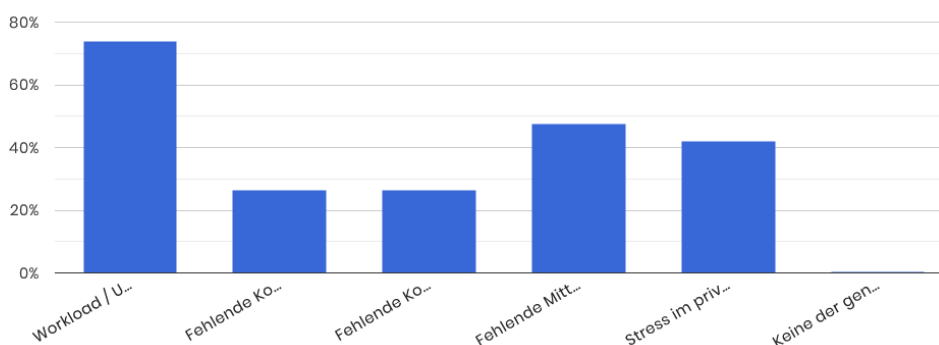


Figure 3: Triggers for stress

Another big part of the survey was realizing which triggers are the reasoning behind the above-mentioned stress. On one hand we had predefined answers we thought were possible triggers on the other hand we had them write down additional triggers which they thought were important. Comparing the results there are two key insights we got through this:

1. The workload certainly is the biggest trigger for stress in a work environment

2. The pandemic which made communication with colleagues harder directly impacted the stress participants felt in their daily work
3. Another big function which many people wrote as part of question 3 is receiving enough feedback to use the data they provide. We achieved this by implementing a dashboard which lets the user see how their stress levels trend overtime.

2.2.3. Burnout

A Burnout can be seen as the result after a certain time of too much stress. Therefore, we asked the participants not only if they know the term burnout but also if they think that it is possible for them to decided whether they are closing in on burnout. To no surprise all participants knew the term burnout in a work-related context. Nevertheless figure 4 clearly shows that most participants could not or are unsure if they could identify burnout themselves.

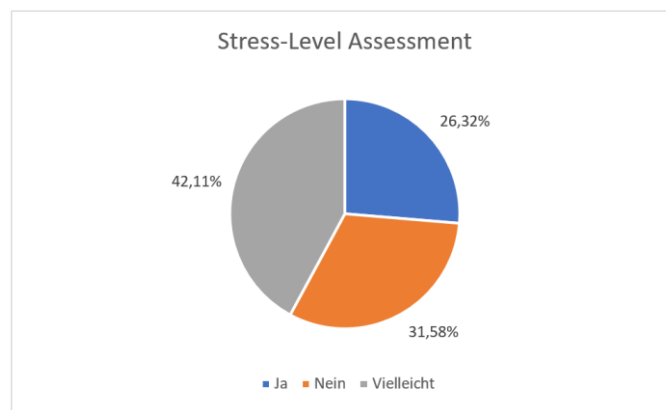


Figure 4: Stress-Level Assessment

With slightly more than 70% of the participants unsure if they can identify burnout, it becomes even more obvious that most people need something to prevent burnout from happening. These results once again confirmed that we were on the right track to develop a device which tracks stress-levels in order to prevent a user from getting too stressed and resulting in burnout.

2.2.4. Functions

The last key insight which will be discussed are functions which the participants deemed relevant in our solution. As before we provided a few functions which we deemed necessary while also leaving some space for the participants to describe their own ideas for the solution.

Welche dieser Funktionen wären für dich essenziell, um das Tracken von Stress zu nutzen?

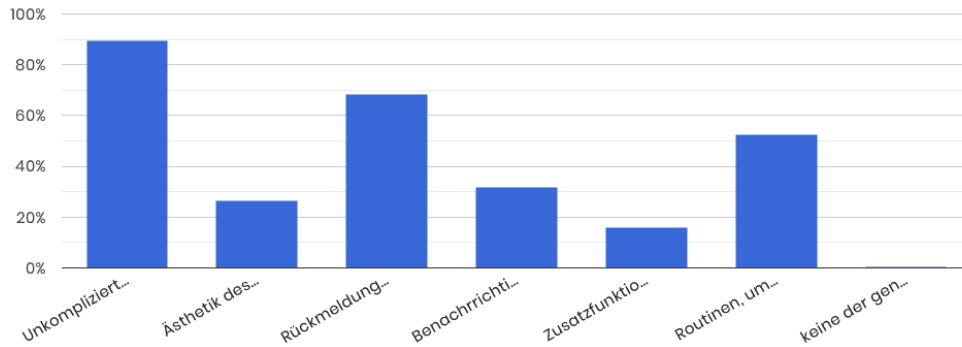


Figure 5: Relevant functions

The above figure shows that there are three main functions the participants wanted in the final solution. One of them being the easy usage with 89% of all participants. We achieved this easy-to-use functionality by limiting the input to only two buttons. This makes the use of the solution quick and easy while also not confusing the user with several inputs. Furthermore, about 68% of the users preferred to have feedback after submitting an answer. This is achieved by adding a dashboard where the user can not only track what they have answered but also how their stress-level changed over time (see chapter 3 for more information on the dashboard). As the last of the three main functions participants suggested to use Routines to relieve stress. However, we decided against implementing a feature yet as this needs substantial research into the field to provide routines which will relieve stress in a meaningful way.

Further discussion on possible functions as well as the user-suggested functions will be conducted in chapter 4 during our discussion and outlook.

3. Solution

Within this chapter we describe the hardware and software aspects of our solution and how they are set up. We also provide the list of needed materials with pricing and quantity and possible purchase options. Furthermore, the full list of questions as one of the main artefacts of our solution is provided and we describe how this list was developed.

3.1. Hardware

The self-constructed hardware part of our solution design consists of several parts, which are described in detail in the following chapter. Mainly a 2,8" screen shield connected to an Arduino Mega to display the questions to the user and an Arduino MKR 1010 Wifi that was used for all further operations. These components connected among each other and together with the two user input buttons were integrated into a wooden case. Thus, it can be reproduced easily appeals to the user's eye and contributes to the overall objective of MoodPod. Furthermore wood proves to be a sustainable resource in comparison to a metal or plastic case. Additionally, a plant that uses very little water and no soil was mounted on a metal wire to please the eye and deliver the calming feel of nature.

List of Materials:

The material list contains all needed components, as well as the average price, quantity, and a source for purchase to rebuild MoodPod.

For the construction, only basic tools are needed. A power drill, a manual jigsaw, sandpaper, and soldering iron are sufficient.

Component	Quantity	Cost (€)	Total (€)
Arduino MKR Wifi	1	33,99€	33,99€
Arduino Mega 2560 R3	1	19,35€	53,34€
Push-button	2	1,65€	54,99€
Jumper cable		included	54,99€
USB-A to USB-B cable	1	included	54,99€
USB-A to micro-USB cable	1	1,99€	56,98€
1000mAh lithium-ion battery pack	1	9,99€	66,97€
Adafruit 2.8" TFT Touch Shield v2	1	19,29€	86,26€
wooden panel (18cmx18cm)	2	6,25€	92,51€
Wooden panel (18cmx12cm)	4	6,25€	98,76€

Cable connections

The two microcontrollers are connected by wire. The Arduino MKR Wifi 1010 is connected to the Arduino IoT Cloud through the onboard wifi chip.

Both microcontrollers are connected via the i2c or Inter-Integrated Circuit. This is a data bus used for communication between two or more microcontrollers. With those commands initializing what to show on the display are transmitted from the Arduino MKR Wifi 1010 to the Arduino Mega 2560 R3. The 2,8" TFT display shield is directly plugged into the Arduino Mega 2560 R3.

Pin MKR 1010 Wifi	Pin Mega 2560 R3
SDA	SDA
SCL	SCL
GND	GND
Pin MKR 1010 Wifi	Button 1
7	5v
GND	GND
Pin MKR 1010 Wifi	Button 2
8	5v
GND	GND
Pin Mega 2560 R3	2,8" TFT Shield

Circuit Board:

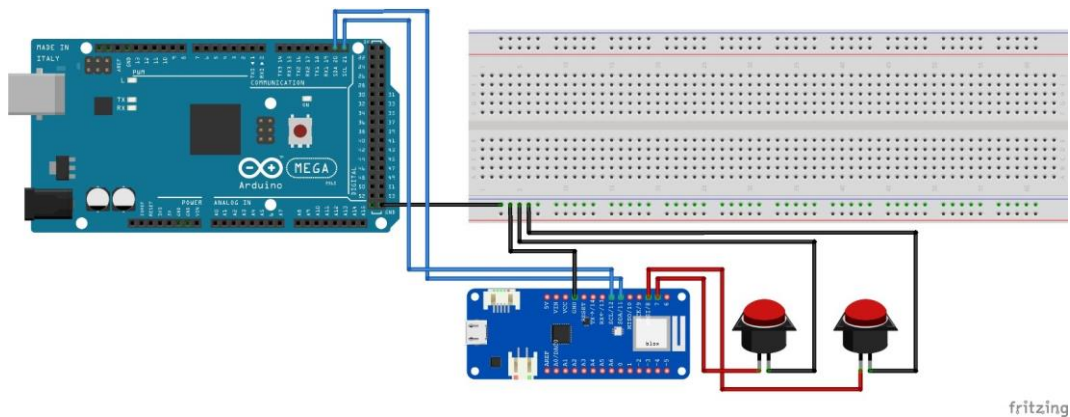


Figure 6: Circuit Board

3.2. Software

All of the software developed for this project is written in C++ using the Arduino framework. Using the Arduino framework ensures the compatibility regarding the microcontrollers as it is

their native one. The code itself was written using the Arduino online IDE. This ensured the connectivity to the Arduino IoT cloud. There is one additional library used for realizing the project and more specific for connecting the display. It is called “MCUFRIEND_kbv”.

All the code of this project can be found in this github-repository:

<https://github.com/Exa2k17/MoodPod>

User-interface

The user interface of the Moodpod consists of the two physical buttons used for voting and the display to show information to the user. The display has different screens to show preprogrammed on the Arduino mega 25260 R3. When starting up it shows a welcome screen. After startup, a first question is displayed. When voted one of the Two Thank You For Voting screens will show up. If a question got voted on and a new question is not available yet a Waiting screen gets displayed.

Dashboard

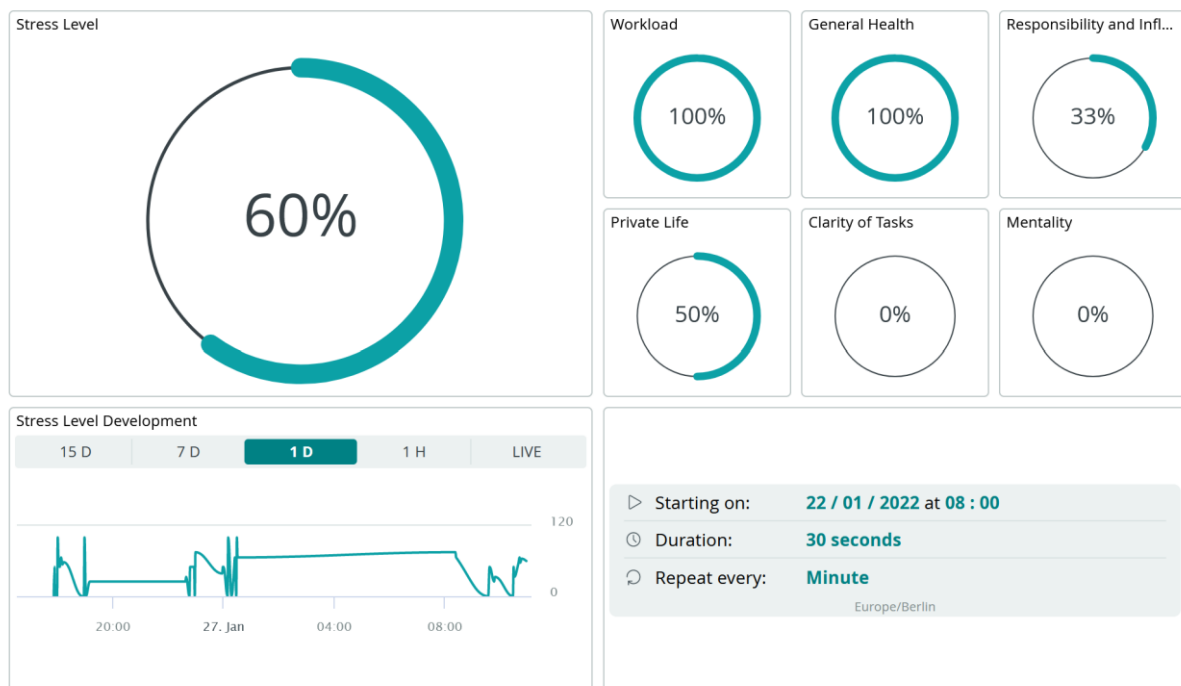


Figure 7: Dashboard

The dashboard shows information summarizing the past votes using the dashboard of the Arduino IoT cloud. It can be viewed on mobile devices and desktop devices. It displays this information using 8 different widgets.

The Stresslevel shows the current overall level of stress determined through answering the questions in percent. The Stress Level Development widget displays the development of the stress level recorded over time. It shows as a line graph. Different views with different time scales can be selected. Additionally, 6 widgets are showing the stress levels of each question category. These are Workload, General Health, Private Life, Clarity of Tasks, Responsibility, and Influence, Mentality. As the 8th widget, there is one that shows the options selected for scheduling the periods wanted for receiving questions. This widget offers the option to change these settings.

3.3. List of Questions

The list of questions is largely based on the Work Stress Questionnaire (WSQ), which was developed by Holmgren et al. (2009) and its reliability and face validity was tested successfully multiple times in the following years (Holmgren et al. 2009; Holmgren et al. 2013; Frantz/Holmgren 2019). The purpose of the WSQ lies in the early identification of individuals at risk of being sick-listed due to work-related stress. Besides some of the 21 that the intentional WSQ provides, further questions from the NIOSH Generic Job Stress Questionnaire (GJSQ) were selected to extend the list of questions (National Institute for Occupational Safety and Health 1991). Thus, it covers an even broader field of work-related stress.

The final list of questions contains a total of 35 questions which were allocated to seven categories: Clarity of Tasks, Conflicts, General Health, Mentality, Private Life, Responsibility and Influence at Work and Workload. All questions can be answered with “yes” and “no”, the only inputs of our hardware solution. The distinct questions are not interconnected, and all are to greater or less extent of equal value. Therefore, they can be displayed randomly at given times, as described in chapter 3.2. Besides that, this is very suitable for statistical analysis. This allows us to record and monitor the data and specially to track changes in the response behaviour and the overall work stress level.

1. Workload

1. Do you have time to finish your assignments?
2. Has your workload increased?
3. Do you have too little assigned to you?
4. Do you work after ordinary working hours to finish your assignments?
5. Do you have time for rest breaks to relax in between work?

2. Clarity of Tasks

1. Do you know who is making decisions concerning your workplace?
2. Are the goals for your assignments clear?
3. Do you know which assignments your work tasks include?
4. Do you know how to find help and adequate resources and materials for your assignments?
5. Do you find it difficult to ask coworkers or your supervisor for help?
6. Are you given supportive feedback on the work you do?
7. Do you understand the reasons for your tasks and how they support your organisation?

3. Responsibility and Influence at work

1. Do you have the possibility to influence decisions at work?
2. Does your supervisor consider your views?
3. Can you decide on your work pace?
4. Do you take more responsibility at work than you ought to?
5. Do you feel proud of what you achieve in your job?

4. Mentality

1. Do you put high demands on yourself at work?
2. Do you often get engaged in your work?
3. Do you find it hard to set a limit to work assignments although you have a lot to do?

5. Conflicts

1. Are there any conflicts at work?
2. Are the members of your group supportive of each other's ideas?
3. Are you involved in any conflicts at your workplace?
4. Has your supervisor done anything to solve the conflicts?
5. Is there bickering in your group over who should do what job?

6. Private Life

1. Do you think about work after your working-day?
2. Do you find it hard to sleep because your mind is occupied with work?
3. Due to work, do you find it hard to find time to be with your nearest and friends?
4. Due to work, do you find it hard to find time for your recreational activities?

7. General Health

1. Do you feel tired at work?
2. Are you bothered by headaches at work occasionally?
3. Do you perceive loss of appetite?
4. Does your job affect your heartbeat or lead to sweat without physical reasons?
5. Do you have problems with your concentration at work?
6. Have you experienced more illness recently (Cold/Flu/Fever/...)?

4. Discussion

4.1. Evaluation

The solution in its current state includes all core functions which are required for the solution to be successful. This includes asking the users questions on a fixed interval while tracking and saving the answers which are received through the two-button input located above the display. Furthermore, the users have the option to check their inputs through a dashboard to get deeper feedback on how their stress has changed over a set period. It has to be noted that this approach does not take into account that there is “good” stress which pushes the user or influences him in a good way rather than impacting physical or mental health.

The casing was designed in more of a functional approach rather than considering possible repercussions from users not wanting to use the device due to its look and feel. This extends to the integrity of the casing itself which can and should be optimized for a more general use. It should also be considered that the code can work on different Arduinos apart from the Mega which we used in our project making it possible to use different displays, connectors and alike. This in turn means that the casing which is provided in the GitHub will not fit every possible iteration of the solution.

However, if a user decides to use the solution, he can use it without having any prior coding or 3D-printing experience as all relevant blueprints and code is available online in the project GitHub. For Troubleshooting especially in terms of using and setting up the Arduino there is an extensive library of tutorials on setting up and installing the board available on the official Arduino homepage.

4.2. Theoretical and practical contribution

We believe that the MoodPod provides users and companies alike a great opportunity to track stress among the workforces. The user benefits directly by seeing his stress level rise and decline and being able to adjust accordingly. The company on the other hand can take action to reduce stress among their employees to reduce sickness rate amongst the workforces. While the main target of the solution is the workforces, they are certainly other population groups which can benefit from the product. This would need to include further research on the impact of stress in these groups as there are usually other reactions than in a work environment (e.g., calling in sick).

Developers or interested people can find all information regarding the solution with this report as well as the code and answers to the survey in our GitHub page. The solution is released as open source under the General Public Licence v3 (GPL) there (<https://github.com/Exa2k17/MoodPod>).

4.3. Outlook and extensibility

Possible Iterations from the MoodPod could support additional features and a sturdier and more visually appealing casing. Especially after presenting the solution, it was discussed that the stress level and the way in which it calculates need a bit of work. It does not take “good” stress into account and right now gives every question the same impact. To better implement the tracking one should give the questions a specific impact on the stress level. Furthermore, it should be clearly visible at which point stress is good, alright or starting to impact health (e.g., 20%, 50% and 80%).

If we investigate the survey, there are a lot of functionalities participants like to see. Some of them include:

- Routines to relieve stress
- Display pictures or facts
- App connectivity
- Weather

It must be noted however that if the device provides more functions which not directly correlate with the issue, we try to solve the user might not use the core features as often. Another feasible outlook could be to implement the code or the idea to track the stress with simple questions into other products which also exist on the market. One approach could be an app on the work smartphone which regularly sends push notification to ask questions. This would eliminate the need for a casing as most users have a smartphone on hand. If a physical artifact is still needed it could also be included as a function into Alexa or alike where it regularly asks or shows questions on the devices.

The next few iterations should focus on making the casing sturdier and including simple functions like weather or pictures in order to not overload the project. The first step must be making the MoodPod easily distributable while maintaining the core functionality.

Right now, the MoodPod is designed as a Do-it-Yourself solution which must be printed, assembled and installed by the user. Since the design is rather simple it should be possible to adapt it for manufacturing by a professional after companies or individuals show interest in the solution. This however should be subsidized by a company or alike because once users must pay a lot of money for the solution the interest in it might plummet.

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