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## PREventive Care Infrastructure based on Ubiquitous Sensing

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### **D2.1 List of usage scenarios and user requirements**

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### **Abstract**

The main objective of PRECIOUS is to provide a preventive health care system that will improve the health of the user, and deliver cost savings in the public health sector. This document reports on activities carried out in PRECIOUS to understand the user requirements of the system and to deliver a set of usage scenarios, which will form the basis of the system design tasks. The end user must be central to the design of PRECIOUS and therefore, an early indication of user requirements is essential. The usage scenarios identified in this document will provide a starting point for system development; however further consultation with end users, as well as other key stakeholders, such as service and technology providers, will be important in delivering the project aims. This document also considers the selection criteria for study participants who will be recruited to efficacy studies in the latter stages of PRECIOUS. It is important that these studies, and the selected participants, reflect the overall goals of PRECIOUS and that they are linked to the requirements of the end user. Early determination of these selection criteria also ensures adequate time to seek appropriate ethical approvals.

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**List of acronyms**

BMI: Body Mass Index

CVD: Cardiovascular disease

FP6: Sixth Framework Programme

FP7: Seventh Framework Programme

GPS: Global Positioning System

HbA1c: Glycated haemoglobin

inCASA: Integrated network for Completely Assisted Senior Citizen's Autonomy

MI: Motivational Interviewing

MINAmI: Micro-Nano integrated platform for transverse Ambient Intelligence applications

MRS: Market Research Society

NGO: Non-governmental organization

PRECIOUS: PREventive Care Infrastructure based On Ubiquitous Sensing

SMEs: Small and Medium Enterprises

T2D: Type II diabetes

UR: User requirement

VIM: Virtual Individual Model

## 1. Executive summary

The main objective of PRECIOUS is to provide a preventive health care system that will improve the health of the user, and deliver cost savings in the public health sector. In particular, the system will collect information about the user from a variety of devices and applications (sensors) that measure food intake, physical activity, stress levels and sleep patterns. This document reports on activities carried out in PRECIOUS to understand user requirements and to deliver a set of usage scenarios, which will form the basis of the system design tasks. There are many important stakeholders in PRECIOUS, including end users/consumers/patients, health professionals, SME's/service providers/software developers, public healthcare organisations, policy makers and researchers. However, this task is specific to the requirements of the end user/consumer/patient ('end user'). The end user must be central to the design of PRECIOUS and therefore, an early indication of user requirements is essential. The user requirements and usage scenarios identified in this document will provide a starting point for development of the PRECIOUS system architecture; however, further consultation with end users, as well as other key stakeholders, will be important in delivering the project aims.

Interviews with a sub-set of potential PRECIOUS users have been carried out to understand users' key motivations for behavioural change (in relation to diet, physical activity, sleep and stress). The interviews also explored the perceived barriers to change and what tools/systems/approaches might help them to achieve desired changes. Through these interviews it was determined that diet and physical activity are the two areas with the more comprehensive and shared cognition with regard to the reasons for change, technological functions and design features. In contrast, interviewees' responses to resolving disrupted sleep and reducing stress levels are more fragmented in nature due to the personal nature of each situation. Therefore to identify core, common, shared language with regard to the functions and design of technology is far more difficult and limited in terms of output.

Using the results of the interviews, a list of 16 user requirements has been identified and these requirements have been prioritised by the consortium to provide a realistic focus for system development within the project time frame. Accompanying the list of user requirements are four usage scenarios. These scenarios are narrative descriptions that explore how different groups of users (young single working professional, family unit, retired couple and student) might interact with PRECIOUS to accomplish their personal goals. These scenarios will help the system development team to envisage a variety of future use possibilities. Engagement of a wider group of PRECIOUS users and stakeholders will also be important as the system develops.

This document also considers the selection criteria for study participants who will be recruited to efficacy studies in the latter stages of PRECIOUS. It is important that these studies, and the selected participants, reflect the overall goals of PRECIOUS and that they are linked to the requirements of the end user. Early determination of these selection criteria also ensures adequate time to seek appropriate ethical approvals.

## 2. Situational interviews

### 2.1. Background

Within this project the requirements of the end user must be central to the system design, with a focus on providing tailored solutions to individual users. In order to achieve this, end users must be actively engaged in the definition of user requirements, as well as throughout the development process. To this end, 'situational interviews' [1,2] were carried out to gather qualitative information regarding users' key motivations for behavioural change (in relation to four risk factors for type II diabetes and cardiovascular diseases, that is, diet, physical activity, sleep and stress). The interviews also explored the perceived barriers to change and what tools/systems/approaches might help them to achieve desired changes. The interview scripts were analysed by risk factor to determine commonality or core patterns in responses, and the results were used to support the development of PRECIOUS user requirements and usage scenarios.

The concept of the situational interview is founded on the work of Latham et al. [1] and Latham [2], where the objective was to explore behavioural intentions in the workplace by asking a job applicant to indicate what he/she would do in dealing with potential work situations posed by an interviewer. Furthermore, *"The situational interview is based on the premise that a person's expressed behavioural intentions are related to subsequent behaviour. Thus, in the situational interview applicants are asked to describe how they think they would respond in certain job-related situations"* [3].

The implicit hypothesis of this approach is that the underlying construct being measured is behavioural intentions. That is, the assumption that applicants cannot determine the response the interviewer desires; therefore they are in effect forced to state their true intentions. Whether people give 'false' ideas of how they would tackle proposed tasks is thought to be reduced through the 'stress' of a live interview and the need to attend to the questions at hand with more limited mental capacity. There is insufficient capacity, it is argued, to permit the 'off the cuff' fabrication of 'correct' answers [4].

In this research, situational interviewing was applied in order to develop an understanding of the motivations and barriers for behavioural change in areas specific to PRECIOUS (diet, physical activity, sleep and stress), as well the tools that interviewees believed would assist them in achieving these changes. Interviewees were presented with the premise that there were no obstacles (technological, monetary or otherwise) to the accessibility of these tools and asked to discuss how the tools they described would help them to achieve their behavioural change goals. The objective of this research was to gain an understanding of the true requirements of potential users within a system such as PRECIOUS and to apply these findings to initial system development tasks.

Convenience sampling was used to select participants; therefore this study was not designed to be representative in terms of sample or data generated. Rather, the aim of this qualitative research was to gather input from a sub-set of potential PRECIOUS end users and generate the initial list of user requirements and usage scenarios. Throughout system development and testing, a range of potential end users will be consulted, as well as other important stakeholders, for example service and technology providers, researchers and health professionals.



## 2.2. Recruitment

A total of 36 men and women, aged 18-64 years, were recruited from various European countries to take part in situational interviews. Participants were assigned to one of four separate interview scenarios on diet, physical activity, sleep or stress, to include a total of nine participants per area of interest. The four sets of interview questions can be found in **Annex I-IV**.

### 2.2.1. Recruitment criteria

In order to achieve useful and detailed responses in these situational interviews, it was important to select participants who were open to the concept of behavioural change in one of the selected interview areas (diet, physical activity, sleep or stress) and who were familiar with the use of technology. Therefore, the following recruitment criteria were applied:

- Male or female
- Aged 18-64 years
- Familiar and comfortable with the use of mobile and computer technology
  - Own at least one device with internet connectivity e.g. smart phone, tablet, laptop, desktop, games console
  - Directly access the internet  $\geq 4$  times per week (out of work)
- Have considered/are considering/are currently making, changes to one of the following:
  - Diet, physical activity, sleep or stress
- Would consider/would definitely use, a computer tool or app to help improve things like diet, physical activity, sleep or stress

Based on these criteria a recruitment questionnaire (**Annex V**) was designed and sent by email to potential participants. Participants were selected by Campden BRI and EuroFIR AISBL according to the recruitment criteria and a sample quota (table 1).

**Table 1: Quota for age and gender across the four areas of interest**

<b>Diet</b>	<b>Physical Activity</b>	<b>Sleep</b>	<b>Stress</b>
3 female 46-55yrs	3 male 18-25yrs	3 female 26-35yrs	3 male 36-45yrs
3 male 26-35yrs	3 male 56-60yrs	3 female 61-64yrs	3 female 18-25yrs
3 male 61-64yrs	3 female 36-45yrs	3 male 46-55yrs	3 female 56-60yrs

A sample quota was applied to ensure a spread of ages and genders across the 4 areas of interest; however, a convenience sampling approach was used to select participants within this quota. Therefore, it was not the intention of this study to be representative in terms of sample or data generated. It was also accepted that the quota may need to be adjusted if it became apparent that a specific age or gender favoured one of the areas more than another.

Campden BRI recruited a UK sample (12 participants) from a food research institute. The interviewees were selected from across the institute, including those working in the area of food science and technology, as well as supportive functions, such as marketing, administration and accounting. EuroFIR AISBL recruited a Finnish sample (12 participants) from a health-oriented research institute. Usually, the interviewees had an academic background in the areas of health, nutrition or technical sciences. EuroFIR AISBL also

recruited a European-wide sample (12 participants) through their existing client mailing list. The sample comprised participants from a variety of different sectors (NGOs, public institutions, research centres, universities, SMEs, individuals, students etc).

It is noted that this sample is weighted towards individuals working in health-related organisations and, typically, with further education qualifications. Therefore, it will be important to gather future feedback from a wider population of potential end users, in addition to other stakeholders. It is the intention that this study, and the resulting list of user requirements and usage scenarios, should be considered as a starting point for system development.

### 2.3. Screening methodology

The recruitment questionnaire was sent to 2,436 potential participants, and 437 completed responses were received.

On completion of the recruitment questionnaire, respondents were automatically excluded if selecting the following options:

- *'Aged 16-17 yrs'* in response to 'Please select your age'
- *'I do not use any of these'* in response to the question 'At home which type(s) of technology do you own and use?'
- *'1-3 times a week, Less than once a week and Do not have access or use the internet'* in response to the question 'Outside work, how often would you say that you connect/use the internet?'
- *'This is NOT something I would be interested in or use'* in response to the question 'If there was a computer tool or app to help you to improve things like your diet, stress levels, sleep patterns and/or your physical activity how likely would you be to use this application?'

At this stage those who responded 'YES' to the question 'Do you limit your intake of any food products or beverages due to health issues, medical conditions or formal diet program?' were retained. The selection of these respondents was considered if no other eligible respondents in a particular quota category responded 'NO' to this question.

Responses were then analysed by quota category e.g. 'Physical activity, male, 18-25 yrs', 'Physical activity, male, 56-60 yrs' etc. Therefore, responses were filtered in the following order:

- Gender
- Age bracket
- Response to question(s) on the relevant area of interest
  - Those respondents who answered that they were 'actively trying to change' or 'would like to change' the relevant area of interest were retained. Respondents who answered that they would like to 'maintain' the relevant area of interest were retained if no other suitable participants were available.
  - In relation to physical activity, respondents were further screened on the question 'How often are you doing some form of physical activity?' Those who responded *'5-7 times a week'* were excluded as their motivation to carry out

physical activity was already considered to be very high, and these individuals are not the main target for PRECIOUS.

Tables 2-4 indicate the number of remaining participants, by organisation and location, following application of these criteria.

**Table 2: Number of eligible respondents in each of the four areas of interest: Campden BRI**

Diet	Physical Activity	Sleep	Stress
15 (4) female 46-55yrs	4 (2) male 18-25yrs	5 (1) female 26-35yrs	6 (1) male 36-45yrs
2 (0) male 26-35yrs	4 (1) male 56-60yrs	1 (1) female 61-64yrs	9 (3) female 18-25yrs
2 (0) male 61-64yrs	15 (5) female 36-45yrs	6 (3) male 46-55yrs	5 (0) female 56-60yrs

() indicates the number of respondents who selected 'YES' in response to the question 'Do you limit your intake of any food products or beverages due to health issues, medical conditions or formal diet program?'. These respondents were exited from the study if enough respondents answering 'NO' remained.

**Table 3: Number of eligible respondents in each of the four areas of interest: EuroFIR AISBL (Finland)**

Diet	Physical Activity	Sleep	Stress
1 (0) female 46-55yrs	0 (0) male 18-25yrs	1 (0) female 26-35yrs	1 (0) male 36-45yrs
1 (0) male 26-35yrs	1 (0) male 56-60yrs	1 (0) female 61-64yrs	1 (0) female 18-25yrs
0 (0) male 61-64yrs	1 (0) female 36-45yrs	1 (0) male 46-55yrs	1 (0) female 56-60yrs

() indicates the number of respondents who selected 'YES' in response to the question 'Do you limit your intake of any food products or beverages due to health issues, medical conditions or formal diet program?'. These respondents were exited from the study if enough respondents answering 'NO' remained.

It was not possible to apply the quota criteria for 'Diet – male 61-64yrs' or 'Physical Activity – male 18-25yrs' due to a lack of participants fulfilling these criteria. Replacements were made as follows: 'Diet – female 36-45yrs' and 'Physical Activity – female 26-35yrs'.

For 'Diet – male 26-35yrs' and 'Diet – female 36-45yrs' respondents indicated that they were trying to 'maintain' their current eating habits.

**Table 4: Number of eligible respondents in each of the four areas of interest: EuroFIR AISBL (European-wide)**

Diet	Physical Activity	Sleep	Stress
9 (6) female 46-55yrs	1 (1) male 18-25yrs	0 (0) female 26-35yrs	6 (3) male 36-45yrs
5 (2) male 26-35yrs	6 (3) male 56-60yrs	1 (1) female 61-64yrs	1 (1) female 18-25yrs
0 (0) male 61-64yrs	9 (6) female 36-45yrs	6 (4) male 46-55yrs	2 (2) female 56-60yrs

() indicates the number of respondents who selected 'YES' in response to the question 'Do you limit your intake of any food products or beverages due to health issues, medical conditions or formal diet

program?'. These respondents were exited from the study if enough respondents answering 'NO' remained.

It was not possible to apply the quota criteria for 'Diet – male 61-64yrs' or 'Sleep – female 26-35yrs' due to a lack of participants fulfilling these criteria. Replacements were made as follows: 'Diet – male 36-45yrs' and 'Sleep – female 46-55yrs'.

#### 2.4. Interview procedure and ethical issues

In designing the study protocol and carrying out recruitment and interviews Campden BRI and EuroFIR AISBL followed the Market Research Society (MRS) Guidelines, which include guidelines for carrying out Qualitative Research [5].

Campden BRI and EuroFIR AISBL carried out interviews in a face-to-face setting in the UK and Finland respectively. Additionally, EuroFIR AISBL carried out interviews by telephone (in order to reach their membership base across Europe).

Data collected during recruitment, interview audio recordings and interview transcripts, were anonymised (records could not be traced back to individual participants). Data were stored in secure files/folders, to which only researchers working on PRECIOUS had access. All interview transcripts were sent to Campden BRI for coding and analysis.

Prior to beginning the interview, the interviewer explained the general purpose of the interview and it was explained to the participant that they had the right to end the discussion at any time. Verbal consent was obtained from each participant to record the interview for transcription at a later date. Written consent (**Annex VI: face-to-face interviews** and **Annex VII: telephone interviews**) was also obtained from all participants taking part in the study.

Due to the participation of employees and members of the organisations undertaking the interviews, it was explained to employees that the study was not related to work and that responses would have no bearing on their employment, and to members that their involvement/withdrawal would not result in penalty or loss of benefits to which they might otherwise be entitled.

#### 2.5. Analysis methodology

An inductive approach to data analysis and interpretation has been used, and as such six categories have emerged within each of the four areas of interest (sleep, stress, physical activity and diet). These overarching categories are applicable to all four areas of interest and are further grouped into two themes for the discussion:

##### **Current behaviour**

1. Current levels of behaviour
2. Reasons for wanting to change behaviour
3. Challenges and/or barriers to behavioural change

##### **Design and purpose of the technology**

4. Functions of the technology to change current behaviour
5. Physical design of the technology to change behaviour

## 6. When and/or where the technology would be used

These categories provide structure to the data, within which, core (consistently elicited from the majority of interviewees) and fragmented (raised by only one or two individuals) cognitions have been identified.

For the purpose of presenting and discussing the findings from the data analysis, each of the four areas will be presented individually. The key categories will be used as subheadings to structure the discussion of the core and fragmented cognitions elicited from the interviews. Direct quotes from the transcripts will be used to support discussion.

The findings for each of the four areas of interest have been generated from interviews conducted in Finland (FIN) and the UK. Interview data from the European-wide subjects lacked sufficient detail for analysis, perhaps due to language barriers (all interviews were conducted in English, which was not the native language for most participants) and interviews being conducted by telephone (perhaps more difficult to elicit detailed responses); therefore these data were excluded. In total, 24 interviews were analysed across the four areas of interest.

### 2.6. Results

#### 2.6.1. Physical activity

##### 2.6.1.1. Current behaviour

The interviewees participated in a range of physical activities, such as, gardening, dancing, swimming and walking, with the majority visiting the gym at their local leisure or sports centre at least once a month.

Overall all interviewees stated that they would like to increase their level of physical activity. The main reasons driving this change in behaviour was a need to become fitter and healthier. Associated with the need to become fitter was the need to lose weight and feel more positive towards their body image and shape. This was particularly emphasised by a young, UK male interviewee.

*“... To feel a bit happier with my body. ...just less fat. You know, to be able to look at yourself and think that’s not the first thing I notice”. UK*

The Finnish interviewees also identified that an increase in fitness and participation in more physical activity was a good way of releasing feelings of stress.

*“Everybody could be somewhat fitter. I could lose some kilograms but that is not the main thing. Usually I have done something every day but now the level is below that. I would like to be back at my usual level, back to being fitter. It is good against stress and of course for my health. I am not getting younger, you know.” FIN*

For the UK interviewees inertia and a lack of motivation to exercise was perceived as the main barrier to change. The reasons for this lack of motivation were often perceived as being related to their personal circumstances and/or personality. Although it was evident from the transcripts that all UK interviewees shared feelings of physical and emotional tiredness after work and this strongly contributed to their lack of motivation. In contrast, the Finnish interviewees identified a lack of time as the main barrier to increasing their levels of physical

activity. A couple of interviewees also recognised that family commitments were prioritised above their personal needs, which included participation in exercise.

*“It’s not time as in I haven’t got the time to do it, it’s the motivation to do it. And I think the weather when it’s brighter; sunnier encourages me to be more motivated to do it than thinking oh that doesn’t look great so I won’t bother. So, I know I have the time, I know I like to, my friends get up and go early on the weekend. And now because I work full time, I don’t want to get up and do it early I’d rather do it later in the day, but then I’m really tired, drained from a day at work”. UK*

### **2.6.1.2. Design and purpose of the technology**

There was a lot of consensus regarding the functions of the technology and the type of output required in order to assist these individuals change their behaviour. The ‘core’ areas regarding the functional design of the technology which all interviewees agreed on were:

- Personal performance data
- Personal targets/goals for exercise
- Cumulative information collection over period of time
- System for measuring and monitoring progress

In order to improve the structure and content of their exercise routine, these interviewees wanted the technology to provide them with specific goals based on an assessment of their current fitness level and types of exercise they currently undertook. However, as one interviewee pointed out, the technology needs to be ‘cheat proof’ and to have artificial intelligence in order to create a personalised programme, set accurate goals, and be able to monitor and measure performance against them. The interviewees described this technology as providing a personal training programme that they could follow and be assessed against in terms of frequency and type of exercise, achievement of goals whether that is an amount of energy or calories burned, heart rate and/or quantity of exercises achieved e.g. 50 sit ups in 3 minutes. Some interviewees suggested an electronic personal trainer to accompany the personal training plan, to assist with motivation and coaching through their programme.

*“Well, it could have videos or pictures. Hints of new exercises would be nice. It is like that the device would have a tailor-made exercise program for me”. FIN*

*“Because the thing is, you can set targets that are real or too low, so it’s got to be a realistic target. There has to be three components, one the overseer, second you actually have to have the participant, and third are you got to have some means of measuring. So if you had a virtual system it, it has to be cheat proof, so if you said, I did four sessions at the gym this week, you can lie, but the technology has a motion sensor of some kind and it can be plugged into the computer, download it on to the internet, up through to the coordinator when your logged on, then ‘Nope you haven’t met your target’ ‘your credit card has been deducted some credit”. UK*

As part of this customised training programme, interviewees wanted the technology to record their performance and compare actual performance against personal targets over time. The ability to monitor performance over time was very important to the interviewees because it would demonstrate their progression from the start of the programme to various time-points in the future e.g. after 1 week, a fortnight, 1 month, 3 months and 6 months etc. The initial



short time-points were considered essential for sustaining the required self-motivation and self-confidence to continue with the training programme.

*“... which could then track the progress and, seeing as you would log into a personal account for instance and during a session it would track your progress and say, this is what you’ve done this time. But then could give you visual data about how things have improved. So you can see a heart rate monitor on there so you could see how well your heart rate is doing compared to when you started and how your running compared to when you started. Having sense of how you’re running, you know what weights you’re lifting now. Things like that to give you a visual feed back over time. Whereas now that is something you would have to chart yourself really, think that would probably help a lot for me. .... I think having something like that would help to be honest because it gives you that motivation to go and see how you’re doing over time. So that would keep the motivation”. UK*

*“I would like to record anything and then see a summary, like a graph. I would like to compare with my previous tracking period. Like some six months earlier or something”. FIN*

*“You should be able to download the information, you wouldn’t be able to edit it, and you could download a read only file so that you see what your performance is. Because you want to be in the position that you can monitor yourself how you’re progressing, through any given period. So if its, expecting you to do so much per week, so much per fortnight, so much per month. You need to have some insight, because the biggest problem is or one of the challenges would be, is that when it comes to you, your convinced that you did well, and that, can be set off target”. UK*

Aligned with the need for cumulative data collection is the need for regular personalised feedback. Various forms of feedback were suggested, such as, visual charts of performance, text messages with one line saying ‘congratulations you’ve reached your target for this week’, setting of new targets on achievement of previous one, voice message of congratulations or chastising if not achieved target and/or rewards for achievement, e.g. points in a loyalty scheme. Personalised feedback on a regular basis, that was ‘top line’ in terms of quantity and depth, was regarded as crucial for continued motivation to increase and change their current exercise levels.

*“Well I suppose it will just have to be set out in such a way that you wouldn’t have to in put too much data. And actually get some sort of overview at the end of it. And I think it would probably have to use a bit of humour to encourage you know, “you’re a slacker this week”. You know I think something like that for me would have to be the minimum amount of data rather than having it too much of a narrative”. UK*

*“Well. I could get a better estimate how I am doing, and maybe doing some different kind of exercise based on the results. ... It would know my personal goals and my training program, a training program just for me and then it would track me guide me to follow the training program. Electronic personal trainer would be nice. ... Well. It would be nice to have a summary. Like if you have followed all the instructions, you could see what you did during the week and how useful that was”. FIN*

*“To be able to look at the overall picture, perhaps on a weekly basis. ...I think it would just give you a bigger overall picture one that you could look back perhaps in 6 months 12 months which you can’t do with a pedometer”. UK*

In addition to these shared functional design requirements, there appeared to be some country specific ones:

- Digital, visual output which can be downloaded (UK)

For the UK interviewees it was important that the feedback was presented in a digital format, preferably visually using simple charts that could be easily understood at a glance or a short sentence with minimal text. The UK interviewees identified that the data needed to be in a 'read only' format, so that they could not alter the performance data and give a false reading for themselves. There was also a general expectation that this technology would integrate with other forms of technology they currently use such as a Smart phone and Ipad, so they could view the visual output conveniently and easily.

*"Well I think it should be like a digital output, should be able to break it down, it would be things like number of calories burned since the last time you logged in, number of calories or percent of target met, this sort of information, preferably in large font. ... You should be able to download the information, in a read only file so you can't edit it, so you see what your performance is". UK*

*"Visual feedback, you know graphs and things that everybody could understand. But that I expect would be when it's linked up to a computer or something then you could see it". UK.*

- Integrated with other technology (UK)

The UK interviewees expected the technology to easily integrate with other technologies for two different purposes. Firstly, to integrate with Smart phones, Ipads and PCs in order to view the feedback easily, and secondly, to integrate with other technologies at the gym, e.g. the running or rowing machines. Interviewees perceived this as being beneficial because it would give a more accurate measurement, providing in-depth information relative to that specific exercise and/or target. These interviewees appeared to segregate their physical activity into 'formalised' sessions at the gym or specific sports training, and 'informal' exercise such as, other forms of exercise that they might naturally do as part of their daily routine, for example, going for a walk at lunchtime or walking into town. As such, these interviewees wanted the technology to record both the 'formal' and 'informal' but wanted the targets and feedback to be focused on the 'formal' exercise sessions.

*"Yeah, so that it would track everything that you do. So you know, you could use it at the gym and link it into the machine for instance, pick-up the data from those machines for when you're doing your 'x' per session. But then it would track how active you are the rest of the time as well. And then potentially provide feedback on that as well". UK*

*"That sort of combined everything as it were into one centralised core. So you know you'd have your treadmill on there, you'd have another configuration that would be your rowing machine, cycling machine. You know you'd have weights on there. But it would all input the data it already uses into a central computer". UK*



- Rewards and/or penalties linked to personal exercise targets (UK)

The UK interviewees suggested that they would be more motivated by the use of personal goals, with rewards for achievement or penalties for not achieving their targets. It was proposed that the penalties should be financially based but the rewards should be experience based, where individuals can either claim their reward instantly or collect 'points over time' for the reward at a time in the future. The idea of cumulatively collecting points would assist in the maintaining their motivation, and the idea that a large number of points could be traded for a significant reward at a later date appealed.

*"No, I think there has to be some other kind of material incentive,. And it could be, again, like in comparison with a group, well XXX was our top performer this week/year, he exceeded".*  
UK

*"I think probably the stick (laughter). I think if, I say if I was in a relationship means that would act like carrot to me. If I had the police application going through I think that would be a combination of a stick ad a carrot I think. You know it would give me that motivation to get out and do it. It would also give me a target to reach. And I would have to be successful, once I'd got past the other steps. I think something personalised probably to the person involved would help".* UK

*"I think if you have some sort of score card as a driver. It's got to be ease of use. I'm traditionally lazy in that way, lazy with technology. So it's got to be simple".* UK

- Virtual support group (UK)

Interviewees expressed that being able to share their information and experiences with people they choose to, would help with their motivation, especially when it became physically and/or mentally challenging. They envisaged using Facebook or some other form of social media to contact people and share their experiences.

*"... almost look at a support group. So weight watchers, and the idea to go again, and drop down a pound this week, congratulations. ... If you had a support group, that said,' yeah, great, but you've 700-100 calories this week than last week or maintained it', that's fine, and then 'you haven't done it', so you would have to pay your penalty fine".* UK

*"The virtual support group would be able to give encouragement. ... that could be done, through some sort of computer discussion group, like a blog or something like that. ... I think if it had a humorous approach which you could then compare with other people so I came out as 'X' this week what were you? You know it becomes more of a competitive in that sense. So I think it would be quite a good thing like that".* UK

*"Sure. That would definitely be better for me I think. You know rather than reading something. A support group might work that sort of thing. You know. ...Probably through social media, so something like Facebook which I already use. Makes it easy to you know, contact people you can do it anonymously through that or you can do it with your data. I think that would be the simplest way of accessing something like that if it was around then".*  
UK

- An alert or message system to increase individual's awareness of the need or time to exercise (FIN)

The Finnish interviewees suggested the use of an alert or message system to signal that it was time to do some exercise. This seemed particularly important when work or home life was particularly busy and finding the time and/or prioritising exercise was not essential. It is at these moments like his that a messaging system could increase awareness as well as provides the initial 'push' to go and do so exercise.

*"It could like give wake me up. Like that now it is so and so much time since you had physical activity. Like that now you have been sitting so and so many hours. Like it is time to stand up ... and then it could show you that it is really so long time since your last physical activity session. And you are like sitting only. So now is the time to react. Something like 15 minutes or one hour. When I am not busy I can take care of my physical activity, but when I am busy, it is quite easy to skip everything, and then I really need the coaching".* FIN

- Recommendations on how to do different exercises or how to change/progress on exercise (FIN)

For the Finnish interviewees the thought of going to the gym was quite boring, many preferred to do exercise outdoors. If this device could demonstrate different forms of exercise in visual and/or written formats, then this may encourage them to increase the amount of activity they are currently doing in and out of the home. The Finnish interviewees often referred to this technology being able to recommend specific exercises to achieve their goals, acting as a coaching tool, especially when combined with the measurement and monitoring of activity over time and achievement of personal performance goals.

*"Well I could get a better estimate of how I am doing, and maybe doing some different kind of exercise based on the results. Perhaps it could give me new ideas to change my exercise and if the device could detect that I am doing something wrong when training, suggest different or better ways of training".* FIN

*"Perhaps it could give me new ideas to change my exercise if the device could detect that I am doing something wrong when training".* FIN

*"Well, it could have videos or pictures. Hints of new exercises would be nice".* FIN

With regard to the physical design of the technology, all interviewees agreed on the need for the technology to be:

- Portable
- Small in size and discrete
- Something that could be worn
- Type of technology – App etc.

Essentially this piece of technology needs to be small in size and portable so that it can be discretely worn within a gym environment or as a fashionable accessory. These interviewees wanted the device to be comfortable and lightweight so that it could be worn during exercise and/or during the whole day, so that all activities e.g. walking around the shops or at lunch

time could contribute to their daily routine and thereby contribute to any daily targets associated with increasing their amount of physical exercise.

*“Oh its’ got to be discreet, something like a pedometer, its’ almost like a pager device, the size of a pager, its’ not embarrassing, its’ not intrusive or anything like that”.* UK

*“Something that I could wear would be more beneficial, and then linked into machines. It would have to be something fairly discreet, so yeah you didn’t necessarily know or notice it was there. ... a watch type wrist band or something. Something that you could wear comfortably and continuously, if needed during the night as well. It would have to look.... not functional but something that you could wear out, you know when you’re going out to a pub or something with friends and not have people say ‘oh what’s that?’”.* UK

*“It would have to be very small and light weight for me to do it. Easily attachable as well. It would have to be some sort of wrist thing I suppose. Probably the easiest way of doing it”.* UK

Overall interviewees suggested that they would like to be able to wear this technology, being able to use it during the day and evening, when either at home, at work, travelling abroad, in the gym or outdoors exercising.

## 2.6.2. Diet

### 2.6.2.1. Current behaviour

Overall the majority of interviewees felt that they held a reasonably balanced diet but they all agreed that it could be improved and that they want to change their current eating behaviour. For the UK interviewees snacking between meals or in the evening was the main habit that negatively impacted on their diet.

*“I’m standing there and I take it because you think ‘oh I fancy that’ and the minute you’ve eaten it you think oh well actually I didn’t really need it I’m going home to have my tea”.* UK

*“So for example last night I bought these little snack things that are not very fattening but are like crisps and because they’re there I say ‘I’ll have that.”* UK

The main reasons for improving and/or changing their eating habits were to lose weight and consequently be healthier. In addition, one of the Finnish interviewees wanted to lose weight in order to improve their physical performance when training and playing sport.

*“Well I’m concerned about my weight”.* UK

*“Manage my weight”* and *“Well, it would be losing weight and health”.* FIN

The interviewees identified that the main barriers or challenges to changing their diet were focused on a lack of self confidence and motivation to be able to change, coupled with the perception that they would not be able to eat the foods that they enjoy. The other barrier to change was living with a partner who was not on a diet and therefore the strength of conviction to change their own eating patterns was so much harder.

*“Well the only thing is now I live with my girl friend, she doesn’t follow the plan and, when she cooks she cooks food that she’s wants, then that’s difficult to follow my plan. For ease, I live in a relationship it’s easier to cook one meal”.* UK

*“I do not see any barriers only my own motivation to do that. With one word you could describe it as laziness”.* FIN

### 2.6.2.2. **Design and purpose of the technology**

There was a lot of agreement amongst the interviewees with regard to the main functions of the technology. The 'core' areas regarding the functional design of the technology were as follows:

- Customised programme with personal goals for weight loss
- Produce nutritional information regarding intake of key nutrients
- To control calorie intake and portion size
- Scan information from product label
- Integrated with other technology and multi-functional

To assist with behavioural change the technology needs to provide the interviewees with a customised programme that enables them to set personal goals based on a reduction of calorie intake, monitor their energy intake on a daily basis and over time, advise on food choice and portion size to achieve calorie target and provide feedback in terms of text or visual outputs and possibly verbal feedback. It is important that the programme is tailor-made to their personal circumstances and therefore includes exercise routines, as well as, current body shape and weight.

*“Something that can advise you to change your habits, for example your goal is to reach two thousand calories per day, you weight eighty kilos and your goal is to decrease to seventy five. You give previously your body measures to the app and then it could advise you how to lower your intake only with the consumption of these two thousand calories per day. For example, can tell you that red meat is worse than white meat or fish and could help you to lower your calories per day or tell you how much of that you can eat”. FIN*

*“First you punch in personal goals and of course if you could combine it with my personal schedule. It would take into account what is in my physical training program and calculate ahead. And tune my eating according to that”. FIN*

To assist with the collection of data about what an individual has selected to eat at home or in a restaurant, or to purchase in supermarket, the technology needs to be able to scan information from menus, product labels and pictures of foods/drinks.

*“Well I'm not so adverse to putting information in to things you know so, that would be ok, if you had to enter in some information, or better still, if it could scan something in. Yes. If the menu options would have bar codes, it would be pretty easy for me to compare the options”. UK*

*“Well, the most important is that if I try to manage my weight, is the calories. I would select pictures that this is my intention to eat and the device would give me calories”. FIN*

Interviewees want the technology to calculate the number of calories in a particular item of food, drink or meal, as well as identify the nutritional content e.g. fat, sugar, salt and protein content. This will enable them to make more informed food choices and control their calorie intake. Part of the feedback mechanism to the individual would be to advise that they are eating too much sugar or too much salt in a day or for a particular meal and also to indicate whether the meal, food or drink item is of an appropriate size/quantity for losing and /or maintaining their desired weight.

*“It could give me the tips, especially when I’m not sure of something. I could take a photo and then it could tell me how many calories, or fat content or if this is now an optimal portion for me”. FIN*

*“The amount of calories or fat or sugar and their amount perhaps, and then the device would, to say that now there is too much sugar, preferably before I have paid it. ... it could also give me some reference values. Like my daily need”. FIN*

*“It’s different when you’re at home, so I tend to have the more exotic foods if you know what I mean, the types of food that might be loaded with calories. So it would be interesting to know how loaded up they really are. Because you tend to think oh I don’t care. Well actually you might care, if you realised you were eating like 10,000 calories in one sitting, and most of it is fat or sugar. So that would be helpful. It’s like fruit juice; you think that is healthy until you see the sugar content of it”. UK*

As an integral part of the personalised data collection, interviewees would like the scanned information to form a food diary, so that over the course of a day, a week or a month, they can easily see what they have eaten, the total calorie intake and where in future they may be able to make changes. The technology could utilise this information to offer recommendations about the type of changes that could be made to their diet and food choice. Several of the interviewees also wanted this information to be related to exercise, in terms of how much exercise would need to be done to burn off 500 calories.

*“If you could scan something and it like recorded a diary of your day. So rather than having to write down what you eat you ate during that day, if you could scan like a packet barcode and it could record information in a diary. So you can look back on the whole day. It could record all of your information and, what, all the information for that day or this product. It would take you an hour on the treadmill or swimming to burn off. You’ve had 15% of your salt intake and all those sorts of calculations for you. ... That would be great, if you could just sort of zap that packaging. So where that nutritional information for that QR code, you could just scan that and all the information just uploaded to your phone. And just do the calculations automatically for you that would be great”. UK*

*“You know what would be great would be a bar code machine you know you go round and you use those. I use that sort of technology that’s a simple swipe. ... That would be good if it popped up and told you”. UK*

*“Something that can work with snack foods that you always have with you, something maybe like an app that you can list what you eat every day, for example today at 10 o’clock I have eaten some chocolate...something that you can tick or add. Where you could tick the different range of food and have quickly access to the kind of food you have eaten, then maybe the quantity and at the end of the day can tells you the calories or if you are achieving your goals or if you are far from your goals or something like that”. FIN*

The other important function of this technology is that it is multi-functional and compatible with other forms of technology such as exercise Apps on Smart phones or Sports Trackers. The emphasis here is on losing weight through a combined effort to reduce calorie intake and increase exercise levels. Therefore the technology needs to combine these two functional components to provide individuals with a holistic approach for capturing information about their diet and exercise. Ideally, interviewees want a single piece of technology to perform these different functions, but if this was not possible, the technology



needs to be compatible with other technologies to enable to transfer and visualisation of information about their achievements.

*“Well, if I think those apps I have in my Smartphone. If you have been running, the device will visualize your running route and count, you know, like how many calories were used, as well as the profile of the run, if there were hills of something like that. This device could link my food and calorie intake with that information”. FIN*

*“Well at the moment there are quite a lot of apps that do each single component of that. But there’s not one app that does all of it in one. So the technology is there, could there, doing another app singular type of app. So you can put in an app to find out each type of food you eat and how long it takes to burn. An app where you can create an online diary, so you can tackle a picture of the barcode and it will record all kinds of information. There are apps; you know that will give you fitness and visualisation. It’s all there but its not in one easy to use app”. UK*

In addition to these shared functional design requirements, there appeared to be some country specific ones which in this instance relate only to Finland.

- Needs to alert me and increase awareness

These particular interviewees would find it beneficial to have a message system built into the technology that alerts them to when they need to eat (particularly if work schedule is very busy and their blood sugar levels are low) and provide them with guidance on what they could eat as a suitable snack or meal. The alert/message system would also be linked to their exercise programme and provide them with prompts about taking exercise in order to maintain weight loss and training programme.

*“There would be instructions for me and reminders. Like now it is time to eat something. And, you know, what that something would be. There could be some options. Like take now a handful of nuts. ... or a graph visualizing that now here is your blood sugar. And if you do not eat soon, what would the prognosis be”. FIN*

*“... and the device would then help you to eat more regularly, and not only when somebody at work reminds you about the lunch hour. You could get like a calendar type reminder. Bimbom, and then the device would give you some healthy options”. FIN*

*“...at least alert me to how much I buy something I shouldn’t, I think, if I was aware of how many time I buy it and how many calories in it, you know jog my memory, maybe t might help me control, you know”. FIN*

- Suggest healthier alternatives

As part of the feedback and advice, Finnish interviewees wanted the technology to recommend healthier alternatives to those currently being considered for purchase and/or consumption. The ideas were largely based on photographs being uploaded and/or for information to be scanned and the technology to suggest alternatives of lower calorie content. Linked to this were cooking suggestions and recipes for using healthier ingredients.

*“Advice you that today you have eaten one hundred grams of red meat and if you want to exchange that with white meat or fish... could be helpful like that...something that monitors and give advice”. FIN*

*“Well, I do not know if it can detect when I am eating. But like when I was taking the photo, it could then ask why did you take that bread. Then I could easily skip eating that. But it could be just general, I could show it photos of food and it give general tips or recommends what else I could eat”. FIN*

*“... so you can put loads more healthy stuff in and you will something like pasta or rice or whatever you want to use as your sort of base or something that goes with it. But knowing how to make the meal or tasty you know without the ingredient you like. It's like mashed potatoes, why don't you use mashed swede instead”. FIN*

With regard to the physical design of the technology, all interviewees agreed on the need for the technology to be:

- Small in size and discrete
- Something you wear
- App on a mobile phone

There was a consensus that people don't want to carry around additional gadgets, this technology has to be compatible with current mobile devices, mainly on a Smartphone. The main suggestion was some form of App on a Smartphone, alternatively something that was small, lightweight, that could be worn.

*“Well, my first idea is that it should be as small as possible or some app loaded into my Smartphone. That would be with me anyway”. FIN*

*“Well, you know, my mobile is always with me. That is why I would not like to have something extra. I hate separate devices. And that is why I would not like to have another gadget”. FIN*

*“So it would have to be something that is, maybe attached to you, you know, I could get that when you had that pedometer challenge you know, you had to be wearing it the whole time or otherwise it's pointless. It has to be small and easy to wear, perhaps it give you an electric shock, a pulse system, because you're eating too much, yeah”. UK*

This technology would be used throughout the day, especially when out shopping, selecting what to eat at meal times either preparing food at home or buying from a canteen at work or out in a restaurant. The device would also be used when shopping for groceries and during the day if buying snacks in between meals. Many of the interviewees would want to combine the use of this technology with exercise and so it would have to be suitably designed to wear for different exercise and sporting activities. There was a consensus that for this technology to be beneficial it had to be easily accessible, possibly worn on their person or at least carried by them e.g. mobile phone, throughout the day.

### 2.6.3. Sleep

#### 2.6.3.1. Current behaviour

For all the interviewees the main problem with their sleep patterns was waking up in the middle of the night, typically between 3am and 4am in the morning and either not being able to return to sleep or having difficulty in returning to sleep.

*“I wake between 3 and 4 every night and I can’t get back to sleep. I’m then going back to sleep about 4ish at some point and my alarms going off at 6 am as it does on work days”.*  
UK

*“I wake up in the middle of the night and then I have difficulty in catching the sleep again”.*  
FIN

To help them return to sleep, these interviewees either listen to gentle music and/or the radio or read a book. These interviewees listen to music or read a book to help them relax and switch off mentally from what their minds are churning over. Quite often this activity will help as long as the music or book is not too stimulating. Although the causes for their disrupted sleep appears to be localised to that individual and often context driven, e.g. concern for family members and/or mental alertness often due to issues not resolved at work, the feelings and emotions experienced from prolonged lack or disrupted sleep are similar for all interviewees, such as, feelings of frustration, tiredness and less alert, not able to think quickly or clearly.

*“Now, I’m waking up and I’m tired, showering will do and everything but I’m not springing out of bed like I used to, which I don’t like. Because it’s just like a light sleep and wake up and you know now this horrible feeling, yeah, that impacting on my daily, definitely, daily life”.* UK

*“The next morning I’m tired, irritated and frustrated that it’s happened, all again. And I’ve still got to get through the day and everything so”.* UK

*“It affects my ability to concentrate, mostly that. On the other hand it makes me irritate easier”.* FIN

The main reasons for change are twofold, firstly to reduce these feelings of tiredness, frustration, inability to concentrate and become less irritable, and secondly, to be able to sleep through the night without waking up. In this instance interviewees could not identify any specific challenges or barriers to behavioural change, because they all wanted to improve their sleeping patterns. The challenges to behavioural change are more aligned to the causes of their disrupted sleep and therefore requiring more proactive action to prevent the broken sleep happening in the first place, rather than reacting to the broken sleep once it has happened.

### **2.6.3.2. Design and purpose of the technology**

There was not lot of agreement amongst all the interviewees (from both UK and FIN) with regard to the main functions of the technology and how this technological device could assist them with changing their behaviour. This appears to be mainly due to the personal, idiosyncratic nature of the problem and how each individual responds to their situation. However, there did appear to be some consistent themes about how the technology could promote sleep or provide data on why they may be waking up in the middle of the night. These themes also tended to emerge from interviewees within the same country rather than being shared across all interviewees from both countries.

The Finnish interviewees’ responses focused on methodological type issues concerned with preparing themselves for sleep and understanding more about how they sleep, in particular the amount of movement during their sleep. The two main areas that emerged were:

- Advice on bedtime routine and the time to go to bed
- Monitor the type and length of sleep, as well as the amount of movement in sleep

The Finnish interviewees wanted this technology to be able to advise them on an appropriate time to go to bed and what an ideal bedtime routine should be. Almost like a



bedtime routine you would create for a child but transferred to an adult. It was suggested that in order to recommend the most appropriate time to go to bed and start the bedtime routine, the technology needed to be able to measure and monitor the psychological state of the individual several hours prior to the bedtime routine. This way, the technology may be able to alert and advise the individual on how to change their behaviour in the run up to the bedtime to facilitate a better night's sleep.

*"It could tell me what the right time to go to bed is; it could be based on my activity or my physiological state. ... Well, not too early or not too late. Like an alarm clock but also measuring your current physiological state, it may be also related with stress, but the optimal time fluctuates". FIN*

*"Like the opposite of the one which is designed to wake you up with a soft way with the light. I imagine that that is something round and it would help me get the sleep as part of a bedtime routine. ... It could somehow invite you to sleep. Like away from the TV. Well, it comes into my mind that the TV could show me some signal. Like the TV would suggest you to stop watching and go to bed. Like a blue moment in TV". FIN*

*"If I would be able to go earlier to bed, it could be something like an alarm clock. That would say: everybody to sleep now! ... More like giving a signal sound that guides everybody to sleep. ... Well, I could use long term monitoring information, if I had my wake up time as well. ... I could follow my sleeping patterns. I think that it could motivate me and the device would help me to have more regular sleep". FIN*

Following on from the technology being able to create a bedtime routine, these interviewees also wanted information on the quality of their sleep, which they perceived as the amount in terms of number of hours in light or deep sleep, as well as, the amount of movement in their sleep. These interviewees talked about sensors being embedded within mattresses or a mattress cover, which could monitor movement and depth of sleep. In order to learn more about their sleep patterns and quality of sleep, the device would need to monitor their sleep patterns over time so they could review this data and possibly link it with events at work or at home and/or stressful times which may have adversely effected their sleep.

*"It could somehow record my sleep and show me how long I slept. Then it should tell me something of my sleep quality. You know, like how deep sleep you have had. There are those different types of sleep and how much of each you had. So, that it would not only record when I go to sleep and when I raise up. But it would record what happens in the meantime. ... Like how much I turn around in bed and things like that. You get information about how much you are actually awake during your sleeping period". FIN*

*"You can get those mats and baby monitors that can sense the movement so maybe something along the lines of that? ... I suppose something that could go under a sheet so that it's not really effecting you but something that feels I suppose like a mattress protector that sort of thing because that doesn't alter anything in your actual bed because you don't want it to make it even worse." FIN*

*"I suppose monitor your sleep for a week or so, so that you can see and then I don't know an option of things to say, 'when you wake up in the night have you tried this?' and then try and do that. And then monitor that for a while and see if that helped and then introduce the next thing. So there's a few things have been suggested because you know you talk to other people and they say of well I find it helpful to do this and that. So you try it for a while but you*

*have no way of really monitoring it, monitoring how well I actually do sleep and how long I'm up unless I'm writing it down and then that's another thing that going to wake me up because I need to write it down when I got up. So I suppose something along that line to help me".*  
FIN

In contrast, the areas which the UK interviewees raised were largely concerned with how the bedroom environment could be changed to promote sleep. The three key issues concerning the sleep environment were:

- Aromas and colours in the environment to promote sleep
- Plays relaxing music or something soothing to listen to
- Provides fresh air or movement of air

Aromas and colours were the most emphasised aspects of the sleeping environment that these UK interviewees talked about. The use of calm, relaxing colours of light green and blues, and neutral colours that sooth the mind and body. These colours could be permanently present in the room i.e. painted walls, or projected into the environment when approaching bedtime to help prepare for sleep, however, once asleep the room needed to be dark. To accompany these peaceful colours was the use of fragrances to help individuals relax. The interviewees mentioned the use of aromatherapy as an integral to creating a conducive environment for sleep. Interviewees identified the following aromas as beneficial for helping them to relax and/or those which they find very pleasant and would like to have in this environment to promote sleep: rose, floral and fresh garden scents.

*"In my bubble/pod I think there would be a fragrance .... so some of the rose scents. They are very calming. So something like that. Yes, a garden, a garden type scent comes to mind".* UK

*"I think its kind of an aromatherapy principle of things that it can help you relax, sometimes I use a spray in the room but I can't for the life of me remember what it was in the spray. But yeah it is meant to help your body physically relax through the fragrance in the actual room".*  
UK

*"Yes colours, all sorts of light green/blues and I love blue, that's one of my favourite colours funnily enough. Blues, pale blues, that sort of soothing maybe almost. Neutral kind of colours, pale yeah like a natural kind of thing".* UK

*"... and then visually, I think it would be kind of calming, different types of colours, pale greens and neutral colours ... maybe something swirling with coloured lights, kind of dreamy ... it's just the sort of those light things that swirl around that have interchangeable colours, like what you have in a Childs room to keep them quiet".* UK

The UK interviewees also talked about the importance of music in the sleep environment to help them relax and distract their mind from other things, such as problems at work. The music tends to be playing in the bedroom or listened to via headphones whilst in bed. One of the interviewee's talks about the technology being voice operated and/or on a timer, so that once in bed and feeling relaxed they did not have to physically move to change the settings.

*"A room that's got some relaxing soft music or, I find music helps. I find if I put on very light opera, not heavy opera but, or something that's very soothing ... soothing, type of strings or violins ... sometimes, I'd pop on some Beethoven, I'm pretty sure I doze off in-between".* UK

*“So I would make it speak to you ... So once you close your eyes you haven’t actually got to see. It’s saying to you ‘I’m going to play XXXX’ or what ever it might be. I’m going to imagine that there is a scent in the air, its going to be ‘gardenias’, or you know or something like that. ... So you probably timed it for something or pressed something and it carried on doing its cycle of things and then, hmm, you drift away”.* UK

Instead of music, one of the interviewees suggested listening to a documentary or lecture where the tone and content of the presentation helps them to switch off from the day’s events and drift into sleep.

*“Well.... sort of talking about the documentary I do find that sometimes there’s something interesting which I think is interesting on Television and then I fall asleep half way through it. So that’s obviously a good way of putting me to sleep. So maybe somebody delivering a lecture about something which I would be interested and engaged in it but something I don’t actually care about so I don’t have to listen to right through. So you could listen to the same lecture the same night and hear something more interesting”.* UK

The other component of creating a conducive sleeping environment was the provision of fresh air or the movement of air. Interviewees talked about the need for fresh air to help regulate the temperature e.g. to provide a warm temperature, but also they liked the sensation of a breeze and the association of that providing fresh air in the room.

*“Warm, not too hot. But nice and warm and a bit of air around”.* UK

*“We have a fan going beside the bed so that sort of provides a bit of fresh air. Something that moves the air around and I like to have fresh air. I think you can get acclimatisers and things like that I’ve never actually tried any of that, but some days when it’s a bit stuffy I don’t sleep as well”.* UK

With regard to the physical design of the technology, the interviewees’ responses were very disparate and in context with their own circumstances and feelings towards their disrupted sleep patterns. The design features mentioned were:

- An eye mask that could be scrunched for packing, which was soft against the skin, with options for providing coloured lighting, music and pleasant aromas.
- A bubble or pod-like thing, with a controllable micro climate to include relaxing colours, music, temperature and fragrances. The environment needs to evoke feelings of comfort, safety and security.
- A wristwatch with an alarm clock and voice commands to advise on appropriate bedtimes and routines.
- A mat or quilted sheet that was fitted with sensors and covered the mattress to collect data on the type and length of sleep, as well as the amount of movement in sleep.

Overall the interviewees wanted the technology to be simple and easy to use, especially if they were going to use it in the middle of the night; they did not want the technology to make them alert or more wakeful.

*“Something very simple to use.... Something very simple, I do not like complicated devices, especially, when you try to sleep”.* FIN

*“Something that is user friendly and simple”.* UK

*“Something that would be portable and easy to use”.* UK

For the majority of the time, interviewees would use the technology at home but would also like to be able to take it away with them on holiday or when staying away from home with work.

#### 2.6.4. Stress

##### 2.6.4.1. Current behaviour

It has been very difficult to generate a comprehensive and coherent picture of individuals' experience of stress because the main causes and symptoms experienced vary from one person to the next, as well as level at which a person considers themselves as 'stressed' varies extremely. Therefore no 'core' themes have emerged across all the interviewees. There have been a few pockets of consistency between interviewees from the same country with regard to the main causes and symptoms of stress, current methods of managing stress, barriers to reducing stress levels and what could be changed to reduce their experience of stress. It is these areas that shall be reported upon.

The main causes of stress for interviewees within the UK were:

- The amount and type of work coupled with project deadlines that needed to be adhered to within the workplace
- Self imposed stress due to being conscientious
- Caring for a member of the family who has a long-term illness whilst also trying to perform at work (unique to one interviewee)

The quantity and type of work, project deadlines and being conscientious were defined as key contributors to individuals' stress levels.

*"Then there's work, and I like to do everything perfectly, that's my own self imposed stress, I like to achieve, and if I'm going to go and deliver a course, I like to get really good evaluations, I can't just go and do the course and come away satisfied that I've done it so it's self imposed as well. That's the baseline that's there all the time". UK*

*"I suppose having deadlines or when doing practical work. I come in very early and I have clients in as well. So it's more you want to make sure the work your doing, gets done and that everyone's kind of happy at the end of it and the work has been completed and things like that. So I think its more kind of I just want to make sure that it runs well. I suppose I'm putting it on myself as well anyway the stress, I want to have this, to achieve this, and I suppose I do get a bit uptight about it". UK*

The main symptoms of stress as experienced by the interviewees are:

- Disrupted sleep patterns
- Lack of energy
- Eating comfort foods and/or not wanting to prepare and cook proper meals
- Irritability and clumsiness

The UK interviewees manage their levels of stress by:

- Going for long walks, where they can mentally and physically escape from source and/or effects of the stress e.g. distract their brains, mentally switch off from work.
- Play sport, either partake in individual events e.g. running or as part of a team, e.g. five-a-side football. The mental and physical effort required to perform the sporting

activities allows the individual to refocus their thoughts and 'lose themselves' in the activity.

*"One thing that tends to work for me is an activity, so walking. Long walk could sort that out. Talk to other people or moving away from that situation and just doing something else, for example, even like gardening or some general chore can relieve that situation". UK*

*"I always find if we go for a really long walk, for miles I forget about the problems, you know, ... on Monday afternoon we went and we walked for a couple of hours, even longer than that is even better because you completely forget what you left at home because you out of home and out of the work situation and you do relax and you go home then you do eat a decent meal because your hungry and not living off adrenaline or black coffee". UK*

*"I do like to play a lot of sports and keep active so that helps. I think that can be a great way to relieve, because a lot of days I come back and even when it hasn't been particularly stressful you know your going for a run or going to go play something you feel better after it. You mightn't want to do it at all but you do feel better for it. ... I play soccer, Gaelic football. They are both kind of summer/winter sports". UK*

*"I play tennis anyway, I play competitive tennis, so I play at least once a week sometimes twice a week, I have a coach, I don't think I have time to do anything else". UK*

In order to reduce their levels of stress, interviewees mainly say that they need time for themselves so that they can mentally switch off from everything. One interviewee suggests that being more organised at work, planning ahead would help, whilst another interviewee considers listening to music as an essential way to help them relax more and de-stress. However, to be able to achieve the desired reduction in stress, these interviewees have to overcome the issue of 'not enough time'. Essentially these interviewees identify the main barrier to reducing their stress levels is time, or more precisely, making time for themselves, something they feel is beyond their control.

*"It is the making time for me, certainly, the making of time. Yes, umm, the time". FIN*

*"It is limited time and that things are out of my control". FIN*

*"Complete switch off. I find that so difficult, as I'm either at work or at home, and there are things to do or I don't know how I could find the time to do anything different at all". UK*

*"I don't know, I think for me, to reduce my stress to deal with my stress, time is identified for me, that would help deal with the sort of underlying stress, I think if, I would probably say, time away from everybody, my husband, work, the girls, I would choose to go and do something girly and have a massage, but it doesn't last long enough and it always seem to be time related, the length of time I'm away or activity involved in playing tennis or something seems to be the reduction factor". UK*

#### **2.6.4.2. Design and purpose of the technology**

Due to the idiosyncratic nature of how individuals experience and respond to stress, each interviewee had different thoughts about whether technology could help them and if so, what the functions and design would be. Therefore, no common themes emerged across all interviewees regarding the design and functions of the technology; however, there were four areas which some of the interviewees shared.

- To assess level of stress (all FIN and 1 UK interviewee)



- Message alert system (2 FIN and 1 UK interviewee)
- Monitoring the participation in activities to relieve stress (1 FIN & 1 UK interviewee)
- An organiser app on a mobile phone (2 FIN and 1 UK interviewee)

The interviewees want a device that can assess how different situations are affecting them in terms of their level of stress. Several interviewees talked about measuring heart rate, pulse, blood pressure or level of sweat at different intervals during the day to give them an indication of how they are coping with increased stress and if required, an alarm to alert them to situations when their stress levels are too high. Interestingly the interviewees said they could feel themselves becoming increasingly stressed but they wanted to be able to measure it and have something that would draw their attention to their stress when it was reaching an unacceptable level. This may suggest that these individuals are aware of their increasing stress levels but currently choose to ignore the physical signals and continue at the same pace and thus placing the body and mind under continued stress.

*“... A device which would measure stress. In some objective way, you know. You would learn the situations which make you stressed. It could measure pulse or whatever would be a good stress indicator, the device could record if I am in a high or in a low stress situation ... yes it could have an alarm, when it is over some limit, it would set off the alarm, and it could tell you that you are now in a high stress situation. Well, usually you can feel that yourself but it would be nice to have a measurement and alarm”. FIN*

*“A heart rate monitor would be a good example. I do not know how you can measure the stress. Perhaps just with the heart rate and perhaps how you sweat?”. FIN*

*“Some small device and I could check later with computer what was my stress level. That could measure my pulse or my wake up time... it could give me a signal and then I would take a look somewhere what I should do. I cannot imagine that I should always react with the same way. But if I had something that now my pulse is skyrocketing and I am sweating”. FIN*

*“Perhaps something that could assess my stress, health at work perhaps or something like that. I know there are certain technologies available to monitor your pulse rate and heart and sort of things, blood pressure for example would be an indicator... and also give me indicators of when my stress levels are rising and what I need to do to alleviate that”. UK*

It is also evident that these interviewees want some information or feedback as a result of the assessment. This may be in the form of instructions on how to take immediate action in response to the situation and/or to identify activities which could be incorporated into their lifestyle in order to manage stress and reduce the effects of it on their physical and mental wellbeing. In order to do this, a monitoring function would need to be built into the technology to accompany the measurement tools. This tool would monitor how the individual is coping with the stress, how they physiologically and mentally change as their levels of stress rise and fall, and what happens they take action to reduce their levels of stress e.g. playing sport or going for a walk. For the measurement, monitoring and feedback mechanisms to be beneficial to the individual, the system needs to be ongoing in the short, medium and long term.

*“A summary every week, it could be something simple like all the meters are now in red or yellow... some could be measured in week intervals and some more often. ... If it is in red, then that would motivate me to do something, I have had a warning. Like if I wished to keep my stress level in the green zone, and then if I am in the red for one week to another, then I*

*need to try and do something about it...the level of blood pressure could be something. I have no hypertension or medication for it but that could be a long term measurement, like if it goes up or down". FIN*

For those interviewees whose stress is predominantly caused at work through projects and deadlines, they suggested that the technology could assist by helping them plan better. An organiser function via an app on their mobile phone could be very beneficial for assisting in their organisation of work as well as helping them to plan time for themselves, sending them messages that it is time to go for a walk or go for a run etc.

*"Well, it should give a schedule. I suppose different organisers could be very helpful so that you could plan things in advance. Like having something on your phone can be really useful. If you could just have something to write everything down and then somehow magically organise it into days so I just write it down once rather than going into every separate day and type it in... I could see exactly that is coming up the next couple of weeks, when I'm going to be getting busy. So that will help me get organised... Yeah you could schedule in your social activities as well and maybe set reminders you need to, you need to go for a run and got training or you've got practise, or a match or something". UK*

With regard to the physical design of the technology, the interviewees' ideas were rather disparate and limited. The areas with some agreement were:

- Portable (2 FIN and 2 UK interviewees)
- Small in size (2 FIN interviewees)

Portability and small in size are seen as a function of each other. Some interviewees suggested a bracelet or wristwatch type design which could be worn throughout the day inconspicuously. For the device to measure and monitor physiological signals of stress, then the device needs to be somehow attached to the individual, as well as being small and easy to use.

*"For me that would be like a bracelet, or some small device and I could check later with computer what was my stress level. That could measure my pulse or my wake up time". FIN*

*"I think it should be something that's portable because that would be more useful and in that way if you moved to certain situations where ever it might be you could assess and use of that situation in coping with and relieving a stressful situation. It would be less limiting if you would like if it was portable like an MP3 player or something like that which you could take with you and give you an indication of stress levels. So for me personally it would be something like that". UK*

## 2.7. Conclusions

There are some general conclusions that can be drawn from across the four areas of diet, physical activity, sleep and stress.

- Diet and physical activity are the two areas with the more comprehensive and shared cognition with regard to the reasons for change, technological functions and design features.
- Improving eating habits and increasing levels of exercise probably lend themselves to the use of technology because these areas utilise programmes that emphasise

goal setting, reward and penalties, visual and customised output and the use of portable technology e.g. Mobile phones with Apps.

- Interviewees' responses to resolving disrupted sleep and reducing stress levels are more fragmented in nature due to the personal nature of each situation. Therefore to identify core, common, shared language with regard to the functions and design of technology is far more difficult and limited in terms of output.
- Reducing stress and improving sleep are going to be the hardest for technology to assist because they are so personal and contextualised.
- With regard to the areas of diet and physical activity there were some generic areas of commonality regarding the functional design of the technology:
  - Customised, personal data collected over time with feedback
  - Targets, goals and rewards for achievement
  - System for measuring and monitoring behavioural changes
- The functional features have to provide individuals with information on their current performance as well as the goals; the technology has to make it easy for people to engage with their personal journey of change, including an increase in their motivation and reward on achievement.
- In terms of the physical design of the technology the areas of diet, physical activity and stress generated very similar requirements:
  - Portability and small in size
  - Something that could be worn
  - App on mobile phone

### **3. Development of user requirements and usage scenarios**

#### **3.1. Background**

The development of a list of user requirements and usage scenarios will provide the system development team with important information regarding the desired functionality of the PRECIOUS system. However; since it is unlikely to be feasible to meet all desired requirements within the project life-span, it is necessary to prioritise the user requirements to provide focus for initial system development. It will also be important to re-visit the user requirements and usage scenarios as the project progresses. Engagement of a wider group of users and key stakeholders will also be required.

#### **3.2. Terminology**

##### User requirements:

In PRECIOUS, the user requirements refer to the ways in which the end user may wish to interact with the service and to the system tools that may help them to achieve their behavioural change goals. The precise requirements of each user will depend on the individual; therefore PRECIOUS should allow users to select preferred options where



possible. The virtual individual model will also play an important role in delivering a personalised service to the user. The PRECIOUS user requirements are listed in Table 5.

### Usage scenarios:

In computer science, the terms 'usage scenario' and 'use case' are often used synonymously, which can cause confusion. In PRECIOUS, the following definitions are used to distinguish between these terms:

#### *Usage scenario*

Scenario-based design is a group of techniques that describe the use of a future system (user requirements) at an early stage of the development process. Rather than detailing the functional system requirements, usage scenarios are stories that describe how individuals will use the system to accomplish particular goals or tasks [6].

Usage scenario 'story' format:

### User background

This section describes the characteristics of the user, for example age/life stage, employment status, marital status, health status, financial position, attitudes towards technology and social influences.

### User requirements

This section of the usage scenario provides examples of how the user could optimise their use of the technology on a day-to-day basis to improve their health. For example "John is gradually gaining weight but finds it difficult to schedule exercise around a busy working day and often eats convenience foods that are low in fibre and high in fat. The technology builds motivation by advising John that even small changes are beneficial and throughout the day a message system reminds John to take a break and go for a walk to buy lunch. Using his GPS location the technology is able to recommend nearby vendors and a range of healthy and affordable options". Examples such as these allow the development team to visualise the use of the technology and design practical solutions.

#### *Use case*

In contrast to a usage scenario, a use case describes sequences of actions that a system or sub-system must perform during its interaction with the external user(s) [7]. The combined application of usage scenarios and use cases has previously been described in the European Commission FP6-funded project MINAmI:

*"Use cases help to identify and clarify the functional requirements of the system to be designed whereas scenarios focus on identifying user and contextual requirements. Scenarios tend to describe actions on a higher level, not focusing on details of actions/responses like use cases. Scenarios are usually defined in connection to user requirements specification, and they are refined to use cases during the functional requirements definition phase. It is quite common that a long scenario may be split into several use cases."* [8]

This task focuses on the identification of user and contextual requirements; therefore the term '*usage scenario*' is applicable. The PRECIOUS usage scenarios can be found in Section 3.4 of this deliverable. In future work (PRECIOUS Deliverable 4.1: System architecture and design specification), these usage scenarios, and their corresponding user

requirements, will be analysed and used to define the functional system requirements (use cases).

### 3.3. User requirements

The development of a user requirements list was based on the results of the user interviews described above, and discussions amongst the PRECIOUS consortium. This resulted in 16 key user requirements, which are grouped into four key areas 1) System features; 2) Informing/reporting; 3) Educating; 4) Motivating.

Following the user interviews it was identified that with regard to the areas of diet and physical activity, there were some generic areas of commonality regarding the functional design of the technology and these are reflected within the user requirements (UR) as follows:

- Customised, personal data collected over time (UR 1) with feedback (UR 9)
- Targets, goals (UR 14) and rewards (UR 15) for achievement
- System for measuring (UR 1) and monitoring behavioural changes (UR 16)

Additionally, it was identified that the technology has to make it easy for people to engage with their personal journey of change, including an increase in their motivation (UR 13) and reward (UR 15) on achievement.

Table 5 lists the 16 user requirements, considers the effort required to implement each requirement, and discusses potential challenges and other important considerations, such as privacy issues.

**Table 5: User requirements**

User requirement number	User requirement	Effort required for implementation (low, medium or high)	Challenges and comments
<b>System features</b>			
UR1	Measurement of risk factors / lifestyle aspects (food intake, physical activity, stress and sleep)	Medium-High	This will be realized through the capture of data from various sensors (as provided by PRECIOUS partners within the project and later through developers who connect with the service). Where possible data capture should be automatic i.e. user input is minimized.
UR2	Options to control data sharing and privacy settings	Low	This requirement is mandatory and should be considered within the interface design.
UR3	Provision of different format options for displaying data e.g. numbers, pictures	Medium-High	This requirement should be considered within the interface design. Data display should be optimized for viewing via multiple devices e.g. phone, iPad, desktop
UR4	Connections to social networks	Medium	Consider how to share data across social networks – security and privacy issues should be considered
UR5	A calendar/organiser that seamlessly syncs with work and/or personal calendars	High	<p>It would be preferable to design a calendar that is able to interact with other personal calendars / diaries; however, achieving this may be challenging:</p> <ul style="list-style-type: none"> <li>• Need a caldav server to sync all agenda</li> <li>• There are multiple calendar formats and some will be blocked by UR company IT services</li> </ul> <p>A basic calendar should be implemented initially and the options to link to external calendars can then be explored.</p>

User requirement number	User requirement	Effort required for implementation (low, medium or high)	Challenges and comments
UR6	Use of location data to suggest local amenities, activities etc that help the user to meet their objectives	High	<p>Achievement is likely to require links to some/all of the following:</p> <ul style="list-style-type: none"> <li>• External services (e.g. Google Maps and Journey Planners provided by transport operators)</li> <li>• Local Authority web pages (e.g. 'Leisure Facilities')</li> <li>• Restaurant menus</li> <li>• Private gyms / sports companies</li> </ul> <p>Security and privacy issues should be considered and in particular users should be able to opt in to the use of location data if desirable.</p>
UR7	Able to access / interact with service through multiple channels e.g. smart TV, smart phone, smart watch, laptop, tablet	Medium-High	<p>Service should be compatible for access through various channels and also with a range of operating systems (iOS, Android, Blackberry, Windows etc). In the initial development phase one or two operating systems will be chosen. The roll out to further platforms will be discussed during the later stages of the project.</p> <p>Challenges:</p> <ul style="list-style-type: none"> <li>• Compatibility with all the various channels</li> <li>• One App for different operating systems</li> <li>• Sharing of information across various channels</li> <li>• Development of a smart watch (because it is a new device)</li> </ul> <p>Some channels will be more appropriate for different groups of people. For instance, an older couple may prefer a smart TV channel, whereas a student might prefer only a smart phone.</p>

User requirement number	User requirement	Effort required for implementation (low, medium or high)	Challenges and comments
UR8	Ability to interact with groups of users who have a common goal(s)	Low	<p>This could include setting of team goals, competition against other users (individuals or groups), a forum to discuss progress etc.</p> <p>Individual profiles should remain private. The user chooses what to share and when.</p> <p>It is not possible to eliminate cheating within such groups. This must be made clear to users and it should be stated that it is their own decision to participate.</p> <p>Interactions may be via social networks or social groups created on the PRECIOUS service platform.</p> <p>It may be challenging to encourage target audience (e.g. sedentary people) to interact with other users. Typically sedentary people don't like to share their information (or even use application). Active people generally like to do that but our target is sedentary people.</p>
<b>Informing / reporting</b>			
UR9	Receive feedback on risk factors / lifestyle aspects	Medium	<p>The user should be able to choose their preferred option(s) for delivery of information*. These actuators should be non-intrusive where possible.</p> <p>Choice of multiple formats may include:</p> <ul style="list-style-type: none"> <li>• Audio / voice</li> <li>• Text</li> <li>• Images</li> </ul> <p>*Choices may be limited by the capacity of the user channel (e.g. smart watch, smart phone and tablet). It could be useful to define a default feedback option for each channel and then propose the</p>

D2.1 List of usage scenarios and user requirements

User requirement number	User requirement	Effort required for implementation (low, medium or high)	Challenges and comments
			<p>option if the device allows several feedback choices.</p> <p>Should also consider quality of voice, language (text to speech soft quality) etc.</p>
UR10	User receives only information that is relevant to their goals	High	<p>The virtual individual model (VIM) will be used to determine what is relevant for each user. The VIM is constantly updated with data relating to an individual, such as physiological, psychological; and personal data.</p> <p>Relevant information could include notifications when goals are reached or exceeded.</p> <p>The service could also link with other personal devices / files (e.g. music library) if requested by the user.</p>
UR11	Delivery of reminders to user	Low-medium	<p>Reminders should be associated to goals of the user, for example:</p> <ul style="list-style-type: none"> <li>• Times allocated for specific activities, such as sleeping, eating and taking a break from the computer screen</li> <li>• Reminders to consume fruit and vegetables with meals</li> <li>• Reminders to go to the gym after work</li> </ul> <p>Therefore, the reminders should be driven by goals entered by the user, and reflect user progress. User should be able to opt-in to reminders and they should be non-intrusive.</p> <p>It may also be useful for reminders to be linked to the users' organiser. This will be simple if the user is reliant on a calendar within the PRECIOUS system; however more challenging if the system needs to link with external calendars or diaries. The capability will depend on achievements within requirement number 5.</p>

User requirement number	User requirement	Effort required for implementation (low, medium or high)	Challenges and comments
<b>Educating</b>			
UR12	Educates the user towards healthier behaviours	Medium	<p>Examples include:</p> <ul style="list-style-type: none"> <li>• Recipe ideas (including for specialised diets)</li> <li>• Cooking tips</li> <li>• Suggestion of alternative foods or activities</li> <li>• Highlights the exercise value and/or energy requirements of household tasks or physical activity commonly performed by the user</li> <li>• Use of gamification</li> <li>• Coaching to lower stress levels e.g. breathing activities, focusing exercises, advising a break when high stress levels detected</li> </ul> <p>The associated challenges and requirements will depend on the method of education.</p> <p>For example the following may be required:</p> <ul style="list-style-type: none"> <li>• Database of recipes or connection to cooking website(s)</li> <li>• Connection to API, need auth.? (challenge because we use an external service)</li> <li>• Need to keep track of available products (links to supermarket grocery lists?)</li> <li>• Understanding of users food preferences and eating habits</li> <li>• Nutritional guidelines e.g. Nutrition Pyramid</li> </ul>

User requirement number	User requirement	Effort required for implementation (low, medium or high)	Challenges and comments
			<ul style="list-style-type: none"> <li>• Physical activity guidelines</li> <li>• Knowledge of local area to suggest appropriate activities (connect with location data feature)</li> <li>• Testing of game concepts to determine efficacy</li> </ul> <p>Education strategies must be linked to specific user goals and be applied at the appropriate time (e.g. when the user shows interest in a topic or starts to make lifestyle changes).</p>
<b>Motivating</b>			
UR13	Motivates the user to make behavioural changes	High	<p>Motivational interviewing (MI), gamification and personalized feedback (through VIM) will be used.</p> <p>Important to include a “thermometer” that will display the users’ self-ratings of the importance for change and self-perceived confidence to change. States of change for each risk factor will also be assessed.</p> <p>One particular challenge is to include an evaluation of the users resources and their reasons for making the selected changes.</p>
UR14	Setting of personal goals	Medium	<p>Use MI to survey priorities and goals of the user</p> <ul style="list-style-type: none"> <li>• Consider use of open questions vs. pull down menus</li> </ul> <p>How does PRECIOUS help the user to set SMART goals?</p> <ul style="list-style-type: none"> <li>• Suggest goals based on responses gained using MI</li> <li>• User able to select, prioritise and re-define their goals</li> <li>• User prompted to fill in SMART boxes for at least one goal (top priority)</li> </ul>



D2.1 List of usage scenarios and user requirements

User requirement number	User requirement	Effort required for implementation (low, medium or high)	Challenges and comments
			<p>Need to consider how progress against goals is measured.</p> <ul style="list-style-type: none"> <li>• State of change?</li> <li>• Specific cut-off points?</li> <li>• Progress bars?</li> </ul>
UR15	Gives rewards for healthier choices and/or encouraging others to make healthier choices	Medium	<p>The system should keep track of the activity and what has been achieved against goals / reward targets.</p> <p>Needs to provide rewards that users are interested in.</p> <p>Examples include:</p> <ul style="list-style-type: none"> <li>• Links with businesses (e.g. restaurants) to deliver rewards when making a healthy choice</li> <li>• healthCOIN (concept under development; Deliverable 2.2: Interim report on socio-economic factors and business models)</li> </ul> <p>Users may be rewarded for a variety of reasons i.e. if they achieve a goal, make actions to change or use the system on a regular basis. Importantly, PRECIOUS should reward progress in general (e.g. if the user has high BMI we can reward that they start to exercise, NOT the reduction of fat, or lower BMI). In other words, to offer feedback based on the actions, not on the user characteristics.</p> <p>At this stage the rewards have not been defined.</p>

D2.1 List of usage scenarios and user requirements

User requirement number	User requirement	Effort required for implementation (low, medium or high)	Challenges and comments
UR16	Representation of self with an avatar	Medium-High	<p>The creation of an avatar can be challenging, particularly the creation of convincing graphics. There are various ways to tackle the avatar representation:</p> <ul style="list-style-type: none"> <li>• One app/module within the system (i.e. tame a monster by eating more healthily)</li> <li>• A system-wide avatar that changes according to all aggregated data from apps &amp; sensors</li> <li>• Changes in avatar appearance / representation based on data collected by sensors and progress against goals</li> <li>• User can personalize their avatar if they choose e.g. clothes, facial features, height, or can perhaps select a pet or garden (or similar) to look after</li> <li>• Progress against goals could unlock access to certain special features e.g. if the user is running regularly, new trainers for their avatar, new tools or seeds for the garden</li> </ul>

### 3.4. User requirements prioritisation

In addition to identifying the user requirements, there is a need to prioritise them to ensure that the implementation of the overall PRECIOUS solution (system, services, applications etc) is feasible within the project time-frame and fulfills the initially conceived vision of the project. In order to achieve this, the user requirements were prioritised by the consortium using the MoSCoW method, whose use has previously been described in the European Commission-funded inCASA project [9].

MoSCoW is a technique which can be used in software development to reach a common understanding within a group regarding the importance placed on the delivery of identified requirements. The acronym MoSCoW stands for:

- **MUST have:** This is a requirement that has to be satisfied for the final PRECIOUS solution to be acceptable
- **SHOULD have:** This is a high-priority requirement that should be included if possible within the PRECIOUS project time frame.
- **COULD have:** This is a desirable or nice-to-have requirement (time and resources permitting) but the PRECIOUS solution will still be accepted if the functionality is not included.
- **WON'T have:** This represents a requirement that users would wish to have, but will not be implemented within the current framework of the PRECIOUS project due to significant implementation constraints and/or misalignment with project objectives.

The prioritisation of the PRECIOUS user requirements was implemented via an online survey form. The survey targeted the implementers of the PRECIOUS system (that is, the whole PRECIOUS consortium) and respondents included at least one representative from each consortium partner (a total of 15 people responded to the survey). This approach allowed consideration of all perspectives from a consortium composed of a multidisciplinary team of researchers with varying background expertise.

In the online survey, one priority level (MUST, SHOULD, COULD, WON'T) was selected for each requirement (UR1-UR16) of Table 5. Following the completion of the survey, the user requirement priority level assignment was carried out based on two possible approaches:

- **Majority Decision:** For the majority decision approach, the priority level that got selected the most in the survey is retained. In case of a tie for top position the priority with higher level is selected so as to add more bias towards retaining the requirement. For example, if *MUST have* and *SHOULD have* tied at top score, then the requirement is considered *MUST have*.
- **Weighted average:** In the weighted average approach, the four priority levels are assigned following weights (as in the FP7 inCASA project): MUST have = 5, SHOULD have = 3, COULD have = 1, WON'T have = 0. The assigned weights are biased towards prioritising the requirements. The weighted average is then evaluated for survey responses of each user requirement. The rounding of the weighted average is done rounding to the nearest weight as shown below:
  - MUST have =  $[5 \geq X \geq 4]$
  - SHOULD have =  $[4 > X \geq 2]$

- COULD have =  $[2 > X \geq 0.5]$
- WON'T have =  $[0.5 > X \geq 0]$

The MoSCoW survey results and subsequent priority level assignment using the two aforementioned approaches are shown in Table 6.

**Table 6: Survey results and requirement priority level assignments**

Requirement	MUST have	SHOULD have	COULD have	WON'T have	Majority Decision	Weight Average
UR1	13	2	0	0	MUST	MUST
UR2	12	3	0	0	MUST	MUST
UR3	3	8	4	0	SHOULD	SHOULD
UR4	3	8	3	1	SHOULD	SHOULD
UR5	3	5	6	0	COULD	SHOULD
UR6	1	5	8	0	COULD	SHOULD
UR7	3	6	5	0	SHOULD	SHOULD
UR8	5	6	3	0	SHOULD	SHOULD
UR9	13	0	1	0	MUST	MUST
UR10	8	3	3	0	MUST	SHOULD
UR11	8	6	0	0	MUST	MUST
UR12	9	4	1	0	MUST	MUST
UR13	12	2	0	0	MUST	MUST
UR14	12	1	1	0	MUST	MUST
UR15	7	4	3	0	MUST	SHOULD
UR16	0	4	10	0	COULD	COULD

It is noted that the weighted average approach allows for relatively more user requirements to be considered in the PRECIOUS system implementation (assuming MUST and SHOULD level implies retain). This observation is highlighted in the plot of Figure 1. Therefore, with the priority being on retaining as many requirements as possible going forward, the weighted average approach has been selected. Requirements categorised as MUST and SHOULD will be carried forward into system implementation.

### Priority Level Selection for Different Approaches

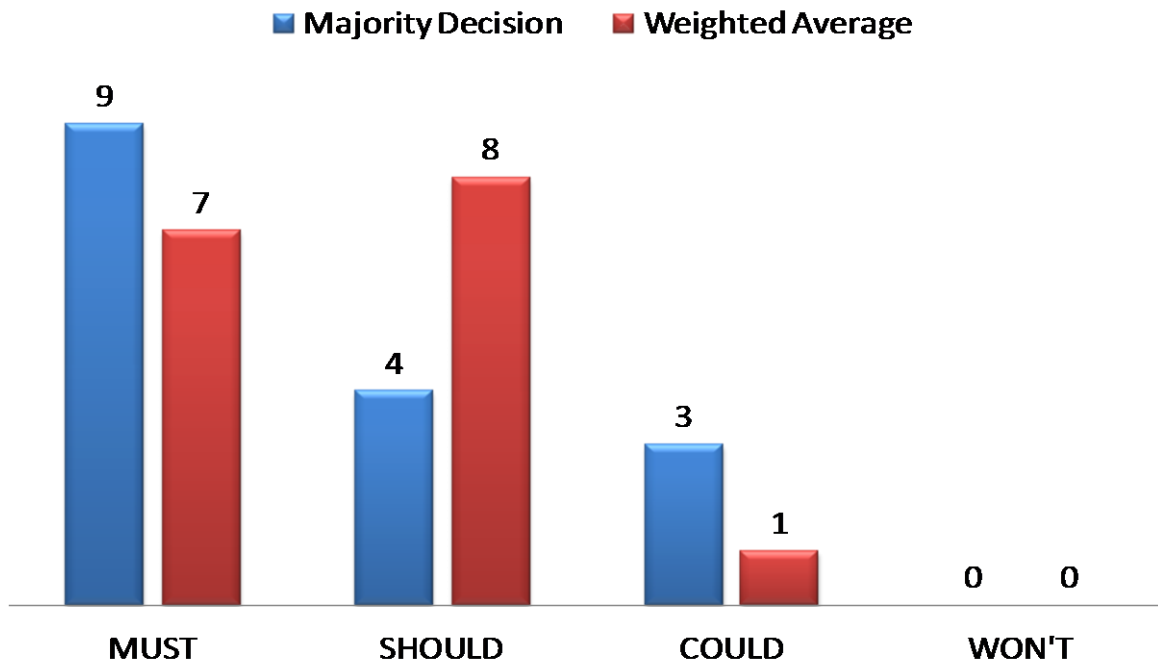


Figure 1: Priority level selection for the majority decision and weighted average approach

#### 3.5. Usage scenarios

In PRECIOUS, usage scenarios are used to describe potential user groups and how individuals within these groups may use the system to accomplish particular goals or tasks. These scenarios will provide the information required for the development of functional use cases during initial system development. Following the development of a prototype system, it will be crucial to seek the opinions of a more diverse group of end users, as well as those of other identified stakeholders, and to refine the user and system requirements based on these opinions.

Consortium discussions were held to identify potential users of PRECIOUS, which resulted in the specification of four example user groups:

1. Young, single working professional
2. Family unit
3. Retired couple
4. Student

Following this, four usage scenarios, that is, one scenario per example user group, were developed. The initial system design will be based on these four usage scenarios; however, following a proof of concept study, and further consultations with end users and project stakeholders, it is expected that the system design will be revised. Additionally, a personalised service will be delivered through representation of the user by individual virtual models, which are generated based on information the system collects about the user, and

selections the user makes. This will ensure that recommendations, motivational techniques and other system outputs are tailored to the users' goals and preferences.

### 3.5.1. Usage scenario - Young, single working professional

#### *Background*

This user is typically in their mid-20's to early 30's, is not married and has a full time profession. Their main focus is on work, which may involve travel, and socialising in the evenings and/or weekends. In general, they allocate very little time to focus on their health. In particular, this group may suffer from stress (due to long working hours/upcoming deadlines), perform little physical activity (perhaps some walking/cycling to commute and occasional gym classes/sports activities), have a poor diet (skip breakfast, lack of fruit and vegetables, low fibre intake, moderate to high alcohol intake) and suffer from lack of sleep or poor sleep quality (long working hours, social activities, stress and/or travel). They are likely to regularly consume food out of home (due to convenience, socialising and/or lack of cooking skills) and may not be aware of the nutritional value of the meals they are eating.

This user may be slightly overweight, with weight fluctuating depending on work and social circumstances. They may be at risk of developing high cholesterol levels, having regularly elevated blood glucose levels and gradually gaining more weight. However, due to their age they do not foresee these potential risks and the future complications they may cause. Therefore, they currently lack motivation to commit to lifestyle changes.

This user is familiar with the use of technology and gadgets and has experimented with different lifestyle monitoring applications in the past. However, due to lack of time and motivation this use has not continued for more than a few weeks.

#### *User requirements*

The main barriers to lifestyle changes for this user are lack of motivation and a busy work and social schedule, which does not accommodate time to focus on healthier behaviours. Despite this, the user would be open to the use of technology to monitor lifestyle aspects.

In tackling motivation it is necessary to encourage the user to regularly monitor lifestyle aspects and use the data collected to educate the user and stimulate changes. Time pressures are a barrier to both the monitoring and change aspects in this scenario. Therefore, an important requirement is for the system to have a calendar/organiser that ideally syncs or integrates with work and/or personal calendars that are already in use. In particular, this feature would offer the ability to block out time in advance e.g. to shop for food, attend exercise sessions, go to bed, question the removal of pre-booked sessions to discourage replacement with work/social activities and deliver automatic reminders e.g. text messages, emails, screen notifications. The user should be able to personalise the calendar e.g. make bookings private, add colours/pictures, specify preferred notification time/alert type etc.

Where possible monitoring tools or sensors should be simple to use and require limited user input. This will encourage the user to continue monitoring in the longer term. The user should also be able to personalise the tools or sensors and/or be able to select from a choice of different applications.

After collecting data about the user the system should make personalised recommendations to assist them in making healthier choices, for example following a 5-step procedure; 1) offer feedback about detected risk factors, 2) compare data from the individual with a desirable 'standard', 3) ask about intention and desire to change, 4) evaluate readiness to change, 5) offer tailored recommendations. The system should offer a range of choices so that the user feels that they have flexibility when working towards their goals. The recommendations should also come with an element of education (e.g. recipe suggestions, calories burnt during particular exercise types) and suggest consequences if changes are not made. As well as highlighting consequences, it will be important to offer encouragement to build motivation. Motivation could be built through the use of an Avatar that reflects the user and the actions that they take. The reflection could take many forms (e.g. colours to depict mood, size and shape to highlight impact of diet and exercise changes) and should be personal to the user. Motivation could also include motivational messages (for example, "you have already completed 90% of your planned activity, well done!" and "you are now just 10% away from completing today's goal") and monetary reward/punishment systems.

It may be helpful for the system to access location data in order to make real-time suggestions for meal choices and exercise locations, especially if the user is travelling in an unfamiliar location. Location data could also be linked to public transport services and suggest making some of the journey on foot or by cycling. The system may also build motivation by linking with the social activities of the user. This might include the use of competition between friends, working as a group to achieve goals, offering rewards for encouraging change in others and rewards for making healthier choices when dining as a group.

### *3.5.2. Usage scenario - Family unit*

#### *Background*

This user group consists of parents (mid-30's to 50 years) and their children, where the children are school age (5-17 years) and the parents are both working. The parents are required to balance the organisation of work schedules, the school run, after school/weekend activities, meals and recreational family time. They are concerned about the health of their children; however, are likely to have little time to consider their own personal health. There may also be budgetary restrictions that limit the funds available for food shopping, sporting activities and tools/applications that record lifestyle aspects. To some extent the parents are likely to suffer from stress (due to both work and family pressures), perform little physical activity (especially if the car is relied upon to co-ordinate family schedules), have a poor diet (rely on convenience foods to save time, which may be high in fat, salt and sugar) and suffer from lack of sleep or poor sleep quality (long working hours, stress & lack of time). The children's diet and physical activity level will be influenced by their parents, and perhaps school policy, in earlier years (e.g. 5-12 years); however teenagers are likely to have more freedom to make their own choices.

The parents are aware that they need to take better care of their health and may have been given early warning signs by their doctor. These early warning signs could include raised blood pressure, elevated cholesterol levels and increases in weight. The children are generally quite active when they are younger; however activity levels decrease with age, unless the child takes part in regular after school sports activities. The main dietary concerns



are likely to be a low level of fruit and vegetable intake and consumption of unhealthy snacks and sugar sweetened beverages.

The parents are familiar with the use of technology, such as tablet computers and mobile phones through work and some social media; however, may not be immediately inclined to use this to monitor their lifestyle habits. Social media and technology play a large part in the lives of younger children and teenagers e.g. games consoles, mobile phones, smart TV's and tablet computers.

#### *User requirements*

This group of users has a number of different requirements, and varying barriers to change. Additionally, these requirements are likely to change when the children move from pre-teen to teenager. Teenagers will begin to make their own choices, and therefore require individual access to the system.

#### Parents + younger children

In this family unit, one of the main barriers to changing behaviour is lack of time and therefore it is important for PRECIOUS to offer a calendar/organiser, which links family activities. In particular, this feature should offer the ability to block out time in advance e.g. to shop for food, attend exercise sessions, monitor children's activities and deliver automatic reminders e.g. text messages, emails, screen notifications. Users should be able to personalise the calendar e.g. make bookings private, add colours/pictures, specify preferred notification time/alert type etc. It would be desirable for the system to have a calendar/organiser that seamlessly syncs or integrates with work and/or personal calendars that are already in use.

Another key requirement for this group should be to increase opportunities to take part in joint activities that improve health and are also fun to do. The use of gamification will be important in increasing enjoyment. This will also involve scheduling of family time, so that mealtimes and physical activities are shared. The calendar function would assist with this. However, the system should also provide ideas for group activities that are based on the family environment, especially work and school hours, local amenities such as parks and leisure centres and food preferences. It would also be useful for the system to access local offers/deals for family activities and suggest these to the user. Suggested activities should also suit the time of year/current weather conditions and provide the family with options e.g. "It is raining today, but you could have a sports tournament using your games console". An element of competition between other families or friends may also help to increase motivation and enjoyment. Also the contribution of household tasks e.g. cleaning, gardening and carrying shopping, to activity levels should be highlighted.

Meal planning may be difficult, especially if family members have different dietary requirements (e.g. lactose intolerance, vegetarian). The system could assist through a shopping list feature, recipe ideas based on ingredients purchased and suggestions for small changes that would make a meal suitable for the whole family. The system may offer information about food that can be purchased in an online supermarket, then the system might reward a shopping basket with fruit, vegetables and healthy food.

It may also be useful for the family to learn together about healthier lifestyles, and to understand the impact of changes that they make. The system could educate in various

ways, including data on food intake and exercise time, pictures to explain more complicated concepts and games to test learning. Links could also be made to community-based reference material and services (e.g. UK Change4life campaign). For the parents, the system could also monitor sleep and stress levels e.g. through a short questionnaire or wearable sensors, and link these to daily activities – work schedule, diet and physical activity.

### Teenagers

Due to their age this user does not foresee the potential health risks posed by sedentary behaviour and poor dietary choices. Therefore, they currently lack motivation to make healthier lifestyle choices. However, this user regularly uses technology and may easily connect with the system if it is enjoyable to use and allows them to link with online/digital applications they are currently using. In this group, social support and peer exchange experiences might be useful to enhance motivation to change habits.

This user places great importance on interaction with their peers, and therefore the system should build on this to encourage use, and to educate the user. Features may include games that provide education, as well as competition with their peers and an ability to share their progress with each other. The user should also be able to personalise the system with images, colours etc that reflect their personality, in addition to being able to choose the level of detail that they share with their peers and with their family.

A source of poor dietary intake in this group of users may be fast food outlets and supermarkets that are visited with friends. The system could assist by suggesting healthier options in places frequently visited, and offer rewards/discounts to groups of friends when making healthier decisions. This would require the user to allow GPS location data to be used.

Also, whilst teenagers have a desire for independence they are still reliant on their parents to facilitate health changes, for example providing funds and transport to take part in physical activity and purchasing/cooking most of their meals. It would therefore be helpful for the teenager to share some of their goals with the main family system.

#### *3.5.3. Usage scenario - Retired couple*

##### *Background*

These users are usually more than 60 years old and may live alone if a spouse has passed away. They have a large amount of free time, but they often spend this time at home. They do not eat out regularly, preferring to eat at home. Overall, they are quite sedentary, and most of the time they only carry out physical activity if it is recommended by the family doctor. However, some users do enjoy activities including walking, golf and swimming.

This user may be concerned about their health due to a specific condition that they suffer from. These users often have poor weight control, being either overweight/obese or underweight. The probability that these users have conditions such as elevated blood pressure, impaired vision, musculoskeletal problems, high levels of cholesterol and type II diabetes is also high. In certain situations some users may suffer from depression, which is often associated with social isolation.

Regarding the use of new technologies, these users may show some resistance, but overall they reveal themselves to be quite curious regarding new technologies.

#### *User requirements*

The system should have the ability to promote appropriate diets for this users' nutritional requirements. In particular, nutrients such as fat and salt should be restricted and the intake of certain nutrients, such as calcium and vitamin D, is highly important. These recommendations should be complemented with cooking tips and recipe ideas. Another important feature is reminders to eat and drink. These users sometimes skip meals, either because they have no appetite, or because they simply forget. This can result in malnutrition, which is a risk factor for certain diseases. A shopping list feature could also be very useful. This feature could help users to make better decisions when choosing foods, and link with cooking tips and recipe ideas.

In order to promote physical activity, the system could suggest certain home-based exercises for users who prefer to stay at home. Involvement in group exercises, either within the couple, or with others who live nearby, might also be stimulated. The system may have the functionality to suggest certain users, who are close by and have common goals.

All of the features noted above must give rewards whenever the user makes a good choice. These types of reward could be enhanced through a community/forum of other users, helping at the same time to reduce social isolation.

#### *3.5.4. Usage scenario - Student*

##### *Background*

This user is typically 18-25 years old, and in most cases they are single and without children. They have very irregular schedules and depending on the academic calendar, they may have some free days during the week. The level of work is also dependent on the academic calendar, and there are periods of stress relating to key deadlines. During the year, they usually have more vacation time/free time than a working individual. Depending on the situation, this user may live with their parents, live alone or share a house with other students.

Regarding nutritional habits, this user rarely likes to cook, and eats most of their meals in dining halls and cafes. This user often looks for quick and cheap solutions, such as fast food, and their cooking skills are limited. They are not overly concerned about their food choices and consumption of alcohol can sometimes be high. This user generally believes that they are healthy. Involvement in physical activity varies widely from individual to individual, and the workload they have. Generally they try to be active, and go to the gym or do sport at least once a week, although sometimes they do not have great motivation for physical exercise.

These users are constantly connected to social networks, and in some cases these social networks serve as affirmation or social approval. Usually they have a large group of friends and give more importance to peers than family.

They are generally healthy individuals, but with a tendency towards overweight/obesity because of their poor food choices and sedentary lifestyle. This type of user is very familiar with new technologies and has some interest in the latest developments in this area. Most of

these users have a Smartphone and are constantly connected to the Internet. This user will focus on features that will fit easily into their lifestyle.

#### *User requirements*

The system could be useful to improve dietary habits, for example it may have the ability to search for nearby restaurants or cafes that have healthier menus/choices and fit within a specified budget. Such suggestions could be based on the GPS location. Healthier meal choices should be positively reinforced through a reward system. For meals at home, the system should have the ability to suggest certain recipes that are tailored to the users objectives e.g. a specific dietary plan that is pre-set by the user. These suggestions should be simple so that the user can prepare meals without great effort and be based on the food preferences of the user. Another useful feature for this type of user is the use of reminders to schedule proper meals. Due to busy work periods and an irregular schedule the user may skip certain meals, or over-consume at particular meal occasions.

To complement the cooking tips, the system could have a shopping list feature. In this case, the system may help the user to prepare a shopping list according the users needs. This type of functionality might have an educational component, for example it could be based on a game that rewards healthier choices. It may also be useful for the system to base the shopping list on a budget that is entered by the user.

The level of stress that this user experiences will fluctuate and for this reason the system should provide a tool that can assess stress levels. The tool might be a simple questionnaire, or the system could suggest appropriate apps or devices that monitor stress. The system could prompt stress measurements based on the calendar, particularly if this feature was used to record upcoming exam periods and work deadlines. According to the results presented, the system may suggest certain activities that would help the user to reduce stress levels e.g. listen to music, go for a walk, plan work schedule.

In order to promote different types of physical activity, the system could suggest alternative travel routes between home and school, such as getting off the train or bus a few stops before the final destination. In particular this could be used if the user was behind on their daily/weekly activity goal.

The connection to social networks is also a crucial factor, especially compared with other user groups. These users are connected to social networks on a daily basis, providing ready-made interactions with other users and friends. If used correctly, the sharing of health behaviours and progress against goals with peer groups may provide additional motivation.

## 4. Selection criteria for efficacy studies

### 4.1. Background

PRECIOUS aims to provide a preventive care system to promote healthy lifestyles. Preventive care involves measures that prevent diseases, rather than curing or treating disease symptoms. Type II diabetes (T2D), preventable cancers, cardiovascular disease (CVD), musculoskeletal disorders, mental disorders, hypersensitivity disorders, osteoporosis and chronic obstructive pulmonary disease have been described as the eight leading non-communicable diseases, or conditions, in the Western world [10]. The prevention/reversal of risk factors for these diseases should therefore be the focus of the PRECIOUS system in the long term. However, within the timescales of the project it is not feasible to evaluate the efficacy of the system to modify risk factors for all eight conditions. Therefore, PRECIOUS efficacy studies will focus on the prevention of T2D or related secondary complications, and also CVD, which share common risk factors. PRECIOUS involves testing and validation in four separate efficacy studies, which are designed to validate different aspects of the PRECIOUS system.

PRECIOUS efficacy studies will take place in the latter stages of the project (Deliverable 5.2: System validation report); however it is important to define the selection criteria at an early stage. This is to allow adequate time for applications to ethical committees, and also to provide a focus for PRECIOUS system development.

### 4.2. Laboratory based validation

#### *Objective of the trial:*

The laboratory test will provide important feedback from the user about each component of the PRECIOUS system. In particular, delivering information about the impact of the general user interface design and determining if users are motivated by the system to change their lifestyle. There are two key objectives for the laboratory based validation:

1. End-to-end validation of basic PRECIOUS components related to environmental monitoring, sleep, physical activity and stress.
2. Separately testing elements (functionality, usability, ergonomics and user impacts) of the system
  - a. Sensors
  - b. Feedback relating to apps
  - c. Gamification-based mobile applications
  - d. Feedback relating to user interface

Testing will include both subjective (questionnaire and face to face discussion) and objective (eye tracking, skin conductance sensor etc) analysis.

#### *Study design:*

Two groups will be recruited to take part in both the end-to-end validation study and functionality tests:

1. Generally healthy subjects who want to change, or are considering behavioural changes, in order to have a healthier lifestyle.
2. Subjects diagnosed with T2D

Each group will include four sub-groups; consisting of young single working professional, student, member of a family unit and member of a retired couple. The aim is to compare compliance with the system based on health status and across the user groups classified according to the usage scenario groups.

A minimum of 8 subjects will be recruited for each of the two studies.

Subjects will follow the below procedure:

- Complete lifestyle questionnaire
- Testing in the living lab (either end-to-end validation or testing of separate elements)
- Complete satisfaction questionnaire
- Face to face discussion

To store data during testing, an agreement is required between IMT and the CNIL (La Commission Nationale de l'Informatique et des Libertés), a French national agency regulating data protection. The authorisation takes some time and must be considered as a potential issue for study start date. For the trials at UNIVIE consent should be obtained from the University ethical board (contacts already established).

*Inclusion and exclusion criteria:*

#### Inclusion criteria

- Male or female
- $\geq 18$  years to  $\leq 65$  years
- Group 1: No chronic diseases, and within one of the usage scenario groups
- Group 2: T2D diagnosis, no other chronic diseases, and within one of the usage scenario groups

*Summary:*

Two main groups will be recruited; those with T2D and those with no chronic diseases. Furthermore, subjects will be recruited according to the four usage scenario groups. Subjects within these specific groups are expected to have different attitudes towards the PRECIOUS system; therefore it is important to assess differences in feedback.

### 4.3. Field trials testing the system with end users

*Objective of the trial:*

To determine whether using the PRECIOUS system helps people to achieve their lifestyle change goals more effectively than a traditional self-monitoring system (self report diary).

*Study Design:*

The study will have an N of 1 design. Twelve subjects will be randomized to three conditions:

1. Self-monitoring of physical activity and dietary intake by self report diary (active control)
2. Self-monitoring of physical activity and dietary intake using PRECIOUS feedback

3. Self-monitoring of physical activity and dietary intake by PRECIOUS + feedback on sleep/stress

*Inclusion and exclusion criteria:*

Inclusion criteria

- Male or female
- Age  $\geq 18$  years
- Aiming to lose weight and improve related metabolic indicators by changing the content and amount of food intake
- Aiming to increase or monitor physical activity

Exclusion criteria

- Having any chronic disease, including T2D

*Summary:*

Selected subjects meet the target criteria for PRECIOUS, that is, people who are trying to change or monitor their diet and physical activity. This study will assess whether PRECIOUS helps users to achieve their lifestyle goals more effectively than traditional self-monitoring techniques.

#### 4.4. Field test with T2D patients

*Objective of the trial:*

To assess users' overall satisfaction and adherence to the PRECIOUS system, and to validate its functions in promotion of behaviour change.

*Study design:*

30 patients with a T2D diagnosis will be randomized to three conditions:

1. Treatment as usual (control group)
2. PRECIOUS system: short onsite training session on how to use the system
3. PRECIOUS system + MI Counselling: face to face counselling session followed by a short onsite training session on how to use the system

The study duration will be 3 months, followed by two scheduled follow-up appointments.

Primary outcome measures:

- Patients' subjective assessment of usability
- Satisfaction and user's acceptance
- Effectiveness (difference between the control group and the intervention groups regarding engagement and adherence to targeted healthy habits) of the PRECIOUS system

Secondary outcome measures:

- Health-related quality of life
- Self-management of T2D
- Change in HbA1c level



- Physical activity
- Nutritional habits
- Other healthy habits (e.g. tobacco use, alcohol, sleep hours)
- Psychosocial factors (e.g. social participation, social support, etc.)

Recruitment:

Patients will be recruited from specialist outpatient consultation at Vall d'Hebron Research Institute. All patients must be under the care of specialists who adhere to national guidelines for diabetes care.

Ethical issues:

The field test will be approved by the Hospital Universitari Vall d'Hebron Clinical Research Ethics Committee. Informed consent will be obtained from each participant in the study.

*Inclusion and exclusion criteria:*

Inclusion criteria:

- Male or female
- Age  $\geq 18$  years
- Diagnosed with T2D  $\geq 3$  months before the study inclusion
- Have an HbA1c level  $> 7.0\%$
- Patients must be cognitively able to participate, understand, and be able to complete questionnaires in Spanish language
- Be able to use the PRECIOUS system provided to the intervention groups

Exclusion criteria:

- Any mental or physical conditions that interfere with the protocol

*Summary:*

Patients with T2D will be recruited for this trial. Although PRECIOUS targets preventive behaviour in populations with risk factors, rather than diseases, it is accepted that in the period of time available for the trial (3 months) it may not be possible to detect significant behavioural changes in such a population. Patients are likely to have increased motivation for change, and may have more extreme risk behaviours on entry into the trial, for instance, unbalanced diet, lack of physical activity, abuse of medication, smoking, excessive alcohol consumption, etc.

The objectives of this trial are to assess user satisfaction and adherence to the PRECIOUS system, both of which can be achieved using patients with T2D. Furthermore, this intervention applies a secondary prevention strategy. Whilst not the focus of this project, PRECIOUS could be applied in a secondary prevention setting in the future, and therefore data collected in this respect is of use.

The first step in this field test will consist of an evaluation of the *status quo* of the patients, and his/her readiness to change for each risk factor identified.

Some examples of desired outcomes will be:

- To achieve a balanced diet
- To increase physical activity
- To improve metabolic control

- To enhance diabetes self-management
- To improve health-related quality of life
- To foster patients' satisfaction with PRECIOUS system

#### 4.5. Food intake monitoring field test

##### *Objective of the trial:*

The primary objective of this trial is to compare key dietary data captured by the PRECIOUS food intake monitoring tool with data recorded using a commercially available food intake monitoring application (e.g. MyFitnessPal) and a paper-based food diary. The paper-based food diary is a well recognised method for collecting dietary information; therefore, this method is included in order to assess accuracy of data recorded using the PRECIOUS and commercial tools. For this objective subjects should have a stable diet; thus allowing comparisons of average food intake between study periods.

The secondary objective is to compare user feedback between the tools/methods used. For this objective subjects should be potential users of the PRECIOUS food intake monitoring tool. This may include users with a range of attitudes towards dietary change (e.g. would like to maintain, would like to change or are actively changing dietary habits).

Both types of subject will be recruited to the field test; however only subjects stating that they would like to maintain their dietary habits will be used in analysis for objective 1.

##### *Study design:*

Subjects will be recruited to a randomised, crossover study involving three conditions, where subjects act as their own control:

- Use of PRECIOUS food intake monitoring tool for 7 consecutive days (test method)
- Use of commercial food intake monitoring application for 7 consecutive days
- Use of paper-based food diary for 7 consecutive days

Subjects will complete a pre-study questionnaire indicating their age, gender, familiarity with use of technology and apps, current dietary habits and attitude towards dietary change. Subjects will be trained in the use of each food intake monitoring tool/methodology on entry into the study. On completion of each condition subjects will be required to complete a user feedback questionnaire assessing satisfaction with the recording method. A wash out period (1-2 weeks) will be applied between completion of each condition. If there is sufficient time, the study will be repeated after 1-2 weeks using the same subjects. This will allow an assessment of the impact of familiarity/learning on recording and user feedback. Informed, written consent will be obtained from each participant in the study.

##### *Inclusion and exclusion criteria:*

###### Inclusion criteria:

- Male or female
- Age  $\geq 18$  years
- Familiar and comfortable with the use of mobile and computer technology

- Use a device(s) with internet connectivity e.g. smart phone, tablet, laptop, desktop, games console at least once a day

#### Exclusion criteria

- Having any chronic disease, including T2D
- Following a formal diet programme (e.g. Weight Watchers®)
- Women who are pregnant or breastfeeding
- Having any gastrointestinal conditions (e.g. Irritable Bowel Syndrome) or allergies/food intolerances

#### *Summary:*

The main objective of the food intake monitoring field tests is the comparison of data collected by the PRECIOUS tool and comparable applications or methods. The PRECIOUS tool also aims to be less burdensome to the user and to encourage more regular data entry (giving a more accurate interpretation of dietary habits). In order to analyse the results, it will be important to gather information on age, gender, dietary habits and attitudes towards dietary change. This information will be used to allocate subjects to balanced study groups where possible, and may help to interpret any anomalous results. Additionally, only subjects stating that they would like to maintain their dietary habits will be used in analysis for objective 1. The secondary objective is to gather feedback from all participants to compare attributes such as ease of use, options available, design etc.

## **5. Selection criteria for general user feedback**

Whilst it is necessary to define specific selection criteria for the individual field and laboratory efficacy studies, it is also important that PRECIOUS can be applied in the future to a wide range of users, with various disease risk factors. In order to ensure that PRECIOUS is applicable for all potential future users, it will be important to engage a wider audience in some of the development stages of PRECIOUS, for example, when defining the user requirements, and in organising public workshops or seminars to gather feedback.

For such activities the following basic inclusion criteria will be suitable:

- Male or female
- Age  $\geq 18$  years
- Familiar and comfortable with the use of mobile and computer technology
- Own at least one device with internet connectivity e.g. smart phone, tablet, laptop, desktop, games console
  - Use at least one such device  $\geq 4$  times per week
- Have considered/are considering making changes to improve their health, or are currently making changes to improve their health
  - Should include one or more of diet, physical activity, sleep and stress

## 6. Summary

This deliverable presents the development of a list of user requirements and usage scenarios, as well as an outline of future field and laboratory studies that will be used to assess the efficacy of PRECIOUS.

In developing the user requirements and usage scenarios, situational interviews were carried out with a sub-set of potential PRECIOUS users. Participants were selected based on their desire to change behaviour and openness to the use of technology for this purpose. This approach elicited detailed responses regarding current behaviour and perceived barriers to change, as well as creative ideas for the design of technology that could assist in behavioural change. This information was vital in producing a challenging set of user requirements, which will be approached in subsequent project work (Deliverable 4.1: System architecture and design specification). However; it will also be important to engage less motivated individuals who are important targets for PRECIOUS, as well as users from a more diverse range of economic and social backgrounds.

The field and laboratory study outcomes will be reported on within Deliverable 5.2: System validation report. Additionally, it will be important to gain appropriate ethical permissions prior to carrying out these studies. An ethical report will be submitted to the European Commission during each year of the project, which will confirm the process undertaken to secure ethical approval for each study. Finally, ethical and privacy issues related to the PRECIOUS system will be outlined in Deliverable 2.4: Ethical and privacy guidelines for PRECIOUS system implementation.

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Ref Type: Report

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Ref Type: Report

## **Annex I: Diet scenario**

### A couple of warm up questions:

How would you describe your current eating habits?

How do you feel about your current eating habits/diet?

### Scenario:

I would like you to imagine that you have an opportunity to change your current eating habits. Tell me a little bit about what you would like to do.

What are the main reasons for making this change to your diet? (Prompts: lose weight, more healthy/feel better about myself, clothes fit better, peer pressure etc.)

Tell me about the likely barriers or challenges you may face when making this change in your behaviour. (Prompts: Time, cost, motivation, don't want to do it alone etc.)

I would like you to be creative and imagine something that can assist you to achieve your goal. Take a moment to visualise this in your mind.

Okay, now describe this to me ...

### Possible prompts:

- What does it look like?
- If a physical thing: How does it feel in your hand? How does it feel on your skin?  
Describe what it is like to wear? What is it like to touch?
- What functions does it perform? What does it have to be able to do?
- How does it show you what to do? (images, instructions, tables, touch or voice operated)

### Follow up questions:

- Where would you want to use this...? (Prompts: outdoors, in the gym, with the family)
- What would your friends think of this ...?
- How does this ... compare to anything you currently use?
- By using this ....., how would it make you feel about being able to change your current levels of food intake?

## Annex II: Physical activity scenario

### A couple of warm up questions:

Tell me about a typical exercise experience for you.

Can you describe for me how exercise makes you feel?

### Scenario:

I would like you to imagine that you have an opportunity to increase and/or change the type of exercise you currently do. Tell me a little bit about what you would like to do.

What are your main reasons for making this change to your level and/or type of exercise? (Prompts: lose weight, get fitter, make friends, more healthy/feel better about myself, a joint hobby etc.)

Tell me about the likely barriers or challenges you may face when making this change in your behaviour. (Prompts: Time, cost, motivation, don't want to do it alone etc.)

I would like you to be creative and imagine something that can assist you to achieve your goal. Take a moment to visualise this in your mind.

Okay, now describe this to me ...

### Possible prompts:

- What does it look like?
- If a physical thing: How does it feel in your hand? How does it feel on your skin?  
Describe what it is like to wear? What is it like to touch?
- What functions does it perform? What does it have to be able to do?
- How does it show you what to do? (images, instructions, tables, touch or voice operated)

### Follow up questions:

- Where would you want to use this...? (Prompts: outdoors, in the gym, with the family)
- What would your friends think of this ...?
- How does this ... compare to anything you currently use?
- By using this ....., how would it make you feel about being able to change your current levels of exercise?



### **Annex III: Sleep scenario**

#### A couple of warm up questions:

Describe for me your current sleeping patterns? (Prompts; disrupted, low, insomnia)

Explain for me, how your lack of or disrupted sleep pattern affects the way you feel?

#### Scenario:

I would like you to imagine that you have an opportunity to change or improve your current sleeping pattern. Tell me a little bit about what you would like to do.

What are the main reasons driving you to change / improve your sleeping pattern? (Prompts: more healthy/feel better about myself, able to cope, less tired, think clearly, have some energy)

Tell me about the likely barriers or challenges you may face when making this change in your behaviour. (Prompts: making time, motivation, don't know how, nothing I've tried so far works etc.)

I would like you to be creative and imagine something that can assist you to achieve your goal. Take a moment to visualise this in your mind.

Okay, now describe this to me ...

#### Possible prompts:

- What does it look like?
- If a physical thing: How does it feel in your hand? How does it feel on your skin?  
Describe what it is like to wear? What is it like to touch?
- What functions does it perform? What does it have to be able to do?
- How does it show you what to do? (images, instructions, tables, touch or voice operated)

#### Follow up questions:

- Where would you want to use this...? (Prompts: outdoors, in the gym, with the family)
- What would your friends think of this ...?
- How does this ... compare to anything you currently use?
- By using this ..., how would it make you feel about being able to change your current levels of sleep?

## Annex IV: Stress scenario

### A couple of warm up questions:

How would you describe your current levels of stress? (Prompts: low, high, fluctuate, work/family)

Describe for me, how stress affects your body and mind? (Prompt: physical and mental health)

### Scenario:

I would like you to imagine that you have an opportunity to change or reduce your current levels of stress. Tell me a little bit about what you would like to do.

What are the main reasons driving you to change / reduce your current levels of stress? (Prompts: more healthy/feel better about myself, to cope, work/life balance, spend time with family/friends)

Tell me about the likely barriers or challenges you may face when making this change in your behaviour. (Prompts: making time, motivation, out of my control, don't know how etc.)

I would like you to be creative and imagine something that can assist you to achieve your goal. Take a moment to visualise this in your mind.

Okay, now describe this to me ...

### Possible prompts:

- What does it look like?
- If a physical thing: How does it feel in your hand? How does it feel on your skin?  
Describe what it is like to wear? What is it like to touch?
- What functions does it perform? What does it have to be able to do?
- How does it show you what to do? (images, instructions, tables, touch or voice operated)

### Follow up questions:

- Where would you want to use this...? (Prompts: outdoors, in the gym, with the family)
- What would your friends think of this ...?
- How does this ... compare to anything you currently use?
- By using this ....., how would it make you feel about being able to change your current levels of stress?

**Annex V: Recruitment questionnaire**

Please select your gender

- Male
- Female

Please select your age

- 16-17
- 18-25
- 26-35
- 36-45
- 46-55
- 56-60
- 61-64
- 65+

Do you limit your intake of any food products or beverages due to health issues, medical conditions or formal diet program?

- Yes
- No

At home which type(s) of technology do you own and use? (Please tick all that apply)

- Smart phone
- Tablet
- Laptop
- Games console
- Computer
- I do not use any of these

Outside work, how often would you say that you connect/use the internet?

- Several times a day
- At least once a day

- 4-6 times a week
- 1-3 times a week
- Less than once a week
- Do not have access or use the internet

Thinking about the type and amount of physical activity you currently do, please select one of the following responses that best reflects your current thinking.

- I would like to maintain my current level of physical activity
- I would like to increase my current level of physical activity
- I may consider changing my current level of physical activity in the future
- I am not at all interested in doing any kind of physical activity

How often are you currently doing some form of physical activity?

- 5-7 times a week
- 2-4 times a week
- At least once a week
- At least once a fortnight
- Less than once a fortnight

Thinking about your current diet/eating habits; please select one of the following responses that best reflects your current thinking.

- I would like to maintain my current diet/eating habits
- I am currently trying to improve my diet/eating habits
- I may consider changing my current diet/eating habits in the future
- I have no real interest in my diet and have no intention to change

Thinking about your current stress levels, please select one of the following responses that best reflects your current thinking.

- I never experience stress. This is not an issue for me.
- I experience stress and this is something I am actively trying to reduce/change
- I experience stress and this is something I would like to reduce/change in the future
- I experience stress but do not feel it is an issue or something I need to change

Thinking about your current sleeping pattern, please select one of the following responses that best reflects your current thinking.

- I sleep well
- I do not sleep as well as I would like. I am currently trying to improve/change this
- I do not sleep as well as I would like. This is something I would like to try to improve/change in the future
- I do not sleep as well as I would like but am not looking at trying to improve/change this

If there was a computer tool or app to help you to improve things like your diet, stress levels, sleep patterns and/or your physical activity, how likely would you be to use this application? From the choices below, please select the one that best reflects your current thinking.

- This is NOT something I would be interested in or use
- This is something I may be interested in and may use
- This is something I would definitely be interested in and would use

*Additional question on EuroFIR's questionnaire (used for information only)*

Are you currently using a computer application or tool that helps you to improve things like your diet, stress levels, sleep patterns and/or your physical activity? (YES/NO)

If yes, could you please write the name of the computer tool/app?

**Annex VI: Consent form for adult participants in face to face interviews**

We would like to thank you for participating in this research. We appreciate your time and valuable input. Please **PRINT** your name in **BLOCK CAPITALS** below and **sign** against it for:

I agree voluntarily to participate in this consumer study, I fully understand what is required of me and I have had an opportunity to ask questions. I give permission for the interview to be audio recorded according to the MRS Code of Conduct.

You may withdraw from the study at any time without explanation and data pertaining to you will be removed from the study within a reasonable number of days.

The information supplied will be used by Campden BRI in connection with market research. Analysis of the information collected will be published in a form that will not enable individual contributions to be recognised. Personal data will not be disclosed to any third parties except as required by law.

If you wish to discuss this information please write to the Data Controller, Campden BRI or email [datacontroller@campden.co.uk](mailto:datacontroller@campden.co.uk)

At the end of the session you will receive a project number on which to allocate an amount of time for attending the interview. (*CAMPDEN BRI*)

NAME \_\_\_\_\_

DATE \_\_\_\_\_

RESPONDENT'S SIGNATURE \_\_\_\_\_

**Annex VII: Consent form for adult participants in telephone interviews**

You are being asked to participate in a research study. Participation is completely voluntary. A researcher on the day of the interview will be available to answer your questions.

There is no cost to you for participation in this study.

No identifiable information will be collected about you. The audio recordings will also be stored in a secure location; then transcribed and erased at the end of the study.

**Participation in this study is voluntary.** You may refuse to answer any question or discontinue your involvement at any time without penalty or loss of benefits to which you might otherwise be entitled. Your decision will not affect your future relationship with EuroFIR AISBL.

**I agree to participate in the study (YES/NO)**

First name:

Last name:

Phone number (with international code):

Availability for the phone interview (please select on or more days that you may be available for this phone interview):

**“Submit”**