

PEGASO Fit for Future

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Abstract. Challenging teen-agers in their own fields and areas of interest, PEGASO – Fit 4 Future - aims at promoting a sustainable behavior change towards healthy lifestyles, with a holistic and multidisciplinary approach. PEGASO is based on a mobile, social and networked gaming platform, considered as a powerful tool to actively engage the younger population in activities that will stimulate healthier choices in their daily lives to counterfeet sedentariness, overweight up to obesity. To support this action, in the platform, represented by the smartphone, three main functionalities are implemented: an individual & environmental monitoring through wearable devices, a feedback system for providing a feedback in terms of “health status” changes, the Social connectivity and engagement to support motivation.

1 Overview and Rationale

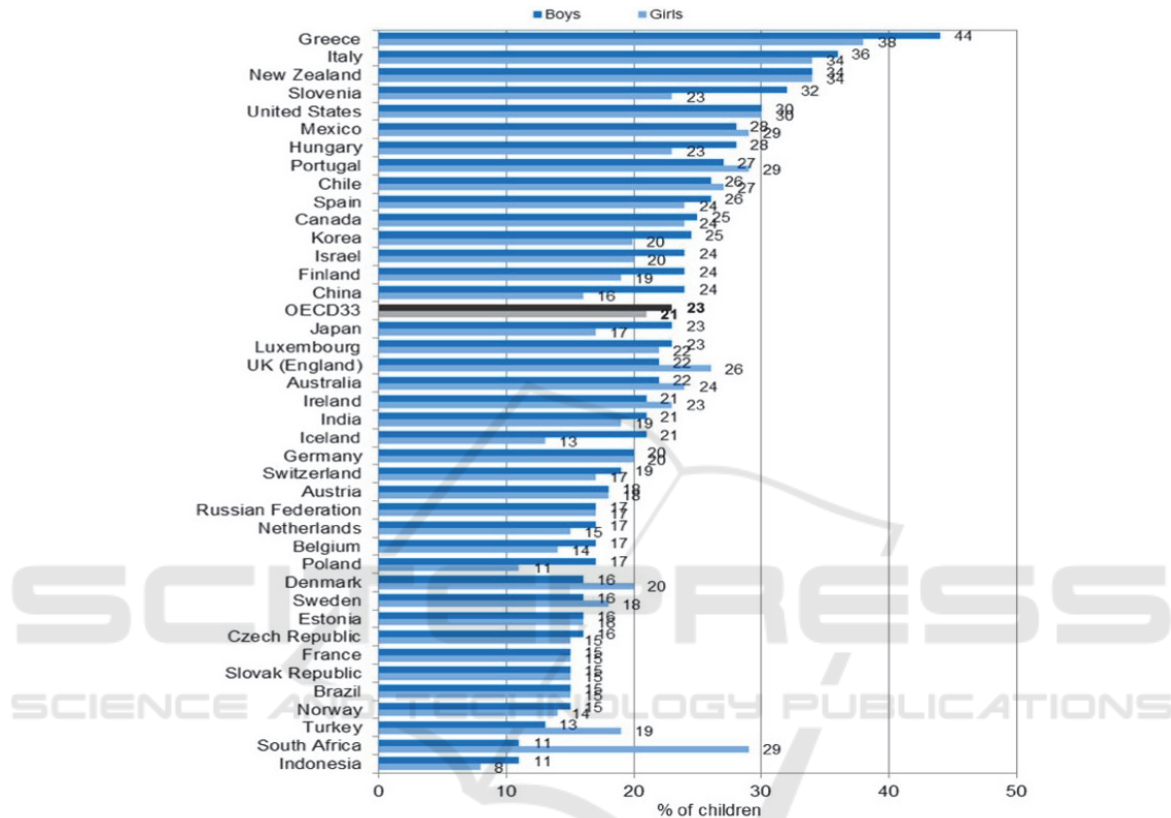
The rapidly increasing prevalence of overweight and obesity among children and adolescents reflects a global ‘epidemic’ worldwide. Recently the US Center for Disease Control and Prevention has evidenced that “Childhood obesity has more than doubled in children and quadrupled in adolescents in the past 30 years.”[1, 2].



Fig. 1. The WHO web page on the priority to overweight and obesity prevention in children (last accessed march 18, 2015).

Also WHO recognized prevention of juvenile overweight and obesity as a priority for future health being in 2014 and in the WHO European region 1 on 3 11-years old children in this condition.

The following histogram represents the dramatic situation and dimension of the problem at European and worldwide level.



Source: International Association for the Study of Obesity, 2013; Bös et al. (2004), Universität Karlsruhe and Ministère de l'Éducation nationale et de la Santé for Luxembourg; and KNHANES 2011 for Korea.

Fig. 2. Measured overweight (including obesity) among children aged 5-17 in 2010 or nearest year.

Due to the associated serious medical conditions, it is estimated that obesity already accounts for up to 7% of healthcare costs in the EU, as well as costs to the wider economy associated with lower productivity, lost output and premature death. Obesity in younger age groups has been recognized as an alarming key predictor for obesity in adulthood, but also entails a number of short term health complications in juvenile age such as hypertension, type 2 diabetes, metabolic syndrome, fatty liver disease, sleep disturbances along with greater risk of social and psychological problems [3, 4].

Sedentariness and over-consumption of high calorie foods and beverages are *a priori* determinants of overweight/obesity and poor health status also in adolescents, according to well-grounded evidences.

“Prevention is of obvious importance and there is an urgent need for further research into how physical activity and training, in addition to nutrition, can prevent the steadily increasing average body mass index of Europeans. This proposal includes a vision that integrates a lifestyle of healthy habits with an environment that promotes healthy living by encouraging exercise and making healthy food affordable.” (Visions for Horizon 2020) [3].

Healthy lifestyle habits, including healthy eating and physical activity, can lower the risk of becoming obese and developing related diseases. The dietary and physical activity behaviors of children and adolescents are influenced by many sectors of society, including families, communities, schools, child care settings, medical care providers, faithbased institutions, government agencies, the media, and the food and beverage industries and entertainment industries.

2 Methodological Approach and Concept of the PEGASO Project

Juvenile obesity is a complex disorder with many interrelated consequences. Addressing the obesity issues requires a *comprehensive approach* taking into account the individual's *physical-physiological* characteristics, *personality* as well as the *social* and *psychological* environments influencing decisions and habits in their everyday life. Challenging teen-agers in their own fields and areas of interest, PEGASO – Fit 4 Future - aims at promoting a sustainable behavior change towards healthy lifestyles, with a holistic and multidisciplinary approach. The approach of PEGASO is based on three level of intervention enabling teen-agers to become co-producers of their wellbeing:

1. Generating self-awareness (acknowledgement of risks associated to unhealthy behaviors),
2. Enhancing and sustaining motivation to take care of their health with a short/medium/long term perspective,
3. Changing behavior towards a healthy lifestyle based on healthy diet and adequate physical activity.

In order to achieve the above targets PEGASO applies behavior change techniques to prevention and will develop a mobile-based Behavior Change Platform that can effectively address teen-agers.

The solution proposed by PEGASO comes from the convergence of the need to address through appropriate preventative measures the rapidly increasing prevalence of obesity among children and adolescents on one side and the rapid development of ICT, and in particular mobile technologies, together with their increasing diffusion among the EU population, on the other side.

Indeed the capabilities of ICT technologies (i.e. mobile phones, digital tablets) together with the possibility to integrate them with the new and fashionable additional technologies for data acquisition (e.g. wearable sensors) offer the opportunity to develop an effective behavior change platform. The solution proposed by PEGASO is

well as multimedia diaries for the acquisition of physical, behavioral and emotional attitude of adolescent.

2. **Feedback System** - This second functionality is aimed at providing a feedback in terms of “health status” changes, required actions to undertake and so on. This function will also propose personalized healthy modification of the lifestyle (in terms of diet and/or physical activity), thus promoting the active involvement of adolescents in changing their behaviors.
3. **Social Connectivity and Engagement** - The third dimension extends to include a social network where the user can share experiences with a community of peers concerning e.g. physical activity, food consumptions and everyday habits through different gaming strategies.

PEGASO has adopted a User Centred Design approach (UCD) by considering the target population (i.e. teenagers) at the centre of the system in a paligenetic process [5]. The UCD approach integrates three main elements: user involvement in all stages of the problem solving process; multidisciplinary research and development team; and iterative design process to refine the solution set. The main target users in PEGASO project are teenagers; however there are also several actors (who are also secondary users – see Figure 4) and products (as shown by the inner circle in Figure 4) involved.

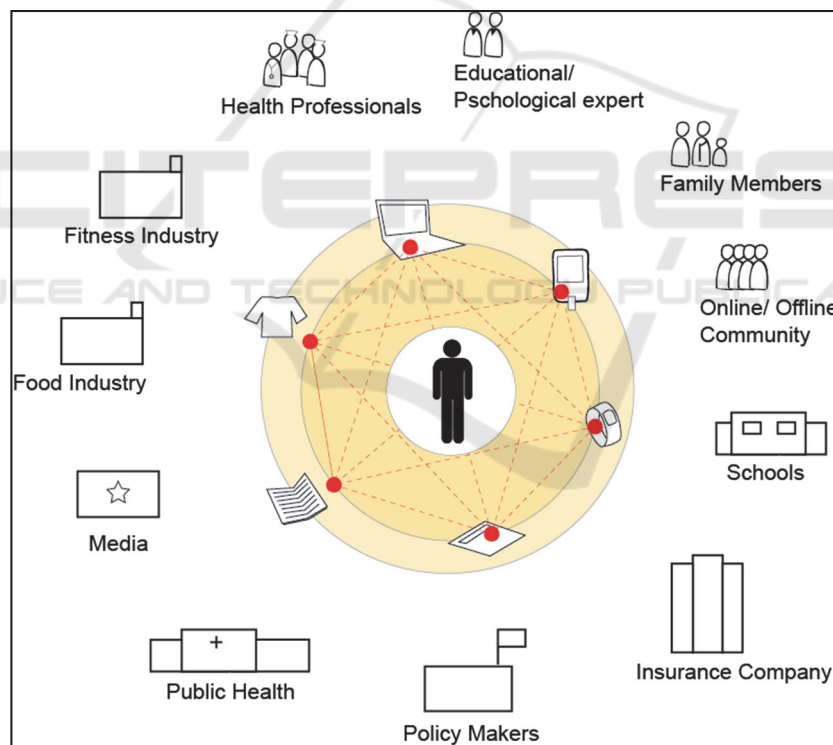


Fig. 4. PEGASO Stakeholders' System.

The ecosystem of stakeholders and enablers is composed of three main parts that are integrated in the user centred PEGASO system: *technological frame* (multimedia

diaries, embedded sensors systems, mobile & web platform), *services frame* (stakeholders services to provide answers to users' needs and desires in real time/not real time, from the health companion to the serious gaming and social experiences) and *experts layer* (which are knowledgeable groups of people from different disciplines - medical/psychological/educational – able to interact with the system, who provide them with filtered accurate and needed information to reach their PEGASO objective).

Technological Frame. Teens are familiar with Internet, social networks, mobile phones and apps, video gaming and, in general, with all the ICT platforms. Smartphones also assures the highest level of technology acceptance. This key issues are assumed as technological starting point to define the PEGASO architecture and to define a successful strategy to empower the teen-agers awareness about healthy lifestyle. The huge amount of personal and social exchanged and/or stored data includes also health records, thus posing severe reliability and security requirements that will be effectively managed through a cloud platform. Finally, PEGASO apps and games from the software layer, as well as wearable sensor and other more traditional systems (balance board for instance) complete the PEGASO technology frame.

Services Frame. Social is the key word for service development: the services created by stakeholders in PEGASO Project promote an individual and social healthier lifestyle through motivating and engaging multiuser serious games. Nevertheless individual support is provided both for data entry through multimedia apps that simplify and engage the users (for instance through multimedia diary compilation or through the health companion interaction). The health companion, developed by PEGASO, constitutes the interface on the smartphone between the guidance system and the teenager. All the stakeholders (including the Food Industry, Public and Private Health Policy actors, Fitness industries, Media, Schools, and Insurance companies) at different levels will offer to users the infrastructure to motivate (and promote) the adoption a healthy behavior.

Experts Layer. in PEGASO motivation and engagement by means of gaming strategies will be integrated with healthier lifestyle. All the information from the users must be “handled” and processed and the corresponding feedback provided. This means building an expert layer that is able to analyse all the data and deliver the resulting answers to the teenagers. A part of this layer will be composed by automatic algorithm (for real-time processing and feedback provision when applicable); a second building block will be the experts' team who will integrate the previous assessment to better stimulate the teenagers' consciousness about obesity and their motivation to adopt a healthy lifestyle. The role of experts in PEGASO project is assumed to be twofold: 1) to personalize information for each individual's physical and psychological models (i.e. personalized care) in order to reach the full acceptance by each teenager and guarantee a correct interpretation; and 2) to follow up of each teenager healthy status.

2.2 The Elements of Behavior Change

PEGASO considers four levels of engagement towards persuasion for user (the teenagers) empowerment in healthcare [6]: awareness of obesity risks, motivation, affective learning and finally behavior change.

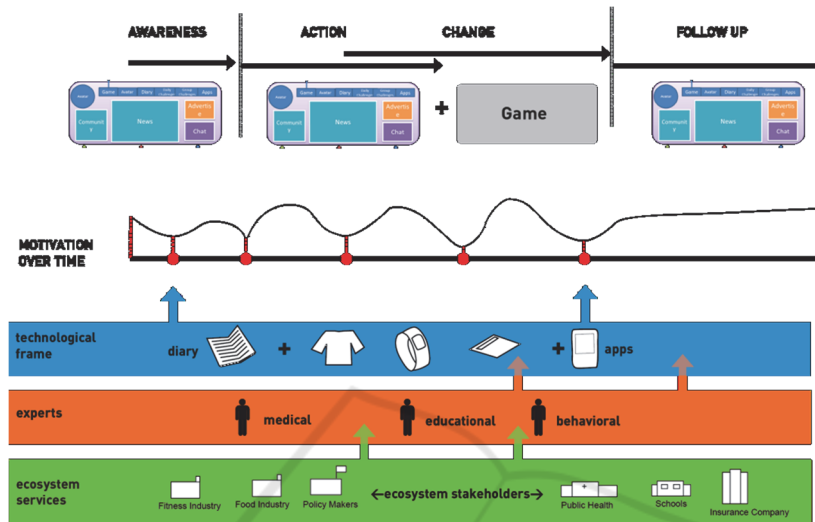


Fig. 5.

Various types of expertise / knowledge and technologies feed these levels of engagement towards healthier lifestyle and empower the teen-agers to take decisions accordingly.

Develop Awareness: teenagers need to be aware of what they are doing; what is right and what is wrong for their healthy living. Some of them are unconsciously and automatically acting, and often under estimate or have no clear notion about information they receive. Monitoring lifestyle of teen's activity, collecting parameters and integrating their own data will enable self-awareness on their current situation. Through developing self-awareness and self-reflection, the user can frame the problem or the opportunity area to act upon or intervene.

Affective Learning is the "highest" learning goal. The learner should trust in something that happens in several years. That is also a good argument in a new "learning level" to use a constructivist learning model and special media like "social games" are adequate to reach this goal. Giving teenagers information through tools they are affectionate is a strategy to reach their behavioral change.

Create Motivation: it is important to motivate teenagers to change their behavior and keep this activity in a long-term period. The actors in the ecosystem offer healthier benefits and services in the users' environment towards satisfying their needs or desires.

This part is quite challenging, since the motivation depends on many factors as well as emotions, psychological environment and personality of teens. The system needs to provide constant different layouts of motivational activities where experts,

technological frame monitoring and stakeholders services come into the scene.

Enable Behavior Change: once teenagers have the awareness and the motivation, it is important to involve experts and use PEGASO system to support the behaviour change process and reinforce existing virtuous behaviors. The turn from old unhealthy behaviors into healthier new ones has to be monitored through technology on a longer period.

In order to create prevention, it is important to change or stop old unhealthy habits and develop new healthier habits. In this respect, PEGASO takes a holistic approach involving the teenager's environment and specifically the families, by means of an education process empowered by training that will be provided on location (schools) and on line. The expert team will give feedbacks to the users allowing them to change their behavior on a long-term basis. The overall system takes advantage of gaming strategies to persuade users to change their behavior.

2.3 PEGASO Evaluation Strategy

PEGASO will be validated by secondary school students with the support of their schools and families. The reason for involving these students as sample population lies on the assumption that around the age of 14 years old the teen-agers acquire more independency and have increasingly the opportunity to make own and independent decisions. It is therefore important that at this stage they become aware of the consequences of inappropriate, unhealthy lifestyles.

Four validation studies will be carried out in Italy (Lombardy), Spain (Catalonia) and United Kingdom (England/Scotland).

The validation activities will assess the following aspects of the PEGASO Behavior Change Platform:

- System and Technology **acceptance**, usability and long-term use: these will constitute also a secondary assessment of motivation and engagement;
- **Reliability** in assessing the teen-agers lifestyles and their changes (with focus on the eating habits and on physical activities) and related efficacy of the sensing platform (i.e. smartphone and wearable sensors' system);
- **Efficacy** of the system in encouraging lifestyle change;
- **Subjective assessment** for awareness;
- System's **compliance** to Stakeholders' needs.

Further studies are required, and are currently out of PEGASO's scope, to be able to evaluate the longer term outcomes of the intervention, and to perform in particular the evaluation of the user risk awareness regarding the development of obesity and related comorbidities, the evaluation of user environmental factors (family and school), the potential harms and costs, all of them assessable involving the same target groups few years after the project completion.

3 Activities and Results

PEGASO Fit for Future has been running for over a year, with the first year being

dedicated mostly to the consolidation of requirements from the user viewpoint and the general architecture of the platform.

3.1 The Comprehensive Virtual Individual Model

The PEGASO project aims at pushing this concept further introducing the feature of dynamically selecting the opportune tailored interventions based on the user's individual characteristics and interaction context [7]. Tailoring the intervention involves modeling the user's characteristics and for this purpose it has been developed the Virtual Individual Model, which comes from the concept of the Virtual Physiological Human. The latter is a methodological and technological framework for integrated modeling of a living human body that describes the interaction of all the physiological components of individuals from molecular to apparatus level [8]. The Virtual Individual Model aims to include individual's characterization composed of physiological, physical, and psychological determinants. This allows integrating biological aspects of human functioning with lifestyle behaviors and psychosocial externalities that are crucial for the determination of the adoption of a certain life-style. This model is integrated in the system through an ontology-based virtualization. This process allows turning the information contained in the Virtual Individual Model into a structured knowledge that can be dynamically updated and elaborated by the computer to select the best interventions for each individual. Tailored interventions make the information personally relevant and researches demonstrated that computer-tailored health education is more effective in motivating people to make dietary changes [9] and that it could be also a good practice to promote physical activity [10].

3 Tailored Intervention Forms The Virtual Individual Model characterizes the user's nutritional habits, physical status, and psychological status to provide personalized intervention to foster the adoption of a healthy life-style. Obviously, the interaction between the system and the user plays a crucial role in the tailoring process and to facilitate the effectiveness of the intervention. Since the teenagers are the targets of the PEGASO project, the smartphone has been chosen as the mediator of the interaction. Indeed, the smartphones are already perceived as a companion and it is most likely that this relationship between user and smartphone will strengthen in the future [11]. The smartphone is the perfect companion because it is personal and it is ubiquitous. It will provide the possibility of interacting directly with the user asking to enter some information or in a discreet and implicit manner allowing monitoring the user activity. The sensed data referring to the parameters that concern the selected characteristics modeled for the tailoring will be updated constantly in the Virtual Individual Model. Moreover, with the many connection possibilities, the smartphone can allow accessing the information stored in the cloud and can connect to other devices, such as wearable accessories that can improve the physical activity monitoring. Since it is ubiquitous, it can always provide the appropriate trigger, as tailored messages, to influence the user's behavior. This is very important, since Fogg observed that "without an appropriate trigger, behavior will not occur even if both motivation and ability are high" [6]. Moreover, the many sensors integrated in the smartphone allow capturing the contextual information, which can help to generate the trigger at the opportune moment maximizing its effectiveness. Moreover, the smartphone allows installing many applications as media services and games that will

motivate the teenagers to interact with the system. The mobile game will be designed to promote physical exercise. The integration with social networks will add the social aspect of the users' life to the parameters for the tailoring of the interventions and, most importantly, the social factor represents a very effective motivator. Another mobile application will be a sort of personal food diary, where the user will be able to note his/her alimentary behavior. This diary will help to understand the alimentary behavior of the user in order to provide the right feedback. For example, some data suggest that breakfast consumption is associated with higher intakes of micronutrients, fruit and vegetables and less frequent use of soft drink [12]. This means that the breakfast consumption habit can help to adopt a healthy dietary behavior. The diary allows following this behavior and to intervene through an alarm in order to remind to the teenager to have breakfast. The eating behavior is not only related to homeostatic reasons. In fact, an important factor that influences people's need and choice of food is represented by the emotional state [13]. The diary will allow noting also the mood in order to include the emotional state in the recognition of behavioral patterns. In fact, this information can be used to find some specific behavioral pattern related to emotional eating in order to generate the best intervention.

The introduction of biological models empowering technological actions for the promotion of citizen's health and well-being is considered to lead to a higher user centricity producing a more individualized strategy of health management and a stronger empowerment and engagement of the user [14].

The concepts supporting the PEGASO Virtual Individual Model (VIM) stem from a background of European experiences based on the vision of the individual as a unique multiple organ system, overtaking the traditional approach - in force in the medical practice - of the human body as a set of independent sections. The current modelling of a living human, such as the Physiome model [8], relies on different body functions incorporating knowledge from several biological disciplines and converges into a holistic integrative architecture. However, such an approach does not account for the behavioral and social externalities, which are known to interfere with and determine the biological balance of functions in health and disease.

By contrast, the PEGASO VIM's ambition is to provide a definition of individual's characteristics relevant for the condition of overweight/obesity, including both biological specifications and alimentary and exercise behavior factors, along with their psycho-social drives, specifically analyzed for young people, in a defined age range of 13-16. To this aim, the contribution of experts from different Europe countries has been integrated into a comprehensive view joining competences including medical, exercise physiology and nutritional knowledge, together with psycho-social expertise.

The PEGASO VIM overall structure is depicted in Figure 6 and considers the individual's health and well-being as resulting from the balance between components of physical, functional and psycho-social domains, according to the World Health Organization founding definition [15].

The model is based on elements relevant for overweight/obesity among adolescents. It considers health and well-being as primarily settled on a balance between physical body structure, body functionalities and psycho-social factors which, on turn, influence dietary and exercise behaviors and their possible changes. Alimentary and physical activity habits are key life-styles for preserving good

physical conditions and a well-functioning organism.

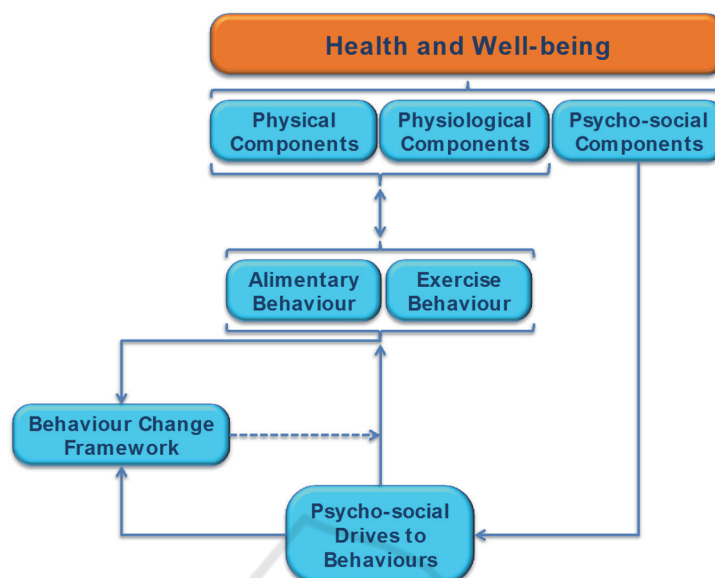


Fig. 6. Overall PEGASO Virtual Individual Model.

Dietary and physical activity behaviors are important life-styles affecting health and well-being through the preservation of optimal physical conditions and functional order. The model thus involves also concepts related to behavioral and psycho-social domains which are only partially covered by current vocabularies and ontologies. Since healthy life-style awareness, motivation and engagement among adolescents are the principal objectives of the PEGASO system, a particular emphasis is given in VIM to the aspects related to behavior change strategies and their relation with psycho-social components driving alimentary and exercise behaviors, especially if liable to be modified.

It is important to consider the psychosocial aspects of overweight and obesity in adolescents because problems associated to these aspects (E.g. peer pressure, low confidence, low self-esteem, depression and attitudes towards food) are likely to have an impact upon their lives and contribute towards differences in physical activity patterns and weight fluctuations. The following sections describe the social and psychological aspects of obesity in adolescents, using a behavioral model based on the analysis of Capability, Opportunity and Motivation as main components of behavior (COM-B). Where relevant in relation to the target behaviors selected for PEGASO adolescents, examples will be given with details.

At the core of the Virtual Individual Model analysis of behaviors is a psychological model of human behavior incorporating the psychological components associated with behavior change. COM-B components are applicable to all human behaviors and are the starting point for developing new behavior change interventions. Each component in the COM-B model directly influences behavior, and interacts with the other components. In combination they can provide the rationale for why the target behavior is not engaged in, and this then identifies the appropriate

components to be addressed to bring about a change in that behavior. In this way all the components of the COM-B model are interdependent, and work in unison to help change a target behavior, or support the maintenance of a target behavior once an individual has adopted it into their regular pattern of behavior. Each component of the COM-B model is divided into sub-components which are used to capture the more refined details of the COM-B components that are specific to the target behavior.

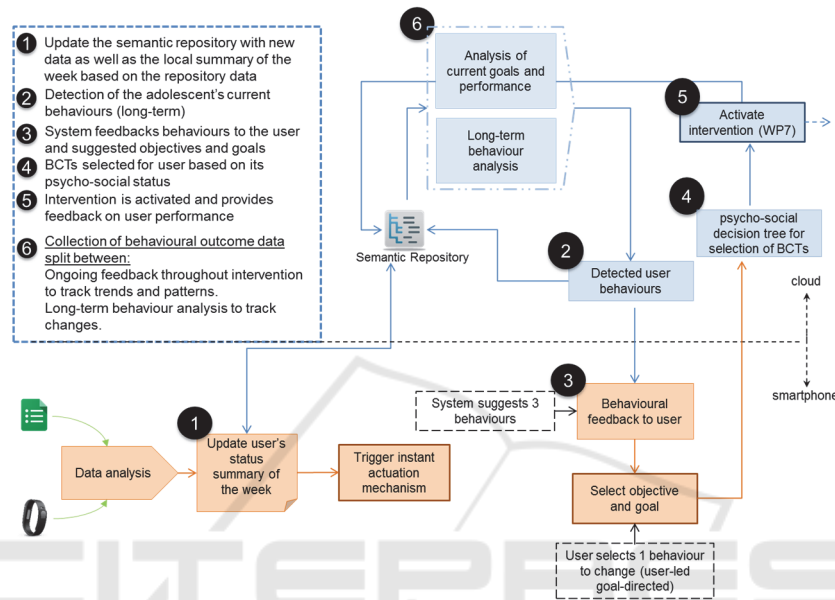


Fig. 7. The functional flow-chart of the PEGASO intervention.

Designing the PEGASO products and service systems the co-design methodology was adopted as key strategy. This is relevant for the specific target population to achieve high acceptance and compliance.

Smartphone, Wearable sensors and Multimedia Diaries have been categorized as sensors of the PEGASO system, and their acceptance and use by the end-user is the first essential requirement for the project success. Together with the sensors two other main fundamental categories constitute the PEGASO system architecture: the Social level of the platform, and the gamification of teens' life.

In this project, Social Network is intended as the creation of a social community that shares the same objective, i.e. healthy lifestyle habits. The End-User requirements aimed at retrieving opinion about the Information Sharing, in particular what teenagers want to share, people they'd prefer to be connected with, how they would like to share those information (feedback system and notification)

Finally, the Social platform represents also the gamification of teens' life and the role of experts is to monitor results from physiological data and to send specific feedback information on the health status of the user through the Health Companion.

Schools play a particularly critical role by establishing a safe and supportive environment with policies and practices that support healthy behaviors. Schools also provide opportunities for students to learn about and practice healthy eating and

physical activity behaviors. For this reason we involved and collaborated with schools in organizing the focus groups and recruiting teenagers in the user requirements definition phase. 16 focus groups in three nations were carried out with about 200 teenagers to gather this information and to iteratively design services and devices, according to the identified directions of PEGASO interventions.



Fig. 8. PEGASO interventions assets.



Fig. 9. The prototypes of garments and wearable devices.

This is a sort of life compass that the PEGASO project aims at helping teenagers to build, through a positive message and tool dedicated to teenagers, for improving their lives. The identified 4 pillars/directions are: a) move, i.e. the adoption of an active lifestyle, b) play, i.e. the serious game sustains engagement and motivation in the choice, c) eat, i.e. food education and pleasure, and d) share, a community and social approach to mutually engage in the actions.

The initial systems have been designed and prototyped and are currently undergoing pre-pilot tests.

A key feature is the PEGASO companion. The smart companion is a Personal Digital “Friend” acting as a daily-life guide for Coaching, Caring for, and Empowering teenagers in their activities toward healthy habits. From this definition the companion has multiple facets fostering behavior change.

- Digital: the companion exists in the smartphone
- Personal: the companion is customized to the single user
- Friend: the companion would establish an affective relationship with the user
- Daily-life guide: the companion accompanies the user (coaching, caring and empowering) during her daily activity
- Toward healthy habits: supporting behavior change to promote healthy lifestyles is the main goal of the companion and PEGASO project in general

Figure 10 highlights the most relevant services that the companion, represented by the circle in the center, should offer to the user in relation to the COM-B model.

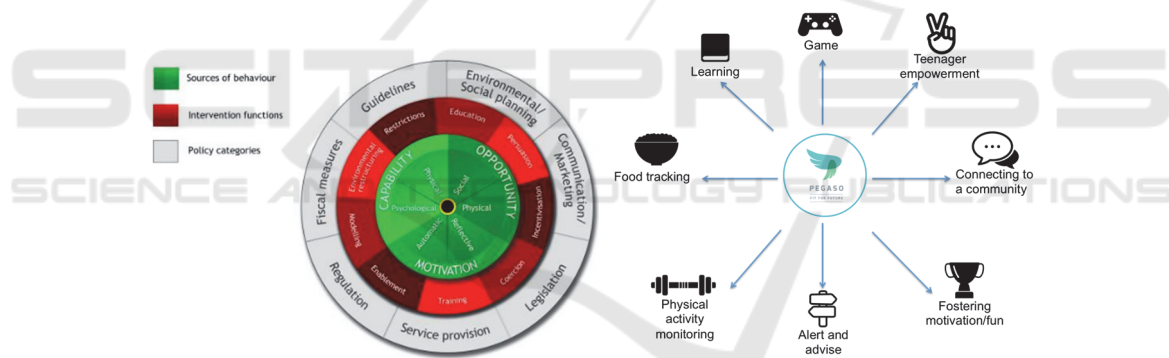


Fig. 10. The reference COM-B model and related services for Companion design.

The main goal of the Companion is to support teenagers’ behavior change increasing Capacity, Opportunity and Motivation to achieve a set of target behaviors.

As we can see from the previous definition, the COM-B model of behavior is at the base of the design of the companion. In particular, the target behaviors have been selected in collaboration with PEGASO experts and taking into account the results of the focus groups. The selected target behaviors are:

- Physical activity: 10.0000 steps, 60 minutes of physical activity per day, Community sports teams, School sports teams, Screen viewing duration, Sleep duration & quality, Walk or cycle to school;
- Alimentation: Breakfast eating, Fruit consumption, Vegetable consumption, Sugar sweetened drinks.

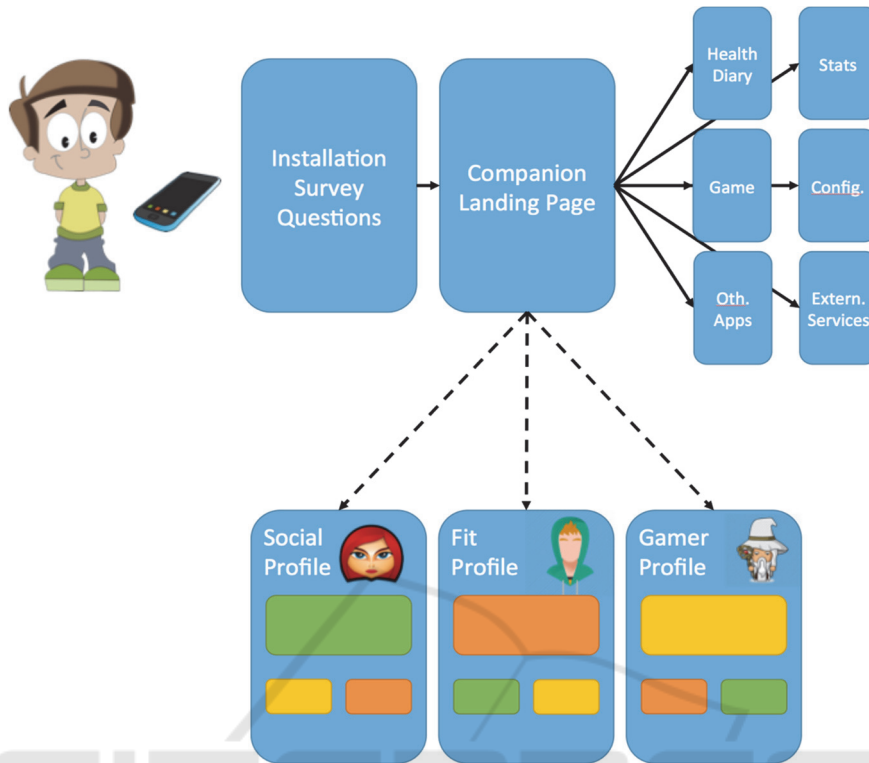


Fig. 11. The first conceptualization of the PEGASO Companion.

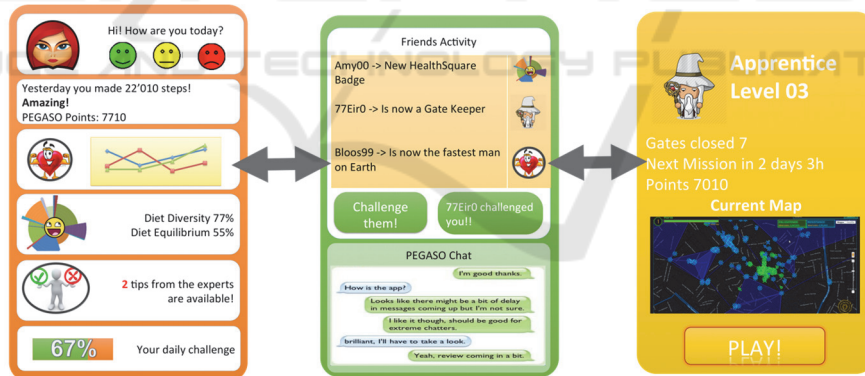


Fig. 12. The first draft PEGASO Companion.

4 Conclusions and Expected Impact

PEGASO believes that we are at a key turning point in the history of the Internet. Convergence of major trends is occurring which is driving changes in people behavior and expectations. These trends include the exponential rise in use of smartphones and

tablets, increased Internet access speeds, new business models driven by online commerce and app stores, the impact of social online communication, and software delivery transitioning from prior PC/internet models to cloud-based services accessed with touch-based devices (smartphones and media tablets).

With more than five billion mobile users worldwide and a massive global network, for the first time in history mobility is attracting significant attention among the healthcare and life sciences community.

Integrating mobility, gamification and life science has the potential to motivate individuals to adopt healthy lifestyles, with personalization techniques and incentives that will be delivered through the PEGASO system.

The following key issues however have to be adequately addressed and are at the center of the PEGASO rationale:

- Knowledge of how to stay healthy is ubiquitous; however, obesity and lifestyle-related illness are still among the top healthcare challenges in Europe.
- Although clinical content and health information have been available through the Internet for years, there has been no improvement in overall health in Europe.
- Motivating individuals to change behavior is not just a clinical issue. Successful programs include incentives along with personalized programs and, increasingly, the inclusion of behavioral science.
- Gamification has emerged as a recognizable trend that can have a significant positive impact on all businesses and is yet to be leveraged by wellness and healthcare.
- Because gamification's goal is to change human behaviors, PEGASO as a wellness player will confront both opportunities and risks, requiring a clear vision of the value of the system.

The strategy proposed by PEGASO, based on behavior changes, is expected to have favorable effects in reducing overweight/obesity and associated diseases and social costs in proportion to the national prevalence of body mass excess in this age class taking advantage of the possibilities offered by innovative ICT and of teens' affection to mobile and social network.

4.1 Enhancing Self-awareness of Younger People for Health Issues, by Means of Inclusive Approach Integrating Individuals into a Community Context, and Promoting Behavioral Changes in Favour of Physical Activity and Healthy Diets

Recommendations specific for children and young people have been released in 2005 also by the Commission of European Communities in the Green Paper on healthy diets and physical activity for the prevention of obesity among EU citizen [16]. Reducing the risks deriving from unhealthy diets and physical inactivity and increasing awareness and understanding of the influences of diet and physical activity on health are the core objectives of the global strategy dictated by the World Health Organization (WHO) against non-communicable disease and changes in behavior has been indicated by WHO among the **outcome indicators** for assessing actions fostering such a global strategy [17, 18]. The relationship between diet, physical

activity and health is based on strong scientific evidence. Studies using motion sensors have shown that children who spend less time in physical activity are at higher risk to become obese during childhood and adolescence [19, 20]. Television and video games contribute to more sedentary leisure activities and are reported to favour concurrent consumption of energy-dense snacks and beverages [21]. In the greatest majority, behavioral aspects related to lifestyle and diet (with a relevant interference of socioeconomic factors) play an important causative role. The findings from the 2009/2010 survey in EU countries from Health Behavior in School-aged Children (HBSC) international report indicate that young people who are overweight/obese are more likely to exhibit unhealthy alimentary patterns, are less physically active and watch television more [22].

4.2 Preventing Juvenile Overweight/Obesity and Reducing Morbidities Associated to Juvenile Overweight/Obesity in the Short Time, and Long Term Health Consequences, including Adult Obesity, and Associated Medical, Social and Personal Costs

According with the 2007 report of the EU Public Health Program Project "Global Report on the Status of Health in the European Union - EUGLOREH", the number of EU children affected by overweight and obesity is estimated to be rising by more than 400,000 a year, adding to the over 14 million of the EU population who are already overweight (including at least 3 million obese children) [23]. Overall, across the entire EU, overweight affects almost 1 out of 4 school age children/adolescents. Childhood obesity has physical, psychosocial and economic consequences. Overweight and obesity in the juvenile age are associated with a number of serious medical conditions such as sleep-related breathing disorders and asthma, fatty liver disease, poor glucose tolerance, increased risk of non-insulin-dependent diabetes, hypertension, and can lead to increased rates of non-communicable disease in adulthood such as cerebro-vascular disease, diabetes, certain types of cancer, osteoarthritis, gall bladder and endocrine disorders, in relation with the high probability for obese children to become obese adults [24]. Recent estimates indicate that more than 27 000 children in the EU have type 2 diabetes and more than 400.000 have impaired glucose tolerance. About 1.1 million suffer from hypertension and 1.2 million suffer from metabolic syndrome (consisting in a clustering of hypertension, abnormalities of lipid metabolism, and raised blood glucose levels)[23]. Moreover, body mass excess in the juvenile age leads to low self-esteem, depression and social exclusion, with immediate consequences in the psychological and social domain, possibly leading also to concurrent or subsequent psychiatric pathology. Specifically, social exclusion in childhood has been associated with reduced psychological functioning in adulthood [19].

4.3 Reducing Medical, Social and Personal Costs Associated to Juvenile and Adult Overweight/Obesity

The economic impact of overweight and obesity on health care and social systems is definitely sizable. Such an economic burden has been recognized in terms of direct

medical costs (including preventive, diagnostic, and treatment services related to obesity), indirect costs (attributable the value of income lost from decreased productivity, restricted activity, absenteeism, and bed days), and intangible costs (which can be referred to as the social and personal costs or losses associated with obesity) [25, 26]. In recent years, health costs deriving from obesity among adults in different Western European countries have been conservatively estimated to amount up to over 10 billion Euros with relative economic burdens ranging from 0.20% to 0.61% of each country's gross domestic product [25]. A fairly higher economic load, although scarcely definable with accuracy, can be considered to arise from the impact of obesity on the wider economy in terms of loss of productivity [26]. It is even more difficult to estimate the overall cost of obesity among children and young people. In the perspective of health care costs, in fact, it has been assessed that overweight and obese children exhibit significantly higher expenditures for outpatient visits, drug prescriptions, and emergency room admissions, and have a higher probability of being high utilizers of health care services [27]. Additionally, in the personal context, it has determined by different studies that individuals who were obese, as adolescents become adults with lower educational attainment, earning less money, experiencing higher rates of poverty and having a lower likelihood of marriage, compared with thinner peers [28]. Furthermore, as childhood obesity is a risk factor for adult diseases, mortality costs in terms of the value of future income lost by premature death in adulthood, should be considered.

4.4 Developing a System Suitable for Interventions based on Equity and Inclusivity

The PEGASO system, integrating state of the art technologies within an holistic approach including social and human aspects, fully complies with WHO guidelines indicating the priority of comprehensive and coordinated multiple-strategy interventions across the whole population promoting behavioral changes in favor of physical activity and healthy diets in order to ensure an effective obesity prevention in childhood [4]. An increased prevalence of overweight/obesity is also significantly associated with low family affluence [23]. The principles of the intervention included in the present proposal, based on a "virtual individual" model considering as basic features also social status and social behaviors, are in accordance with the main outcomes from the 2009/2010 HBSC report recommending to address not only health and health behavior issues, but also the social context in which young people live, providing equal opportunities for all [22].

4.5 Providing a Transnational Opportunity for a Coordinated Effort to Tackle a Transnational Issue

The transnational relevance of the growing prevalence of overweight/obesity among younger population in industrialized and developing countries worldwide, prompts also to an EU co-ordinated effort in research and industrial development to face such an epidemic in member countries, which is another main feature entailed in the present proposal. Indeed, the promotion of research for the prevention and control of

non-communicable diseases (which include overweight/obesity) is one of the main objectives recently focused by the WHO 2008/2013 Action Plan, proposing for international partners the action of work jointly on "research on socioeconomic determinants, lifestyle and behavior modification as well as community-based interventions" [29].

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