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D2.2 Interim report on socio-economic factors and business models

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Abstract

Fed by the rampant obesity spread in western societies, the e-Health market has been booming in the last years with thousands of apps having emerged in the last years. The creation of e-Health-specific marketplaces fostering the integration and exchange of domain knowledge across apps has not yet been targeted. Complementing the motivational and user-centric aspects from WP3 and the technical viewpoints in WP4, D2.2 targets the market and socio-economic dimension of PRECIOUS by concentrating on sustainable and cooperative solutions. The maximisation of the social welfare, including the central integration of user needs, has taken a key role. In particular, the present defines prospective business models and business ecosystems (value networks) around preventive care and wellbeing marketplaces. In addition, a rollout roadmap is presented in order to maximise the

impact chances of PRECIOUS solutions. Future work will concentrate on the qualitative and quantitative assessment of the proposed business solutions, backed by numeric market data evidences wherever applicable.

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List of Acronyms

API	Application Programming Interface
BCT	Behavioural Change Technique
BI	Behavioural Intention
EM	Extrinsic Motivation
FI	Food-Intake
HSR	Health Summary Record
IM	Intrinsic Motivation
MI	Motivational Interviewing
PA	Physical Activity
RoI	Return on Investment
SDT	Self-Determination Theory
SES	Socioeconomic Status
UI	User Interface
VIM	Virtual Individual Model
VN	Value Network

Executive Summary

Due to the widespread obesity crisis in western societies, the e-Health market has been booming in the last years with thousands of apps emerging on the market in the last few years, especially by the big players. However, the integration of smaller businesses, professional health expertise, and the facilitation of coordination among individual efforts for individual target groups, has received limited attention so far. Complementing the motivational and user-centric aspects from WP3 and the technical viewpoints in WP4, D2.2 targets the market and socio-economic dimension of PRECIOUS by concentrating on sustainable and cooperative solutions that maximise the social welfare gain (including user interests).

In particular, this report sets out to present the initial views on **prospective business models** and **business ecosystems (value networks)** for PRECIOUS. Those solutions have to support preventive care and the wellbeing of users to keep up the user motivation and to enable lifestyle change around a sustainable business case. For this purpose, the **healthCOIN business model** has been proposed, which has been modularly characterised using the notion of Osterwalder [16] and utilises the well-known Freemium business model. healthCOIN is designed to ease the **collaboration** among and user transition (e.g. reducing lock-in effects) between apps, which have been reflected in the design of an **inter-app reward scheme** (i.e. activity and monetary rewarding metrics). healthCOIN furthermore centrally focuses on the **diversity of user needs** (in terms of motivation, rewarding, health goals and conditions, interaction preferences etc.) by providing an open business ecosystem that bridges the interests of masses of users, app developers, service providers and external business partners in order to utilise the full innovation potential of the community.

In healthCOIN rewarding is an important factor for the motivation of users, but also for kick-starting a new marketplace and overcoming two-sided market issues. The initial market phase requires a **stimulation of the market** where extrinsic rewards can help to attract a critical mass of users. In the next usage phase, the **internalisation of motivation** is in focus in order to sustain the behavioural change and to truly support healthier lifestyles. The effectivty of healthCOIN has further been supported by a series of strategies such as on active **cheat prevention** (both by app developers and in users), **privacy** and user right protection mechanisms, and the simplication of the end user **trust relationship** (i.e. a single point of trust instead of direct relationships to any app developer of interest).

In particular due to the difficulty of creating a new market, as intermediary between supplying app providers and demanding end users, a **three-stage rollout process** has been designed: The first phase focuses on reaching a critical mass of customers and apps (counteracting common two-sided market issues), the second phase will focus on growth potentials, and the third phase will cover monetary outcomes (i.e. revenue and profit). The first phase is regarded to be especially critical, which could profit from the (financial) assistance of public health organisations and insurance companies. Generally, the business model of PRECIOUS will follow **Freemium** paradigm where the healthCOIN model facilitates the extrinsic motivation build-up and monetary cohesion of platform service providers in the bootstrapping phase.

The healthCOIN ecosystem has been addressed by proposing a series of prospective value networks to be quantitatively (using a novel analysis technique) and qualitatively assessed in the final report. Our first assessment has illustrated the importance to clarify **who can operate a healthCOIN platform** in the future and how **(public) health organisations are optimally integrated**. For this purpose, our novel quantitative assessment technique will be utilised in the next phase to report on the attractivity and sustainability of candidate market configurations (based on real world market data input) in the final report.

The final report will report on the quantitative (using our dedicated analysis methodology) and qualitative assessment and parameterisation of those candidate models in order to provide clear market design recommendations. Subsequent works have to further strengthen the relationship to advancements in the architecture and most relevant use cases and scenarios.

1. Introduction

1.1 Motivation

Due to the widespread obesity crisis in western societies[1], the e-Health market has been booming in the last years. In 2014, *research2guidance* estimated the m-Health market, consisted of two main mobile platforms; iOS and Android and their shared market value had reached $2.4 bn [1]. More than 100 000 apps have been listed in the corresponding marketplaces where most of the apps have been provided by players that have newly entered the e-Health market and the apps have often only been downloaded up to a thousand times in total. Apart from chronically ill patients (about one third), the report has further illustrated that almost one third of all usage refers to fitness-oriented users, which are part of the target group of PRECIOUS. The market seems to be more attractive for app publishers and bigger players that are well connected with players of a similar kind.

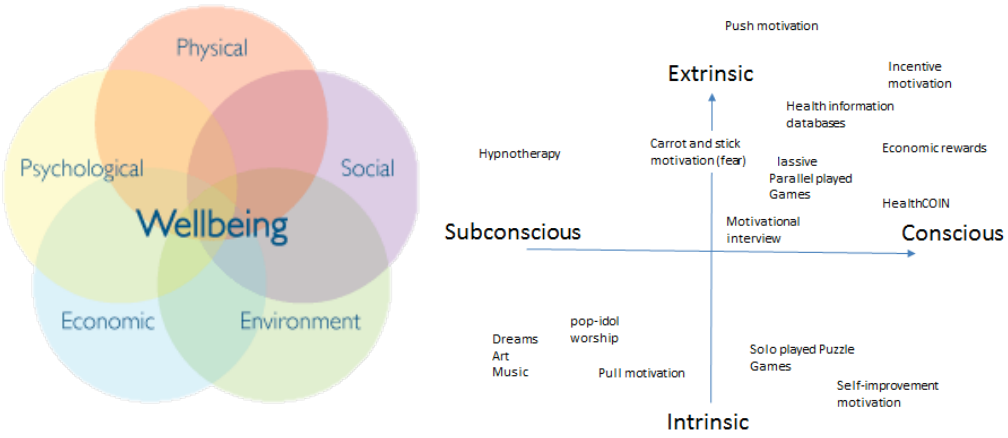

Figure 1: (a) components of wellbeing and (b) build-up and maintenance of motivation

In order to address a more lasting lifestyle change and a more personalised service adaptation, m-Health application design needs to consider all the factors depicted in Figure 1 (a). This needs to be realised such a way, that user's motivation is better granted following Fig 1b framework. Present well-being service design tends to be technically oriented focusing on physical measurements of Figure 1 (a) and to the upper right corner of Figure 1 (b).

These figures also clearly illustrate the need for viewing the e-Health domain as a multiplayer service field with the users in need of preventive care (driven by multi-source motivation and health goals), service providers applying some service platform using software/hardware components, and developing/applying business models and other stakeholders as private companies, societal players and insurance companies connected by monetary and other reasons to the health service platforms. PRECIOUS project WP3 (Virtual individual model and building motivation) focuses on modelling the users, and WP4 (System, sensors and feedback tools) concentrates on the implementation technology of the

[1] According to CDC almost 40% "of all U.S. adults are obese": http://www.cdc.gov/obesity/data/adult.html, last accessed: 2015-04-29

service platform. In WP2 (Requirements identification and socio-economics), that this report belongs to, we discuss the business models and associated value network supporting the PRECIOUS service. While developing innovative preventive care services, their true, long term survival is subject to understanding and utilizing series of interdependent factors characterised by all stakeholders providing the service and working often in very different fields of health technologies. The developed service model should connect all the players in a win-win fashion. This makes the service development work in this case especially multidisciplinary and challenging.

1.2 Problem

Despite the soaring e-Health market figures, the coordination among individual stakeholders has been rather limited. In m-Health, for customers it is difficult to select the appropriate app from the trustworthiest player meeting the motivational and physiological needs. It is further even more difficult to find a second or third app complementing the previously installed without facing usage problems, and ill-conceived recommendations. For example, when a user targets to improve their health, they might start with an app that supports only their first set of physical exercising endeavours. However, for more lasting results, a complementary food intake application should be synchronised to other efforts in order to achieve a higher goal of an improved user health. Poorly justified and formulated recommendations may lead to inappropriate workout or food intake experiences.

PRECIOUS targets the following user groups (D2.1 List of usage scenarios and user-requirements):

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

Each of these user groups are characterised by their own set of needs, values, life circumstances, view on technology (esp. on apps and mobile apps), and economic status. There is also a large variability inside of each user group. Hence we need to carefully align and adapt the service composition and respective value network to fit the target groups in order to meet a well-personalised and sustainable user experience.

1.3 Contribution

The present report complements the motivational and architectural considerations of WP3 and WP4 respectively by socio-economic and business perspectives. This report in particular, targets the design of the PRECIOUS ecosystem by a specially designed business approach, named healthCOIN. The healthCOIN will be founded on key lessons learned from the e-Health industry so far, but also from promising other innovative sectors such as the gaming or content industries. The focus will be set on how PRECIOUS can design the marketplace in order to motivate users better and use their data in order to keep them healthy in the long run.

This report will methodologically carry out a critical review of interdisciplinary literature involving the m- and e-Health markets, as well as business model and value network design methods. The latter will be based on novel quantitative assessment technique, which will measure the dependency of individual roles on the value network in order to identify sustainable configurations.

The **key outcomes** of this report are as follows:

- Determination of clear business boundaries for e-Health solutions focusing on preventive care
- A evaluation/summary of the socio-economic factors affecting PRECIOUS and its solution concepts
- Clarification of the added value of e-Health-specific preventive care marketplaces
- Proposition of a suitable preventative care business model, following common business modelling design structures, for heterogeneous user groups denoted by the term healthCOIN
- An approach for the integration of human factors such as “hooks” for exploring tailored motivational techniques around a common motivational framework (as designed in WP3) and the active prevention of cheating strategies
- Definition of a market rollout concept, which integrates strategies to overcome two-sided market phenomena hampering the successful initial marketisation
- A definition of promising value network configurations around healthCOIN and associated quantitative assessment tools allowing a detailed study in successor deliverables

1.4 Structure

The remainder of this work is structured as follows: We will start with a critical review of literature on fundamental building blocks of a preventive care infrastructure (cf. Section 2). This includes fundamental concepts from economics and management studies such as business modelling design, value chains and value networks, but also includes noteworthy business strategies from the health and other industries. In Section 3, we will detail the e-Health ecosystem by discussing interesting market issues and configurations. The main outcome of this deliverable will be reported in Section 4, where the healthCOIN business model is introduced. While healthCOIN may substitute alternative business models, we have designed healthCOIN to be the PRECIOUS business model. This report will further introduce interesting variations of healthCOIN in the form of various value networks, which will be analysed in the successor deliverable by applying the quantitative assessment techniques introduced in this report. After providing a series of recommendations in Section 6, this deliverable will close with concluding remarks and outlooks in Section 7.

2. Related Work and Requirements

Working in the area of preventive care is difficult even when the objectives of target users are clearly formulated in the offered service. In our case, these objectes include to circumvent potential future illnesses by a lifestyle change, and to obtain a higher quality of living. This is clearly illustrated by the 'MDPrevent' clinic start-up case[2]. The establishing idea of the clinic was clearly stated in the Mission Statement of the MDPrevent: "The patients are better off, if doctors can focus their attention more on preventing diseases than for simply treating them".

To start with, the clinic housed a health psychologist, registered dietitian, exercise physiologist, yoga instructor, health educator, and nurse practitioners. The patients were offered healthy cooking, exercise, nutritional therapy, diabetes education, and mindfulness meditation in dedicated teaching kitchen, gym, and classrooms. Hence, the service palette was quite versatile and well served. Users in need of preventive care were obviously well addressed. Dozens out of more than 1000 patients sustained marked weight loss without drugs, supplements, or surgery.

What turned out to be a problem was then the business case formulation and having a true understanding of value network stakeholders. The business case was formulated such that the main income would not come from the regular customers (in the form of out-of-pocket payments), but rather from insurance reimbursements. It was assumed that the rest of the medical establishment would thereafter see the merit and join the stakeholders hence making the value network gradually stronger.

The service economic problems that turned out could be classified to three categories:

1. Too small reimbursements from insurances compared to service cost structure. Most of the third-party insurance companies did not cover the MDPrevent clinic costs at all.
2. Many kinds of marketing problems (resulting lack of customers).
3. Miscalculated subservices were initiated by MDPrevent. For instance, a Certified Diabetes Education Centre was setup, with a time consuming and expensive certification process. But again, no customers would use it due to available, other comparable certified services.

In summary, for successful business case, it is not enough to just meet customers' needs and demands. One should also carefully take into account the whole value network, its evolution and to have clear backup plans if something goes wrong. This calls for developed risk and sensitivity analysis. For instance, due to the requirement of continuous service portfolio development, assisting critical path analysis can recognise some of the associated dynamic operational risks.

[2] http://www.theatlantic.com/health/archive/2014/01/why-i-had-to-close-my-preventive-Healthcare-clinic/282929/

In the last years a series of (mobile) digital ecosystems have emerged that may be of interest for the e-Health sector. These ecosystems include application stores such as Apple's "App Store" (iOS, Mac OS), Google's Play (Android), BlackBerry World, Windows store, Ubuntu Apps Directory, PlayStation store, steam etc. Apart from that, e-Health platforms such as Jawbone Up, Fitbit, Apple HealthKit or Google Fit have emerged and have established their own hardware- and data-based business model around application stores. Orthogonally, the (clinical) e-Health sector has received substantial interests for years, but has been less oriented towards consumers and consumer hardware. Game and content industries have further experienced a rise in the last decade in terms of utilising digital marketplaces to dynamically reach out to further customer segments. The linkage between the perspectives of e-Health, app stores, and game/content industries could enable modern motivational techniques (such as supported by gamification) to be used for improving the health of end users.

The contribution of this section will thus be threefold:

- We will review fundamental literature on management concepts such as business modelling design and value network assessment.
- We will present a review on successful business practices, which are potentially applicable to the context of PRECIOUS.
- We will further illustrate the limitations of current solutions in related work in order to sufficiently support preventive care and motivational techniques as envisioned by PRECIOUS.

While early works like [2] have differentiated m-Health (mobile health solutions) from e-Health, the integrated approach of this present report avoids this separation (wherever applicable). For instance this report only stresses the difference between m-Health and e-Health whenever specific actor roles may have to be considered, or a business case cannot be generalised (e-Health will be used synonymously with close-by terms). In other words, we are using e-Health as a hypenym for m-Health and other kinds of electronically assisted health tools. On a general level, e-Health refers to all kind of often-remote ICT dominated services used both in healthcare and in wellbeing. Nowadays m-Health is more wellbeing oriented, which is more in focus of PRECIOUS.

2.1 Value Chains & Value Networks

Value chains [3] originate from the age of industrial production where a sequence of production activities led to stepwise manufacture of a product. For example, in order to build a car, the chassis may be produced in one factory while the engine is produced elsewhere. Once both parts are created they may be "married" in a subsequent step. Thereafter, other details like tyres or the interior are sequentially added until a final product can be shipped to the customer.

However, today's economy is different and much more complex, dynamic and distributed. The emergence of the Internet has played a specific role in this economic transition, which

has further facilitated the information-orientation of our economies [4] and has enabled different kinds of business models to be explored. Nowadays, the tightly coupled sequential production chains have been replaced by an ecosystem where stakeholders are weakly linked and many processes are highly parallelised. For example, when big Internet firms such as Google deploy a new service, they may be able to plan their rollout and market entrance entirely independently from new technology deployments by Internet service providers such as AT&T or Deutsche Telekom. These new flexible business models will also affect the marketing of e-Health applications or services. As we will illustrate later, a variety of business models have recently emerged, which would not have been possible within the older economic environment.

Due to this economic transition the concept of Value Networks (VNs) has emerged, which provides an external view on business models. VNs provide a (visual) representation of business interactions between all actors (entities) of an industry or specific business case. VNs, e.g. formulated as a graph, describe the non-sequential value stream within an industry based on modelling business interactions between comprised entities. Today, a wide range of literature exists on Value VNs—e.g. [5] or [6]—, and in recent years new academic interest has emerged, originating from the mobile services industry – e.g. [7]. VNs describe the value creation process as networks of different kinds of business interactions. They may capture tangible and intangible assets, shorter and longer perspective business interactions or interactions of different kinds of importance. While in newer works (see quantification approaches later) a more standardised and sound representation is preferred, in any case the strong interlinkage with business models needs to be acknowledged (internal perspective of an enterprise)—e.g. [8], or [9]. The relationship between VNs and business models may best be described by the statement of Casey & Töyli [10] who claim that market success “largely depends on how it [editor’s note: referring to business models] interacts with models of other players in the industry”.

In this light, business models have recently been interlinked with VNs, i.e. dedicated business modelling design parameters e.g. in [11] or [12]. The basis for analysing both VNs and their linkages to business models is nowadays dominated by qualitative approaches – e.g. see [13,14]. While qualitative assessments should not be underestimated, a more precise and quantitatively-backed view could lead to more clarity on strategic positioning within an ecosystem. Following the work of [15,16] and [10] quantitative assessment alternatives have recently emerged, which have been further supported by the efforts of the PRECIOUS project (as partially reported in this deliverable) in order to provide a clearer model of marketization issues related to the e-Health domain (see dedicated section).

2.2 Business Modelling Design

Business modelling design is a discipline that aims to characterise the essential components of a business model. Business models describe the value creation process for stakeholders.

This section will briefly revisit common business modelling design frameworks in order to allow both a proper linkage of VNs and business models and the realisation of PRECIOUS-specific business ecosystems:

Osterwalder [17] has proposed nine components that are associated with the following four modules:

- **Infrastructure components (3 components)**: Core capabilities, partner network and value configuration
- **Offer components (1)**: Value proposition (perceived value)
- **Customer components (3)**: Customer relationship (e.g. self-service or personal assistance; customer ownership effects), distribution channel (e.g. web store or classical retail) and target customer
- **Finance components (2)**: Cost structure and revenue streams

By contrast, Chesbrough and Rosenbloom [18] have identified six components or modules:

- **Value proposition** (perceived value)
- **Market segment** (target customers)
- **Value chain structure** (position and value generation in the value chain)
- **Revenue generation**, e.g. usage-based charging, subscriptions, advertisements licensing etc., and **margins**, i.e. cost-revenue relationship and cost structure
- **Position in VN** (e.g. network effects, substitutes or industry rivalry, as well as customer ownership or access to bottlenecks in the VN)
- **Competitive strategy** (competitive advantage, e.g. technical capabilities or strategic position)

Another noteworthy work by Ballon *et al.* [11], specifically addressing technology-related business models, differentiates by control and value parameter categories:

Control parameters:

- **VN parameters:**
    - **Combination of assets**: Critical assets (resources) may be equally distributed in the VN or may be a central entity on their own. The degree of centralisation and the access to those resources is important for realising business models. Thus, a proper business model has to assure the access to required critical resources.

- **Vertical integration**: The degree of integrating all involved activities for producing a single service or outcome in the same company is called vertical integration. So, whenever an e-Health platform outsources the database storage to an external firm, more business interactions in the VN will appear and the vertical integration will be lowered. The vertical integration of industry critical roles may essentially impact the strategic value of a business model. On the other hand, the clever outsourcing of unattractive activities to specialised entities may help to reduce costs without lowering the market power.
- **Customer ownership**: The direct access and moderation of end customers is very important. Whenever a firm holds an intermediary role between service providers and interested end customers, those service providers become dependent on this platform, i.e. an attractive strategic position is rendered for intermediary roles (cf. [19]).

- **Functional architecture parameters**:
  - **Modularity**: Independent components without reciprocal dependencies enable the creation of a bigger "product variety", as well as the utilisation of scaling effects (due to reuse of modules for multiple purposes)
  - **Distribution of intelligence**: Comparably to critical assets, the (production) intelligence, functionality and control may be federated (centralised) within the system (or VN).
  - **Interoperability**: The exchange of information typically refers to "interfaces" between modules, which may play a critical role within a VN – interfaces are the enabler for any kind of business interaction (but also technical interaction) [20].

Value parameters:

- **Financial model parameters**:
  - **Cost (Sharing) model**: Keeping costs low while optimally sharing costs with involved other parties is a key factor for creating a successful business model (especially in relationship to the chosen revenue model). Particular cost models may target the utilisation of economies of scale effects or the clever outsourcing of inefficient tasks (see vertical integration).
  - **Revenue model**: The revenue model is often regarded to be a decisive category, but may only represent a short-lived perspective if not embedded in a more complete business model strategy.
  - **Revenue sharing model**: Whenever a cooperation or collaboration is required, a certain degree of sharing revenues (or distributing revenues) is required. For example, when an operator sells a global service to a customer they may have to share revenues with local service providers in order to

practically realise the sold product. Revenues may be forwarded in a sequential manner from one actor to another one, or may be distributed by a central entity. Many more options exist regarding the “fair” configuration of sharing models.

- **Value proposition parameters**:
    - **Positioning**: It is very important to strategically position towards addressing attractive customer segments (target customers), markets (e.g. geographical markets), and product segments (e.g. niche technologies).
    - **Customer involvement:** The cognitive load (e.g. when processing product information, comparing offers etc.) varies with the degree of customer involvement. The longer and more extensive a decision process (i.e. the more important a product), the higher the cognitive load and the associate customer involvement. We distinguish between three levels of customer involvement, which are often used in practice: low involvement (habitual decisions), moderate involvement (simple but active decision) and high involvement (lengthy decisions, e.g. when purchasing).
    - **Intended value**: An enterprise has to generate a certain value for the customers of its products. This value may be created on the basis of specific competencies or resources that may not be equally accessible to customers or competing firms. In e-Health, non-monetary customer values may be of high interest, e.g. the comparison with friends, having the possibility to care about the family or motivating others to get active may be examples for such non-monetary “rewards”. For details, we kindly refer to the used definition of “utility” in the context of PRECIOUS.

Ghezzi *et al.* [12] have introduced a comparable view, optimised for network service collaboration, which stresses the importance of the distribution channel. The concept of Spil & Kjil [21] (four main components: service, technology, organization, and finance – again highly comparable to the Ballon *et al.* concept) considers a “technology” component, which may be comparable to a distribution channel. In particular, they refer to technical architecture, service platform, device, and application aspects. Spil & Kjil [21] have also introduced the notion of risk sources in their financial component. It can be argued that the extrapolation of distribution channels, especially technology, may be very important due to their importance in highly technologised information economies such as the e-Health industry. In the e-Health cases, social distribution channels (word-of-mouth advertising, sharing via social media channels etc.) may especially be of interest). Spil & Kjil further recommend an early focus on the value proposition elements for e-Health services, instead of solely focusing on technological innovations.

2.3 E-Health Intervention Design & Socio-Economic Factors

One of the most systematic findings in health research are inequalities between those who are in a better position in society compared to lower position in terms of education, income

or occupation. For instance, a Finnish man who belongs to lowest income fifth dies on average 11 years earlier than man in the highest tertile [22]. One important cause for these inequalities, among many others, is the health related behaviours. People in lower social positions are more likely to smoke, to eat less healthy and to engage in less physical activity than people in higher social positions. Similar considerations have led to the formation of the following "social determinants" for health in [23]:

- *Social factors: Community safety, social support, education, food recreation*
- *Economic factors: Employment, income and demographic makeup*
- *Physical enviroments: Air and water quality, housing, transit, access to health care, access to health information, including use of services, safety steps to take during an emergency, such as local outbreak of illness.*

Now, when digital technologies are used to improve these health behaviours, there is a widespread concern that this will increase health inequalities due to accessibility, availability or capacity to use new technology [24]. Although most of the people in the EU have access to Internet, there are large differences in quality of mobile phones, devices connected to mobiles and connection to Internet through mobiles that are important parts of most health related technologies.

Clar *et al.* [25] have made a scoping review of 4615 publications about digital media use in a health context. They expressed a worry that digital interventions might either fail to be effective or even increase health inequalities. This was based on the observations that the possibilities of digital media to reach hard-to-access populations and build interaction were not used efficiently but it was mostly built on traditional ways of information dissemination in which users have a passive role. They did not find any good examples of community engagement through digital intervention. Evidence for cost-effectiveness was very limited. Visual methodologies that might surpass language and literacy related issues were scarce. Very few publications about the ethics and quality of digital media in public health were available. To improve the situation, the authors called especially for systematic reviews of "active qualitative and participatory digital visual methods based in the community or in specific settings" exploring specifically the effects of health theories. The authors also encouraged multidisciplinary work in order to improve the efficacy and interactive nature of the interventions. However, the review was only based on abstracts and may therefore have overlooked many findings. In this light, the present deliverable will specifically focus on a multidisciplinary perspective in order to assure high quality health interventions from several different angles (health, motivation, technology, user interaction, etc.). However, there also are some contradictory findings. A recent UK trial that tested an Internet based intervention called 'StopAdvisor' - for smoking cessation, found it was more effective for low socioeconomic status (SES) smokers. While in a high socioeconomic group, the intervention did not help quitting compared to information only intervention [26]. Earlier studies have found that low SES smokers engaged less with the Internet based support [27]. 'StopAdvisor' has been tested only among low SES smokers, which may explain why it has been more successful for this group.

The SES is often related to the quality of devices, speed of Internet connection and possibly the use of mobile apps. However, PRECIOUS cannot affect the devices that people possess and the conditions of their usage, though the project can take different socio-economic groups into account when planning the system in order to maximise the inclusion of heterogeneous user groups and their devices. Potentially, the service design of PRECIOUS can be made to adapt also to low quality devices (e.g. consumer sensors, smartphones, etc.) if required by building the service to rely on, for instance, cheap text message push notifications. The project can target different service needs and device categories (ranging from professional sensors to onboard smartphone input) through the inclusion of heterogeneous service design (i.e. apps) and their individual motivational approaches.

Large number of service features does not anyhow guarantee efficiency of the service design. Also, it is important how the feedback is served back to the user. These points are inspected in Figure 3. When for example users cannot meet their weight loss targets for a measurement period, but have performed well on average, the feedback to the user is critical. A system could provide user with objective information on their weight readings, body mass index, and dehydration percentages, as well as on their metabolic state. However, it is not self-evident that this information will support longer lasting motivation or a healthier lifestyle in general. Depending on the personalities, overwhelming information could in some cases demotivate users.

Hence a critical inspection of service features and means of user feedbacks are important for the entire service design. In terms of economic feasibility of the service, this is also important, as the inclusion of features and additional measurements is a cost factor, where inefficient investments should be avoided. Applications should instead provide the appropriate measurement feedback tailored to the needs of the users, supporting selectively the factors of Figure 2. Also, auxiliary services, as various forms of social support can be extremely useful for many users.

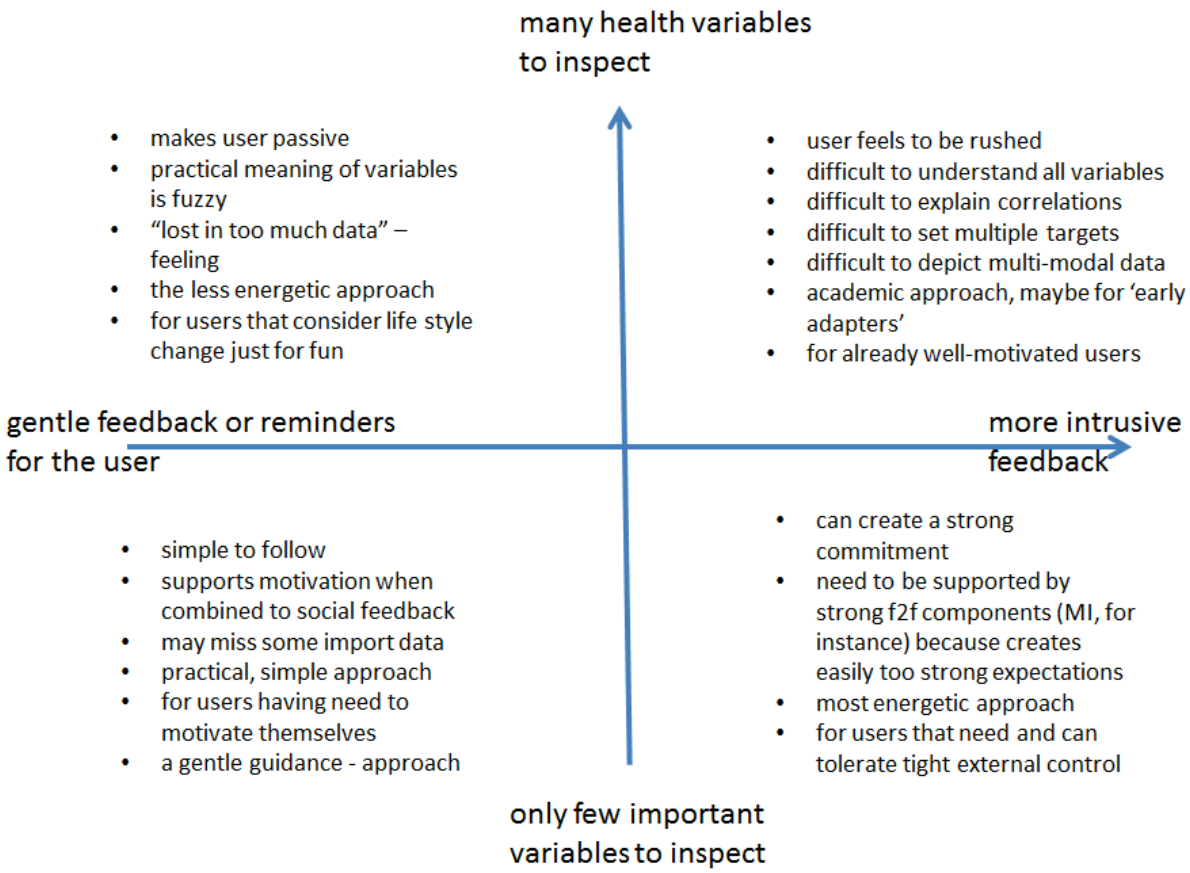

Figure 2: Appropriateness of feedback and number of service parameters

2.4 Business Models in e-Health

The following sections introduce business models currently employed for or potentially transferable to e-Health. Starting with a clarification of the specifics of e-Health business models, we will then review for expert-oriented and consumer-oriented business model approaches in dedicated sections.

2.4.1 e-Health Specifics

This section summarises, interprets and extends some specifics within the e-Health market as identified in [28]. For further details please refer to the original works.

While e-Health, as well as preventive care, business models share many aspects with generic business model concepts (or business models from other fields), some specifics need to be acknowledged according to [29] (see Figure 3).

Differences	Similarities
• *Management* is unified in most sectors, but health care has clinical and administrative reporting.	• All sectors seek improvements in cost, quality and delay through integrated *processes*.
• Most sectors have a clear group of *customers* with typically a few product variants; health care involves a multiplicity of *actors* with distinct needs (e.g. patients, insurance companies, governmental authorities, doctors).	• Following the customer-centred success in other sectors, the *centre of attention* in health care should be primarily the patient but also the mentioned variety of other customer segments.
• Most industrial systems have hard *metrics*, in health care people's feelings and choices matter too.	• As in other sectors, health care will benefit from *system integration*.

Figure 3: Specifics of e-Health business models [29]

In particular, these works recognise the broad range of involved stakeholders, different kinds of management activities and psychological dimensions (e.g. emotions) in e-Health, whereas in other disciplines a clearer positioning is typically targeted.

According to [28] stakeholders in the e-Health market may be categorised as internal (typically medical practitioners or personnel) and external (e.g. insurance companies) where externals may only receive relevant subsets of the available information collected by e-Health services.

We also acknowledge the requirement to consider further stakeholders such as hardware manufacturers, software firms, application developers, data storage providers or other comparable stakeholders in a modern e-Health environment. We further acknowledge that the quality of the "product" in the e-Health context spans to all aspects of user's health (see Figure 1):

- physical
- social
- psychological
- environment
- economic

Successful m-Health business models should be based on PWC report [30] fulfil the following conditions:

1 **Interoperability** – the ability to be compatible with sensors and other mobile or non-mobile devices to share vast amounts of data — such as sharing patient records and healthcare plans.
2 **Integration** – being a natural part of existing provider and patient workflows, so supporting new behaviours.
3 **Intelligence** – problem-solving capability to give real-time, qualitative answers based on data.

4 **Socialisation** – being a trusted community for people to share information, offer support, coaching and recommendations.
5 **Outcomes** – being driven by healthcare objectives and return on investment with the focus on cost, access and quality.
6 **Engagement** – being open and responsive to patient (users) participation. This includes rapid feedback from multiple sources so that behaviour and performance can be fully realised and understood.

Mettler and Vimarlund [28] also recognise the need for collaboration e.g. among medicating hospitals, for which trust, as well as knowledge about the other parties' competencies, play an important role. Collaboration among health organisations is, however, difficult to be realised in practice when minding privacy constraints, heterogeneity of systems etc. These difficulties can be alleviated if the participating organizations can recognise mutual win-wins and that their economic value is correctly estimated by the PRECIOUS service up keeping. There are often other than direct economic values only that can be exchanged between parties to further support the win-wins (see Figure 4).

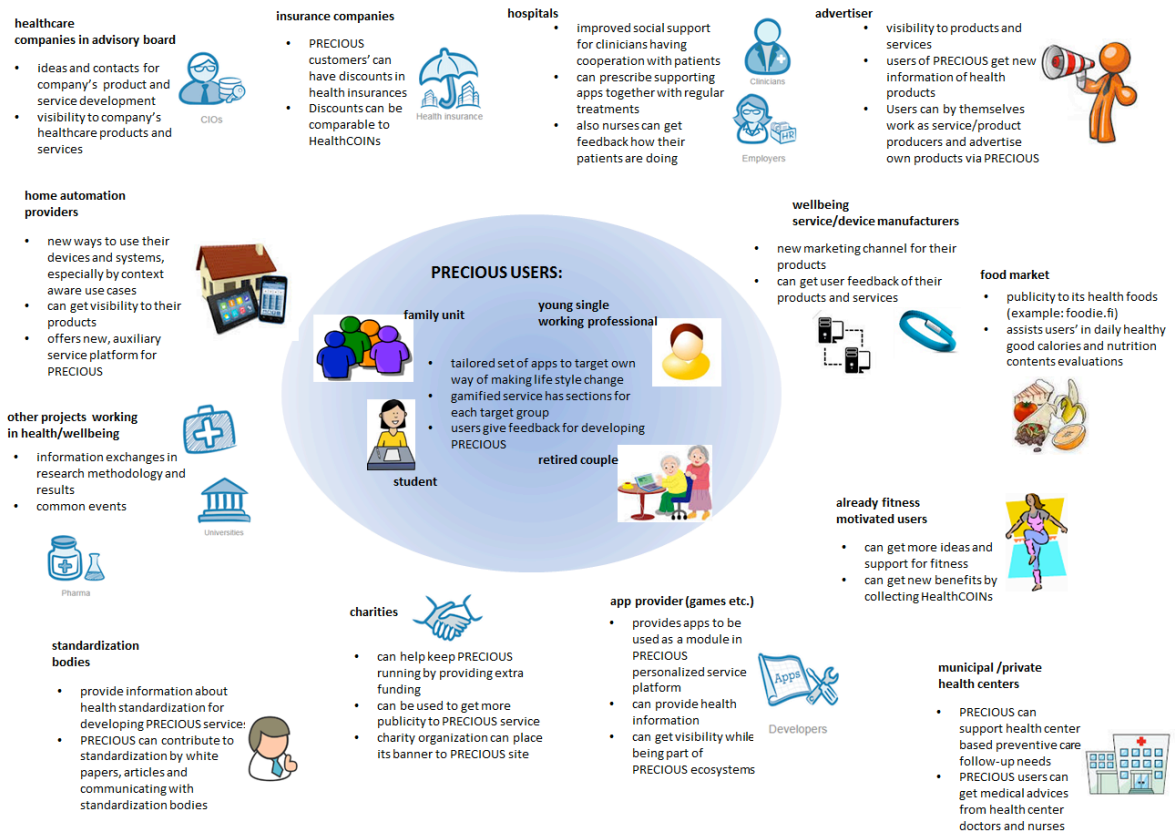

Figure 4: Mapping WIN-WINS between various PRECIOUS users and stakeholders

Economic impact of dietary preventive care interventions

Treatment of disease and its associated conditions is expensive, for example, in the EU it was estimated that in 2011 around 30 million people had diabetes (type 1 and type 2), and around 10% of total yearly healthcare costs were spent on these conditions [31]. The prevalence of chronic diseases continues to rise and the importance of prevention and better management of diseases has been rising [31]. However, only around 3% of the health budget in the Organisation for Economic Co-operation and Development (OECD) countries is currently allocated to promoting health and preventing disease. The European Health 2020 policy [32] outlines the importance of investing in health. There is strong evidence (e.g. from national strategies to reduce cardiovascular disease and diabetes) to suggest that cost-effective policy pathways can have a direct impact on population health and wellbeing [32].

- Preventive care is, however, a long term investment and the return on individual intervention strategies are not always easy to determine. In light of this, some research studies have considered the financial implications of different health interventions. For example Fattore *et al.* (2014) [33] have reviewed the economic impact of direct (e.g. counselling) or indirect (e.g. food labelling) interventions aimed at promoting voluntary dietary improvements. Of the 36 intervention studies reviewed, 18 were found to be cost saving and 11 were determined to be cost effective, when compared with the status quo. However, 7 studies determined that the nutrition intervention in question was not cost effective or that the health outcome improvements were negligible. This may suggest that health interventions are, on average, economically viable. Although, in the design of future interventions, it is clearly important to understand the differences between cost saving/cost effective interventions and those which were not successful.

- Some of the studies reviewed by Fattore *et al*. considered e-Health interventions specifically. Miners *et al.* (2012) [34] assessed the cost-effectiveness of e-learning devices, compared with conventional care (e.g. drugs, slimming clubs and health care visits), as a method of promoting weight loss via dietary change. E-learning is reported to involve the use of interactive electronic media to assist teaching and learning. Some e-learning interventions are also able to adapt to produce iterative, interactive and more immediate feedback. However, this study determined that the use of e-learning devices for managing the weight of obese individuals was unlikely to be cost-effective unless, 1) the development and running costs were much lower than estimated or 2) future devices prove to be much more effective. Furthermore, Robroek *et al*. (2012) [35] conducted a two-year workplace health promotion programme with two intervention groups. One group received a physical health check, as well as face to face advice on physical activity and nutrition, and personalised feedback on a website. The second group received additional website functionalities, including action-oriented feedback, self-monitoring, opportunities to ask questions and monthly email messages. However, no additional health or cost benefits were achieved following the more detailed intervention. In this study the use of the website was voluntary and no difference in visit frequency was observed between the two groups. Therefore, the lack of effect may be due to limited use of the websites enhanced features. The authors suggest that the ability to access

information via more portable devices, such as mobile phones, may increase programme adherence.

- Overall, these results highlight the combined importance of intervention efficacy and control of running costs. PRECIOUS will consider the efficacy of various elements of the system during the latter stages of the project (Work Package 5 System Validation) and this document focuses on economic models that could be applied to PRECIOUS, ideally resulting in a financially viable solution for preventive care.

Figure 5: Various service components potentially provided by PRECIOUS system

Figure 4 depicts some of important service components that PRECIOUS can apply. Note that important concepts of gamification and user centered design are not shown in this figure because they are research paradigms expressing themselves in internal structure of the service design.

The implementation timeline of the various features or their composition for some particular user is a question of personal service tailoring having different priority levels. For instance, weight follow up will be supported for all users (e.g. making use of xAAL-based retrieval of measurement data and the integration in an home automation environment), but IFTTT-like receipts (Figure 5) will be likely to tailored to a very specific user group, a subset of those who follow their weight measurements. Mood monitoring

and control (Figure 4) can be an effective first indicator on a user's motivation across different user groups. The mood can be tracked by self-assessment or more advanced solutions (e.g. social mood detection as targeted in WP4). If the weight measurements are having missing days in-between, that might provide first indications on the lack of motivation, but may also be explained by other factors, e.g. busy schedule or pressing matters etc. For this reason, such indicators should be combined with other information available, e.g. the calendar.

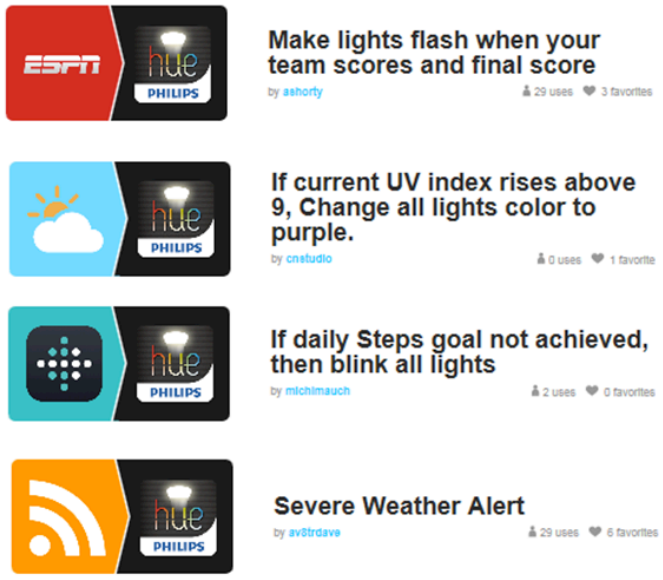

Figure 6: Examples of Philips hue led lamp guiding IFTTT receipts that provide environmental feedback relating to health goals and/or some elements of group support.

2.4.2 m-Health-Specifics

m-Health is an emergent concept in healthcare with a lot of potentialities. Mobile phones, patient monitoring devices, tablets or other wireless devices can be easily integrated in m-Health systems. To date, existing solutions have demonstrated that m-Health solutions serve several purposes: 1) to provide enhanced access to health information to patients, GPs or researchers, 2) to facilitate remote monitoring and diagnosing of patients, 3)). to deliver timely and up-to-date recommendations for health.

However, few m-Health apps for diabetes have been rigorously tested. In 2013, El-Gayar *et al.* [36] identified and reviewed 71 commercial m-Health applications for diabetes available at the Apple store as well as 16 mobile diabetes applications from the medical literature. Overall, they found that these applications incorporated inputted data from up to 6 monitoring tasks and provided up to 7 support tasks. In summary, these applications support self-management tasks such as: insulin dosage and medication, blood glucose testing, diet, practice of physical exercise, decision support, notification/alert, tagging of input data and integration with social media. This review pointed out to the potential positive impact on diabetes self-management, mainly associated with improvements in patients' attitudes towards the disease and their self-management.

Recent advances and clinical guidelines recommend considering and including the following features (in random order) as part of important variables for diabetes self-management [37,38]:

1. Education and personalized feedback
2. Diet management
3. Weight management
4. Physical activity monitoring
5. Communication and patient monitoring by healthcare providers
6. Insulin and medication self-management
7. Other therapeutics to self-care (e.g. eyes, feet, etc.)
8. Psychosocial care
9. Immunization monitoring
10. Complications management

Despite all these potentialities, it is important to note that few current applications meet these requirements, or only do it partially. Besides, more research is needed to further support the effects and its cost-effectiveness [39,40]. Thus, regulatory approval of m-Health products will require demonstration of the following issues: 1) Safety, 2) privacy, 3) clinical benefits and 4) cost-effectiveness. Additionally, some limitations of the applications include lack of personalised feedback, usability issues (specifically, the use of data entry), integration with patients and electronic health records and the lack of a theoretical framework including motivational elements. This last issue is especially relevant to ensure perceived usefulness and adoption of technology among potential users.

PRECIOUS is aimed to overcome these hurdles and facilitate the widespread adoption of this technology not only for diabetic patients -on which a field test will be carried out as planned in the project- but with general healthy population as a preventive solution.

'Modz' has for example targeted a hardware-centric business model. Modz diabetes self-care device was created for children with type 1 diabetes. Unlike earlier applications this was designed to be appealing for children (e.g. decorated with Angry Birds theme) and to include motivational aspects like gaming. It is a separate device (carried in the pocket or as a necklace) and glucose is measured with measuring sticks (capillary blood sample) that are inserted to the device. Children are reminded to take tests and they receive points for good test results, which allow them to progress up the levels. The device can send information of the glucose levels through SMS to the parents. As a business model this example includes a different approach as the device is using measurements sticks that have to be bought separately, so a reasonable amount of money is coming from these sticks. An obstacle for marketing is that in many countries the health care system, public or private, has to accept

all the health care devices, which takes time and money. After this, families could have some refunds and information could be connected to health care system. Hence, hardware-centric business models are also realistic in the e-Health sector.

2.4.3 High Volume Expert Markets

Based on a literature survey Valeri *et al*. [41] conclude that "the value of business models is not just linked to technology, but to the identification of a supporting business model where stakeholders' interests are represented and all appropriate operational elements are considered". Such stakeholder interests and operational elements refer to the components identified by the business modelling design literature introduced in section 2.3.

On the other hand, when targeting high volume expert customer markets (for medical practitioners, hospitals or other professional organisations, etc.), time and cost efficiency, as well as public funding specifics, may take an even more important role. Valeri *et al.* also recognise other issues such as "staffing constraints", "system operator and maintainer (user) skills" and "the training time available".

Only a handful of e-market business models are recognised (mainly targeting high volume expert or health care customers) in [41]:

- **Clinical Information System (CIS)**: Systems to undertake or support activities in professional health care institutions such as hospitals (e.g. for radiology) and primary care information systems (e.g. pharmacy information systems).
- **Secondary Usage Non-Clinical Systems (SUNCS)**: Systems for health education, promotion, research, and data collection, but also support systems (e.g. for supply chain management, billing, administrative processes).
- **Telemedicine**: Systems for monitoring patients, home consulting and treatment etc. (According to [42] telemedicine is especially sensitive to knowledge barriers, which have hampered its diffusion in the past despite the substantial cost saving potentials as acknowledged e.g. by [43]). These models are interesting for the reason that present e-Health and m-Health services have partly been developed based on earlier telemedicine techniques.
- **Integrated Health Clinical Information System**: Health record systems for example for e-prescriptions or e-referrals. In Austria, the Elektronische Gesundheitsakte (ELGA[3]) presents a similar kind of system where the entire patient file is electronically recorded and accessible to all professionals treating the patient. This information includes prescriptions, diagnoses, health check data and test results, for example X-ray pictures or blood test results.

2.4.4 Consumer Markets

[3] http://www.elga.gv.at/

Since 2010, the telecommunications industry has experienced the rise of application stores ("app stores") such as Apple's iPhone app market (for an extensive listing and description, see European Directory[4] of Health Apps 2012-2013). This type of industry creates a space for smaller scale business models, which are developed by small firms or individual developers. As a result, not only has a great variety of applications emerged, but also new business models have been enabled, which directly target end consumers.

For e-Health this means that consumers may purchase specific applications that support them in keeping track of their health and in becoming or staying healthier, for example educational apps to increase physical activity levels. Between 2008 and 2012 Valeri *et al.* (2010) envisioned an annual e-Health market growth rate of about 2.9% (strong growth for telemedicine), and it is likely that the new possibilities for involving end customers has substantially increased this growth potential.

Below we will briefly review the business models arising from this new context with a particular focus on revenue models:

- **Hardware sales** (also see [19]): Apple is one of the manufacturers of computers, tablets and smartphones in the world. Their profit is generated via hardware sales and partially via platform fees when using their app store infrastructure. Many similar business models have emerged for e-Health, which focus on hardware sales, for example Jawbone sells an Up activity tracker wristband to customers and supports them with free data storage in the cloud (for synchronising devices), free applications for inspecting activity data, and free interfaces for integrating the collected data with other platforms. This model is also employed by many other companies especially those providing equipment for more professional exercising such as Runtastic and Samsung Gear products.

- **Platform sales**: Platform sale revenues are currently limited to classical application stores, which also offer a broad range of e-Health applications. To the best of our knowledge, app store platform dedicated to the e-Health sector has successfully been established.

- **Application / service sales**: Many applications exist that provide e-Health services on mobile platforms. The application is often sold via application stores where the app developer's business model generates revenues via direct or indirect sales or subscription fees (one-time or repeated charging). In the telecommunications industry, hardware sales are often linked to subscriptions (Internet packages). Sometimes the telecom operator subsidises the hardware sale in order to sell a longer term subscription package (e.g. for 24 months).

- **Freemium**: Community platforms such as RunKeeper cannot rely on application sales as the main source of income (apps are typically free), but have to focus on scaling their network, i.e. the community needs to grow and any kind of direct fee may hamper the success. Internet business models, such as Dropbox and

[4] www.openhealthnews.com/resources/european-directory-health-apps-2012-2013

RunKeeper, use this freemium business model. Essentially, the basic functionalities such as tracking the route a user has been running or interacting with the community is complimentary, but premium offers, such as advanced training plans, more statistics, coaches, workout comparisons etc. are charged.

- **Advertisement / Data**: Utilising user data in order to create advertisement-based business models is a common strategy in the Internet industry. However, for e-Health, such data-centric business models are especially problematic since personal workout profiles, health statistics, sleep figures, etc. may be collected. Whenever a service or application shares such information, the interest of users may be substantially lowered, which hinders economies of scale (advertising becomes more and more effective and efficient when shown to a large community and tailored to the right customer segment). Static advertisements, which are not based on actual user-data but only on content categorisations, will most likely provide lower returns due to the lower adaptation to each user's background and interests.

- **Razor-Blade:** The razor-blade business model refers to the concept of providing a main product, tool or service for a low price. The profit is then made on consumables, maintenance fees or supplementary services. This business model is derived, as inferred from the name, from the concept of cheap razors with expensive blades, but also includes expensive coffee capsules, printer cartridges or elevator service fees[5]. The same business model has been integrated in content-related business models in the Internet ecosystem, for example for games (e.g. Playstation or Nintendo), books and media (e.g. Amazon Fire tablet and Kindle e-book readers). To the best of our knowledge such a system has not yet emerged for e-Health but may be realisable, for example an activity tracker band may be sold below actual hardware costs. However, the hardware needs a paid service subscription to be fully utilised.

- **Crowdfunding:** In the last years many crowdfunding platforms like Kickstarter and Indiegogo have hosted many more projects that required funding from society or the crowd in order to start their business. Hence, the (general) public is providing the required monetary support in order to produce a product of e.g. societal interest. In analogy, the public funding schemes for actions, which positively contribute to the society's wellbeing (e.g. medical treatments for the general public), represents an even wider and more classical form of crowdfunding. Comparably, public funding could also exist for preventive care in the e-Health case, but may not be equally likely. Thus, it is realistic to argue that privately organised crowdfunding schemes may be more realistic. In subsequent phases a combination with other business models such as Freemium appears to be appropriate.

- **Product licensing and partnership model:** Businesses often employ a variety of business strategies to generate income, and the same is true in the food and health industries. The following case study on Weight Watchers International, Inc considers some interesting approaches applied by a global weight management brand to

[5] Elevators or esecalators are typically sold with long lasting service contracts that are often claimed to be financially more attractive than the initial sales.

extend the reach of their programme. Weight Watchers International, Inc is a weight loss programme that offers support and motivation to its customers during their weight loss journey. The Weight Watchers® brand includes an online platform, which offers customers a digital pathway to healthier eating and successful weight loss. Members are charged a subscription fee to receive access to healthy eating guides, information and tips, an online community and mobile apps to track food choices, activity and weight. Weight Watchers® also offer meetings in community venues at an extra cost and produce branded food and drink products, which are available to purchase through major retailers or online, and produce a monthly magazine. Additionally, Weight Watchers® work in partnership with health services to provide weight management solutions. It is stated on their website that this solution is "proven to be an effective, scalable and value for money partnership model, one that people are highly satisfied with and is simple to commission and implement".

Additionally, customer involvement, positioning and intended value components may be even more critical than within other business models. This is due to the difficulty of motivating users to follow a healthier lifestyle, while at the same time accommodating for different personalities, target groups, technological affinities and device capabilities etc.

Behavioural change services

Apart from known platforms and workout-oriented e-Health and m-Health applications like Jawbone Up, there are many more successful applications targeting other aspects of the consumer e-Health or m-Health market. In the following we will concentrate on related apps and services targeting motivational aspects like the behavioural change:

- **Behavioural change framework**: A Dutch project has sketched a behavioural change framework in [44] for reaching a health goal. To the best of our knowledge, this project has neither provided a link to technology nor aimed at creating a pluralistic e-Health market.

- **Habits**: "Fabulous" is an interactive service that aims at helping the user to change their habits. It provides a rational for the suggested habits and prompts goal setting and action planning, and encourages sharing behavioural engagement goals in social media. Fabulous provides reminders of the chosen goals at a chosen time. The reminders include exercise and meditation videos, which facilitates the execution of the plan. User is verbally rewarded when a habit has been completed many days in a row, thus encouraging self-monitoring of behaviour. Fabulous business model is based on personal coaching as a paid feature. Fabulous is, as most health apps, mostly a tool for planning and self-monitoring. It does not include personalising of the service in any other way than displaying the chosen reminders at a chosen time. Social interaction is limited to monitoring friends 'achievements and sharing goals in social media. There are no tangible or monetary rewards for the user. "Fabulous" has received lots of positive feedback for its graphics and User Interfaces (UI).

- **HabitRPG**: Another app, HabitRPG (role play game), presents the idea of an avatar that gains or loses force according to user's (self-reported) behaviours. The more

self-evaluated good actions the user performs, the more resources they have in a virtual game. It was crowdfunded via Kickstarter by selling virtual tools to be used in the game and offering a special status for paying clients. The app was found to be complicated to use. In a practical test within the PRECIOUS project, the avatar died if test users did not report healthy actions for two consecutive days, which seems to be decoupled from real life challenges (busy days, stress, etc.). PRECIOUS should thus on the one hand seamlessly adapt to the needs, challenges and opportunities of the user. On the other hand, PRECIOUS should augment the data recording by automatic activity tracking (e.g. physical activity, sleep quality) in order to complement the rather bothersome manual self-reporting.

- Known techniques like Motivational Interviewing (MI) could further be linked to role play games in e-Health. One feature of MI is creating a pros and cons list about the intended behaviour change in order to illustrate discrepancies. All pros and cons are listed of the desired new behaviour, but also of the old undesired behaviour. For instance, a person who wants to lose weight may see advantages in dieting (better health, nicer appearance), but also in the old way of eating (enjoying the taste of sweets, relaxing in nice cafés with friends):

Table 1: Pros and cons of the new behaviour and the old behaviour; *change talk* marked in grey.

Goal: Lose weight	New behaviour +	New behaviour –	Old behaviour +	Old behaviour –
	Smaller risk of Type 2 Diabetes	I must learn to cook healthy.	Eating pastries with friends is relaxing	Cannot fit in clothes
	More energy etc.	Self-monitoring is boring etc.	Chocolate makes feel better etc.	High blood pressure etc.

With gamification, the *change talk*, as one central MI technique, can be supported, and good aspects of the new behaviour may be reinforced (see Table 1), for instance by connecting them with the rewarding scheme (see healthCOIN) in a role play game. The positive aspects of the new behaviour are provided by the user and, therefore, can be used as personalised reminders of their goals.

Also, the user provided negative aspects of the new behaviour should not be neglected, but they can be used to identify barriers of change. These may be used to help the user create coping plans and start the process of creative problem solving for future hurdles (in analogy to [45]):

"You told us that a good aspect in your old habit is *eating pastries with friends, which is relaxing*. What would be the way to keep this aspect in your life while remembering your goal: *Lose weight*?"

This example underlines the need for tailored motivation and intervention strategies and a generally pluralistic ecosystem.

2.5 Consumer Needs

VHIR has conducted a small but representative empirical questionnaire-based survey with diabetes patients (N=8), which collects usage feedback for web- or app-based diabetes tools. We will briefly summarise interesting conclusions for the present deliverable from the anonymised data. Confirming our prior expectations, patients have been most interested in information, i.e. diabetes-related parameters and corresponding graphs, in order to experience a self-perceived control of their diabetes disease and to be able to share collected data with healthcare providers. The latter may also reduce the anxiety and uncertainty of patients with their disease. Patients have further looked for concrete measures to cope with their disease, rather than generic wellbeing tools. Therefore we can recommend the integration of tailored and very specific apps in e-Health platforms such as provided by PRECIOUS.

Regarding the distribution channel of such tools, we can conclude from this study that expert recommendation still plays the most important role due to their experience, reliability and knowledge of the patients. Experts tend to actively motivate users to try specific tools in order to improve on their day-to-day routines. In general purpose health sites, such as *oldkids.cn* or *hoitonetti.fi*, that provide expert advices are also available and they have proved to be very popular.

Users satisfied with the functionality (direct information sharing with doctors etc.) and usability, have interactively used the application – often daily. Hence, PRECIOUS can assume that e-Health and wellbeing apps can be created in a way to obtain a high frequency of use. We further believe that the project should target more intensive and more frequent interactions with users, if possible and in the interest of the specific users (i.e. options and personalisation).

It is possible that users' motivation can fluctuate or change targets during the course of using PRECIOUS. This can happen especially because various apps accessed by PRECIOUS IFTTT techniques can have variable sub-motivation targets. This fluctuation should serve the intended lifestyle change but it is naturally important that the user would still stick on the overall scheme of the intended lifestyle change. This can be reassured by providing appropriate health feedbacks, served the correct way (Fig.2). Motivational components of subconsciousness can often make the user to return to the service site relating especially to personal emotion related issues (personal taste) in the gamified service environment of PRECIOUS. These components can relate to users' own emotional motivation up keeping processes in a wider sense, and they can be intrinsic by nature but the users don't need to be totally aware of their composition.

2.6 Business Models in the Gaming Industry

Already in 2012, (mobile) gaming had already left the niche segment with good penetration or growth rates in any age group and across gaming genre – cf. [46]. The gaming industry (as a notable example for a content-related industry) may, provide some examples on how to reach market penetration for these kind of services that may resemble some characteristics of gamified e-Health applications as in the focus of PRECIOUS.

Content-related industries (games, videos, music, books, etc.) on the Internet are highly competitive [19] and multifaceted due to a series of market characteristics (extracted from [47]:

- Low market entrance barriers leading to a large number of players[6]
- Niche segments, i.e. abundance of "niche publishers"
- Open market access
- Broadly available off the shelf technology, i.e. web technologies that only require a web browser and Internet access to use a multitude of services
- "Universal access", i.e. consumers can directly trade with a multitude of sellers, which leads to a high degree of seller's competition

Thus, the efficiency in modern content-related industries is high due to the possibility of directly comparing features and prices, as well as obtaining goods from any (small) player on the market. Classical distribution channels, however, are often limited to the physical reach of customers, visually noticeable competing offers, and product information at hand, i.e. high asymmetry of information (the seller, agent, consultant or broker has access to information that is hidden to their customers). As a result, Internet gaming markets are especially embattled on the axis of pricing (both for the desktop-based gaming market or the associated mobile gaming industry [46]). O'Reilly [47] stresses the importance of branding in order to distinguish on highly competitive markets with "abundant opportunities to consume content'' [19].

Utilising the cost savings and novel distribution channel (i.e. means of interacting and trading with customers) opportunities as envisioned by Wigand and Benjamin [48] as well as Palmer and Erikson [49] (as summarised in [19]) recommend "personalization, archiving and versioning, cost savings …, subscriptions and pay per use …, advertising" as strategies for approaching such kind of markets. In addition, the strategy of solely focusing on in-app purchases has been successful on mobile app store platforms due to ability of enticing customers to plunge into the gameplay first and then profiting from the customer's interest to sustain the gameplay.

[6] In the case of gaming, the specific gameplay may provide a market advantage in the first stage. This advantage may be lost whenever no scaling effects can be utilised and new players can replicate the business model and game play of a particular game developer.

Macinnes *et al.* [19] clearly distinguishes between the following gaming industry actors and their specific business strategies (updated to match to today's market environments with application stores):

- The primary source of revenue for **hardware developers** (game consoles, mobile phones etc.) is the sale of the hardware itself (additional services or software may sometimes be provided free of charge in order to make the device more attractive)
- **Game developers** develop and sell video games by the means of one-time fees (classical business case), royalties or licensing (for commissional work or diffusion of original work), subscription fees (e.g. in order to access online servers for multiplayer games – also see [46]), advertisement ("advergaming" [46]) and product placement fees (mainly for free applications) and in-app purchases ("value-added applications" [46]).
- **Game publishers** use their distribution network in order to facilitate the market penetration of games. Game publishers typically receive a notable share of all revenues from game sales.
- **Game platform providers** represent a classical intermediary marketplace where consumer interests are matched with available games. Platform providers receive a share of the revenues from game sales (if a marketplace exists) or the receive advertisement fees for listing or promoting specific games.
- **Gaming co-enablers** provide supporting services like payments or advertisement frameworks in order to ease the game development, revenue generation and customer handling. They are directly compensated for their efforts by game developers, publishers or platform providers.
- **Internet service providers** provide the Internet access for multi-player or online games. The revenue model is typically separated from content-specific revenue streams, e.g. dedicated Internet access contracts.

Shankar & Bayus [50] highlight the importance of utilising customer networks in order to create isolating effects being subject to the network size and strength (also referred to as "network effects"). For example an online game may become more attractive the more players are participating, i.e. a utility gain due to scaling effects, and current customers may be loyal to some degree (also see branding), i.e. they may pay a premium for retaining the provider.

Especially the first point may provide good means for counteracting the high competitiveness on the Internet gaming market. Whenever a unique game play is provided which improves the game experience with the growing number of users, the scaling effects may prevent the direct replication of the game and business model by new market entrants. In this case, the

separation and protection of the own customer base, and lock-in effects may help to sustain the market success for some time[7].

Another common issue for content-based industries is content "piracy" (see Choi *et al.* [51]), which potentially undermines legal business models and innovation. Nevertheless, Choi *et al.* also claim that piracy and illegitimate business models may foster the usage of pioneering technologies and may "spur the development of legitimate and innovative business models (in new markets). Especially when customer needs are perfectly met, the rivalry between illegitimate and legitimate business models may be low. Apart from that, we have seen with the emergence of app stores and more modern content distribution platforms (Amazon Kindle, Steam, etc.) that comfortable access to a broad range of legal contents helps to shift usage shares and transitively revenues to legitimate markets.

Apart from this, we acknowledge that enormous amount of available contents may be regarded as perfect diffusion scenario where around a common idea various kinds of user groups, genres, markets or platforms are targeted. Thus, the content industry is a notable example for approaching heterogeneous user groups and markets.

2.7 Motivational Aspects

One of the targets for PRECIOUS is to understand how motivational aspects can be used to design a more functioning platform or ecosystem than the existing app-stores.

The premise for this is the assessment of the user and creation of the Virtual Individual Model (VIM). This is the basis for enabling a more flexible, tailored presentation of existing apps and the contextualised, time- and environment-based recommendations of suitable apps. PRECIOUS is approaching health apps from a multidimensional perspective, taking into account the social and environmental context in addition to quantified measuring of oneself. With sensor technology and guided questions PRECIOUS may explore the reasons that make choices interesting or uninteresting the current moment and thus defining the motivators and barriers in real time. This can be applied by e.g. supporting the social dimension of learning [52,53]; using location based information for recommending a restaurant or a gym, or warning of an unhealthy choices - and communicating this information with social networks. The PRECIOUS platform might display the information collected from several apps in an integrated, easy-to-read form for an easier comparison of metrics and a more complete picture of the personal health as a whole.

By so far, suitable apps have been sorted more or less manually by several clearinghouses, such as the NHS-library, Happtique, iMedicalApps, Eat Right, IMS Health's AppScript, and HealthTap's AppRx (Boudreaux *et al.*, 2014 [54]). With the existing technology, the sorting cannot be completely automated but there needs to be a phase of human evaluation of the usability of the apps. An ideal solution would be standards, such as the behaviour change taxonomy of Michie *et al.,* (2013), that would be established for describing app content. The app developers would need to label the content with a standardised terminology. This would

[7] The case of Nintendo and Sega illustrate that technological disruption may render customer base separation and other unique selling points obsolete.

enable automatic sorting of apps by their content. The problem is that motivational aspects such as the usability and amenity might easily escape this kind of automatic processing.

A customising platform would also help with the problem that usually there is no information about the users of an app before the actual moment they upload the app. Their initial motivational readiness for change, goals, and preferences are not used for tailoring the recommendation in the current app stores. Therefore, the solution might be an additional interface that would communicate with the user's smart phone, assessing the existing apps and the data collected from the user, and with the app stores assessing the available apps and computing the most apposite recommendations.

There also are limitations for applying behavioural change techniques and motivational techniques in the mobile environment: for instance, there are no clearly defined metrics (excluding user's own sense of mood or progress in the path of lifestyle change) that would link together all personal data (e.g. exercising scores or other achieved goals) stored in different apps. Thus, there is no overall image of a users' health as the achievements in different fields are hidden in separate apps and possible measured with incompatible scales. In addition, there is no single, reliable, objective means for measuring motivation, as the construct is multifaceted and escapes simple definitions. Motivations, as most human features are neither easy to evaluate and measure, nor do they stay the same. They fluctuate in time, magnitude and features. The more tailored the app is, the more time it needs for assessing the user. Keeping in mind the usability, a balance must be found between the ease of use and the level of customisation. More service features don't mean a better app for all users (Fig.2). The development of most psychologically influential service features needs to be assessed by self-evaluations, which demand the user time and patience. (This may be changing, however, with new techniques such as Linguistic Inquiry and Word Count [55] that enable language processing, and can for instance detect depression from the user's word choices).

In the existing apps, behavioural strategies are relatively narrow and stay on the surface, concentrating mostly on tracking of behaviour and goal setting, which risks not being motivating, extrinsic, long-term motivating strategy. For instance, Pagoto e*t al.* [56] screened the 100 most popular apps for weight loss and found that none of them targeted following techniques that would be essential for people with low adherence and motivation: stress management, problem solving, relapse prevention, negative thinking, social cues, developing regular behavioural patterns, time management, or nutrition label reading. The current apps also are limited in their motivational support as they are often indeed based on extrinsic rewards. Apps based on more sustained, internalised motivations would remind the user of their values and identities, which are relatively stable motivators, compared to momentarily cravings. Present apps are also very much concentrated on following up of vital statics and very technical of their basic nature.

Social relatedness is a facilitating factor of motivation internalisation [57]. Therefore, a well-functioning social platform as part of the service is likely to support engagement to the use of the app. Social aspects of the service should therefore base on networks and interaction, not on detached social media features or separate chat rooms. Big data analyses enable

locating individuals that are facing similar challenges or targeting similar goals, and that could be used to bond individuals to groups based on personal choices.

In addition, different motivational strategies may be explored by different kinds of applications that equally require different business strategies to successfully approach the market. This is supposed to be taken care of by PRECIOUS by allowing for the required flexibility in order to realise or try any kind of motivational technique with various kinds of different approaches or storylines for particular target groups. While today's app stores provide much flexibility, they do not tackle the coordinated motivation of users to achieve their individual health goals. Despite app-specific improvement potentials, isolated health apps further only (creatively) address particular symptoms of the user's health status without neither coming with a holistic health assessment nor systematic cross-app motivation.

Quite obvious approach to solve this service design dilemma is to apply a Freemium business model. Hence, all the basic components of the PRECIOUS service are offered free of charge. For some extra components you may need to pay for and some extra components give rewards in a non-monitory forms that can also potentially support better intrinsic motivation. In order to realise this, service development around healthCOIN can provide very useful service features. Apart from this, non-monetary rewards need to be carefully inspected for a successful service design. Figure 7 should be inspected to recognise and understand the overall value network around PRECIOUS. Some service components should support user motivation in a deeper and wider sense. This Freemium business model is also extremely flexible, as it allows a great deal of tailoring for each customer and for each phase of his or her lifestyle change process.

From PRECIOUS point of view, the lack of app stores that would customise the app recommendations with the virtual individual model of the user lead to difficulty in finding the users that would need the app most. The least motivated individuals for exercise and healthy diet are unlikely to search for health apps. In these cases, a real-life recommendation of the app by for instance a physician might reach and convince the risk groups. Respective recommendation via social media or motivational interview discussions could also provide to be useful.

Mobile health apps are very much based on and centred on behaviour change – people use health apps in order to change. Therefore, the users' initial motivation for healthy choices exists, the challenge is to base the app design on effective behaviour change mechanisms, create a highly usable interface, and offer mechanisms that support adherence to the service.

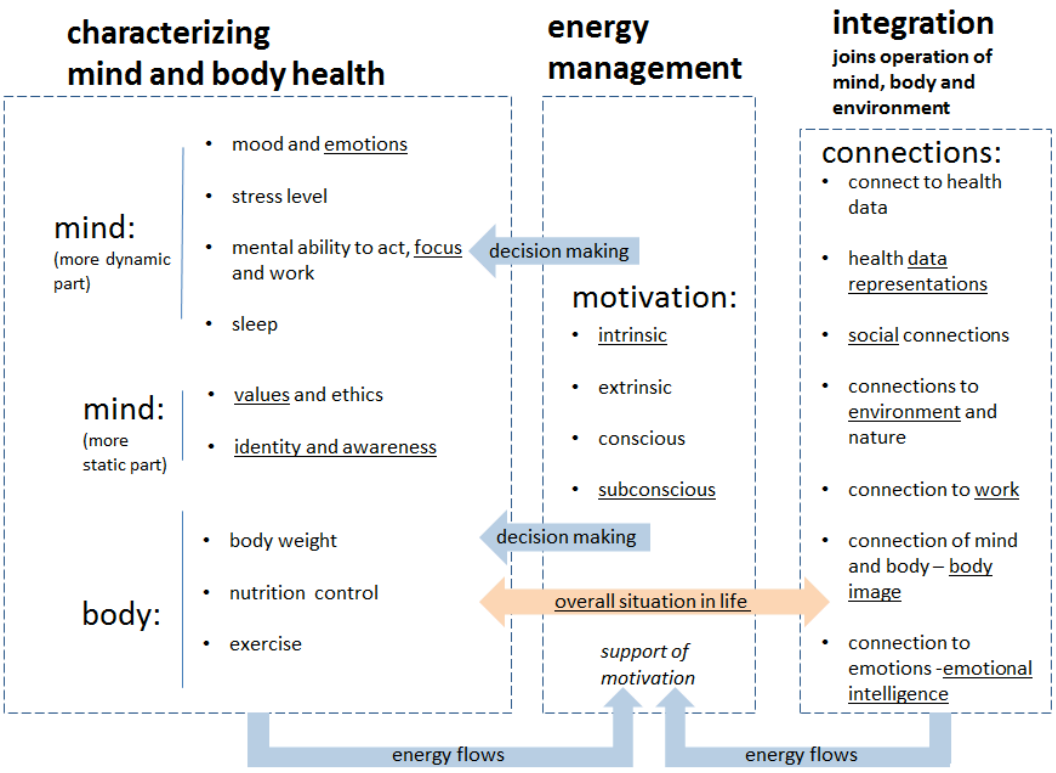

Figure 7: Summarizing building up and supporting motivation in well-being apps. Underlines depict important components of the service design that can be difficult to address.

Figure 7 summarises a perspective of how the motivation building can happen in usage of wellbeing apps. The used basic motivations components are categorised (following the illustration given in Figure 1 (b)) in conscious and subconscious as well as extrinsic and intrinsic elements. Hence, not all components of the motivational framework may be conscious to the user. Often, for example the overall situation of life has elements that hinder the acknowledged, wished lifestyle change to take place. For instance, some people might wish to quit smoking for monitory and health reasons. The more efficient personal motivation of smoking is anyhow build to the internal chemical reward mechanisms of the user's brain that is much harder to alter relating to the gas composition of cigarette smoke. Smoking can also provide enjoyable social connections (for instance having discussions in smoking premises) that also counter act the wished change to take place.

There can be multiple, contradicting motivation components conflicting the wished lifestyle change that are not easily recognised by the user. They might not even be directly controllable. However, reinforcing the "integrating elements" (depicted on right of Figure 7) may open up new reward systems helping in the lifestyle change. Sometimes by chemical alteration of brain's internal reward paths it is also possible to "rewire" brains and alter motivations. For instance, Chantix and Naltrexone are known to be efficient to inhibit endorphins production in the brain associated with tobacco and alcohol, respectively.

In summary, Figure 7 underlines that providing alternative reward pathways (replacing unwanted approaches) can enable a successful lifestyle change. These can relate to the

whole lifestyle, some of its components, or just to some internal reward mechanisms of the brain. User's motivation background can be much more contradicting and diverged than the user is aware. Its alteration may need to access the parts of internal reward systems of the brain and life situation features that are difficult to realise. The gamified service design of PRECIOUS can potentially lure the user to become more aware of these components; there after changing life can be easier. In the respective service design process of PRECIOUS several components of Figure 1 a might be required to access that makes the truly functional service design demanding.

2.8 Interpretation

The focus of PRECIOUS is clearly set on newer and more innovative concepts that target consumers. In lieu of existing professional service business models (mostly directly or indirectly collecting revenues from public organisations), the newer "app store"-related models create the opportunity to directly approach consumers. In the preventive care case, e-Health business models have to find the best and most direct link to consumers who are not yet involved in medical treatment. Those consumers can best be reached by drawing analogies from the industry around smartphones and their application stores. To start with, let us consider an interesting quite recent example first:

Figure 8: User interface for Apple HealthKit in IOS 8

A well-describing step to consider various health apps to construct an integrated service environment is formed by the Apple HealthKit service development. The basic service environment logic and idea is simple: to provide a service platform for various sensor devises and apps by utilised the common service interface provided by Apple. With

HealthKit, developers can make their apps more useful by allowing them to access user's health data in a secured way. Hence, by HealthKit[8] one can:

- See the well-being and health status and statistics, depending on sensors/devices accessed.
- Manage what is show: List of the different types of data being managed and selecting to inspect some particular parameter as a function of time.
- Control of personal data sharing with health apps.

Still the design philosophy of HealthKit is a good step to the direction of efficient health service platforms, it does not automatically support our findings of overall motivation management. It feels to be very technical and is obviously in its present form mainly targeted to fitness aware users. However, much depends on individual application designers using the HealthKit interface, so there is interesting development to be seen in the future. Finnish company Medixine is already providing health care personnel targeted service by using this interface[9].

HealthKit seems to fill our envision of a modular marketplace, which supports the innovation diffusion process by creating a unified interface that matches creative products (applications and their business models) and customers with their needs and preferences. Hence basically hardware-related business case (e.g. when primarily focusing on the sales of smartphones, activity trackers or other devices) does not limit the scope of e-Health applications or the scope of developing market but rather enables it.

When realised in a fair and trusted manner, such a platform provides a unified interface to end customers, on top of which, potentially less trusted services can also be deployed. This concept holds for technical aspects like privacy, but also trust when purchasing/investing in an unknown product, and may help to increase the collective apriority value of services (see "the market for lemons'' [58]) and may increase the consumers' choice and ease of comparing competing alternatives.

The subsequent section presents the e-Health ecosystem as basis for business models, which are specifically defined for the context (see Section 4). Using the collection of business models and the lessons learned from related works, we will aim at optimally facilitating the innovation in the e-Health sector, where increased innovation pressure on developers is balanced with increased market opportunities due to scaling effects.

2.9 High-level Requirements

While for PRECIOUS utility is an important term, modern e-Health approaches require a broader view than might have been envisioned by Von Neumann [59] many years ago. For PRECIOUS **utility** can refer to (**non-exclusive list**)

- **Monetary gains** (cash or equivalents like virtual currencies, stocks, company value, etc.);

[8] https://www.apple.com/ios/whats-new/health/
[9] http://www.medixine.com/2014/10/14/medixine-connects-iphone-users-healthcare-providers/

- **Valuation** of goods, services, social interaction and other kinds of feeling appreciation for something;
- **Delight** or **gains of positive feelings** (equivalent to the avoidance of negative feelings), e.g. positive emotions triggered by caring about others, helping others, competing with others (and potentially also winning or coming close to it) etc. ;
- **Social gains**, e.g. being perceived to be part of a community, positively perceived social interactions;
- **Intangible gains** such as obtaining new knowledge, creation of a network, intellectual exchange etc.

The **gains of utilities** may further be **classified** along the following **dimensions (not limited to the given list)**:

- **Self-centred** (own health or direct utility advancements) or **socialised gains** (helping others, working together, caring about others, being seen as supporting person, etc.)
- **Subjective health gains**, e.g. improved visual appearance / aesthetics, improved body feeling etc., and **objective health gains**, e.g. lowered blood pressure.
- **Societal vs. individual gains**: Individuals or an entire user or context group may profit. The utility may be higher if someone gains in a group, as the subjective utility is increased.
- **Short term or long term gains** and trade-offs thereof.

On this basis we can derive general PRECIOUS's **strategic goals**:

- **Social welfare** (utility of all stakeholders such as users, service providers etc.) optimisation shall be preferred over plain revenue or profit optimisation. Hence, the users' health has to be inherently integrated into the logic of the entire system.
- PRECIOUS shall **protect user data** and **other minimal quality standards** (see below)
- PRECIOUS shall support a **multitude of business models** (like Freemium) and **business ideas** (e.g. tailored to a very specific kind of user group or disparate motivational strategies)
- **Sustainable long term success** shall be preferred over short term effects (plain attention seeking strategies of applications in order to maximise short term usage rates is only of limited interest)
- **Preventive measures** are preferred over classical treatment. For classical treatment successful solution approaches have typically already emerged and are not supposed to be cannibalised by an additional offer. Nevertheless, the modern

support for behavioural change towards a healthier lifestyle for patients with existing health issues, although not in focus of PRECIOUS, may still provide benefit to individuals and the society.

The corresponding minimal quality standards are defined as follows (also see Section 3.4 for non-functional system requirements from a socio-economic perspective):

- **Privacy (also see [23])**: When handling critical and very personal information such as health data, privacy plays a very important role for creating the required trust relationship, i.e. a general disposition of users to share such data with another stakeholder. Privacy-protecting measures are, for instance, cardinal in e-Health. For this purpose, PRECIOUS will aim at **separating billing information** (legal names, addresses, contact information, credit cards etc.) from **individual app data**. Payments for paid apps are handled via a given PRECIOUS API, which shall **anonym's payment senders**. HealthCOINs (as introduced later); will serve as anonymous virtual currency that supports this separation. The **trade-off between information** gains when **sharing data among different kind of applications** and the potential handover privacy-relating information shall be **critically reviewed** (in doubt, the protection of customers is regarded to be more important than the creation of new features). Applications may also be **restricted** in their **communication** and **external data storage / processing** behaviour in order to keep users' data private. The tailoring of applications to its users shall be possible unless personal information needs to be scanned; shared or traded (e.g. advertisement-based business models cannot be tailored to the particular user in the PRECIOUS case).

- **Positive for health**: Applications have to successfully **contribute to the improvement of user's health**. Applications that do not meet those standards are not admitted to the marketplace. The **short term and long term success** of applications and the suitability for particular user groups shall be **continuously assessed** (reviews; recommendations per target groups based on available success rates).

- **Target groups**: Applications are supposed to be designed for specific target groups. Those target groups need to be defined by the application. On this basis, recommendations will be given to users and the success can be assessed. Each target group has to be clearly addressed by value propositions – e.g. the creation tailored health information for individuals in respect to the recommendations given in **[23].**

- **Low entrance barrier**: Entrance barriers are typically very high when considering a behavioural change. Barriers encompass the cost of change, the difficulty of getting rid of unwanted habits, the long term build-up of workout endurance, but also monetary considerations like equipment costs, application fees, etc. For this purpose, PRECIOUS will aim at **reducing entrance barriers** by giving **early feedback** (motivational system; metrics), providing extrinsic rewards for intensive

usage (healthCOIN as introduced later will support the first usage phase) and reducing **monetary burdens** (no dedicated equipment needs to be purchased to get started; support for business models like Freemium). Positive early feedback will help to compensate for unalterable barriers.

These quality standards are an effective measure in order to avoid *lemon market* issues [58], i.e. raise the apriori expected utility for applications, and are hence a **Unique Selling Point (USP)** of the PRECIOUS platform. The **following additional USPs** can be acknowledged:

- **Unified trust relationship**: PRECIOUS represents an intermediary between application developers and interested users. Once a trust relationship to the operator of the PRECIOUS system has been built up, the usage of applications from the PRECIOUS marketplace, which have been designed by different developers, do not involve a need to know each developer's trustworthiness. Thus, the user's attention shifts from trust to health concerns to characteristics of applications: *Does this app support my goal? Are the reviews from people like me encouraging? Do I like the approach and feature set of the app? Etc.*

- **Unified interface**: Today almost every application has very different kind of user interface, data organisation and feedback mechanism (e.g. scores, achievement levels, avatars, etc.). Those applications are typically separately started and do not work together in any sense. With PRECIOUS, we can provide a unified interface to the most important common functionalities like starting a workout, reviewing the own progress, getting advise, receiving recommendations, purchasing upgrades etc. Thus, a more simplified and collaborative environment can be created.

- **Common individualised goal setting engine**: Based on their health background, users may agree to target a certain health goal for the upcoming period, e.g. substantial progress in the physical exercising category. The goal setting and achievement can be designed relative to the user's current health status and abilities, and is supposed to be carried out by the entire PRECIOUS system and all its applications. Thus, every application can retrieve the current goals of the user and is supposed to actively contribute to the achievement of those goals.

- **Professional representation of each user's health**: The Virtual Individual Model (VIM; see WP3) captures the most important physiological and psychological parameters representing the user's current health. In lieu of absolute values (raw data), the VIM is capable of providing interpretations and recommendations for the user but also the applications and the goal-setting engine. Thus, application developers do not have to be experts in every health category, but are supposed to creatively support the collaborative efforts to support healthy lifestyles.

- **Comparison**: Users can compare their activities and progress (across application; not bound to the measurement of a single application) among themselvey by using specifically defined PRECIOUS metrics, e.g. activity coins or healthCOINs. Thus, advancements in the gampleay are supported by objective measures that may be shared or analysed.

- **Relative achievement levels**: Users are supported by valuable interpretations of their health data and activities. In particular, we will provide activity levels per category that give a timely and highly relative interpretation of your progress (sustaining the efforts in the long run and allowing a comparison with others without any direct social pressure), e.g. “you are now silver level in the food intake category – try to keep it up” may be more helpful than pure statistics.

- **Proactive health inteventions (based on predictive data analysis as recommended in [23])**: Contrary to static e-Health solutions, PRECIOUS is centrally built around a central data storage solution and its e-Health-specific interpretation in the form of a VIM. The VIM is continuously updated and proactively designed rules can help to prevent unhealthy practices before they manifest. Intelligent proactive data analysis techniques and interpretations can directly be integrated in the core of the system, and transitively influence associated apps produced by third parties.

3. e-Health Ecosystem

This section addresses fundamentals and challenges when forming an e-Health ecosystem, which will be used in subsequent sections in order to form business model and value network designs. We will first start by reviewing the applicability of relevant standards, and will then continue by specifically investigating the role of communication services in the e-Health context. The subsequent subsection will concentrate on known market issues to be avoided by PRECIOUS. We will further derive non-functional requirements and motivational considerations arising around business considerations.

3.1 Standards

From ISO/TR 12773-1:2009(en) (Part I) on "Business requirements for health summary records — Part 1: Requirements" ([60], Section 7) is standard specifying business requirements for so called Health Summary Record (HSR). An HSR is defined as a "*standardized collection of clinical and contextual information (retrospective, concurrent, prospective) that provides a snapshot in time of a subject of care's health information and healthcare*". While this definition sounds similar to our VIM representation (see WP3, and WP4) at the first glance, the VIM extends this perspective to a broader set of motivational and user variables and parameters, as well as a direct interaction between (external) apps and a unified metric.

ISO/TR 12773-1:2009 further defines HSRs to be data- and patient/consumer-centric, and an information aggregation of multiple information sources. HRS should further satisfy a series of qualities such as timeliness, accuracy and relevance to the context. The VIM will provide such an information set. Beyond that, also the system and system-adaptation will be tailored around user needs within PRECIOUS. We also transitively infer that business models should be tailored around individual users instead of imposing one size fits all solutions on every user.

3.2 Communication Services

The m-Health business models still remain largely unproven (or unsuccessful) and there is yet to be a clear benchmark model to adopt, even after analysts made this observation a few years ago [61]. The fact that mobile networks provide the fundamental infrastructure to facilitate m-Health services makes mobile network operators a key player in m-Health service delivery. However, insights from the initial wave of commercial m-Health services strongly suggest that m-Health business models could only be feasible (and indeed sustainable) in an ecosystem of partners delivering essential capabilities that cannot be provided by a single m-Health stakeholder [61,62].

In this section we present a high-level classification of m-Health business models (from a mobile operator's perspective), survey contemporary m-Health services of note and further illustrate this classification by focusing on some exemplary m-Health services (one for each business model).

3.2.1 Classification and Description of Different Business Models

The m-Health services are implemented end-to-end using a collection of services and components that usually belong to more than one stakeholder [62,63]. This end-to-end high-level view of m-Health services typically constitutes the following:

- **m-Health devices**: This includes health sensors or actuators, which may be worn, implanted or carried by the monitored individual, or alternatively deployed within their local environment (home, office, etc.). Furthermore, this domain also includes smartphones, tablet computers, smart televisions and connectivity hubs, that aggregate data from other health sensors (that may also be embedded within these devices) and provide a connectivity gateway towards remote m-Health provider's servers or networks. For instance, smartphones may have integrated sensors and health monitoring apps while also serving as remote connectivity gateway for health devices worn on the wrist.
- **Radio access and backhaul network:** The radio access network constitutes the air interface and base stations to provide the last mile wireless connectivity to m-Health devices for exchange of voice, video or data traffic with the m-Health provider's servers and networks. The backhaul is the middle segment linking the radio access network to the core network.
- **Mobile core network:** The mobile connectivity is the mobile operator's primary assets for managing connectivity for all devices and subscribers connected to their network. This includes functionalities for connectivity management, identity management, security management, and so on. The mobile core network also provides the interfaces towards external elements and packet data networks (e.g. m-Health provider's network) that connect remotely to the mobile devices (e.g. m-Health devices).
- **m-Health provider's servers and networks:** This includes relevant components (servers, network elements etc.) that are deployed and managed in the m-Health provider's domain (external to the mobile network). These components provide management functionality that is specific for the m-Health data and services. For instance, m-Health provider's domain could include web server platform that receives aggregated health data from an end user's Smartphone and uses it to provision a personalised health or wellness service (e.g. exercise reminder service), or a highly-secured server farm that offers a repository for electronic health data. This m-Health provider's domain may interface to systems belonging to multiple preventive health stakeholders, such as, public or occupational health organisations, employers, nutritional expert networks, fitness or wellness centres; insurance companies and so on.

This m-Health system may give rise to different value networks each with differing mobile operator business models depending on the participation of different other stakeholders in the implementation of the end-to-end m-Health service. To that end, we identify three general mobile business models depicted in Figure 9 and described briefly below.

- **Connectivity Provider (Model 1)**: In this model the mobile operator is only a "bitpipe" provider that only provides mobile connectivity services for m-Health service providers. The minimal involvement of the mobile operator in this model

means that the m-Health providers synonymous with so called “Over-The-Top” or OTT providers.

- **Enabling Services Provider (Model 2)**: For this model the mobile operator adds value to the m-Health providers by also leveraging some of its mobile core network assets to support some of the key m-Health service functionality (e.g. subscription management, itemised billing for multiple stakeholders, etc.).
- **Full Service Provider (Model 3)**: At the other end of the spectrum is the full service provider model, whereby, mobile network operator is also an m-Health service provider in addition to being a conventional communications service provider (CSP).

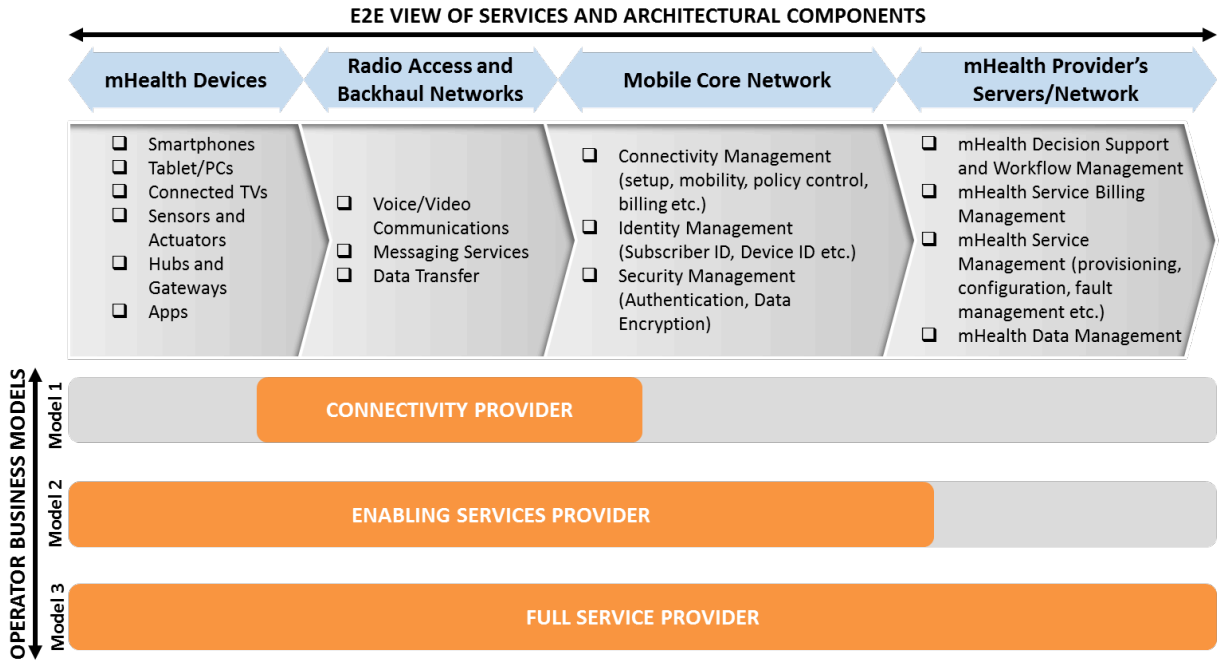

Figure 9: General classification of m-Health business models

The business models described above present varying level of benefits (and opportunities) as well as threats for the connectivity providers.

Table 2: Benefits, Opportunities, Disadvantages and Threats of Operator Business Models

Operator Business Model	Benefits & Opportunities	Disadvantages and/or Threats
Model 1: Connectivity Provider	• Increased connection number and data traffic	• Reduced competiveness and limited revenue • Higher subscriber churn
Model 2: Enabling Services Provider	• Increased data traffic and activation of new revenue streams from value-added services for m-Health	• Increased signalling load due to machine-type m-Health connections[10]

[10] The challenges of machine-type or machine-to-machine communications are being addressed by solutions, such as, implementation of dedicated MTC/M2M core networks with network function virtualisation [64].

	• Improved m-Health service-aware quality of service (QoS) control • Enhanced subscriber retention and more durable partners m-Health providers through tighter coupling with operator services (e.g. mobile payments) • Enhanced innovation through exposure of core network assets (e.g. location servers) to external m-Health developer communities	• Need for extra resilience and security measures due to exposure of network functionalities to external parties
Model 3: Full Service Provider	• Mobile operator at the heart of m-Health operations • Further reduced churn and increased subscriber loyalty • Significantly reduced (or completely eliminated) revenue share with m-Health service co-providers	• High monetary and brand risk due to exposure to relatively unfamiliar business activity

3.2.2 Exemplary m-Health Services

The connectivity provider model (Model 1) is becoming the common business model for mobile operators in a wellness and preventive care landscape increasingly dominated by over-the-top m-Health service offerings from mobile device vendors and platform providers. Prominent examples include Samsung's S Health[11], Apple's HealthKit[12] and Google's Google Fit[13] solution.

However, mobile network enhancements for handling machine-type communication services (like m-Health), proliferation of mobile payment systems and need for stronger data security and regulation continues to underline importance for active participation of mobile operators in the m-Health service delivery (including for preventive care). Moreover, the downward pressure on the traditional voice and data revenue streams is also obliging the mobile operators to adopt strategies for generating new revenue for vertical areas, such as, m-Health, smart grids, environmental monitoring emergency response, transport and logistics.

Below we present two exemplary mobile operator enabled m-Health services that are riding on the aforementioned trend.

Example 1: Sprint M2M and IDEAL LIFE Inc. (Model 2: Enabling Services Provider)

Sprint is one of the top 3 mobile operators in the USA and has been active producing a number of mobile wireless products for healthcare providers (e.g. Mobile Device Management and Mobile Security Bundles for Healthcare).[14] In the case of preventive care and home disease management, Sprint has partnered with IDEAL LIFE[15] providing a M2M

[11] https://shealth.samsung.com/
[12] https://www.apple.com/ios/whats-new/health/
[13] https://fit.google.com/
[14] www.sprint.com/healthcare
[15] http://www.ideallifeonline.com/

platform (with wide coverage) to support connectivity their health and wellness. The IDEAL LIFE device portfolio (IDEAL LIFE Managers) includes connected devices for measuring glucose, blood pressure, weight, heart rate and oxygen saturation. The company also provides a wireless gateway device (IDEAL LIFE Pod) for its measurement devices; and interactive touchscreen health management hubs (IDEAL LIFE Kiosks) that are deployed for shared use analogous to cash-dispensing machines (see Figure 10). These gateway devices are both connected to care provider domains via Sprint's 3G/4G network.

Figure 10 IDEAL LIFE Pod gateway device (left) and Kiosk interactive health hub

Example 2: NTT DOCOMO Healthcare Services (Model 3: Full Service Provider)

NTT DOCOMO Healthcare[16] is a joint venture between NTT DOCOMO (Japan's leading mobile operator by market share) and OMRON Healthcare Ltd (a health device vendor). NTT DOCOMO Healthcare service portfolio includes the following paid m-Health services [65,66]:

- *i Bodymo* a health service that use smartphones for monitoring or reporting your daily activities (walking, eating) and awards "docomo points" based on activity contribution to improved health The awarded points can be used to buy goods, repair services etc. (100 docomo points = 100 Yen).[17]

[16] http://www.d-healthcare.co.jp/english/
[17] 100 Japanese Yen = 0.74 EUR (February 2015)

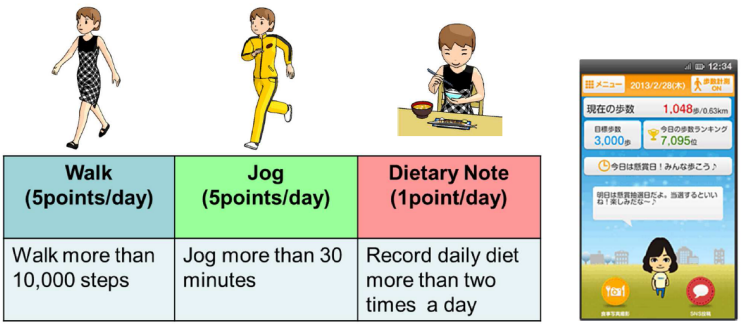

Figure 11: Example docomo points awards use the NTT DOCOMO i BodyMo service [65].

- *Karada-no-Kimochi* (Body Mood) a healthcare support service target for women that uses smartphone and wearable devices to monitor their daily biorhythms and basal (lowest) body temperature. The "avatar" on the smartphone may recommend hospital visits depending on the observed data. This is seen method for early detection of various forms of cancer (breast, uterine, etc.). NTT DOCOMO's insurance division (Docomo Medical Insurance) contributes 5000 Yen or 30000 Yen towards the medical fee depending on medical recommendation provided by the service. The service has a monthly subscription fee of 315 Yen.
- *Karada-no-Tokei* (Body Clock) a daily activity planning app that instructs the user to list their upcoming day activities (breakfast, exercise, travel, lunch, work, bathing, resting etc.) and the app automatically advises the best timing for each activity. The service is 315 Yen/month or 126 Yen/month for those who also use a wearable wrist sensor.

3.3 Market Issues

This subsection will briefly investigate noteworthy market issues and strategies to involve public stakeholders. A focus is set on how to obtain sustainable configurations and how to bootstrap the market.

3.3.1 Private-public Stakeholder Involvement

The conversion from a purely treatment-oriented health system to a new system also including preventive care measures would also require rethinking public health services. PRECIOUS will later on design business models in order to accept public subsidies in order to stimulate the market and in order to ensure quality in the app store. As this report is primarily concerned with economic, technological, and user aspects referring to the creation of such a modern e-Health market, the political dimension will briefly be discussed in this section.

There are examples of successful private-public collaborations in the health sector such as by the Finnish students' health service FSHS. FSHS has started to collaborate with a private m-Health provider, Meallogger[18]. They have initiated an online program that aims to help the students in weight management. Meallogger is a service in which people take photos of all

[18] http://www.meallogger.com/ (last accessed Mar 4, 2015)

the food they eat and share them in a social media platform. The purpose is to encourage others to eat healthy. This program is only just beginning, but it has attracted so many students that several new groups have been started. Meallogger has previously collaborated with several other health care providers.

Especially outside the e-Health domain **Private-Public Partnerships (PPPs)** have been successful for the collaborative creation and operation of infrastructure. The European Investment Bank (EIB) has estimated the PPP contracts with a value of €260 **billion** have been signed in the EU in only 10 years [67]. Notable global examples are VIVA[19] (transport) in Canada, several motorways in Germany[20], The Channel Tunnel Rail Link (CTRL) in the UK and the Perpignan rail project connecting France and Spain[21].
However, those PPP models are centrally motivated by their investment character with an expected Return on Investment (RoI) for the public entity. In a sustainable and functioning e-Health system we, however, require more than just investment from private actors and a substantially different role from public actors. We require the direct, proactive and positive integration of public health services in order to increase the impact of preventive care measures. This refers to activities increasing trust in preventive care apps and platforms by providing recommendations, but also providing promotional materials, market stimuli or the creation of own apps following the needs of the own organisation. The private end of the collaboration has to create and maintain the majority of the preventive care apps.

Private-public collaboration may be realised within PRECIOUS as external players or by the integration of further private or public stakeholders into the operational or strategic business of PRECIOUS platforms.

3.3.2 Market Power & Sustainable Ecosystems

The distribution of the market power among stakeholders within an ecosystem e.g. represented by a value network essentially influences long-term satisfaction odds of all individual stakeholders. Whenever a single stakeholder plays a role that dominates all others the entire market pressure may be shifted to a specific subset of roles. For example, when a marketplace has substantial market power in the ecosystem, it could shift its bargaining powers to take most of the profits from partnering firms. Those partnering firms, e.g. app providers, may face difficulties to sustain their business in the medium or long run. Hence, substantial market power imbalances may jeopardise the creativity that (small) players could add to the entire system. In some cases, low market power of individual roles endangers the entire industry as illustrated in [15,68]. Thus, when focusing on a motivational framework that adapts to user needs, as sketched in D3.3, a manifold of innovative and creative solutions will be important in order to create the required impact. We will in subsequent sections look

[19] http://www.yrt.ca/en/ (last accessed April 29, 2015)
[20] http://www.mondaq.com/x/87762/Government+Contracts+Procurement+PPP/Public+Private+Partnerships+In+Germany+An+Overview, (last accessed April 29, 2015)
[21] http://www.adbi.org/working-paper/2011/05/13/4531.financial.instruments.ppp.infrastructural.dev.eu/illustrative.examples.of.ppp.in.the.eu/ (last accessed April 29, 2015)

for solutions and techniques to assess and later on steer the market power distribution in the ecosystem – esp. see concepts and proposals in Section 5.1.

3.3.3 Two-sided market issues

Two-sided markets, or more generically multi-sided markets, describe the structural linkage of two distinct business interactios. The credit card industry, e.g. described as value network, requires a proper functioning of both the terminal and card business. In other words, credit card systems only work if customers are willing to have a credit card and pay with it, as well as shop owners have deployed a critical number of payment terminals. According to the definition of Rochet and Tirole [69] the monetary flows (fees charged at each side) inherently affect the participation in the customer groups at one or more sides. In practice, the monetary flow design is, hence, crucial to create a successful two-sided market. Credit cards may for example be issued for free and end users may not need to pay for transaction in order to establish a critical mass. However, also the terminal side needs to be motivated to transition to a cashless system, e.g. through a credible prospect of attracting more customers and reducing cash handling costs. Needless to say this represents a "chicken-and-egg problem" when kickstarting a new market.

For any kind of (digital) marketplace, we have to face a two-sided (or multi-sided) market, which requires specific structural handling. During the last years, the "ecosystem wars"[22] have mirrored this view by drawing even more attention to scaling effects. Customers of smartphones have increasingly begun to choose their operating system on the basis of available applications (amount, quality, unique applications, availability of favourite apps etc.) in the associated marketplaces. Unfortunately e-Health marketplaces are no exception – PRECIOUS will have to carefully moderate a two-sided marketplace and will have to compete with classical app market offers.

In this light, PRECIOUS requires unique selling points to render promising prospects for developers (developers have to join first) and to sufficiently attract a critical mass of users:

- **E-health application focus**: Finding the right application is faster and easier than on competing platforms, which are overloaded by apps that do not follow e-Health purposes
- **High quality**: Applications in the PRECIOUS marketplace have to of high quality for the desired context and target groups
- **Built-in privacy protection**: Web and app business models are often data-centric, which is an inapplicable strategy for health-related data. PRECIOUS has to be disassociated from any such practices by regarding privacy protection as cardinal element in the entire architecture.

[22] Forbes: „Apple And Google And The Fight For The Mobile Ecosystem: A Conversation And Review," http://www.forbes.com/sites/rakeshsharma/2014/04/02/apple-and-google-and-the-fight-for-the-mobile-ecosystem-a-conversation-and-review/ (last accessed April 29, 2015)

- **Unified metrics / Corss-app collaboration:** Contrary to isolated solutions in classical app stores, PRECIOUS will esp. unify the motivational strategy: unified metrics and cross-app collaboration features will bind together applications. Supported by marketplace-wide preference and goal setting mechansisms (e.g. “I want to increase my physical activity”) an app-centric approach is replaced by a user-centric counterpart within PRECIOUS.

Apart from unique selling points the **communication strategy** has to raise attention towards the PRECIOUS marketplace with the characteristics listed above:

- Collaboration and cooperation with known health institutions, e.g. public and private social insurance organisations, known health organisations etc.
- Usage of healthCOINS to raise the awareness in the entire health domain (e.g. healthCOINs being accepted in fitness centres may draw attention to healthCOIN and the entire PRECIOUS marketplace)

Nevertheless, the main barrier to kickstart the market will be the provisioning of an **attractive initial app selection**. PRECIOUS can target this by developing own applications, which both illustrate the platform potential to other developers (role models) and help to facilitate the marketplace (more applications). A common measure could be subsides and other promotions in order to strengthen both sides of the marketplace.

Another strategy actively supported by PRECIOUS will be the creation of free apps that come with in-app purchases. Such apps allow allow a low entrance barrier for customers to experiment with the app, but also provide app developers with opportunities to earn money on advanced features. This strategy relates to the Freemium business model as often applied in digital industries.

3.4 Required System Interactions

This section will briefly revisit non-functional requirements for interacting with the PRECIOUS system from a business perspective. In particular, we are looking at the interplay between the envisionend ecosystems and the technical solutions backing the realisation in practice. The review is summarised in the tables below. An NFR*x* requirement identifier (where *x* is a unique number) is used for each non-functional requirement. For further details on the classical non-functional system requirements we kindly refer to D4.1 (where the requirements employ same identifiers).

NFR1	System must meet or exceed levels of security as specified by relevant legislation for data protection. **Relevance from a business perspective**: PRECIOUS system handles significant amounts of user monitored and context data that places stringent demands in terms of privacy preservation and access controls. These security and data integrity requirements are critical from a business perspective in terms of not only fulfilling legislative requirements but also in terms of guaranteeing end user acceptibility and trustworthiness.
NFR2	System must have *flexibility* to adapt to variable usage contexts and environments. **Relevance from a business perspective**: A flexible system allows for ease in reconfiguration or adoption on response to varying user requirements and system, as well as, ability to support changes in business rules or business policies.
NFR3	System must have *scalability* to perform under increasing or expanding data volumes or workload. **Relevance from a business perspective**: The PRECIOUS system may have to respond to increased monitored data traffic, user number, device number, number of actice applications and so on. The success of from a business perspective is underpinned by ability to achieve by high adoption rates and usage levels. Therefore, system scalability should maintained at levels which do not inhibit growth. Moreover, scalability could also support alternative business models that, for instance, customise capital expenditures in pay-as-you-grow models. High scalability (e.g. due to good market penetration) will provide cost advantages due to scaling effects (i.e. economies of scale).
NFR5	System must have *extensibility* for adding new features or capabilities. **Relevance from a business perspective**: The PRECIOUS system design philosophy is one of on open architecture that favours system extensibility with the aim of facilititating evolutionary or incremental developments by a broader developer ecosystem. The developers are critical actors in the business ecosystem as their innovations ensure the long-term business sustainability of the system, which places a strong incentive on guaranteeing system extensibility. Extensibility also supports the scalability of the platform, and its economic advantages.
NFR6	System must make *efficient* use of computational/or and communications resources. **Relevance from a business perspective**: PRECIOUS system must be designed within the resource and cost constraints of devices and distributing computing platforms. This requirement from a business perspective this could be viewed in terms of its contribution to optimising the operational expenditures of the system.

NFR7	System must have acceptable levels of *availability*, *reliability and robustness*. **Relevance from a business perspective**: The system's availability is the amount of time that the system is operational and available for use and it is a critical factor in terms for user retention strategies and business disruption. This calls for approaches, such as, Business Impact Planning and Business Continuity Planning to to identify advervse impacts of system downtime in the event of a disruption or disaster and improve preparedness of the business in the case of those events.
NFR8	System must be easily *maintanable or serviceable.* **Relevance from a business perspective**: PRECIOUS system must have the ability to allow alterations in devices, services, features or interfaces to the extent that such changes are required when adding or changing functionality, correcting defects or supplementing new business requirements. This will lower the maintainance, operations and adaptation costs in the long run.
NFR9	System must be acceptable levels of *usability* for its intended users. **Relevance from a business perspective**: PRECIOUS system design must incorporate the capacity for the system to be understood, learned, and used by its intended users and other relevant actors in the business ecosystem. While especially the onboarding phase is often decisive[23], the satisfaction and ease of exploring new apps may determine the market success in later phases. In other words, if things are hard to find, complicated to install or are associated to unpleasant feelings, the utility for end users will be lower and their expenditure will decrease.

Gamification fundamentally builds on very tailored solutions to very specific problems. For this reason one solution, including its business model may not be an adequate solution for a different problem. Health has many facets, which have to be respected in e-Health alike. Heterogeneous user groups and varying circumstances of life may further increase the requirement for more flexible frameworks.

GR1	Gamification should not be limited by a limitation of business approaches.
GR2	Marketisation strategies should allow addressing the heterogeneous user group of PRECIOUS, including the support for different personalities.
GR3	Marketisation strategies should allow addressing various circumstances of life.

[23] Applications with unpleasant onboarding experiences are often uninstalled quickly after the initial contact.

Efforts to deploy gamified solutions should be limited. This could be obtained by providing common services, common APIs and assistance for developers.

GR4	Common services, APIs and developer assistance tools and tutorials should be provided.

3.5 The Perspective of Motivational Techniques

Most m-Health applications fail to include sufficient and satisfactory educational and motivational elements at once [70]. PRECIOUS' **added value** is the **inclusion of such features** in an integrated manner with the expertise of the multidisciplinary approach. The open-minded concept of integrating various kinds of apps will help to focus on motivational techniques tailored to various kinds of user groups in order to increase the impact.

Two prominent models of IT acceptance are the technology acceptance model (TAM) [71,72] and the motivational model (Davis, Bagozzi & Warshaw, 1992 [73]). TAM extends the theory of reasoned action by proposing that individuals' perceptions of a technology's usefulness and ease of use are key contributors to Behavioural Intention (BI) to use the technology. The motivational model proposes that Intrinsic Motivation (IM) and Extrinsic Motivation (EM) are key in determining BI (see Figure 12). In technology acceptance research, BI is typically used as the dependent variable in place of actual usage. BI is available for measurement at the same time as other constructs in acceptance models and is considered to be an accurate predictor of future usage behaviour. A meta-analysis of 87 studies found an average correlation (0.5) between BI and actual usage [74-76] (Sheppard, Hartwick & Warshaw, 1988). Both TAM and the motivational model have been applied successfully to predict technology acceptance outside health care domains. Moreover, TAM has been used successfully to model physicians' acceptance of telemedicine technology (Hu, Chau, Sheng & Tam, 1999 [75]) and e-Health acceptance [77].

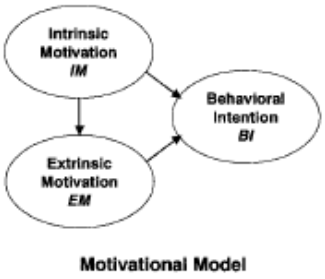

Figure 12: Extracted from [77]

It is recognised that theory-based self-management programs are more effective than non-theory-based programs. Theories can help to specify key determinants of the target behaviours and behavioural change strategies required to arrive at the desired health outcomes. Abraham and Michie [78,79] have developed a taxonomy of behavioural change techniques (BCTs) for different health behaviours. This taxonomy is very helpful to support

the development of m-Health self-management solutions for T2D and other conditions, as van Vugt and colleagues have demonstrated in [80] (see Table 3).

Table 3: BCTs used in the interventions discussed by van Vugt *et al.* [80].

Provide feedback on performance
Provide information on consequences of behavior in general
Barrier identification/problem solving
Provide information on consequences of behavior to the individual
Prompt self-monitoring of behavior
Prompt self-monitoring of behavioural outcome
Provide instruction on how to perform the behavior
Facilitate social comparison
Plan social support/social change
Goal setting (behavior)
Action planning
Prompt review of behavioural goals
Stress management/emotional control training
Provide normative information about others' behavior
Model/Demonstrate the behavior
Prompt practice
Use of follow-up prompts
Goal setting (outcome)
Provide rewards contingent on successful behavior
Relapse prevention/coping planning
Provide information about others' approval
Set graded tasks
Prompt review of outcome goals
Prompt rewards contingent on effort or progress toward behavior
Prompting generalization of a target behavior
Provide information on where and when to perform the behavior
Teach to use prompts/cues

Environmental restructuring
Prompt identification as role model/position advocate
Prompt self-talk
Prompt use of imagery
General communication skills training
Stimulate anticipation of future rewards
Shaping
Prompting focus on past success
Agree behavioural contract
Prompt anticipated regret
Fear arousal
Motivational interviewing
Time management

From previous reviews of a wide range of online diabetes self-management tools and programs, it would appear that it is still unclear which BCTs are most used and most effective when it comes to improving self-management behaviours related to health [81,82].

Theories of motivation have distinguished between intrinsic and extrinsic motivations. Intrinsic motivation is innate and it is characterised by engaging in behaviours for their own sake, while extrinsic motivation is regulated externally and characterised by engaging in behaviours for some separable outcome, whether this comes in the form of tangible rewards, social acceptance, proving something to oneself, or maintaining consistency between one's values and one's behaviours.

Considering these definitions, many behaviours, particularly those relevant to health promotion (e.g. making dietary changes), disease prevention (e.g. screenings such as colonoscopy), and disease management (e.g. taking medications) are likely extrinsic in nature. However, from SDT a motivational continuum have been proposed to characterise the extent to which extrinsic motivations are relatively more or less internalised [57]. It is relevant to note that different types of motivation do not exclude each other. People typically regulate their behaviours with several motives simultaneously. It is possible to stay physically active because of intrinsic pleasure, but simultaneously, for external goals such as health goals, appearance goals, wanting to identify as member of a sports group, and also negative emotions, such as guilt or shame for not exercising, or experiencing peer pressure to do sports. All these reasons together contribute to the general motivation, which then translates into activity. Some of these regulations have been connected to more sustainable behaviour change than others. The more internalised and autonomous the behavior

regulation is by nature, the more likely it is that the behaviour change is relatively sustainable. A useful conceptualization for health behaviours is to divide intrinsic and extrinsic aspirations to two classes depending of their autonomous or controlled nature. *Autonomous motivations* include both the intrinsic regulation, performing tasks for their inherent pleasure, and also other regulations that have an external goal but are, nevertheless, highly autonomous. With *integrated regulation*, despite the external goal, individuals experience a behaviour as a part of their values and beliefs system, fully assimilated to the self, and are committed to it (Ryan & Deci, 2000 [57]). With *identified regulation*, the behavioural goal is accepted as personally important and individuals are ready to face challenges in order to achieve it [57]. Identified regulation has been associated more strongly to initial or short-term adoption of exercising than any other regulation style (whereas intrinsic motivation has been found to be the strongest predictor of persistent exercise) (Teixeira *et al.,* 2012 [83]). For these reasons, supporting the internalisation of behaviour regulations from controlled regulations towards autonomous, identified and integrated behaviour regulations increases the likelihood to create a sustainable behaviour change. All the different types of external motivation have the potential to be integrated more to the values, identity, and personality of the individual.

Therefore, in PRECIOUS, the key question is, how do we manage to support the internalization of health behaviours? There are three factors that have been connected to increasing internalization of behaviours: (1) autonomy support, (2) experiences of competence and (3) relatedness [57]. In PRECIOUS, these are supported by, for instance, (1) offering the user chances to customise the service, set their own goals, modify those goals, and be the independent stakeholder in the healthCOIN model (see Section 4) in order to feel more autonomous; (2) monitor their behavioural achievements, be rewarded of their success and receive encouragement in order to feel more competent; (3) be connected to peers using PRECIOUS and provide and receive positive feedback to others who have achieved their goals in order to experience relatedness [57].

3.5.1 Role of Extrinsic Rewards

Intrinsic motivation is the core type of motivation underlying the fun aspects of a potential service design because they are intrinsically satisfying [84] or what is often referred to as autotelic [85]. Furthermore, games have been found to increase people's intrinsic motivation to engage with contexts that have educational material in them embedded [86]. Positive challenges and following one's progress is intrinsically rewarding.

In PRECIOUS, extrinsic rewards may play a gatekeeper role: Extrinsic rewards are easy to communicate, can easily be introduced in marketing strategies and as such can facilitate the acquisition of new users. Once the user has got used to a new behaviour (internalisation of behaviours into one owns daily routines), autonomous motivations will help to maintain the activities in the long run. PRECIOUS will effectively focus on the long-term success of e-Health solutions. In PRECIOUS, rewards will be used as indicators of success, thus contributing to the experience of competence, a significant predictor of autonomous

motivations. The configuration and type of rewards, however, strongly impact the behavioural change effect to be expected from a stimulus as elaborated in [87]. Rewards may also spur competition, which has widely positively affected users in the study of [88] (only some users ignore the stimulus or are even negatively affected). The competition may be used to develop the relatedness to others, another important determinant of autonomous motivations.

4. The healthCOIN business model

In this section, we construct the healthCOIN concept as a modular economic framework for a broad variety of business models in the e-Health market. While our focus will be strongly on digital services, and preventive care, the application fields of healthCOIN will clearly reach out to non-digital domains and any kind of e-Health application.

The healthCOIN concept will provide directions in e-Health, which will facilitate;

- a platform for applying various kinds of motivational techniques;
- an economically feasible framework (a marketplace with agreed metrics/measures for activity and e-Health purchases);
- assistance for the diffusion of innovation (openness for many kinds of apps and ideas);
- cooperation among apps (and their providers), e.g. sharing a community;
- a “bridge” for individual e-Health efforts to optimally target the health needs of each individual user;
- collaboration of users, e.g. assisting friends to reach their health goals;
- the hooks meeting unifying architectural, technical, motivational and economic constraints.

The healthCOIN concept will not characterise particular designs to optimally motivate users (see WP3), create apps (stories, interactions, required APIs, …), the architecture of PRECIOUS (see WP4), but will focus on creating hooks to link together individual perspective around a marketisation concept.

4.1 Lessons Learned

The aviation industry has taken a leading role in exploring the business power of strategic alliances, e.g. StarAlliance, oneworld, etc. On a global scale, each airline is unable to target the dynamically changing needs of all of their passengers; therefore airlines are sharing their business with partnering airlines to meet the needs of their consumers.

In similar fashion we can draw from the membership points design of the airline alliances. Often several kinds of points are collected where some just represent a currency for obtaining a status with bonuses (e.g. business class check-in even for economy class tickets) and others are points that can be used to purchase tickets, upgrades or other items (e.g. luggage). The collection of membership points further leads, to some extend, a platform lock-in, which can be inindistinguished by the following two cases:

- **Points usable for purchases** should be transferrable between monetary equivalents and their virtual representation in order to establish them as means of payment. This represents only a nudging and thus sets defaults motivating the usage within rather

than outside the health domain. If discounts or vouchers are broadly transferred outside the health domain, a restriction can be added later that disallows the transfers of such kind of points.

- **Points as activity indications** are always lost whenever a user leaves PRECIOUS for another platform[24]. However, PRECIOUS can help to overcome similar effects regarding individual applications by allowing an easier transition esp. between similar apps, i.e. the same kind of points are collected for the usage of each app instead of receiving game- or app-specific points. This clearly presents an added value for the user and increases the competition for high quality contents.

The e-Health industry is no different, as individual apps and attempts to achieve behavioural change may be insufficient to cover each user, the entire lifecycle and changing needs of current users, as well as the range of required interventions, e.g. motivate users to become more physically active, improve their eating and drinking habits, etc.

In analogy to the experiences from content-related industries (see [47]), e.g. gaming industry, a successful e-Health platform has to come with a strong and communicable brand in order to distinguish from competitors (which is necessary in order to reach a critical mass of customers for the successful long term operations in markets with scalability gains) and has to use low cost distribution channels, i.e. in our case the Internet via various kinds of apps. The broad availability of content further stresses the importance for coordinating efforts, e.g. common platforms, single means of payment, cross-app promotions, review and rating process, etc., in order to tailor the functionality to a heterogeneous group of users and obtain the required visibility. Notable examples are

- IFTTT[25] for a tailored and user-defined interactions between individual services, apps and tools the user likes;
- Google Play[26], Apple App Store, etc. as unified marketplace with defined means of payment, reviews etc.
- Steam[27] as marketplace being tailored to the specific needs of the gaming industry;
- Google Fit[28], Apple HealthKit[29] etc. providing a unified dashboard on mobile phones in order to track data from smartphone sensors and running health applications

In analogy to IFTTT, PRECIOUS will target heterogeneous user groups with heterogeneous needs and backgrounds. We can, therefore learn from the flexible and API-based interaction designs by IFTTT in order to better involve users in their own treatment design and

[24] This is based on a rationality assumption as platforms may be operated by public bodies (serving the public interest and thus aiming at keeping users in a controlled and non-commercial zone) or private profit-driven companies (that will aim at maximizing profits in the short and long run).
[25] https://ifttt.com/
[26] https://play.google.com/store
[27] http://store.steampowered.com/
[28] https://developers.google.com/fit/
[29] https://developer.apple.com/healthkit/

procedure. Further to this, the success and endeavours of apps like Google Health (but also specific tools like Jawbone Up) stress the importance of creating automatisms in order to optimally profit from technologies and to lower the usage barrier (including the cost of change from a current behaviour or transition from another contextual situation).

We can also learn a lession from the available app selection literature, where for example [89] concludes that app selection of individuals is best understood as “simple heuristic-based decision-making”, which is subject to a limited number of cues such as “personal traits” (highlighting the requirement for regarding app selection to be a personal process) and app characteristics. Under this reasoning, a unified and organised access to the very complex and heterogeneous markets will lead to better, more personalised, and more effective app selection (e.g. in terms of VIM-like data improvement or behavioural change statistics). Hence, a unified marketplace or framework is required, that abstracts on the various backgrounds of apps and is entirely focused on e-Health, to ease the decision process for users (a factor potentially increasing the impact). When combining this line of thought with the nudge theory, as known from behavioural economics [90], a unified marketplace provides an optimal point for application for positively influencing the app selection and usage process of users by clever but non-binding recommendations (following the nature of “libertarian paternalism” characteristicing the nudging process).

Besides all commonalities with other industries, the e-Health industry is disparate for the following reasons:

- User interests have to go first in order to obtain reasonable behavioural change. This includes both privacy considerations and the need to foster the transition between used apps in order to optimally target the user’s health goals under changing conditions. For example, a user may have started with an app that promotes increased walking, – e.g. to work or to the grocery –, but after some time has been transitioned to other sports apps such as running apps in order to achieve the next level of their behavioural change. Specific contextual needs may also be addressed by different applications, e.g. while users may prefer to play games, the proximity to a training court may also open opportunities to suggest further activities.
- Domain expertise integration is key to successfully targeting healthier lifestyles of users. Thus, health goals and motivational techniques need to be professionally moderated and pursued across applications, while individual app developer’s needs or preferences have to wait in line.
- Frameworks for realizing the intensified cooperation and user-centricity are required that allow the app developers

4.2 Big Picture

The central component of healthCOIN ecosystem is the trusted platform[30], which moderates any activity (data, payments, user interaction, etc.) and aims at protecting the users. For this reason, the platform represents a “bridge”, which discouples the direct data interaction between users (customers) and any kind of app developer or service provider.

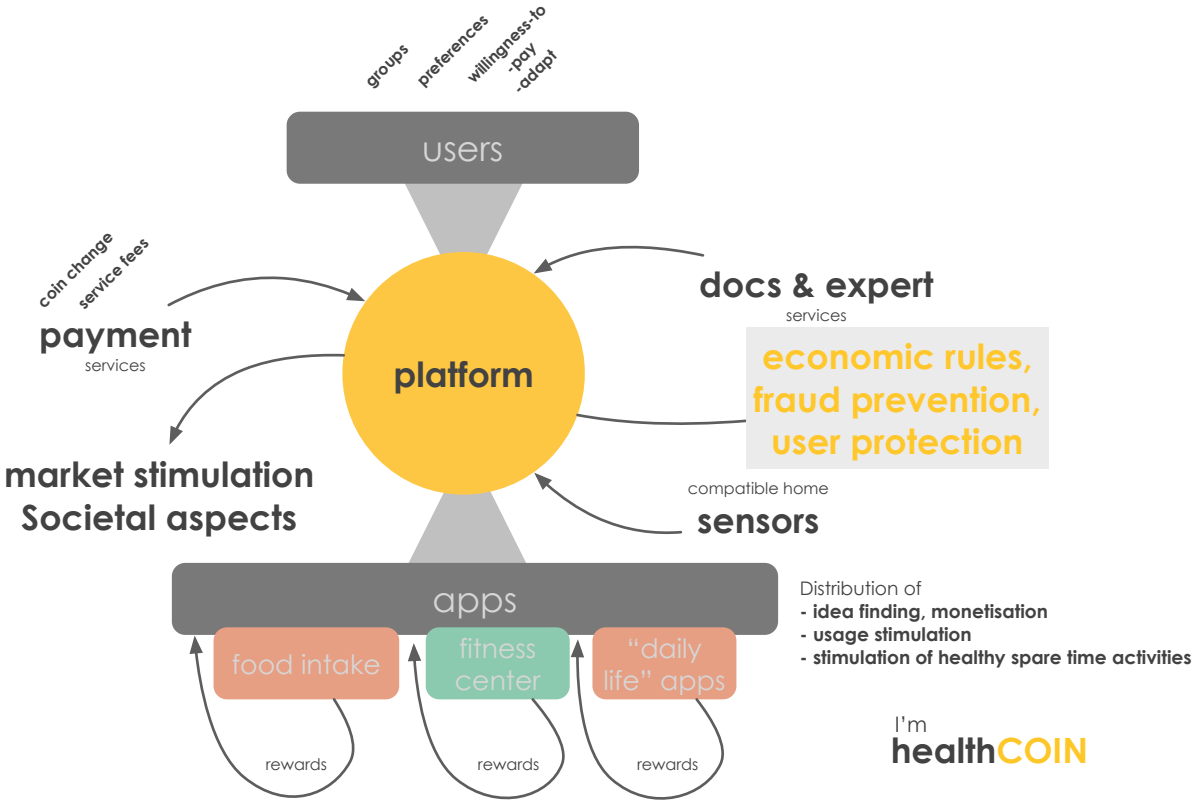

Figure 13: healthCOIN big picture

Stakeholders

- **Platform operator**: The platform needs to be operatored by a dedicated actor role (role of a stakeholder). The operator may or may not be the owner of the platform. Platform roles have to be outmost trustworthy and have to protect their reputation in the long run.
- **Users / Customers**: Preventive care “patients” or any person interested in receiving support for transitioning to a healthier lifestyle may be regarded as target customer.
- **Sensor / hardware manufacturers:** E-health services fundamentally rely on the availability of high quality health data. For this purpose, healthCOIN aims at promoting the usage of 3rd party sensors by selling sensors, integrating sensor data, and providing APIs for additional services to be realised. healthCOIN is in the position to recommend interesting high quality sensors to users, which requires

[30] Depending on the configuration of the overall market, several such platforms may coexist – e.g. comparable to travel agencies on the Internet.

cooperation with known sensor manufacturers. Likewise, the integration of simple sensors like Smartphone sensors needs to be targeted by providing technical integration in the healthCOIN platform. The integration of such smartphones can be achieved by providing data APIs and by collaborating with manufacturers of interest in the first phase.

- **3rd party service providers:** Some services cannot be internalised in healhCOIN, e.g. social media platform like Facebook (requires enormous scale to be effective), payment services (two-sided market itself), weather information (requires orthogonal expertise and competencies), expert services (doctoral advice services) etc.

- **Application and service providers / developers:** The success of healthCOIN and any platform resulting from PRECIOUS is inherently linked to the practical application of motivational techniques for preventive care patients. The technical and economic core thus consists of apps, which are provided and sold by independent developers. Both customers and application and service providers are key actors for the two-sided healthCOIN platform.

    - According to [1], apps are typically provided by "traditional healthcare players, helpers, mobile app specialists, connectors, medical and fitness specialists".

- **Public health organizations:** In the European Union, an extensive network of social insurance services exists that is operated by the public to serve the society (e.g. to cope with illnesses, injuries, loss of jobs, loss of income due to unemployment or retirement, etc.). Apart from this many public organisations (or related NGOs) exist that inform the society about healthy lifestyles and other health-related issues such as the World Health Organization (WHO), Publich Health England (PHE), the National Health Service (NHS)[31], or the EU Public Health portal[32].

- **Health association and professional associations:** Some organisations may primarily inform the society about health practices and dangers, and may provide recommendations. Examples may be the VFED[33], European Public Health Association[34] (EUPHA) and its 40 national members, the World Health Organization (WHO), the Food and Drug Administration (FDA), etc.

- **Private Insurances:** Many companies sell insurances that cover risks for the own life and health, and possessions (home, car, etc.), and the retirement phase (e.g. insufficient income after retirement). Their business is typically indirectly related to the health of their clients.

[31] The NHS has for example proposed to use the eatwell plate indicating how a healthy meal could look like. Such plates increasingly replace the form of food pyramids. http://www.nhs.uk/livewell/goodfood/pages/eatwell-plate.aspx, last accessed: 2015-03-23.
[32] http://ec.europa.eu/health/index_en.htm, last accessed: 2015-03-23
[33] Verband für Ernährung und Diätetik e.V.:http://www.vfed.de/de/leistungen, last accessed: 2015-03-23.
[34] http://www.eupha.org/, last accessed: 2015-03-23

Open Source vs. Commercial Platform

Originating from the idea of mainly serving the public interest, PRECIOUS could solely be based upon Open Source software. We will, however, subsequently argue why Open Source software will be insufficient to target the challenges in the e-Health domain, especially when aiming at integrating various kinds of efforts to motivate users to achieve a behavioural change towards the positive:

First of all, let's assume the platform software itself will be Open Source and can thus be deployed by any skilled private user on their own server or by smaller or bigger corporations / organisations in order to provide cloud solutions for other users. In the first case, it will be difficult to purchase apps to be executed in the context of this platform software and the operational overhead to do such agreements with individual software developers will probably be too high for a very limited user group, e.g. the own family. In the latter case, the platform will be operated by a commercial platform. Hence, licenses should not limit the commercialisation of platforms, as it could limit the impact of PRECIOUS software tools.

Once the decision on the software licensing modalities has been clarified, the operator or owner of the individual platform has the strongest impact on the nature of the platform. **Platform operators** may be

- **Public authorities or organizations** (including social security services): The main interest will be the promotion of healthier lifestyles in order to reduce required investments to take care of illnesses and a society with lower productivity and happiness. However, the required promotion activities and initial investments may hamper the interest of public organizations to invest money that need to treat ill people right now.
- **Health associations or organisations:** While the motivation may be similar to public authorities, the cost factors will be of minor interest. However, most associations may have difficulties in handling the financing of such platforms and may not have competencies or experiences in creating start-ups.
- **Insurance companies** or other companies with indirect business interests: Already today, private insurance companies[35] have started to track the user behaviour in order to better shape their products (and the associated risk portfolio) to match their customers. Similar discussions have recently emerged for life and health insurances, where health trackers could viable evidences for setting the height of insurance fees. In similar, fashion insurance companies have provided reward programs that have in particular promoted wellness holiday. Thus, the operation and potential subsidising of a PRECIOUS platform may be a viable next step in order to preventively influence the rate of insurance cases.

[35] Car insurances with GPS-based discounts: http://www.liveinsurancenews.com/usage-based-insurance-devices-track-drivers-using-gps/

- **Classical commercial operators:** Comparable to other content-centric marketplaces or app stores, a commercial operator can make a profit on app fee commissions and related sources of revenues. This will represent the classical case in practice.

Hence, Open Source software may only constitute a factor that facilitates the diffusion process and hence diversity in the e-Health field, but will not ease the operational complexity or strongly impact the commercial-orientation of individual platforms. Open Source, however, may assist in creating a co-existence of (non-inter-operable) commercial and non-commercial platforms.

Revenue Flows

For covering the expenses of the platform (and potentially creating profits) we have envisioned the following revenue streams:

- **App sales:** A share of subscription or one-time app purchase fees will be kept by the platform, while the greater part is forwarded to the app developers. The typical share for the platform is below 30%. For supporting the long-term perspective of the platform and each user's involvement we recommend subscriptions over one-time fees. This will generate incentives for app developers to continuously update their applications, e.g. to create additional story lines or levels for games.

- **Expert service sales:** In similar fashion, expert services like advice from medical practioniers (e.g. human verification of health data and workout / diet plans) will generate revenues from which the platform provider will keep a commission. Expert services should be used sparsely and meaningfully and is always initiated and paid by the user directly – i.e. app / service providers should not play a driving role for such kind of services. For the beginning only carefully selected external services are considered[36], which may in later phases be complemented by own offers. Due to impracticality of verifying each expert advise by a healthCOIN domain expert, clear warning messages have to be given to users before using such services (despite the highest effort for quality control using customer feedback).

- **Hardware sales:** The platform may directly offer health hardware like sensors for sale. The profit in the hardware business may help to sustain the rest of the platform.

- **Consumer service fees:** The platform may support the meet up of workout partners by providing additional supportive features like the reservation of training grounds, e.g. the reservation of tennis courts is directly handled by the platform for which it receives a commission.

- **Product placement:** Apps may be realised in cooperation with partnering organisations. Contrary, to classical advertisements, non user-aware product placement strategies (if properly executed) may provide useful additional means of

[36] Today a series of web platforms exist that provide medical advise by medical practitioners for a fee, e.g. https://www.dred.com/at/

funding. The platform owner could receive commission on any kind of monetary or non-monetary supports for the application due to product placements in the apps of the PRECIOUS marketplace.

- **Licensing**: The health COIN brand, once established, could be licensed to other companies in the health domain in order to sell other health services, e.g. fitness services or coaching's, or products, e.g. sensors or sporting goods.

Following the argumentation line on privacy issues in the related work section, we believe that advertisement-based revenues, especially when based on sensitive customer data, are hardly applicable for the e-Health case in the long run. For this reason, we will neglect such revenues in the subsequent analysis.

Other sources of revenues may mainly result from **subsidies** due to:

- Interests in a health society and low costs incurred by public social insurance services (e.g. by public authorities, health organizations, health associations, microfunding, donations, etc.)

- Interests in secondary or indirectly related business cases such as private insurances lowering their costs due to high numbers of insurance cases

Business Model / Technical openness

We have to distinguish between two kinds of business models, those of app developers (individual; very specific) and for the healthCOIN platform itself. The latter is important to create an ecosystem in which various kinds of app developers' business models can find nutrious grounds for targeting the e-Health objectives.

While healthCOIN seeks for the highest degree of openness regarding choosing technical solutions but also realising various kinds of **highly tailored business models by app / service providers**, some restrictions have to be minded in order to protect the user, other app developers and the entire ecosystem:

- any generated direct revenue needs to generate a commission for the platform (see above) – whether it concerns subscriptions or one-time payments

- direct sources of revenue are limited to the healthCOIN applications marketplace (and associated means of payment), while indirect sources like product placement or non-personalised advertisements may not be restrictable by healthCOIN

- sending data to external servers / resources has to be limited for privacy reasons (the reception of data does not have similar restrictions); depending on research outcomes the inter-app communication may have to be limited alike

- quality control of each application is necessary in order to assure that the e-Health objective is sufficiently targeted by each application

- direct offenses against other applications (reviews and similar mechanisms will be used in order to allow the users to asses the quality and suitability of each application) are disallowed in order to keep a positive mood for the entire platform
- a purchase can only be realised via the controlled marketplace of healthCOIN

These restrictions mainly apply to applicable distribution channels and source of revenue, as well as revenue distribution schemes. However, all other business model aspects are not restricted by healthCOIN in any way in order to allow for the **highest degress of variety in the marketplace** (minding the quality standards required by PRECIOUS – avoiding lemon market and trust issues). App developers may for example offer trials, low/high market entrance prices, freemium bundles, usage-based fees / flatrates, etc.

Subsequently, we will specify more details of **the platform's business model** using the notions of Osterwalder [17]:

- **Infrastructure components**:
    - Core capabilities
    - Partner network
    - Value configuration
- **Offer component**:
    - **Value proposition (perceived value)**:
        - **Rationale for project**:
            - Good encapsulation and modularisation allows a good follow-up on individual parts of the project
            - Individual use cases are presented in the bigger picture in order to target health on a more global scale
            - Alignment of user, economic and business, and technological considerations in one ecosystem design
        - **Rationale for platform**:
            - The platform can obtain higher goals by stimulating the healthy activities in the users' spare time.
            - The platform can profit from the cross-service market stimulation once a critical mass of users and apps has been reached. This will provide a lucrative commission business with limited direct competition. Users are bound to the platform, while before they were bound to individual apps. This

shifts market power to the platform, while the level of competition and associated bargaining powers of suppliers and customers have to be kept the balance in the market.

- The success validation is automated and distributed. The costs for editorial work are limited.
- The costs for creating own apps or resources are limited.
- Parts of the system can quickly be adapted due to modulare market design

- **Rationale for App Developers**:
  - **Shared with other app stores**:
    - Intermediary relating the interests of the target user group and the app developers, providing the apps for the healthCOIN marketplace;
    - Unified payment interface and general business terms (comparable to other app stores; including the collection of user payments);
    - Moderated access to external libraries such as social media channels or geolocation services;
    - Secure transactional framework.
  - **Gain over alternative app stores**:
    - Acccess to relevant customer group and customer segments, i.e. the platform represents an intermediary briding the interest of suppliers and customers;
    - Tracking and aggregation of health data by integrating food intake and motivational sciences domain expertise;
    - Integration with expert services and expert sensors for a better user experience (data integration) and an extended reach of dedicated services and products.
    - Branding as healthy ecosystem (apps are branded as healthy too);
    - Standardised access to relevant APIs (such as access to processed data, the health status or direct access to sensors);

- Health-specific extra services such as expert validation;
- No privacy relationship between app developer and users required in many cases (due to privacy protection and intermediary moderation of data access and handling);
- Quality-centricity (bad apps are pulled from the marketplace) can provide an additional asset.

- **Perceived value for customers:**
  - **Gain over alternative app stores**:
    - Trust through systematic privacy protection, app filtering (security, suitability, etc.), app reviewing, moderation of payments (no data needs to be handed over to others) and non-data centric business models (no tailored advertisement campaigns, etc.);
      - Privacy: Only in rare and specifically selected cases, 3rd party services can receive anonyomous data if absolutely necessary for their functioning. In the case of expert services (providical doctoral edvice) the data is kept anonymous without exception.
    - Filtering of irrelevant applications, which will reduce the efforts required to discover and compare most relevant e-Health applications (contrary to other app stores);
    - Unified interface and consistent means of interaction;
    - Linkage of individual applications to form a unified goal engine and in order to collaboratively target the defined goals;
    - Common set of metrics allowing the progress comparison across applications (e.g. based on progress levels);

- **Customer components**:
  - **Customer relationship:** Scaling effects in digital marketplaces motivate the focus on broader user group with less customer-to-sales assistance interaction. However, e-Health requires solutions that are tailored to the needs of users (motivational technique, health status, intensity of training, selection of recommendations, etc.), comparable to the personal assistance

that is required when purchasing optimal training equipment (running shoes). Hence, healthCOIN has tailor the offer by

- Keeping track of the user's status (motivational and health figures in the VIM),
- Smart automatisms (see inference modul described in WP3 and WP4) allowing the dynamic reaction to location-, context-based, and health-data fluctuations,
- Smart assistance for discovering new applications,
- Smart assistance in catching up on most important missed activities and action points,
- A personal assistant providing means for efficiently using time to do e.g. workouts machting the current health goals and status,
- User preferences specifiying which kind of goals, interesting applications, and app genres, and
- User control over social comparison techniques, e.g. via social media platforms or direct interaction.

The customer ownership is determined by the ownership of the healthCOIN platform and its marketplace, as it moderates the access to customers and their data for privacy reasons. The platform takes the role of an intermediary player linking the interests of supplying app developers and customers. Common infrastructure like platform metrics, means of payments (including an own healthCOIN currency), the user basis, the app basis, access to external libraries, etc. further strengthen the customer ownership role by the platform. Hence, the platform role needs to be evenmore needs to be played by an outmost trustworthy organization.

- **Distribution channel**: Most products will be distributed via PRECIOUS's healthCOIN marketplace accessible on most relevant mobile platforms such as iOS or Android (lessons may also be learned from the open platform provided by the asuniversAAL project[37]). Offline activities relevant to the health domain, e.g. practicing at fitness studios, will be integrated via the healthCOIN metric (means of payment) and interactions between in-store terminals and mobile phones (and transitively the healthCOIN platform and its marketplace). Classical retail (without digital means of payments, e.g. with healthCOINs) is out of focus.
- **Target customer**: The focus is on preventive care patients and thus on the general public. The general public is following unhealthy food intake practices

[37] http://universaal.org/index.php/en/ universAAL is an EU project related to ambient assisting living, which has defined a dedicated store concept named uStore in deliverable D3.4.

(e.g. fast and junk food), is insufficiently physically exercising (desk jobs) and have risks to contract diabetes and similar diseases at older age. More details on specific examples for preventice care patients are given in the scenarios of deliverable D2.1.

- **Finance components**:
    - **Cost structure**:
        - **Bootstrapping phase / CAPEX**: The system (implementation effort) of the platform needs to be run on server hardware, which may be purchased or rented. The latter option is more cost-efficient and thus tendentially preferred if a trustworthy provider with a secure storage and computational solution can be found. Apart from that, the kickstarting of the marketplace will require substantial marketing efforts in order to create an initial awareness of its availability as well as subsidieds to overcome two-sdied market and scalability issues.
        - **Operations / OPEX**: Part of the operations costs are hardware operations, software maintainance & platform development, complaint management, app reviewing and quality control, refunds (in the case of dissatisfied customers), marketing and discounts etc. The platform can utilise scalability gains, thus the broad customer base will be essential for the success of the entire platform in the long run.
    - **Revenue streams**: The commission for app and subscription fees dominates the revenue streams. Additional businesses may relate to cooperations with public and/or private insurance organizations, as well as commission for the sales of certified sensors and associated expert services (e.g. support by doctors, nutritional experts or fitness coaches).

4.3 Rewarding & Reward Metrics

Rewards have a dual function: firstly, they represent a form of mainly extrinsic motivation. Extrinsic motivation is useful in order to attract new users without limited intentions to achieve a behavioural change and support them in the first usage phase. Secondly, rewards provide means for strengthing the platform (soft “lock-in” effects as rewards are paid out in a health currency that needs action to be actively transferred back to cash) and providing incentives for users to try more applications, i.e. a mechanism for mitigating two-sided market effects (see Section 3.3.3).

A rewarding metric, denoted by healthCOIN, has to transfer activities towards a healthier lifestyle to both a metric reflecting the progress and a second metric providing cashbacks stimulating further usage (of the same or other applications) – also see Table 4:

- **Activity coin (non-monetary metric)**: PRECIOUS will provide the activity coin metric as standardised interface for measured activity in each associated app. Activity coins are linearly scaled relative to the estimated health progress. Activity

coins can drop due to inactivity or unhealthy behaviours, e.g. activity coins are traded for an unbalanced meal that violates the planned dietary goals. Activity coins cannot be purchased or transferred to others. On top of activity coins, activity levels and target profiles may be used for relative comparisons within the social group and in order to semantically classify the the current status, e.g. silver level in food intake but only bronze level for physical activity or sleep.

- **healthCOIN (monetary transactional metric)**: A digitial and virtual health currency named healthCOIN is used in order to provide an equivalent to monetary means, i.e, a new e-Health-centric means of payment. For simplicity, we define that €1 = 1 coin (i.e. healthCOIN). Using standard means of payment, e.g. credit cards, users can top up their healthCOIN balance. Each application is paid in healthCOINs and may provide rewards in healthCOINs (due to excellent health progress or remarkable behavioural change figures). Rewards will represent discounts or vouchers for future usages and should not exceed the fee that has been initially paid by users (no monetary gains; also see Section 4.5). Non-digital goods at participating dealers, e.g. fitness studio fees, may also be purchased in healthCOINs based on cooperation agreements and using specific terminals. This is mainly used in order to extend the reach of PRECIOUS, to cross-promote digital and non-digital health services, and may thus be seen as marketing strategy to attract more customers.

Table 4: Comparison of monetary and non-monetary metrics.

	Pay In/Out	Transfer	Decay / Expiration	Gain	Validity	Public
healthCOIN ("coin")	Yes	Yes	No	Top up or paypacks (discounts, rewards) for prior purchases.	Internal and external validity.	No
Activity coin (on similar)	No	No, activity coins are personal.	Yes, due to inactivity		Platform-only	No
Achievement Levels	No	No	Yes, based on activity coins generated in this	Via activity coins per health category	Platform-only	Can be shared within the social group.

			health category.			

healthCOIN requires a secure transactional framework for trading healthCOINs. Such a framework can be built in analogy to other virtual currencies or means of payment such as PayPal[38]. Contrary to activity coins, healthCOINs have to be reflected in accounting procedures. healthCOINs are only created based on monetary inputs by the users, subsidies by the platform provider or external bodies or generated as discount for paid apps. Free apps can only generate activity coins that will not generate healthCOINs (also see Section 4.5).

4.3.1 Reward & Motivational Design

Positive behavioural change and continuous health activities are rewarded. There are two distinct rewarding cases: for free (non-paid) and paid applications.

Free applications provide their users with the opportunity to collect activity coins based on positively attributed behaviour. Acivity coins are gained relative to the current user's position (see reward levels), i.e. continuous but non-increasing activities will lead to a stagnation of activity coins. Due to the punctual loss of privacy, additional activity coins (or specific coins) can be collected for social interactions that may support or strength the involvement of other users.

- Applications may motivate users by updating the avatar, unlocking new features or levels, scores / app support levels and score comparisions, generated activity coins, effect on achievement levels, or by tailored means of interactions, e.g. motivating phrases, symbols or a motivating coach.
- Based on **reviews** and **machine learning algorithms** the generation of activity coins will be weighted based on the activity coming from each app, e.g. when an app reports high activity, but low health improvement output is observed, the app does not seem to be achieving the desired goals and has to be weighted lower than average.
- **Awarding winning applications** will be subsidised by sending them payments for their good efforts. Hence, an additional business model (or at least revenue stream) seeking for subisidies is created.

Paid applications additionally provide discounts as healthCOIN rewards on the initially paid fee. healthCOINs are not bound to any application or health category. Rewards are issued relative to the own health progress and the health progress of others:

- We define an **average cashback (= discount)** of e.g. 20% of the initially paid fee.

[38] www.paypal.com

- Let's define the **average progress of users** of this application have been e.g. 5% of the activity coins (absolute progress is ignored). Then users with relative progress close to the mean will receive an average discount for the next payment iteration, e.g. month. Users with higher progress will receive a higher discount while others will receive a lower discount (minimum is 0% and maximum is twice the average.).
- The paybacks will **flatten towards the extrema** in order to avoid excessive behavioural changes (besides absolute maxima).

Both kinds of applications may also come with in-app purchases, which are handled identicial to paid applications.

4.3.2 Activity & Achievement

The achievement starts with the meaningful definition of goals. The goals (satisfying domain expert recommendations) are derived around the current VIM status of the user and their progress history. We recommend letting the user choose from a series of more and less challenging goals (cf. Figure 14). Both the difficulty of the chosen goal and the degree of achievement will affect the activity coins that are collected.

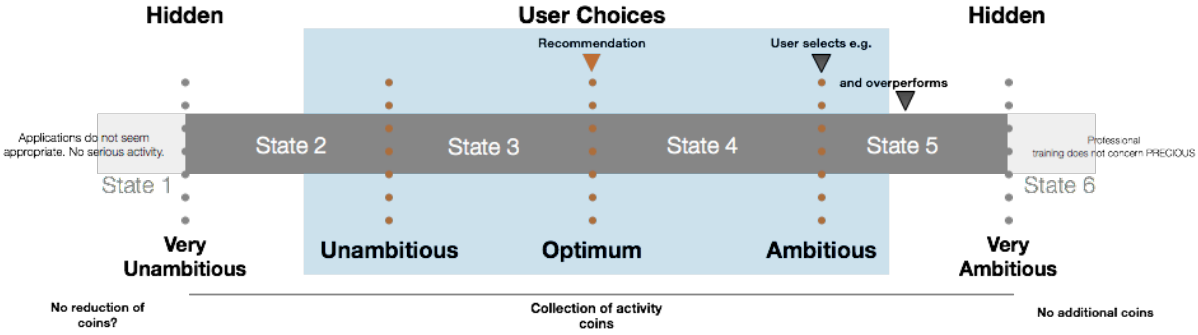

Figure 14: Goal selection and achievement

PRECIOUS has to avoid motivating users to select arbitrarily low or high goals. Neither inactivity nor professional sports are desired goals for a preventive care platform. Hence, unreasonable goal setting and massive over- or underachievement is not rewarded. The achievement will hence be classified in achievement states around the initially proposed goals. While the achievement of the selected goals (strengthening the user involvement) is taken as primary source for activity coins, a reasonable bonus for high goals has to be granted in order to counteract the tendency to pick low hanging goals.

Extreme underachievement (State 1 in Figure 3) especially over several measurement iterations deserves specific attention. The user may be on the verge to drop out of the entire system, may be unsatisfied with the current app choice, or may just go through a busy period in work or at home.

Comparabley to airline alliances, achievement levels (see Figure 15) will be used to perform a dual role: firstly, they will be used in order to communicate the health progress to users.

Secondly, they will affect the self and public image of the user, e.g. users can compare their achievement levels.

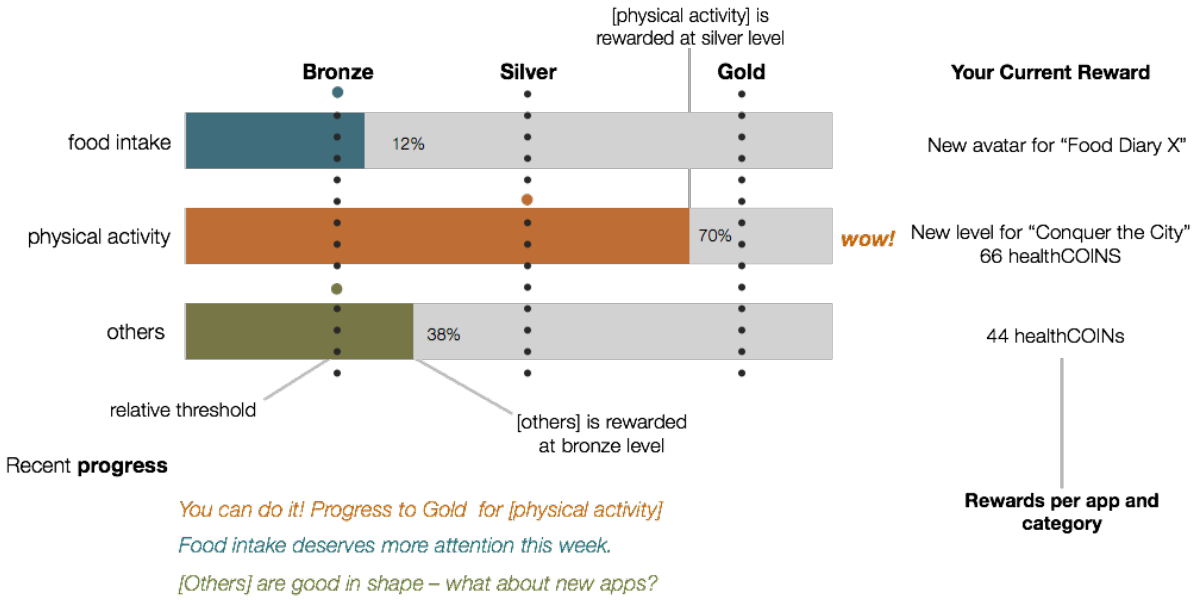

Figure 15: Achievement levels

The health progress will also affect the healthCOIN-based rewarding scheme. When users advance to a next level, e.g. in food intake or sleep quality, they will receive a bonus for apps of this category in order to reflect their breakthrough and determination.

4.3.3 Coaching & Collaboration

Coaching represents a direct feedback function for the users, which may in the case of automated coaching be based on historic usage and health data as well as on the current activity, context, social group (and their progress), the defined health goals and health interventions. Virtual coaches may provide direct feedback during exercising or food intake or recording[39] situations, e.g. via earphones).

Indirect coaching may also be realised with the help of social comparision functions, e.g. where the own progress is compared with similar users or the own progress is shared with members of the same social group (e.g. family or work colleagues). We recommend, wherever possible, to use an anonymous social comparision, e.g. based on nicknames, based on relative progress rather than absolute numbers, e.g. instead of comparing the kilometres users have been running this week, their exercising progress score may compared.

[39] Food intake recording should rather promote the truthful input of data rather than rebuking users for unhealthy behaviours.

Recent research results [91] have identified the "social embeddednes" (even with strangers) to be the determining factor for the effectivity of weight loss programs[40]. In terms of realising coaching-like functionalities, virtual running mates (even strangers) may thus be recommended based on historic data (health, progress, social background, geographical area, age, etc.). Later on users may compare their progress (even in realtime) with those mates, even if they do not know them personally. Examples could be:

- "Your friend NicknameA has recently progressed to gold level in physical exercising, you can follow the same line!"
- "Your friend NicknameB is currently running faster." *(in the case the actual performance seems to be substantially below the trainings plan and previous workouts)*

In-person collaboration, e.g. meetups for joint training sessions of users with similar trainings experiences and health backgrounds, should be treated with special care due to safety issues. In the last phase, personal contact information has to be exchanged and recorded for the safety of training partners.

Any kind of social interaction or social comparison could be rewarded in order to overcome the cost of sharing data and ceding some of the the user's privacy – mainly by issuing specific Charma points (see D3.3), small activity rewards, and/or by providing additional in-app functionalities. In-person meetups due to strong social bonds[41] but also due to the risk of meetups with strangers should be rewarded with additional non-monetary rewards.

4.3.4 Quality Control & Attribution to Apps

The quality control and achievement attribution to apps is important in order to create an attractive ecosystem. For this reason, we envision the following protective masures:

- App guidelines, rules and app development support: The development of high quality apps requires the proper support by the platform. Hence, educating materials and useful guidelines and rules (UI, user interaction, motivational techniques, activity measurement, etc.) have to be provided to app developers.
- **App review and filtering**: A prior app filtering has to assure that only apps are admitted that meet the quality standards (no "ripp-off"), requirements (e.g. in terms of privacy and (inter-app) communication, system security, etc.), and are placed in the e-Health domain. Apps will also be validated against the given guidelines and rules in order to transparently assess minimum standards. Hence, only apps shall be submitted that can positively support users towards meeting their health goals.

[40] The Economist, „A burden shared: Even friends you have never met might help you to lose weight",http://www.economist.com/news/science-and-technology/21641136-even-friends-you-have-never-met-might-help-you-lose-weight-burden-shared, Jan 31, 2015.
[41] Social bonds may create a "responsibility" to stick to the trainings plan and schedule, as well as to avoid cheating and to generally progress towards meeting the set health goals.

- **Classification of apps**: Applications have to be meanifully classified according to predefined health categories, e.g. supports the healthier food intake, promotes physical activity, etc.
- **Compulsory trial phase**: The first month or accounting period is always free. The app is then automatically purchase if not deinstalled or used afterwards (a warning will be issued by the platform in order to protect the interest of users).
- **Reviews**: Users can rate apps and provide descriptive comments in order to share their experiences. The review process will distinguish between the overall rating and several rating categories such as suitability (for health goals), activity reward process, playfulness/interest, and technical quality – compare to hotel booking and review pages. The activity reward process is used in order to assess the appropriateness and fairness of distributing healthCOINs and activity coins to users, e.g. when very active users do not receive rewards, while others do, the ratings is supposed to be lower. This feature has to further control the tendency of app providers to potentially favour the reward distribution to customers of in-app offers.
- **Objective usage statistics and correlation to outcome (efficiency and effectivity)**: The system can monitor the popularity and functioning of each app. For example, when the usage positively correlates to health progress of the app users, the success can be (partially) attribute to this particular application. Recommendations can take efficiency and effectivity of applications for particular user groups into account.
- **Assessment of usage frequency**: Applications that are very infrequently used (almost no activity has been measured on average) in the short or longer term might be marked for review in order to evaluate the removal or quarantining of those apps. In other words, the acceptance or suitability of apps may be too insignificant in order to be listed in a marketplace that aims at providing the straight access to meaniful apps with high quality. App developers should be transparently kept in the process in order to motivate advancements of apps rather than facilitating the actual removal.
- **Best-in-class Quality Awards & Promotion**: The platform will further provide **additional rewards for winning applications** in order to continuously increase the quality in the marketplace. While such activities are important in order to shape the customer experience, any monetary impact has to be compensated by other purchases and the residual of the commission (if not external, e.g. publicly financed, subsidy exists). Hence, monetary stimuli have to be complemented by other kinds of support for best-in-class app developers, which could encompass the following set of rewards:
    - Badges or certificates reflecting the best-in-class quality rating for a given period, e.g. best sleep quality application in May 2015.

- Prizes and non-monetary rewards, e.g. equipment prizes, preference in search engines, preference in the algorithms selecting fitting apps for a required health intervention, etc.
- Additional healthCOIN rewards are given to users of this app
- Subsidies for app purchases, i.e. a temporary discount is granted for best-in-class apps (which is paid by the platform provider) in order to lower charged prices and to increase the adoption rates
- Lower commission for the next payment period or even direct monetary payments
- Extra advertisement, e.g. presenting award winning applications in a top section “in the spotlight” in the PRECIOUS app’s dashboard

4.4 Business Model of External Entities

Commercial communications service providers, particularly from the mobile sector, have a number of potential multifaceted roles to play in the healthCOIN ecosystem – as illustrated from the examples of Section 3.2. Among others these may include the roles of service enablers, business partners, value-added resellers or providers, primary service providers and so on. The communications service providers bring a number of useful features to healthCOIN ecosystem that may help to compete and/or collaborate against the traditional e/m-Health services providers. These include network and infrastructure services (e.g. voice, messaging, data transport, data storage etc.); platform and enabler services (e.g. payment and billing management, security, customer care, differentiated service quality, identity management etc.); and end user services (e.g. apps, content aggregation, personalisation, etc.). The question on the actual level of involvement of the communications service providers in the healthCOIN is framed by the greater ongoing debate on the tension between the traditional communication service providers and the so-called over-to-top providers[42].

Insurance companies, whether public or private, may participate in several ways in the healthCOIN ecosystem. They may run a healthCOIN-like platform on their own and may thus become the platform operator. This may be seen as extension of their competencies to nearby business areas.

Insurance companies may further stimulate the usage of health apps by providing vouchers to their customers. For example when customers sign a life insurance, they may be provided with a voucher for the healthCOIN platform year by year. This stands in analogy to bonus programs that are currenly in place for e.g. private health insurances that provide bonuses for healthier lifestlyes[43]. Bonuses do not neccsarily have to be monetary cash backs, but can

[42] http://www.strategyand.pwc.com/media/file/Strategyand_Enabling-the-OTT-Revolution.pdf last accessed: 2015-03-28
[43] Handelsblatt (Ger): http://www.handelsblatt.com/finanzen/vorsorge/versicherung/krankenversicherung-die-haelfte-der-krankenkassen-foerdert-eine-gesunde-lebensweise/6211346-3.html, last accessed: 2015-03-23

also be discounts for wellness or relax trips, which positively affect the health of customers again. Using a similar scheme, users could be provided with a set of paid apps, which are paid by the insurance company. By intensively using the app further bonuses are unlocked (further apps or even relax vacations paid by the insurance). In the long run those practices will lower the costs of the health insurance and may provide an added value to be exploited by the marketing departments of those firms.

Many employer wellness programs[44] have been initiated over the last years that provide incentives for healthier lifestyles. Due to the high return on the investment money, parts of these funds could be redirected to the healthCOIN marketplace. Classical wellness offers primarily focus on recovering from daily business stress, while healthCOIN can better address the daily life of users without necessarily requiring any expensive trips, equipment or fees. For the employer only a few Europs per year may help to facilitate healthier routines and to assist employees to cope with daily life stress. We thus recommend extending the employer wellness programs in place by adding a few Euros for healthCOIN-like marketplaces. The costs for employers will remain almost identical, as wellness packages are typically far more expensive.

4.5 Avoidance of Cheating

healthCOIN has to reduce the probability of cheating or malicious strategies of end users or app developers. While users may for example aim at profiting from discounts or payouts only or may aim at recording a single activity twice, app developers may try to obtain and sell user data or distribute spam via their application or notification function of the PRECIOUS system.

On the user side, accounts validated with a functioning e-mail address of the user may already limit the probability of **multiple account or device strategies**. Users can only simultaneously record one kind of activity with a single device. However, users may of course record for example heartbeat, GPS movement and game interaction data at the same time, which need to be correlated within the system. Apart from that, **cashbacks** or discounts should be kept **within reasonable perimeters**: Market stimulations should e.g. be provided as vouchers that cannot be transferred to monetary means. Cashbacks or rewards should only represent discounts on initially paid fees, which render profit-making strategies impossible.

Further, users shall not receive monety (or equivalent) rewards for using social comparision or social collaboration / workout functionalities. Monetary rewards could facilitate the exchange of arbitrary pieces of information in order to obtain e.g. a voucher for a free app.

On the app developer side, the mean **cashback on initial payments needs to be fixed** in order to eliminate strategies for intentionally lowering the cashback to unreasonable extents in order to maximise the own profit. Further it is undesireable to allow unreasonable high cashbacks as low initial fees are easier for customers to be compared than combinations of

[44] http://www.bankrate.com/finance/insurance/wellness-programs-health-incentives.aspx, last accessed: 2015-03-23

fees and cashbacks. In analogy to the quality measures in Section 4.3.4, healthCOIN should allow the **users to rate** whether the assessment of activities and associated **distributions of rewards** have been **meaningful** and **fair** in order to avoid the deliberate dedication of rewards to favoured customers, i.e. nepotism should be avoided at all means.

Attention seeking

Apps may further use “attention seeking strategies” in order to attract more new users to their apps or to facilitate the usage of their app in order to increase revenues from in-app purchases. In other words, below-average quality apps may aim at being triggered or recommended above-average times, in order to improve subscription fee or other revenue figures.

Technically, this strategy refers to the manipulation of the app broker component that aims at transferring particular health interventions (see D3.3) into direct requests to best fitting applications (in terms of accessibility, current context, intervention requirements, success rates for similar users etc.). Whenever an app is able to pretend to deliver exactly this intervention for this user, the app broker will have tendency towards selecting this apps. Thus, the app has to pretend to be

1. a successful treatment;
2. popular among the user group, e.g. by using spam-like notification that pull users back in;
3. tailored to many kind of interventions, e.g. by wrongly classifying itself and/or specify inappropriate requirements for calling the application

Especialy problematic are hardly controllable apps, which are based **“**non-objective” data (unless validated by experts), i.e. app-specific own data, such as creative food intake records or diaries, which can hardly be cross-validated with other apps or be easily correlated with sensor data.

Thus, we recommend that e-Health platforms, which integrate commercial apps or contents from multiple sources, **classify apps in “based on objective data”** (cross-validation possible) and others. The first category has to be **cross-validated** properly during its entire lifetime, but does not necessarily require a deep manual review before its admission to the marketplace. In contrast, the latter category should be very **intensively be reviewed** by the platform filtering system and manual inspection before it gets admitted to the marketplace. In addition, whenever highly critical reviews appear, a new manual review should be scheduled.

We further recommend to apply **machine learning techniques** that try to spot strange attention seeking behaviours, e.g. users often start an app but do not seem to be using the app for longer than a frew seconds, users are deinstalling apps frequently after a notification has been issued. This approach should be paired with a **limit on** the issuing of **notifications** and fine-granular control for users to block notifications or dashboard listings for specific apps.

Apart from this, user reviews and ratings will help to better classify the quality of app also w.r.t. the suitability to be used for a certain intervention type.

4.6 Rollout Roadmap

In terms of mastering the successful market rollout, we suggest to use the following three stages:

1. **Initial rollout**: The initial rollout shall be supported by “simple apps” that can show the potential of PRECIOUS and the healthCOIN approach. Those apps probably do not come with extensive interactions with other platforms and may not connect to sophisticated sensor platforms. Nevertheless, the apps should be able to illustre the usage of raw data such as simple sensor information and transfer it to a motivating client app for a particular target group with specific needs. Interesting sensors should be already integrated in the sensor to reassure app developers that developing data-centric apps is straightforward. Those simple apps may for example be provided by or enriched by the creation of PRECIOUS-specific own apps in order to demonstrate functionalities and app development processes. They will further help to reach a critical mass of apps for approaching customers in order to reach critical mass there too. Practically, this needs to be supported by advertisement activities both towards end users and app developers.

2. **Growth**: In this phase, the number of services as reached a level where additional sensors or external data APIs can be addressed by the platform. The goal is improve the functionalities provided by the sensors in order to reduce the effort of custom solutions by each app, i.e. apps should not need to address sensors on their own anymore, which is targeted by the xAAL inclusion and managed functions in PRECIOUS. The more services are available, the more interesting will be the link of sensor platforms to the PRECIOUS platform. Hence, with the growth of services, more sensors can be integrated, which again create more opportunities for app developers. This relationship shares many characteristics with two-sided markets. Hence, the creation of an initial set of applications and the addition of interesting data sources will be crucial for the establishment of the marketplace. While in today’s technological world, we can profit from the availability of low cost sensors integrated in smartphones, the successful mastering of the first phase will still be crucial to reach this frowth phase. Further interesting data sources could also be paid expert services, which could be integrated in PRECIOUS (depending on progression in phase 2, such services may also shifted to phase 3).

3. **Monetisation & branding**: We assume that phases 1 and 2 are used for creating a critical mass of services (supply) and reaching a critical mass of customers (demand). The next phase will, however, focus on the sustainability of healthCOIN by targeting the monetisation. Monetisation will include the creation of more paid services and the inclusion of more means of payment. healthCOIN

should further establish its brand by establishing healthCOINs as means of payment in the digital, e.g. in external web stores, and non-digital contexts, e.g. in fitness studios. Very likely a cooperation with mobile payments providers would be necessary to achieve this goal.

5. Value Network Analysis

The present section will provide the roots for the value network analysis of the healtCOIN approach. First, relevant value network models will be presented, which are in the second step complemented by a quantitative analysis methodology.

5.1 Value Network Configuration Models

Despite the characteristics introduced in previous sections, the healthCOIN value network may be realised in multiple ways. As discussed in Section 3.3.3, two-sided market issues may among others hamper the easy deployment of new platforms. For this purpose, a considerate investigation of alternatives will be crucial for assuring credible market chances. In the following, we will investigate three main models and several submodels, which are represented by corresponding value networks. The detailed qualitative and quanitative analysis will remain for the final report, due to the effort of collecting adequate market data and integrating expert views wherever applicable.

The models presented hereinafter will serve as candidate models for the detailed analysis, which is reported in subsequent deliverables. The selection of key aspects to focus the investigation on will also be provided in the final report.

5.1.1 Variant 1: Private app store model

In analogy to app store models and business models in the content and gaming industry, a healthCOIn marketplace can be created, which is mainly funded by commission fees. Commission fees are collected for every app/service (typically subscription fee) and hardware sale via the healthCOIN platform's marketplace. The inclusion of expert services and a bigger variety of partnering hardware products can increase the overall revenue levels.

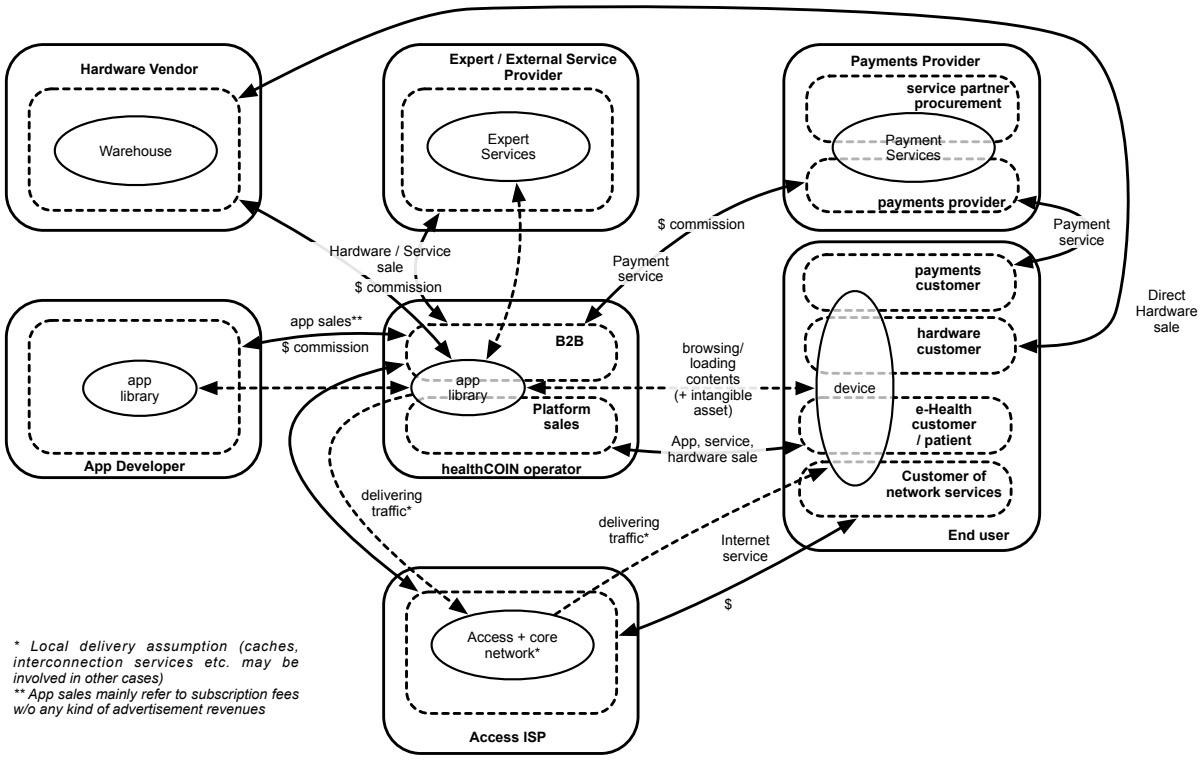

Figure 16: Private app store value network[45]

The customer of e-Health services plays multiple roles. It consumes Internet services in order to connect to the healthCOIN marketplace and other Internet services. Such contracts are typically separately agreed upon with Access Internet Service Providers (ISPs). Moreover, end users require hardware to use e-Health services, which is reflect in the role as *hardware customer*, which may handle the direct purchase of hardware from vendors (or other marketplaces) or via the healthCOIN marketplace. Payment services are further required to conduct common e-commerce activities like purchasing products or subscribing to apps. These services are handled by external payments providers, which may be credit card companies or specialised firms like PayPal. Finally, end users are also customers of services or products purchased from the healthCOIN platform.

The healthCON platform is the central moderator of various stakeholders' interests. The end user is interested in attractive app/service/hardware offers, the hardware manufacturers looks for a platform to sell their hardware, the app developer require customers for their tailored services, expert services want to extend their business reach, and payment service provider are always interested in addint further servie providers to their list of partners (in order to tackle their two-sided market problems). In that sense the platform is a two-sided or pluralistic market that provides the intermediary service of bridging the interests of various stakeholders. This is the main value proposition of such a role.

[45] The solid rectangular boxes with rounded edges represent actors (or stakeholders), which play one or more business roles (dashed rectangular boxes). Business interactions are represnted by solid edges, which connect two roles (typically of separate actors). Technical interaction (dashed edge) connects two technical components, which are represented as ellipse.

This case will further be used as base case for explaining other value network models.

5.1.2 *Variant 2: Public-private cooperation*

In alternative to purely privately operated platforms following the app store principle, a collaboration of public-private organisations may be considered in order to exploit synergies, increase the credibility of the marketplace or to bootstrap the marketplace.

(A) Operational Involvement of External Organisations. When involving public organisations (e.g. social insurance services), the value network is altered. The public organisations have existing roles. For the case of public insurance companies this refers to the role as *social security service* role where it supports the treatment of patients through publich funding and recommendations.

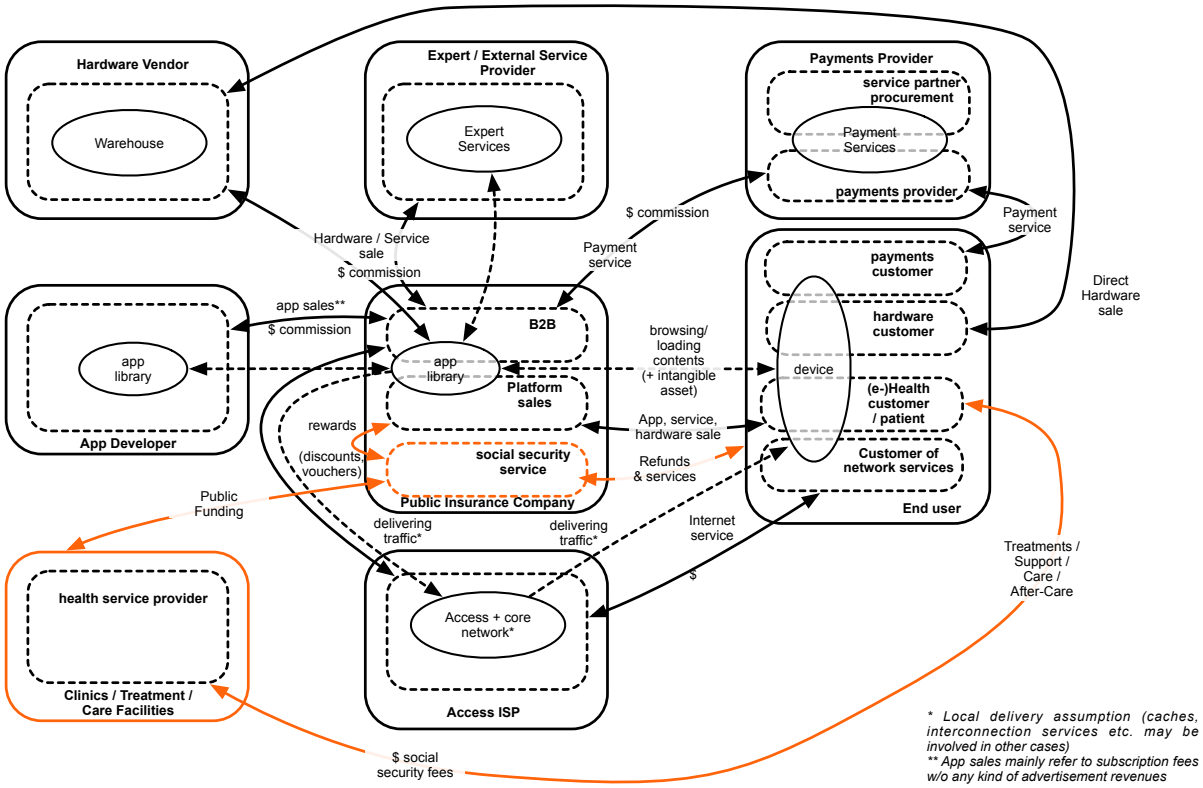

Figure 17: Public insurance healthCOIN value network

Around this additional role a series of further business interactions are created over the base case in Figure 16, which are highlighted in orange in Figure 17. The additional business interactions may appear periphery to the core function of the healthCOIN platform but may affet the strategic positioning e.g. due to altering the bargaining powers of other roles in the value network.

The public insurance company may further use its dual role as social security service provider and as operator of the platform-related roles in order to cross-finance e-Health app sales in order to promote healthier lifestyles of their clients. This practice can help to reduce

the patient treatment costs in the long run, but may represent a financial loss in the short run.

(B) Strategic Involvement of External Organisations. Contrary to model (A), public or even private organisations may especially support the bootstrapping phase of healthCOIN platforms in order to support activities facilitating healthier lifestyles without operational involvements. External organisations could further use payments in order to gain influence on the functioning or realisation of the platform or may buy a stake in the platform operator firm to maintain strategic involvements in the long run.

The bootstrapping phase is especially critical due to two-sided market effects that require both substantial consumer as well as app developer interest in order to assure a functioning of the marketplace. External actors could help by promoting platforms in order to increase the trust and expectation in the platform, and could further provide financial aid or means for promotion activities.

5.1.3 Variant 3: External Stakeholder Promotion of Healthy Lifestyle

Public / private insurance firms may aim at actively facilitating health lifestyles of their clients by introducing **(A) rewards or discounts for using healthCOIN services or (B) by altering social security fees based on health practices of their clients** (e.g. using healthCOIN apps, workouts at fitness centers, yearly health-checks etc.). Both flavours of this model are captured in Figure 18 (green business interactions).

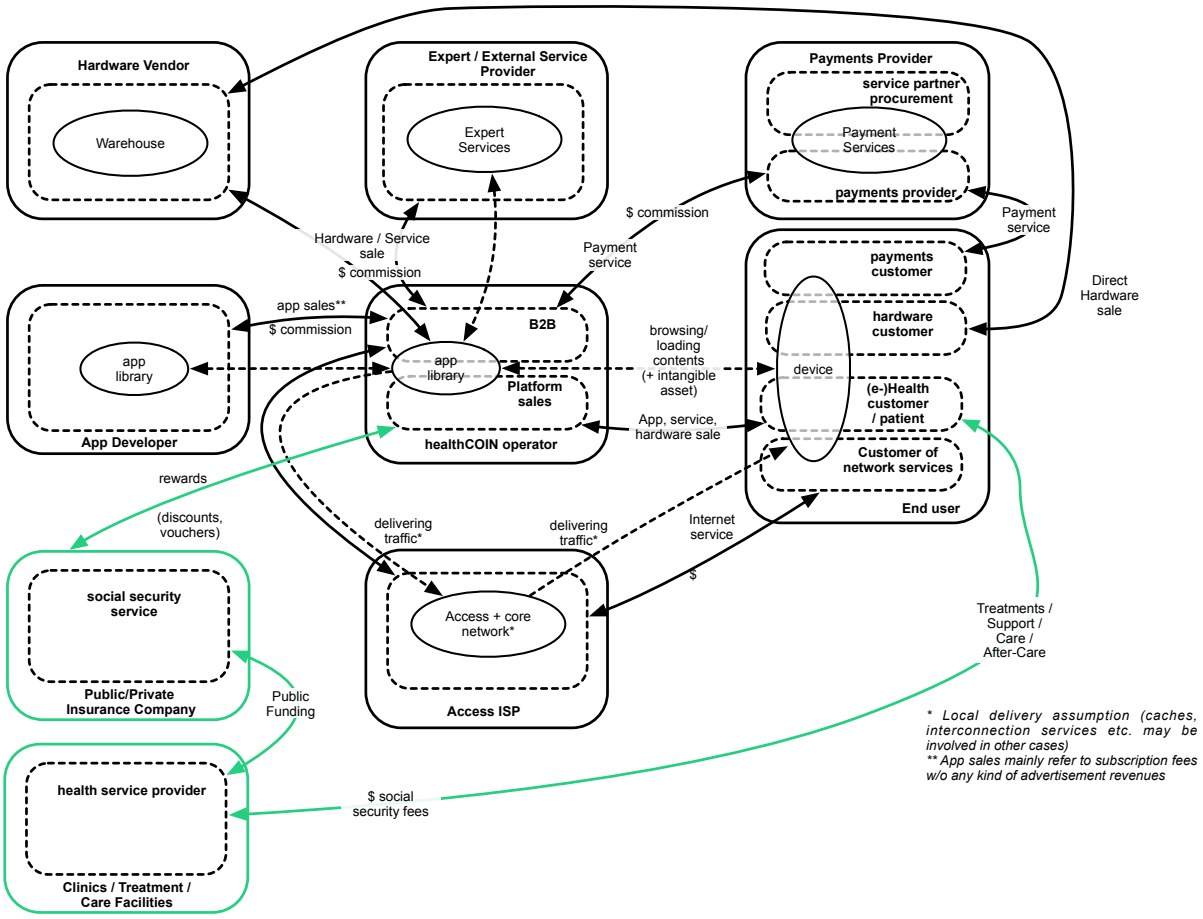

Figure 18: Stimulation of healthy lifestyles by external stakeholders

Model A may be regarded to be positive extrinsic reward, while the social security fee-based mechanisms of model B can use either positive or negative rewards (e.g. bonus/malus-system, or bonus-only or malus-only systems; i.e. positive and/or negative incentives).

5.2 Methodology

While in the past, value chains have provided a useful technique for assessing manufacturing processes and business models have further shaped the intra-enterprise perspective, today's technology-oriented industries require a tool that is capable of assessing non-sequential, highly parallelised, knowledge- and information-oriented techniques. The e-Health sector, linkscomputer science with various health domains, is no exception to this trend, as new app stores and mobile ecosystems integrate various kinds of business models and approaches, in a single picture, in a complex manner. For this purpose, the present work will focus on the assessment of value networks, which are capable of meeting those new standards.

However, until recently, the analysis of value networks has been subject to the available qualitative assessment tools, which may not provide results with acceptable precision. In this light, the present section will summarise the introduction of a novel quantitative value network assessment technique presented in [15,16] and [68], and will further tailor it to the

needs of PRECIOUS. Apart from this, PRECIOUS has advanced the systematically understanding of this tool set by supporting the development of a Python-based toolset.

Approach

Our value network quantification approach will be able to assess the dependency of individual entities on the rest of the value network. The market power in the value network is, hence, the exact opposite of this dependency metric (i.e. the lower the dependency, the better it is).

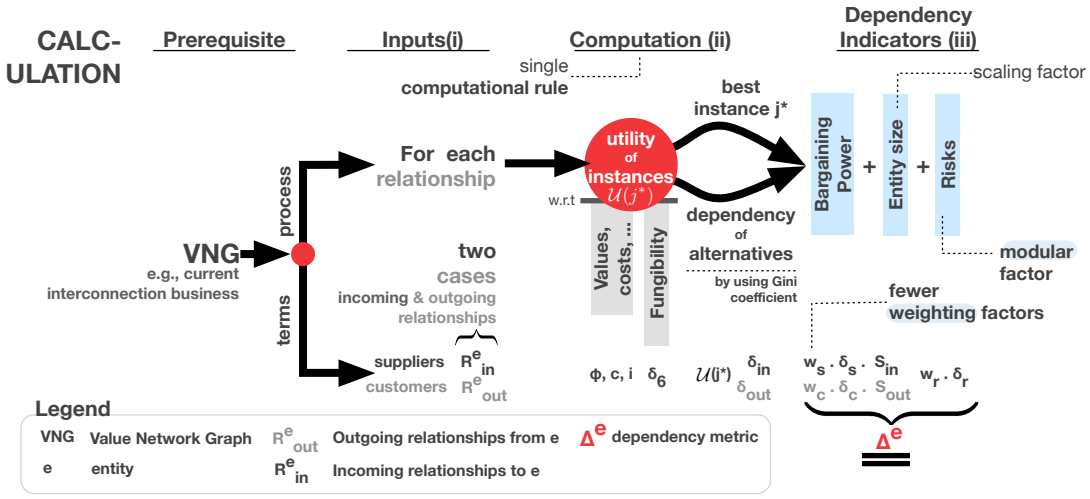

Figure 19: The big picture for quantifying dependencies in value networks

Prerequisite for the quantification of the value network is the (visual) representation, a graph being denoted as Value Network Graph (VNG), of an ecosystem (in its current or in a desired configuration). Multiple VNGs may be construct in order to compare entity dependency results with each other in a later phase, e.g. in order to identify the configuration that best balances the market power distribution in the VNG and hence may provide the highest long term stability. Each VNG has to contain the unidirectional business interactions between all relevant entities (completeness assumption) including the specification of cost (CAPEX and OPEX), revenue and fungibility values. The fungibility represents a factor that expresses how difficult (or easy) it is to sell/buy a good/service to/from other entities. For example a monetary flow can easily be redirected to another recipient, while customised products are typically tailored to the needs of the customer entity.

The **quantification** consists of **three phases** (see Figure 19):

(i) the VNG in its current form provides the **input information**. The assessment will focus on the business interactions (relationship) where we differentiate in incoming (supply) and outgoing (customer) relationships, i.e. two separate computation cases in the next phase;

(ii) for both the incoming and outgoing relationship case, the **computation** of individual dependency indicators, which consists of two subprocesses:

a. **Within entities**: The assessment of the graph inherently relies on a detailed understanding of utilities of business interactions. These utilities are calculated in the first process on the basis of assessing the properties of each available alternative, e.g. when a company purchases a raw material from a single provider, alternative goods (and their economic value) but also competitors are integrated in the assessment of the relative importance of an individual good or service. Hence, after modeling the utility of each alternative, we utilise Yitzaki's Gini coefficient form [92] in order to describe the utility distribution among offers. The Gini coefficient is widely use technique for assessing the value (or wealth) distribution and disparity among a set of users or in our case entities. Contrary, to other alternatives such as the Theil index (as derived from Shannon's [93] information entropy), the Gini coefficient provides interesting special forms such as with Yitzaki's representation that add further control to optimal fit the objective function. We parametrise this Gini-based distribution assessment in a way to overweight discrepancies for high-utility offers[46], i.e. we intentionally weight a high difference between the best and the second best alternative more severely than a steep utility from the second lowest to the lowest valuated alternative.

b. **Between entities**: Similar to the previous step, we utilise the classical Gini-coefficient[47], without overweighting neither the head nor the tail of the distribution, on a level higher. In particular, we calculate the Gini coefficient across relationship values where the value of each relationship represents the best alternative's utility being weighted by the economic pressure added from similar alternatives (i.e. the within entities Gini coefficients are now used in order to provide aggregated figures for each relationship's value). By retaining the separation between supplier (incoming) and customer (outgoing) relationships, we yield the **bargaining power of suppliers** and **customers** (see PORTER) after normalisation against the maximum in the value network as separate **dependency indicators. Orthogonal dependency indicators** are the **entity size** (as scaling factor to the qualitative description provided by bargaining power indicators), and **additional risks** that span multiple atomic graph elements (or may vaguely be related to the entire VNG) and are hence assessed by using external techniques (e.g. the Composite Risk Index based on meaningful qualitative value network assessment categories).

(iii) the aggregation phases where all dependency indicators are weighted (w factor or function) according their relevance and then integrated in the **dependency metric Δe** (the final outcome). The lower the result for an entity e the lower the

[46] Hence, in the model of [92] we parametrise at v > 2 (we recommend v=3.
[47] Classical parametrised Gini coefficients refer to setting v=2.

dependency on the VN, the higher is its market power in the current configuration.

Prototypical Implementation

The method as described in [68] has been prototypically implemented using Python and the networkX library. Although until now the graphical visualization has been left out of focus, the integration with networkX (also adding complexity to the solution) enables a visualization and export of the graph at later stages. The prototype supports the formulation of VNGs in Python, JSON, XML or other exchange formats[48]. The tool has been developed by the team of the University of Vienna, but will be made available to interested and/or collaborating consortium partners. Moreover, the release under an OpenSource license is targeted at a later stage (potentially within the project runtime), when documentation and stability requirements are sufficiently satisfied.

[48] Connectors are only available for JSON, XML and Bytecode. Python code and objects represent the native representation to which a conversion is created. The modular design allows the creation of own connectors with very low effort.

6. Recommendations & Open Research Questions

This section will provide clear recommendations that can be extracted from this work, whether due to evidences found in literature or considerations within this report, in order to sustainably configure the healthCOIN ecosystem. The focus of this work is to assist users in improving their wellbeing or even health through the means of digital toolsets and modern technology-assisted motivational techniques (e.g. gamification).

The healthCOIN concept targets preventive care users instead of focusing on patients, which creates a mass market with a high heterogeneity of end users (w.r.t. age, SES, personalities, etc.). healthCOIN thus profits from scaling effects that will allow the deployment of a richer feature set and further allows for health interventions before diseases such as type 2 diabetes and cardiovascular disease are detected. Minding the heterogeneity of end users, we recommend to;

- support different kinds of devices / platforms in order to address various socio-economic groups with access to different resources;
- enable various kind of motivational techniques under the professional assistance of healthCOIN (e.g. providing APIs or modules that provide basic functionalities or recommendations); and
- relatively assess the situation of all users (in terms of achievements, rewarding etc.)

Heterogeneous users groups also require to be addressed by heterogeneous solutions. We recommend that PRECIOUS supports creative ideas that may employ creative business strategies for a practical realisation. Hence, solutions should not limit the creativity of app developers unless the user needs to be protected or the functioning of the platform is endangered (e.g. free-riding preventions).

Relative membership levels (rewards levels), comparable to membership models known from many industries such as aviation, may help to bind users to the platform in the long run. Those levels should not affect individual apps in order to create a high flexibility for users within the healthCOIN environment.

From a business axis we can recommend to:

- support and integrate various kinds of stakeholders through a common set of metrics;
- balance the interests of stakeholders by focusing on sustainable value networks;
- foster the collaboration among stakeholders;
- support the easy deployment of software without requiring to involve payment services, review systems etc. (in analogy to common app store models);
- extend the visibility of healthCOIN through the addition of adequate offline usages of healthCOINs as currency (e.g. for paying fitness studio fees) and through healthCOIN certification (e.g. hardware manufacturers could provide certified

equipment that is known to function out of the box with any healthCOIN platform, which could promote both healthCOIN and the hardware);

- employ cheat prevention techniques.

We further recommend a three stage rollout process (see Section 4.6), which starts with simple services solutions in an initial phase (critical mass of initial offers), grows in a second phase (in terms of services and users), and focuses on monetisation opportunities in the third phase. Due to the difficulty of creating a trust relationship and two-sided market issues that inherently affect the creation of any intermediary platform; the profit orientation is not realistic in the first two phases.

For meeting the interest of end users, we recommend to

- avoid app lock-in effects, i.e. the transition from one app to another app should be as straightforward as possible (activity points are not lost, rewards might be useable across apps et.);
- establish a single point of trust (the platform), which is operated by a trusted party;
- focus on motivation internalisation rather than on extrinsic rewards schemes;
- protect their privacy through the isolation of apps
- focus on high-quality e-Health apps rather than on their overall number (e.g. strict exclusion of apps not meeting common quality standards or outside the e-Health domain)

When integrating e-Health-specific needs in app ecosystems, public and private health care organisations and social insurance companies may have to be integrated. Several models exist to profit from an integration of such stakeholders.

Referring to the investigation of Section 5.1, a series of research questions for the final report can be derived:

- Which model best supports the formation of trust relationship with end users?
- Which is the best model to integrate health care organisation and insurance firms?
- Which model best integrates communication service providers, device platforms and hardware vendors/manufacturers?
- What is the impact (if any) of the legal and regulatory framework on the overall healthCOIN platform design and business models?
- What is the effect of considering various kinds of private or public operators of an e-Health platform such as healthCOIN?

- Which configuration is most sustainable? (in terms of balancing the market powers of stakeholders in the long run, creating financial prospects for key stakeholders, and protecting the interests of end users)
- What are heartbeat roles and key business interactions in the value network?
- Which model best supports to overcome the two-sides market issues discussed in Section 3.3.3? Which model best supports the market entrance?
- Which model best supports most common use cases and scenarios?
- How can the healthCOIN market be parameterised?

7. Conclusions

The present deliverable has defined the boundaries of business solutions aiming at optimally supporting preventive care and wellbeing users. This further encompasses the need to integrate motivational frameworks in a suitable rewarding scheme that supports target health objectives individually set by users.

In this light, a business model called healthCOIN has been developed, which unifies individual apps and their individual business models in a common framework with a common trust interface. Following the notions of Osterwalder [17], the present report has modularly characterised this business model, which has further been extended by motivational considerations: A proper rewarding scheme is required in order to flexibly support a variety of business approaches, while avoiding lock-in effects to individual apps and facilitating the internalisation of motivation.

The proper functioning and commercial operations of healthCOIN requires providing means for preventing cheating (of users, business partners, etc.), protecting user rights and privacy, and obtaining a critical mass of users and app offers. For the latter, the present deliverable has suggested a three-stage rollout process, which focuses on scaling in first phases and monetary outcomes in the last phase. We have further considered the integration of public bodies in order to increase the trustworthiness and visibility of a healthCOIN platform. Public health organisations and insurance companies may further provide financial assistance in order to master the critical market rollout phase.

From these considerations, a series of candidate value networks has been formed, which describe the ecosystem around the healthCOIN business model. Special consideration has been paid to the integration of health care stakeholders. The present report has further introduced a novel toolset for quantitatively and qualitatively studying ecosystems in the form of value networks. This toolset is available to be used for the assessment, which will be reported in the final socio-economic report. Among others the sustainability and attractiveness of candidate models will be studied, where especially the access to critical assets (such as customers and suppliers) and realistic market data will be integrated.

Future work shall further concentrate on the parameterisation of the healthCOIN market and the optimal integration of most relevant use cases and scenarios. The final report will further include advancements made to the motivational techniques designed in WP3 (including gamification approaches) and will be conducted in direct exchange with the architectural work in WP4.

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