Modeling an Information Visualization Engine for Situational-Awareness in Health Insurance

Flávio Epifânio[1](✉) and Gabriel Pestana[2]

[1] Future Healthcare, Lisbon, Portugal
flavio.epifanio@future-healthcare.pt
[2] INOV, Lisbon, Portugal
gabriel.pestana@inov.pt

Abstract. Nowadays private health insurance is experiencing a substantial transformation. The number of chronic patients has increased greatly because of unhealthy behaviors, chronic medical conditions are responsible for two-thirds of current healthcare cost's increase. Health insurance players face new challenges on how to prevent disease burdens and how to act preventively by promoting healthy behaviors to improve quality of life and wellbeing. Promoting a collaborative dataflow to keep all actors aware about events requiring their immediate attention assumes therefore a key relevance to enable an active participation of healthcare professionals in monitoring patient's healthy behaviors. The implementation of self-awareness mechanisms addresses the responsibility of the patients for their actions. Following a user-centric approach and service design thinking principles, this paper presents an information visualization model for situational-awareness that streamlines visual representation of events in a collaborative decision making environment, as a way to proactively monitor unhealthy risk behaviors and risk situations within the health insurance domain. This work presents the outcomes of a prototype that describes two operational scenarios, demonstrating how the proposed model can be applied to health insurance.

Keywords: Information visualization · BPMN · Gamification
Spatio-temporal data · Situational-awareness · User model

1 Introduction

Private health insurance is experiencing a substantial transformation. Classic insurance business models covering older adults with chronic condition represents only 28% of the total health expenses [1], but chronic clinical events are responsible for two-thirds of healthcare costs, it is the largest spending reason in healthcare in the United States [2]. With the emergence of the digital market, new business models addressing high-risk costumers are emerging. The approach is to target the community of chronic patients with sedentary live-styles and unhealthy habits [3]. Despite of its high risk to health insurance providers, the implementation of active surveillance procedures, to prevent disease burdens, can mitigate the risk and improve quality of life and wellbeing [4] of those patients. The challenge is to be aware whenever the insured person presents

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a systematic deviant behavior, so that health insurance providers may acts accordingly (e.g., by triggering negative rewards).

Peoples' daily activity can easily be tracked and automatically analyzed using non-invasive wearable devices, enabling the introduction of innovative and low-cost monitoring mechanisms. Wearable devices can be provided in a health insurance product package, or through a BYOD[1] approach, providing a self-awareness mechanism to mitigate the risk of adverse clinical situations. When a suspicious situation is detected, the system triggers an event to inform all intervenient actors, creating in this way a collaborative dataflow to keep all actors well informed.

This work addressed how such events should be presented to each actor, assuming that raw data are pre-processed and are ready to be visualized. The information has to be presented in an understandable way, addressing the user model (e.g., user profile/role), providing quick insights and minimizing user's effort to interpret and understand the reported information, triggering alert messages whenever a reported measurements exceeds predefined thresholds (the study of such clinical indicators' thresholds is outside of the scope of this work).

The Information Visualization field has a relevant role in providing value to existing data where sensemaking fits into the whole process of working with vast volumes of datasets [5]. The use of Information Visualization principles provides a way to streamline visual representation of critical data to support the decision-making process. This is particularly relevant when the user relies on the system situational awareness capabilities to be aware about events requiring an immediate attention, keeping all actors (e.g. healthcare professional, patient) well informed about undergoing events, mitigating in this way the risk of recurrent deviant behaviors.

When addressing patient's health and wellbeing, it is most important to address the motivational factors of each individual [6]. In this domain, Gamification techniques can play an important role in helping the patient to be committed with prescribed behaviors and healthy lifestyles, reducing the risk of undesired events, that may lead to positive or negative rewards [4].

To address these concerns, an Information Visualization Engine was designed to promote situational-awareness and spatio-temporal data-sensemaking regarding risk situations in health insurance. This design uses service design thinking principles in an iterative, user-centric design process with a clear and active participation of the intervenient actors. The proposed solution empowers users in building personalized interactive dashboards supporting data integration and aggregation, filtering and searching capabilities, streamlining the exploration and analysis of data, enabling the user to repeatedly redefine goals as new insights is acquired [7].

The contributions of this work entail in the following three criteria: (1) design of an information visualization engine for situational-awareness as a way to create a collaborative community to improve patient healthcare and wellbeing, (2) develop a prototype for the health insurance case-study, and (3) the specification of a decision-making processes in health insurance domain, addressing high-risk clients (chronic patients).

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[1] BYOD - Bring your own device, possibility for customer to use their personally owned wearable or mobile devices (e.g., smartwatch, smartphone).

The structure of the paper is as follows. Section 2 provides a literature review, taking in consideration the health insurance case study, addressing concepts from information visualization, gamification, and service design thinking. Section 3 presents the proposed data model for the information visualization engine. Section 4 presents its application to a case study, modeling a health insurance management program. Finally, Sect. 5 presents the main conclusions and future research work.

2 Related Work

2.1 Information Visualization and Gamification

Information Visualization addresses the transformation of data and knowledge into graphical representation using, for instance, Dashboard viewers. Such informational artifacts can be used to enhance human cognition [5], contributing simultaneously to streamline the detection of patterns and to increase perceptual inference [8].

Interactive and personalized dashboards are an Information Visualization technique to transform datasets into relevant information, supporting the decision making process and dynamically triggering alerts [9]. In a dashboard, data are organized to be monitored and visualized at a glance, making them the ideal communication mechanism for situational-awareness [10]. In the health insurance sector, situational-awareness plays an important role in preventing adverse clinical situations and in promoting healthier lifestyles (by reducing health risk factors).

Situational-awareness requires the ability to present different types of data in a comprehensive format, taking advantage of different representations (e.g. colors, geometry, size) and visualization elements (e.g. charts, tables or indicators) in order to alert and point those situations requiring an immediate attention, improving the ability to take actions based on informed decisions [11]. In this domain, the end-user should have the possibility to autonomously customize the Dashboard views or personalize the graphical elements without requiring any programming skills [11]. To improve interactions, the end-user should be able to operate with aggregations, filters and other operators to search and drill into more granular data. When combined with other research areas, such as gamification, information visualization techniques has a relevant role in providing value to the existing data, improving user self-awareness, engaging users to increase motivation and, ultimately, improve health outcomes by involving patient's in their own health management [6].

In a recent study [4], it was demonstrated that gamification had a positive impact in promoting physical activity, keeping all intervenient actors informed about abnormal situations. Gamification uses game design elements in order to increase the user engagement in achieving the expected results. According to [12], the approach starts by analyzing the information from a "gamified" business perspective, with a clear categorization of information's relevance, the definition of business metric's thresholds and the ability to identify achievements using a standard classification.

In this paper, healthy indicators were characterized as cost (e.g. cholesterol), benefit (e.g. daily steps) or on-target (e.g. hearth rate, weight, body temperature). The adoption of gamification techniques, such as recognition or rakings, intends to enhance self-awareness regarding good behavior or achievement of goals; but for healthcare professionals, indicators monitoring risky situations are more relevant. Therefore, notifications must be configured based on the user profile/role, providing the ability to draw users' attention to relevant data [13].

The users can configure visual elements in a Dashboard, using color, shape, or other visual attributes, to retrieve insights based on the way users interpret and interact with visual elements in the Dashboard. As explained in [8], raw data are combined with visual graphical elements to build visual representations of the information. Each visual structure can serve one or more viewpoint, allowing users to analyze data from different perspectives and levels of detail.

This work designs a domain model associated to the information visualization engine, using valuable inputs from [8]. This model is used in the iterative process to transform raw data into visual representations relevant to the end-user. The information visualization guidelines are the building-block to the specification of a user-centric dashboard engine empowering users to configure and customize the visual artifacts they are interested on. Thus, our work extends the model presented in [8] by merging gamification techniques with visual elements using data from the health insurance sector. Access to granular data is restricted based on health insurance policies and by taking into account the role and user profile of the different actors.

2.2 Service Design Thinking

Service Design Thinking is an emerging approach, yet, without any common accepted definition. It highlights the need for an active participation of users in the research process, as a way to gain comprehension and understanding of the user needs [14]. The Service Design Thinking approach follows five principles: User-centered (design for user needs), co-creative (all stakeholders collaborating in the design process), sequencing (modeling correlative actions and interactions), evidencing (artifacts as outcome of intangible services), and holistic (considering service environment) [14].

The *user-centered* principle offers a common language during the development process, providing a way to receive input from users, making service design based on user needs rather than the internal needs of the business. User needs can differ based on the user model/role. Thus, using a *co-creative* principle, services should be designed in collaboration with the user to address their needs (e.g. providing motivational self-awareness features to clients or to healthcare professionals).

The design process requires the understanding of service's actions and interactions (*sequencing* principle). In this domain, prototyping plays an essential role as a way to test service impact on users and add additional value based on iterative user feedback. *Evidencing*, the (intangible) design process focus on modeling complete informational artifacts rather than components of the identified artifacts, making users aware of the provided services. Finally, service design should be *holistic*, considering that, special events (variations in general processes) must be considered and treated as standard events. This is particularly important when modeling an event driven Information Visualization Engine platform aiming to improve self-awareness.

In this paper, Service Design Thinking principles are used as guidelines when designing and modeling a set of services that ensures the required system behavior in terms of guided surveillance, triggering awareness mechanisms within a collaborative dataflow to keep all actors well informed.

2.3 Health Insurance Case Study

The growing demand for healthcare insurance, especially in the private sector, has reached in 2016 a 1.3 trillion Euros in global revenues (forecasted to double by 2025) [1]. Healthcare insurance risks dimensions are classified in eight categories: low-cost routine care, preventive care, chronic care, non-obligational procedures, expensive discretionary care with no medical justification, unpredictable and chronic catastrophic care, and end-of-life care [1].

In United States, the largest spending reason in healthcare are derived from chronicle medical conditions [2]. According to the Portuguese Insurance Supervision Authority (ASF)[2], insured person pre-existing health conditions, such as chronicle diseases, are a usual exclusion condition to figure in any health insurance contract. Apart from the high-risk for health providers, these health-risk dimensions can be an opportunity to develop innovative products and services addressing consumer niches.

We believe that information technologies can play an important role. The use of wearable devices enables clients to share day-to-day data, providing health insurance providers the means to address telemedicine programs in monitoring client's progress in real time. In health insurance, when monitoring chronic patients, any awareness must be characterized based on the situation triggering an alert. This may include information regarding the client health status (e.g. client's biometric data), changes to the client daily environment (eating habits) or knowledge of the service quality (e.g. alert notification response rate). Enabling a nutritionist to be informed about each patient results (e.g. a dashboard with a nutritional program), or assist a client in achieving prescribed physical activities, with data collected from wearable devices.

Healthy behaviors surveillance, supported by an information visualization engine for situational-awareness about risk-situations improves timely interventions, mitigating the risk of adverse clinical situations, promoting simultaneously client's quality of life and wellbeing.

3 Information Visualization Engine

The proposed solution follows a client-server architecture comprised of a JavaScript client, a Java backend server and a metadata info-structure database for engine's configurations. The main features were designed to assure scalability and a high level of configurability, for a multi-user environment with authorization procedures based on the user model (user roles/profiles). This work assumes that all incoming data are ready to be visualized, focusing on how to present the information to better understand the health-status of the patient.

[2] http://www.asf.com.pt/EN.

The design followed a user-centric approach, providing a solution to enhance end-users' flexibility in the creation and customization of interactive dashboard as a way to present events and data to different user profiles in an understandable way, providing quick insights and minimizing user's effort to interpret and understand the reported information. End user's interact with the informational artifacts presented at the dashboard elements (i.e. Tabs), where each artifact is expressed as a set of customized content instances. Based on the user profile/role the information presented on a specific dashboard might change including the number of events triggered to keep the user informed about those situations requiring an immediate attention.

Such level of awareness is mostly expressed though the configuration of Content/Indicators elements responsible to dynamically trigger notifications whenever predefined thresholds are exceeded. The dashboard can hold a set of different Content Types, each one customized based on the user preferences and access level.

At the server side, the engine provides access to several data connectivity mechanisms, such as REST, JDBC, MDX and CSV, supporting data access. It also manages the metadata info-structure that supports the designed model (present in Fig. 1). The communication between the server and client side was implemented using a RESTful API with serialized and de-serialized JSON messages.

The informational artifacts are structured into six layers, each one encapsulating specific aspects of the information visualization engine. To streamline the association of the layers with the informational artifacts, Fig. 1 presents the adopted color code (A: Blue, B:Orange, C:Beige, D:Brown, E:Gray, F:Pink). The approach follows a classical 3-tier architecture model: presentation layer (D), business logic layer (C) and data layer (B). The schema is complemented with two additional layers encapsulating functionalities related to security (E) and collaboration (F) aspects. Finally, a metadata layer (A) is responsible to handle and manage the info-structure of metadata used to characterize some of the informational artifacts within the domain model.

Metadata Layer. This is the base layer of the design model. Addresses the characterization and management of the informational artifact's metadata in a centralized way for all reported artifacts. Each entity present in the design model are described by *Metadata*, managed by this module layer.

Data Layer. This layer addresses the informational artifacts required to manage data connectivity and information gathering, providing the ability to retrieve and structure data for visual mapping. Following Card et al. [7] approach to build structured data from raw data: *DataSources* provide data connectivity and access to heterogeneous data, and *DataItems* provide structure to the source data in a set of *Columns* with functionalities to filter and configure how to visualize the data.

Business Logic Layer. This layer addresses the management of informational artifacts used to fill the workspace of the tab elements in each configured dashboard. *DataItems* and corresponding structural data components (i.e. *Columns*) are associated to *Contents* using categories and series. *Contents* provide the configuration of *Thresholds* and *Alerts* with a spatio-temporal context using colors and shapes to draw users' attention to relevant data and enhancing information-awareness. A *Threshold* can raise *Alerts*

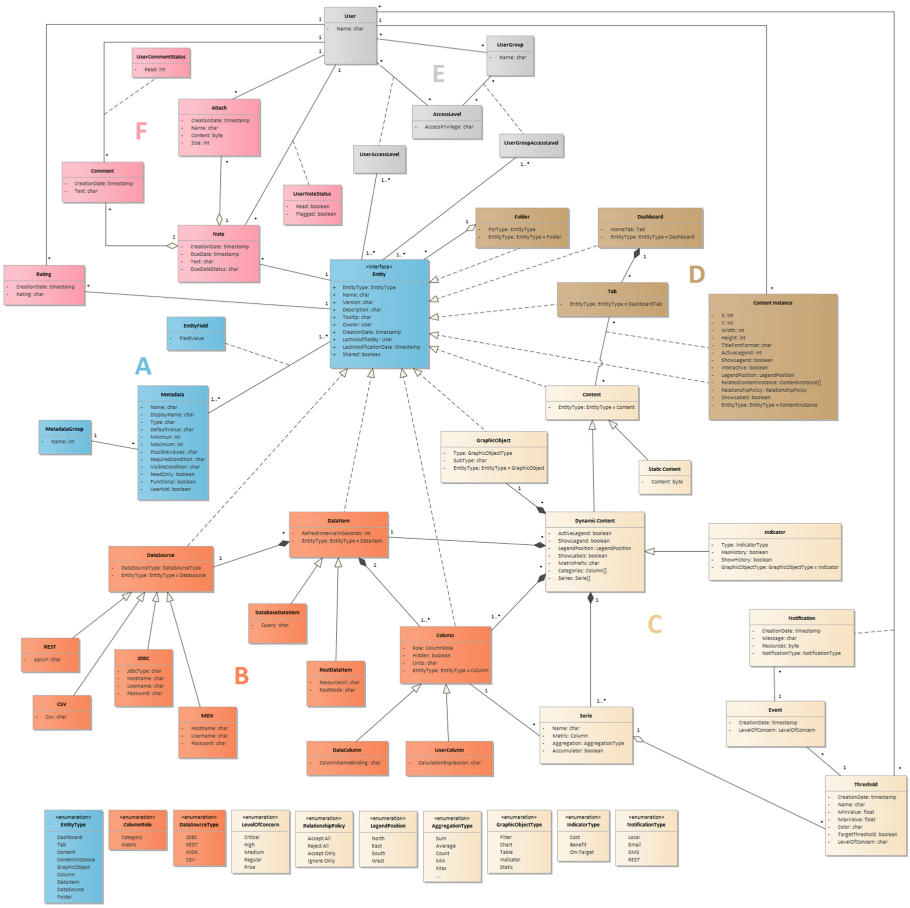

Fig. 1. Domain Model of the Information Visualization Engine

and *Notifications* to "subscribing" *Users*. Based on the *Threshold* values, events are generated and identified with different symbols/colors.

Presentation Layer. This layer addresses the informational artifacts required to create, view and customize an interactive context dashboard. A dashboard provides a tab-based structure, empowering end-user's customization and interactivity regarding visualizations (*ContentInstances*).

Collaboration Layer. This layer addresses the informational artifacts used to enhance collaborative work, sharing information in the form of comments and annotations, discussion threads/chats or ratings.

Security Layer. This layer addresses the informational artifacts that instantiates the user model, enabling user management and configuration of access levels.

4 Case Study: Health Management Program at Future Healthcare

The case study addresses an innovative and ambitious health management program from FH[3], a company operating in the health insurance domain. FH is a private international group, established in 2003, with headquarters in Lisbon and an office in Zurich. In Portugal, FH manages a medical network with over 25.000 health providers, including 80 private hospitals, over 3000 wellbeing providers (e.g. nutrition, senior care or nursing) and over 20.000 medical doctors spread by dozens of specialties, such as cardiology, pneumology or sports medicine. The information visualization engine was configured for situational-awareness of high-risk clients (e.g. adult chronic patients), enabling quick interventions as a way to mitigate the risk of adverse clinical situations and promoting client's quality of life and wellbeing.

4.1 Operational System Behavior Scenarios

The following sections models a set of operational system behavior scenarios using storytelling techniques [15] and a BPMN representation of the business process on FH's health insurance program. All scenarios address system's awareness capabilities in order to monitor unhealthy risk behaviors. It is assumed that the interactive dashboard was configured (see Fig. 2 for engine's backoffice configuration views) accordingly to the client's clinical profile. This assumption relates to the creation of an instance of the standard interactive dashboard, together with the informational entities (*DataSource, DataItem/Column)* at the data layer, the business rules at the business logic layer (*Content*) and the graphical visualization at the presentation layer (*Dashboard*, *Tab*, *ContentInstance*).

Figure 2 addresses the engine's backoffice configuration views. The *DataSource* workspace shows the connection configuration to a database supporting the Health Management Program and the *DataItem* workspace shows the configuration of Weigh Metrics data structure with five *Columns*, showing in particular, "BMI" Data Column with the associated metadata fields. At the center, the "Weigh Evolution" *Content* workspace presents a preview of the current configurations (providing a fast-feedback configuration cycle) and two tabs to configure *Content* visualization attributes and data selection/calculation using categories and *Series* through *DataItem's Columns*.

4.2 S1: Mitigate Insurance Risk Regarding Recurrent Unhealthy Behaviors

Figure 3 is a visual outcome of the first health insurance scenario monitoring health behaviors of Philip's *persona*, instantiated with multiple views (accordingly with different user roles). This scenario is formally represented (BPMN) in Fig. 4. Philip is a male taxi driver of 57 years old, diabetic (type I), smoker, with moderate drinking habits and has been deteriorating his diabetes condition lately. Monica, a health

[3] http://future-health.care/en/.

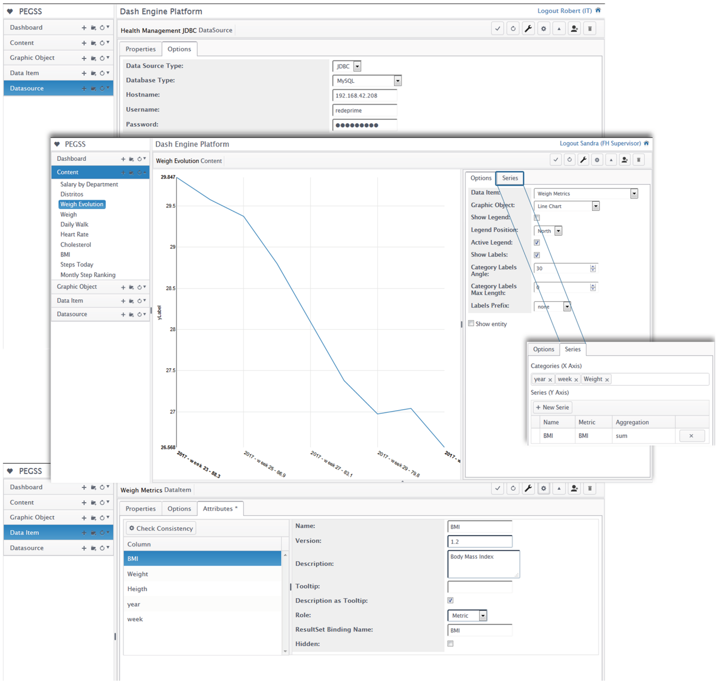

Fig. 2. Information Visualization Engine backoffice configuration views of *DataSources* (top) *DataItems* (bottom) and *Contents* (center).

professional nurse, became aware of Philip's deviant behaviors by an event triggered by the information visualization engine regarding an increase in HbA1c[4] values. Combined with an increase in cholesterol values, a food diet and a 10.000 daily step exercise, were prescribed and configured in Philip's dashboard tab. Phillip missed this target, generating recurrent notifications. Despite the collaborative effort of the health professionals to address his unhealthy behaviors, Phillip still failed to change to healthier behaviors. Phillip failed to behave as expected to improve his wellbeing, leading to a penalty in insurance product premium, mitigating health insurance risk burdens that may occur due to Phillip's unhealthy behaviors.

Modeling different views of the same dashboard highlights the multi-user engine configurability capabilities. Each profile view is mapped to a dashboard tab. Client's layout instantiation in Fig. 3 (bottom image) involves him in his own health management, providing user self-awareness. Gamification plays an important role promoting healthy behaviors though user rewards and mitigating risks through penalties. The health professionals' layout (top image) is configured with detailed metrics regarding relevant risk situations, supporting a collaborative multichannel awareness

[4] HbA1c refers to glycated hemoglobin, which identifies average plasma glucose concentration. HbA1c provides a longer-term trend, similar to an average, of how high your blood sugar levels have been over a period of time.

Fig. 3. Scenario S1 dashboard layout addressing different user roles.

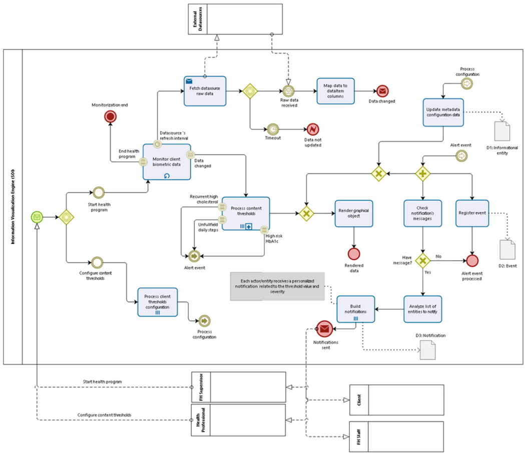

Fig. 4. Scenario S1 BPMN collaboration diagram.

mechanism that contributes to improve patient health status and wellbeing. The center image instantiates FH supervisor view, providing a way to monitor deviant behaviors metrics (i.e. generated events) and resulting rewards/penalties.

This engine provides risk situations awareness using the visual informational artifacts (i.e. indicators and contents) listed in Table 1. Indicators are special types of contents. Each indicator shows a measure/value (from the configured series' metric and aggregator function), the indicator type (cost, benefit or on-target), specified goal (based on the value of the threshold configuration) and a variation arrow (showing metric trend). Values use thresholds configured color and the variation arrow makes use of green (benefit) or red (cost) color to express trend awareness.

For example, in Fig. 3, the "HbA1c" indicator shows a high-risk situation through value's red color and a negative tendency (metric is increasing) using a red arrow. Although dedicated predictive analysis is outside the scope of this work, the use of the trend together with the target goal composes mechanisms supporting the implementation of a predictive model, understanding on what is likely to happen next.

4.3 S2: Motivational Awareness for Healthier Behaviors

Figure 5 is a visual outcome of the second health insurance scenario (formally represented by a BPMN collaboration diagram in Fig. 6) monitoring health behaviors of Samantha's *persona*, instantiated in two different moments in time, highlighting client's health behavior changes representation.

Samantha, an overweight, 47 years old, female, stockbroker, suffers from asthma and has been experiencing an increase number of asthma crises (increasing risk of deterioration the lung function over time) due to an abrupt attempt to follow an intense exercise program for weight loss. Samantha was prescribed a continuous 30 min daily

Table 1. Scenario S1 indicators list addressing multi-user and multichannel awareness.

Content	Type	Awareness
HbA1c	Cost Indicator	Risk indicator related to client's chronicle condition (diabetic). Presents a high risk metric value, with negative trend and associated event
Cholesterol	Cost Indicator	Risk indicator, presenting a high risk metric value, with a negative trend. The recurred aggravation generated an associated event
Steps Today	Benefit Indicator	Indicator addressing client's health behaviors. Unhealthy behavior is reflected by a low metric value, without a positive trend. The recurred behavior generated an associated event
BMI	On-target Indicator	Presents a moderate risk metric value with a negative trend
Hearth Rate	On-target Indicator	Presents a positive metric value without any trend information
Events Count	Chart	Presents generated events count by severity using a pie chart
Insurance Premium Variations	Chart	Presents health insurance premium values variations in form of a line chart
Weight	On-target Indicator	Presents a moderate risk metric value with a negative trend

walk, avoiding abrupt exercise effort. Although the prescribed walk, Samantha continued to over exercise, raising multiple events on high hearth rate. As a response to the generated events, Martha, a physical trainer, reinforced the risks of over exercise. Also, Joseph, a pneumologist, received a notification regarding Samantha's risk behavior, generating a medication prescription change. Now, for the past two months, Samantha started to follow the exercise prescription, lowering the experienced asthma episodes, improving her wellbeing and life quality. Also, she received a bonus discount (due to target goals fulfillment) in the policy premium promoting positive health behaviors.

The instantiate interactive dashboard provides awareness related with risk situations using visual informational artifacts listed in Table 2. This table describes indicators/contents referring two moments (separated by two months). Modeling different moments in time of the same dashboard highlights the potentials of the awareness capabilities was a way to address client's health behaviors, mitigation risk situations an improving client's wellbeing. The second layout shows a "Weigh Evolution" line chart with a multi-value/level X-Axis' values: year, week and weight. The "Weigh Evolution" content configuration is presented in Fig. 2.

Both BPMN collaboration diagram in Fig. 4 (Scenario S1) and Fig. 6 (Scenario S2) identifies three data objects (D1 to D3). Informational Entity (D1) data object addresses the defined metadata model (see Fig. 1 for domain model detail) and represents the informational entity state. Event (D2) and Notification (D3) data objects represents the informational artifacts outcome of the implemented awareness mechanisms.

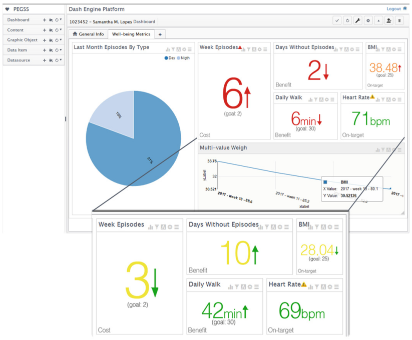

Fig. 5. Scenario S2 dashboard layout addressing initial metrics (top) and after two months (bottom)

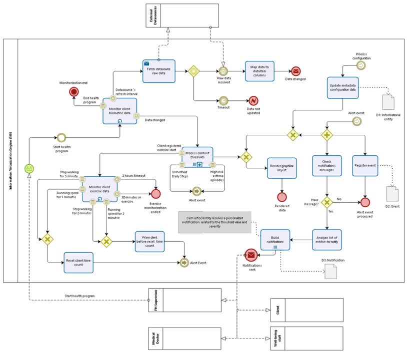

Fig. 6. Scenario S2 BPMN collaboration diagram.

Table 2. Scenario S2 indicators list addressing multi-user and multichannel awareness.

Content	Type	Awareness
Episodes By Type	Chart	Content related to client's chronicle condition (asthmatic). Presents last month asthma episodes count by type
Week Episodes	Cost Indicator	Indicator related to asthmatic condition. At moment 1 presents a high risk metric value, with negative trend and associated event. At moment 2 presents a low risk metric value with a positive trend
Days Without Episodes	Benefit Indicator	Risk indicator related to client's chronicle condition (asthmatic). At moment 1 presents a stable (no variation) high risk metric value. At moment 2 presents a low risk metric value with a positive trend
Daily Walk	Benefit Indicator	Indicator addressing client's health behaviors. At moment, 1 unhealthy behavior is reflected by a low metric value. Also, shows a negative trend and associated events. At moment 2 shows a positive metric value with a positive trend
BMI	On-target Indicator	Presents a high-risk metric value with positive trend at both moments
Hearth Rate	On-target Indicator	At moment 1 presents a recurrent high metric value, and at moment 2 shows a more controlled metric value
Multi-value Weight	Chart	Presents weight metric values history in form of a multi-value line chart

When suspicious situations are detected (taking into consideration its level-of-concern) the system triggers events to inform all intervenient stakeholders (trough configured notifications), creating a collaborative community acting proactively to assure the person health status and wellbeing. This alert is represented with a related symbols and colors accordingly with the level-of concern (e.g. "regular" level-of-concern alert on

"Daily Walk" indicator and "high" level-of-concern alert on recurrent risk situation regarding "Asthma Episodes" metrics. The use of different levels of severity empowers awareness mechanisms, enabling user awareness regarding deviant behaviors (accordingly with defined goals), and secondly, the need to act accordingly as a way to mitigate deviations.

5 Conclusions

The paper outlines the main achievements in designing and implementing an information visualization engine that uses information visualization and gamification techniques to streamline visual representation of events in a collaborative decision making environment. It also makes use of service design thinking principles as guidelines to model a set of services that ensures system behavior capabilities concerning situational-awareness mechanisms within a collaborative dataflow (based on the user model). The engine was designed to be used in any context, but for demonstration purposes, the system was configured to comply with requirements from the health insurance sector, in particular to mitigate the risk of disease burdens and promote client's quality of life and wellbeing. The research work contributes with two operational scenarios to model the decision-making processes and awareness challenges regarding high-risk clients (e.g. chronic patients) and health risk behaviors.

The proposed solution interacts with heterogeneous data sources to analyze the data, providing spacio-temporal data-sensemaking, providing clients with self-awareness capabilities regarding deviant behaviors and consequences (e.g. insurance policy premium aggravation). The solution also provides a multichannel awareness mechanism as a way to assure situational-awareness in health insurance. Following information visualization guidelines, the paper presents a complete metadata model capable of supporting (in a flexible approach) the creation of informational artifacts addressing proactive client's unhealthy risk behaviors monitoring, keeping all intervenient actors aware about events requiring their immediate attention.

The user is empowered to configure and customize information artifacts to promote situational-awareness (e.g. health status and wellbeing monitor for unhealthy behaviors) and streamline the way events and data are presented to the user in a collaborative decision making environment, contributing to improve patient health status and wellbeing.

In terms of future work, it is intended to conduct a formal evaluation study of the proposed information visualization engine within an innovative health program project sponsored by FH. Such study will integrate the company strategy and business context. Moreover, we intend to address the model limitations regarding embedding and dynamically publishing the dashboard layout into external systems (e.g. webportals). Finally, although this work assumes that raw data are pre-processed and are ready to be visualized, it would be interesting to address a new data mining module focused in providing the ability to address new health insurance products (more effective for customers and sustainable for a health insurance providers).

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