A Modern Approach to Total Wellbeing

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Abstract. The events of the last decades have impacted our lives and our health significantly. We expected that the technology boom will improve our lives. While this may be true in a specific context, generally speaking our societies are suffering from moral decays, terrorism fears, wars, financial crisis and unpredictable acts of nature that are increasing in frequency and in intensity. The complex nature of the world we live is impacting our health and wellbeing considerably. Our health is not only determined by our physical health but is the end product of the interplay of the physical, mental, emotional, financial, relational and spiritual events of a lifetime. In this paper we develop a framework that will help us define and measure total wellbeing of individuals in our volatile societies. This framework will help us better understand the complex nature of total wellbeing and develop effective prevention and intervention strategies.

Keywords: total wellbeing, health informatics, ontology, electronic total wellbeing record, data mining.

1 Introduction

We live in a digital milieu, we have a high standard of living but the increase in affluence and materialism has failed to bring us better health, greater inner peace and a fuller sense of meaning, direction and satisfaction [1]. The revolutionary technology development has resulted in rapid introduction of cutting-edge technologies into our societies. We became very dependant on the high technologies and comfort they brought. We started enjoying the modern way of living and were hoping that the new things will make our lives better. We were up for better lives.

While the lives of individuals may have become better, evidence [1] suggests that general health and wellbeing of our societies became worse. Since 1960:

- the divorce rate has doubled
- the teen suicide rate has tripled
- the recorded violent crime rate has quadrupled
- the prison population has quintupled

- the percentage of the babies born to unmarried parents has increased six fold
- cohabitation (a predictor of future divorce [2]) has increased sevenfold

Terrorist attacks and fear of terrorism are adding additional pressure on our societies [3]. Wars and rumors of wars are marking our society. This moral corruption is closely followed by the financial insecurity, times of market instabilities, increasing interest rates and bankruptcies [4].

We have control of the abovementioned factors but have still allowed them to degrade our societies, lives and health. We are exposed to additional pressure created by the factors we have less control of. For example, earthquakes, tsunamis, tornados and cyclones have not only increased in frequency but also in intensity. There were 368 documented US tornados in January and February this year, which exceeded the previous record of 243 in 1999 for that two month period [5]. The recent cyclone in Burma and earthquakes in China have shaken both nations.

It appears that the occurring problems are increasing over time, and are gaining a momentum rather than being random events. The increasing stress, pressure and fears associated with these events are affecting our lives negatively. Depression, as predicted, will be the world's leading cause of disability by 2020 [6]. Why do we live more modernized but not necessarily happier lives as we enter the twenty-first century?

In this paper we focus on developing a framework that will help us precisely define and measure the total wellbeing of individuals in our modern society. Total wellbeing is not only determined by our physical health but the end product of the interplay of the physical, mental, emotional, financial, relational and spiritual events of a lifetime. The background of this statement is explained in Section 2. The six-dimensional conceptual model or 6D Ontology is described in Section 3. In Section 4 we illustrate how the 6D Ontology can be used in the design of intelligent health information systems. This paper is concluded in Section 5.

2   Why the Six-Dimensional Approach?

The concept of health as a "state of complete *physical*, *mental* and *social* well-being and not merely the absence of disease or infirmity" was originally defined by the World Health Organization [7]. Since then, a multitude of research has attempted to delineate the factors that contribute to positive human health. In this paper, we will explain that additional dimensions need to be taken into account when defining and accessing total wellbeing of individuals. These include *emotional*, *financial* and *spiritual* dimensions.

A number of researchers have established links between 2 or 3 different aspects of health. The complex relationships between the different aspects of health have been fueled by energetic and innovative research programs in several fields, including sociology, psychology, health behavior and health education, psychiatry, gerontology, and social epidemiology [8].

2.1   Physical and Mental Health

Numerous studies have demonstrated a strong association between mental perceptions and physical health, in particular behavioral responses to stress. Chronic activation of the stress response can put a strain on various organs, leading to systems breakdown,

compromised immune response and ultimately the deterioration of physical health [9, 10]. Significant links between mental illnesses such as depression, and chronic physical illnesses such as asthma [11], diabetes [12] and cardiovascular disease [13] have also been reported. According to the 1996 U.S. Surgeon General's Report on Physical Activity and Health [14], physically active people tend to have better mental health. In comparison to inactive people, the physically active had higher scores for positive self-concept, more self-esteem and more positive "moods" and "affects." Consequently, physical activity has been successfully used as a non-pharmacological treatment for depression [15, 16]. Additionally, physical activity may reduce the symptoms of anxiety, improve self-image, social skills, and cognitive functioning, and be a beneficial adjunct for alcoholism and substance abuse programs [17].

2.2   Financial, Physical and Mental Health

Cross-national comparison studies report an elevated level of wellbeing from countries high in per capita income (GNP); in contrast, countries lowest in reported wellbeing were those in Eastern Europe, where people were suffering from low income [18]. A comparison between self-reported happiness and GNP from seven parts of the world indicated a clear relationship between happiness and per capita GNP [19]. However, there are some inconsistencies between the data; Latin America scored almost as high in reported happiness as Western Europe, which has more than double the Latin American GNP. This suggests that even though financial factors play a large role in total wellbeing, there are other factors which play a significant part in contributing to total wellbeing. Data from the National Health Interview Survey, the National Survey of Families and Households, the Survey of Income and Program Participation indicates that increases in income significantly improve mental and physical health [20]. However, the study also provides evidence that increases in income increase the prevalence of alcohol consumption which in its turn may damage mental and physical health.

2.3   Social, Physical and Mental Health

A study by House et al. [21] has provided both a theoretical basis and strong empirical evidence for impact of social relationships on health. Prospective studies exposed the evidence that persons with a low quantity, and sometimes low quality, of social relationships have increased risk of death. Experimental and quasi-experimental studies of humans and animals gave similar results. The social isolation has proven to be the major risk factor for mortality from widely varying causes. While House et al. [21] report increased mortality rate in isolated individuals and Kawachi & Berkman [22] highlight a beneficial role of the social ties play on the mental wellbeing, not all relationships are beneficial. Some relationship can be destructive and it is better to avoid them. Rolland [23] does study from a different perspective. He studies situations where illness or disability strikes a couple's relationship. These situations often put the relationship out of balance and consequently result in dysfunctional relationship patterns.

2.4   Emotions, Physical and Mental Health

The relationship between emotional and physical health has also been explored. It was demonstrated that emotional stress such as anxiety has a negative impact on

immunity [24]. In a recent study, anxiety characteristic was even found to be a significant and independent predictor of cardiovascular disease [25]. Dr Colbert [26] further defines the destructive emotions, their origin and manifestations and exposes their negative effect on health. The toxic effect of these emotions may result in a variety of illnesses including hypertension, arthritis, multiple sclerosis, irritable bowel syndrome and some types of cancer.

2.5   Physical and Spiritual Health

Positive association between *physical* health and *spirituality* has been reported by Powell *et al.* [27]. The researchers state that the risk of mortality is reduced by 25% in church/service attendees and conclude that church/service attendance protects healthy people against death. Additionally, they provide evidence that the religion or spirituality protects against cardiovascular disease, which is largely mediated by the healthy lifestyle the doctrine encourages.

2.6   Mental and Spiritual Health

Dr D'Souza [28, 29] highlights the need of *mental health* patients to have their *spiritual* issues addressed. The majority of patients rated spirituality as very important and wanted their therapist to take their spiritual needs into consideration. Sixty-seven per cent of the patients said that their spirituality helped them cope with their condition. As the majority of the mentally ill patients appeared to be spiritual, the question here is: "Did spirituality trigger mental disorder in the first place?" One would expect relationships with the divine to affect the mental health positively. Is it possible that the patients had revelation of God in the past, but have lost the closeness to God over time? Their minds became battlefields of knowing what is right and doing what is wrong which brought continual torment upon their minds, eventually resulting in mental disorder. Bergin [30] addresses these questions as he discusses the effect of spirituality on mental health. He provides some explanation on the multi-factorial nature of religion and describes both positive and negative effects of religion. The positive impact is marked by inspirational conviction or commitment and is manifested in dramatic personal healing or transformation. The effects have proven to be extraordinary when this kind of experience becomes linked with social forces. The negative impact is described as evil clothed in religious language or religion that is clearly not constructive. He states that 'spiritual phenomena have an equal potential for destructiveness, as in fundamentalist hate groups'.

Since the identified factors are interactive and mutually dependant on one another, there is a need to employ an integrated, multidimensional approach to total wellbeing. This requires the analysis of each factor individually and in relation to other factors. The study of a single dimension on its own is not sufficient. We can find no evidence that such comprehensive research has ever been performed i.e., the design of an intelligent system to map the different factors on a person's total wellbeing and reveal the interrelationships and interdependencies between the six dimensions.

We need to fully embrace information technology and its potential to develop an information infrastructure that will enable us to simultaneously study the different

dimensions and relationships between them. In this paper, we propose a six-dimensional model that takes into account physical condition, along with mental, emotional, financial, relational and spiritual wellbeing. The Physical, Mental, Emotional, Financial, Relational and Spiritual Wellbeing of a person are the six 'dimensions' (6D) that interact to culminate in total wellbeing.

3   6D Ontology

Ontology is an enriched conceptual model for representing domain knowledge. Ontology captures and represents specific domain knowledge through specification of meaning of concepts including definition of the concepts and domain-specific relationships between those concepts. Ontology provides a shared common understanding of a domain and has been suggested as a mechanism to provide applications with domain knowledge and support knowledge integration, use and sharing by different applications, software systems and human resources [31]. Hence, ontology can be used to empower a system with the required knowledge and enable it to operate effectively and efficiently.

The importance of ontologies has been recognised within the medical community and work has begun on developing and sharing biomedical ontologies [32]. A number of biomedical ontologies exist, for example, Gene Ontology and UMLS. The aim of Gene Ontology (GO) (http://www.geneontology.org/) project is to enable consistent descriptions of gene products in different databases by using GO to annotate major repositories for plant, animal and microbial genomes. The Unified Medical Language System (UMLS) [33] is a collection of many biomedical vocabularies. There are 1 million biomedical concepts in UMLS, as well as 135 semantic types and 54 relationships used to classify these concepts. Human Disease Ontology [34] captures and represents knowledge about human diseases. It consists of disease types, symptoms, causes and treatments subontologies. Protein Ontology (http://proteinontology.info/) [35] provides a unified vocabulary for capturing declarative knowledge about protein domain and to classify that knowledge to allow reasoning. It acts as a mediator for accessing not only related data but also semi-structured data such as XML or metadata annotations and unstructured information. A great variety of biomedical ontologies is available via The Open Biomedical Ontologies (http://obofoundry.org/) covering various domains such as anatomy, biological processes, biochemistry, health and taxonomy.

We are in the process of creating a 6D Ontology (6DO), a comprehensive conceptual model to capture and represent the knowledge specific to the six dimensions of the Total Wellbeing. In Figure 1, we represent Total Wellbeing as a result of Physical, Mental, Emotional, Financial, Relational and Spiritual Wellbeing. 6DO will specify the meaning of the concepts used within total wellbeing domain, including definition of these concepts and the domain-specific relationships between them. These precise specifications will constrain the potential interpretations of 6DO concepts and enable 6DO to be used by automatic application. For the modelling of 6DO, we have utilized Protégé tool developed by Stanford University.
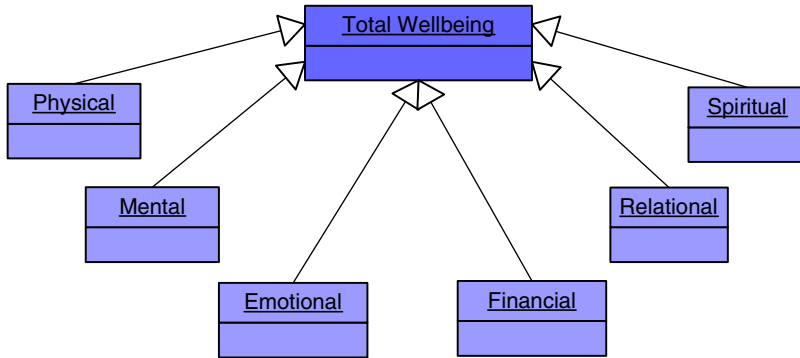
Fig. 1. The Six Dimensions of the Total Wellbeing Ontology

6DO provides a common and shared conceptual framework for specification of each of the Total Wellbeing dimensions. 6DO contains generic information that is always true for the 6D system. Each dimension is further specified by a number of factors that jointly define this particular dimension. For example, the Relational dimension is defined by different kinds of relationships such as with parents, with spouse, with children, with friends, with class mates, with work colleagues, with appointed authorities etc. The emotional wellbeing is determined by different kinds of emotions such as anger, anxiety, bitterness, delusion, disbelief, doubt, fear, guilt, happiness, hope hurt, joy, peace, rage, self-hatred, self-rejection, stress, torment, trauma, etc.

We are told that every person has a unique background, understanding, needs, desires and goals, but are there certain patterns that emerge as we observe the different circumstances in which people live? Doctors have discerned that some emotions are common to patients experiencing same illness. Until now, this has only been an observation. Making a formal model like 6DO will enable us to effectively capture interesting information, and through further data analysis, expose the evidence that will help us manage our health better.

The use of 6DO within health information systems can have many advantages such as (1) increasing data semantic (i.e. provide context for information); (2) enabling of effective knowledge storage, structuring, organization, representation, management, sharing and creation; and (3) supporting intelligent information integration and analysis. In the next section, we will describe a health information system that can be designed to incorporate 6DO.

4 6DO-Based Health Information System

The framework specified by 6DO can be used to design software to systematically collect, store and analyse patients' information. The four different phases are shown in Figure 2.
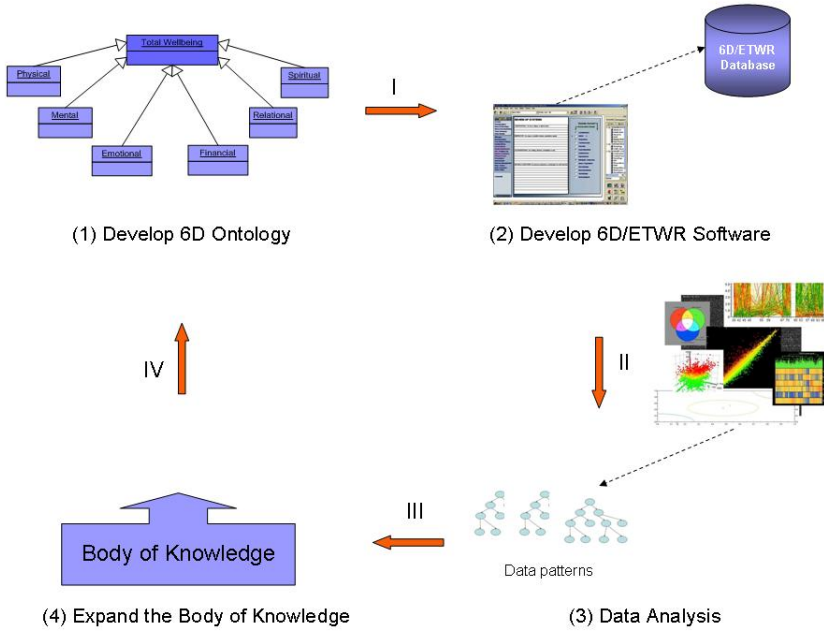
Fig. 2. 6D intelligent information system

In the first phase, the existing body of knowledge is used to design 6DO. We have already started designing the ontology using the Protégé tool. An extensive literature survey is being carried out to identify the key ontology concepts. Additionally, a number of domain experts is involved to advise the ontology design.

In the second phase, 6DO will be used as a basis for design a software that will capture and store patients' information. The 6D data template will be populated by information specific to an individual and saved as Electronic Total Wellbeing Record (ETWR) for each individual. The principle of population of generic ontology by specific information to create specific ontologies is explained in our previous work [36]. The ETWR will contain information describing a person's Physical, Mental, Emotional, Financial, Relational and Spiritual Wellbeing. Privacy preserving mechanisms must be implemented in such system. Our research centre specializes in data privacy issues, particularly privacy of medical data [37, 38].

In the third phase, the collected data will be analysed using automatic analysis techniques such as data mining. Data mining techniques enable us to explore and analyse the collected data, and identify embedded patterns and knowledge in this data. Data mining techniques permit advanced and effective study of complex problems.Within the health domain, data mining techniques have been predominately used for tasks such as analysis of genes and proteins, text mining and drug design. We will apply the data mining to collectively mine ETWRs for noteworthy data patterns. Our research centre has developed a number of data mining algorithms for both structured [39, 40, 41, 42, 43] and semi structured data [44, 45, 46, 47, 48]. The developed algorithms were applied on

large and complex data and these experiments successfully demonstrated the scalability of the developed algorithms [39, 41, 43]. From an application perspective in [49], we have applied our tree mining algorithm to extract useful pattern structures from the Protein Ontology database for Human Prion proteins [50].

The 6D dataset under examination will be split into two subsets, one for deriving the knowledge model (source set) and one for testing the derived knowledge model (test set). The source set will be intelligently explored and analysed to extract information, find hidden patterns and knowledge embedded in the data. Predictive models will be proposed. These hypotheses if supported through further testing, could make a significant contribution to research into human Total Wellbeing. The test set will be used to verify the hypothesis so that it can become reliable enough to extend the current knowledge. The research team will collaboratively work and experiment with variation of data mining parameters as their choice can affect the nature and granularity of the obtained results.

In the fourth phase, the knowledge that has been revealed and validated during the data mining phase will be published. This will extend the existing body of knowledge and in the combination with other new knowledge that emerged over time, may be used to extend and/or correct the ontology model. This principle of ontology evolution is frequent in the societies with rapidly accumulating knowledge.

5   Conclusion

Our society is changing in all aspects. The technology breakthrough, the modern way of living and modern societies have not only resulted in comfortable lives but also in increased stress, pressure and fears which in their turn started degrading our health and wellbeing.

More than ever, we need to take a holistic approach in studying and controlling our health ad wellbeing. We have exposed evidence to support the statement that the total wellbeing is the end product of the interplay of the following six dimensions or events of a lifetime: physical, mental, emotional, financial, relational and spiritual. We are currently designing 6DO, an integrated conceptual model to capture and represent each dimensions on its own an in relationship with other dimensions. We aim to design a software based on 6DO that will systematically collect and analyze data to expose the evidence that will support general public in managing their personal wellbeing better, and health professionals in adapting their services to address patients' needs more systematically and effectively. Innovative breakthroughs from this technique will change the way we understand, control and manage our health. A pilot study will be carried out at the Total Wellbeing Medical and Counseling Centre, but generic findings will be made available to the general public, and health providers both in policy and practice that target total wellbeing.

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