BUSINESS INTELLIGENCE FOR HUMAN HEALTHCARE AND WELLBEING AND ITS POTENTIALLY OPEN NATURE

Yasaman Soltan-Zadeh
Royal Holloway, University of London, UK
Email: Y.Soltan-Zadeh@rhul.ac.uk
José-Rodrigo Córdoba-Pachón
Royal Holloway, University of London, UK
Email: J.R.Cordoba-Pachon@rhul.ac.uk

Abstract

This paper provides a first glimpse of the use of business intelligence (BI) into healthcare and wellbeing. There are new and exciting possibilities to use BI business intelligence in this area. With the help of big data technologies, there is interest from public and private organisations, academic researchers, health professionals and technology vendors to implement as well as evaluate the impact of BI. A potentially important issue is that of the openness of the data for BI which could have repercussions for different actors. . In relation to the 'openness' of the data being managed, we identify a number of challenges. Discussion of these issues should inform future research and practice in BI in this area and elsewhere.

Keywords: Healthcare, Wellbeing, Business Intelligence, Open Data, Ecosystem, Information

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1.0   Introduction

The emergence of Business Intelligence (BI) and its use in human healthcare and wellbeing contexts creates opportunities to extract and use relevant knowledge obtained from analysing large volumes of data. Generally speaking, BI is a set of processes supported by technologies that enable people to discover patterns that are 'hidden' in the data to the human eye in order to inform decisions. Technologies to process and analyse data include transactional databases, data warehouses, online analytical processing (OLAP) and data mining tools and techniques (Laudon and Laudon, 2013; Chen et al, 2012). With BI, better, specialised and cost effective services and treatments can also yield benefits for payers and the public in general.

With new technologies and practices of big data in these contexts, there is interest from different stakeholders (public and private organisations, health professionals, technology vendors and patients) to better understand the role that BI could play and more specifically the issues related to the openness of data. The purpose of this paper is to provide a brief overview as well as an initial evaluation of what would happen if data generated from BI would be made open to different stakeholders and more specifically to

prospective and current healthcare and well being users. This would require addressing a number of issues in both the design as well as implementation of BI. In the next section an overview of BI in healthcare is presented.

2.0   What we know so far: Business Intelligence in Healthcare and Wellbeing

Business intelligence or BI in healthcare is relatively a young area of research and practice. There are different technologies that have been applied to healthcare problems ranging from telemedicine to detailed analysis of human tissue for detection of illnesses (i.e. cancer) (Laudon and Laudon, 2013; Chen et al, 2012).   Wellbeing is a complementary area to healthcare regarding health prevention and is taking shape in the form of early detection of diseases as well as support for quality of life improvement personal programmes (Stewart and Ware, 1992)

In trying to understand how new technologies of big data for BI as well as government policies to 'open' healthcare data, a future trend is that of conceptualising BI as part of an *ecosystem* of data in which different actors, their values and interests intersect and mutually co-evolve and use latest technologies to both generate as well as access data (Chen et al, 2012; Harrison et al. 2012).   The following diagram follows Mettler and Virmalund (2009)'s framework and provides an overview of BI in the healthcare context. This framework can be discussed and enriched with actors as new technologies and policies affecting both healthcare/wellbeing contexts are formulated and implemented by governments.
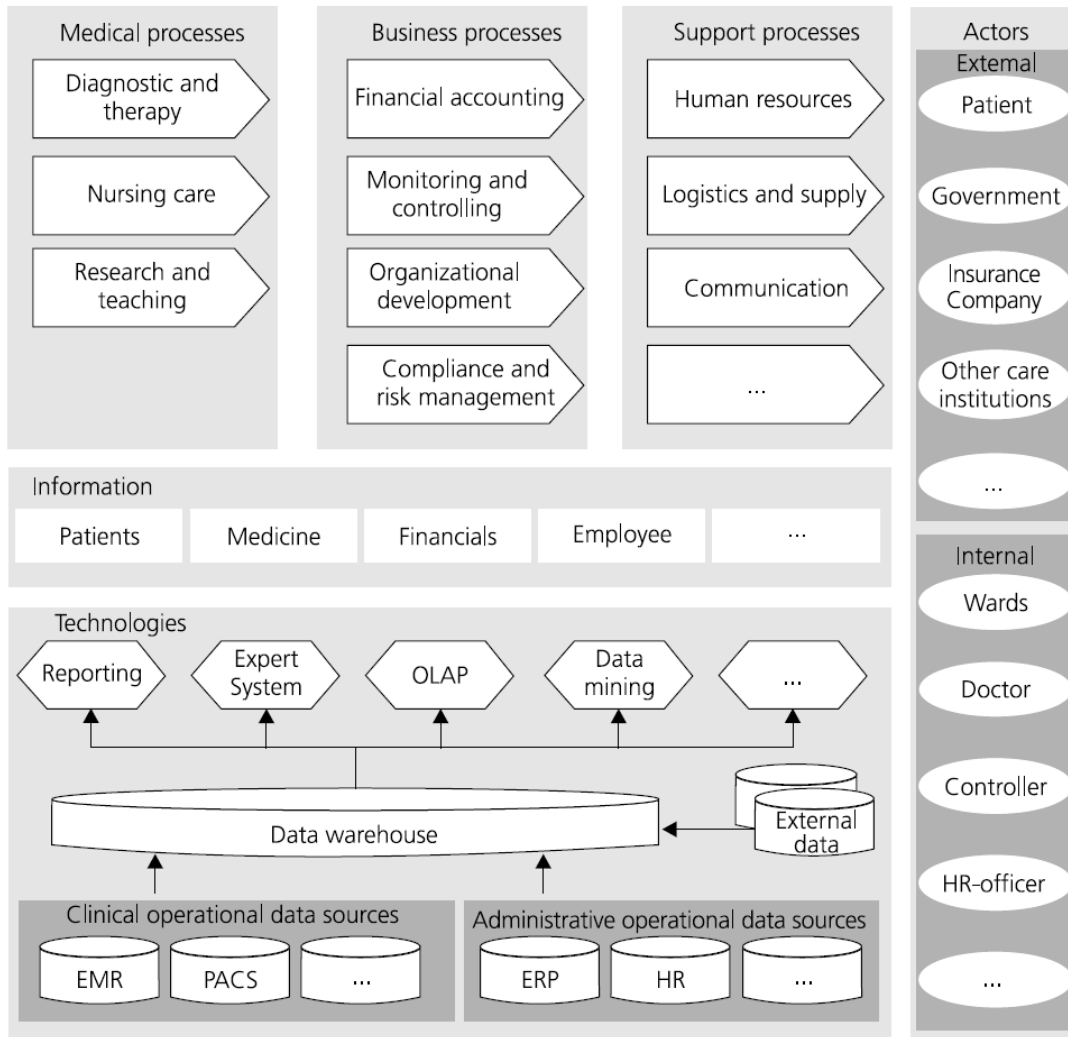
Figure 1. **A framework for Business Intelligence in Healthcare (and Wellbeing) (from Mettler and Virmalund, 2009).**

In the diagram, it can be seen that the main components include processes, actors, information technologies and data. Of particular importance is the *distinction between information and data*. Data are sets of raw measurements and facts which are collected from different sectors and from different actors involved (Stewart and Ware, 1992; Scott, 2012). In turn information is the representation of those facts and measurements through analysed reports or visualised graphs. Data are normally machine readable facts and the result of processing them will generate the information that is used by human actors in the system. The main sources of data include:

- Clinical data sources, which are required to provide and deliver healthcare/wellbeing services and products to patients. These are all medical data collected from patient records, laboratory results, treatment process and follow ups. With current policies in countries like the UK, billions of personal health records are being created, made anonymous and sold to third parties (i.e. market research companies) (Sunday Times, 2014).

- Administrative data, which are needed to run the healthcare business and organisation. These data are business data from organisational actors' personnel data, financial data and back office requirements.

- External data that includes external providers' clinical or administrative data such as statistical data, medical reports or insurance forms.

As the data comes from different sources and is used in various ways, in BI for healthcare what is also relevant to note is the diversity of actors involved. Unlike other industries, there are clinical and administrative actors. Each of these needs different access and reporting mechanisms. Furthermore BI solutions could –in principle offer data to a variety of users (actors) with diverse needs (e.g. patients, insurance companies, governmental authorities, doctors). These can be seen as customers whose behaviour and expectations differ from one to the other. Considering this diversity, BI solutions should also include some *soft metrics* to include patient's feelings and choices, as well as *hard metrics* that are required to monitor and evaluate the business performance of organisational actors (Avison and Young, 2007)

3.0   Meaningful use

Successful BI implementation in healthcare can be expensive and difficult. Achieving desired benefits is a slow process until benefits become apparent and perceived by different actors. A managerial and linear perspective on BI would suggest that its implementation should be gradual, in other words **'lineally oriented'**, and in each stage there should be clear objectives to achieve. In countries like the US, there are different

legislations to clarify different stages and objectives for each one (Blumenthal and Tavenner, 2010). These are:

- Creating and gathering information including the entry of basic data such as patients' vital signs, demographics, up-to-date list of problems and current diagnoses, current and active medications, allergies, tobacco status and weight screening (Blumenthal and Tavenner, 2010).

- Use of BI applications to 'discover patterns' and hence reveal the true potential of these systems to advance quality, efficiency and safety of care. With patterns, providers could have better access to patients' information for a better decision making as well as avoiding preventable errors (Blumenthal and Tavenner, 2010). For instance, there are BI examples that have supported large case-control of pancreatic cancer risks. Using BI, researchers have analylsed electronic records for symptomatic patients in primary care to identify and quantify the features of pancreatice cancer. (Stapley S., et al., 2012). Another example in this area is the discovery of patterns of cancer risk in patients with different hip replacements bearing surface types. The data that was used was the US General Practice Research Database which is part of the Clinical Practice Research Datalink (CPRD) and which collects computerised medical records from general practitioners (Lalmohamed A., et al., 2013).

- Patient empowerment. This is achieved by enabling patients to access their complete health records. BI systems also improve the personal healthcare that patients receive by performing different services such as: reminders for check-ups, patient-specific health education, prescription checks, integrated clinical laboratory results as well as supporting patients' transitions between care settings or personnel (Blumenthal and Tavenner, 2010).

All these stages involve the generation of quality reports. These reports could identify and assess health providers' performance and decision making, control medicine prescriptions as well as patients' satisfaction. These reports may eventually become public (Blumenthal and Tavenner, 2010).

4.0   Opening the data from BI

Current government policies in countries like the US and the UK encourage the opening up of healthcare data (Harrison et al, 2012). The idea is to generate an ecosystem in which data circulates through different actors and is recycled to fulfil a number of goals. There can be new technological innovations in the form of for instance software applications that use the data for the benefit of patients. In addition, patients can exert better accountability over their healthcare providers and use data to provide evidence and argue their case against government (Harrison et al, 2012; Gurstein, 2011). Finally, governments can assess the impact of their health policies in several areas as well as the quality of services provided by third parties.

The opening of data follows a general trend to open government to public accountability and facilitate citizens' engagement with new technologies like social media (Lee and Kwak, 2012). Within this trend, and similar to BI, the idea is to follow a **linear** process of development. Lee and Kwak (2012) show this process when they set out the following stages for open government: initial conditions (availability of data, Level 1), data transparency (making data accessible, Level 2), open participation (encouraging citizens' access, Level 3), open collaboration (data partnerships Level 4), and ubiquitous engagement (use of social media, Level 5).

BI '3.0' (including big data technologies as stated by Chen et al 2012) can follow a similar pattern and transform healthcare and wellbeing from being disease control based to patient centred. With the help of new applications that make use of sensor, mobile and social media technologies, more sophisticated health monitoring and analysis, health text analytics, health ontology definitions, patient network analysis as well as economic analysis can be performed (Chen et al, 2012). However, when it comes to 'opening up' the BI data of such analyses to users (patients), there are a number of issues which policies and initiatives will need to consider. The following issues are proposed to be considered in BI in health care/wellbeing initiatives as 'open' data:

- Data neutrality and contextualisation. According to Johnson (2013), "it is exceptionally easy for data scientists and users to accept current data practices and outcomes as natural or inevitable, and to make data use the only moral question of interest" (pp.2). Even the opening of people's data is not going to benefit them unless the assumptions and worldviews that led to the construction of such data are critically reviewed and discussed. This is the case for instance of marginalised communities or minorities whose data does not tell much about them (there is not much data that they were able to fill) (Gurstein, 2011; Johnson, 2013) and therefore any future initiative is not going to be of much help to them.

- Future use of data. This is one of the biggest concerns posed by the public. Although people are often promised that their own personal data is to be made anonymous and is to be managed by 'bona fide' experts (business intelligence analysts, health professionals and scientists among others), experience in countries like the US with the human genome data shows that once data is collected, aggregated and analysed, it can be sold to third parties which can then use it to produce commercial solutions (i.e. drugs). The case of the NHS in the UK (Sunday Times, 2014) shows that governments have already established bilateral partnerships which go contrary to the philosophy of open data, in which governments provide some guiding intentions for the use of data but then facilitate collaboration, co-operation and the achievement of public value through the work of different actors in open data initiatives (Harrison et al, 2012). Patients who want to opt out from this initiative have to fill forms and check on the process. An espoused rationale for building big data infrastructures based on citizens' trust can be eroded if data is used for commercial purposes (Dickenson, 2014; Sunday Times, 2014). This could affect negatively the future engagement of citizens in healthcare/wellbeing policies and initiatives.

- Ownership of data. The future management of large volumes of data requires important investments in resources as well as decisions on who is to own its preservation (Lynch, 2008). In countries like the UK, Universities seem to be

taking the lead in collecting and storing online data (Pritchard and Whiting, 2012). In other parts of the world, well-being BI initiatives are emerging. A long-term strategy to store and making data available to different actors should be defined alongside the design of BI initiatives.

- Accuracy of data. The experience of using human genome data shows that analysis of big data can produce different results. Analysis techniques are still unproven and increasingly being refined. If analysis data is available for direct public consumption there could be different answers provided to them with the risk of contradictory well-being decisions being made (Dickenson, 2014). In the context of BI for healthcare and wellbeing, the distinction between data and information is a key one if people are going to be provided with meaningful BI information.

- Transparency and accountability. The collection, gathering and analysis of data can become a public source of transparency and accountability of healthcare and wellbeing professionals. Information provided by BI initiatives can put into question the knowledge and expertise that is exhibited by these professionals, in particular if the aim of their organisations show transparency to the public via electronic data (Gabe et al. 2012). However, in achieving transparency and accountability it is important to promote **data literacy**. Gurstein (2011) makes a case for empowering the citizens rather than simply enabling them to access data. In particular when data is being summarised, it loses its context, in other words it loses its meaning and therefore meaning for citizens needs to be created. Data literacy needs to be encouraged, and in doing so the role of intermediaries is essential to both help citizens analyse the data as well as use it in a relevant context of application.

- Social media use for data collection. According to Lee and Kwak (2012), social media technologies can be a supporting platform to facilitate citizens' engagement. However, other actors from the BI 'ecosystem' (i.e. government)

could be gathering citizens' data without citizens being fully informed or being aware of it (Oboler et al, 2012). This is worrying, given that often citizens rely on their governments to protect them from invasion to their privacy by commercial actors. Open discussions about how data is to be used should inform future development of BI initiatives.

These and other issues are interconnected and require a holistic system of enquiry to address them, one which is critically constructive of the ecosystem one. Given their social, ethical and technical nature, they also signal the importance of adopting a less functionally oriented and linear approach in favour of a more ethical and human centred perspective to BI in the healthcare and wellbeing contexts. If this is the case, it becomes important to facilitate debate or dialogue about what / who should constitute relevant and legitimate aims, actors and potential effects of BI initiatives, in particular in relation to their potentially 'open' nature; the meaning of 'open for what' and 'open to whom' should be discussed. A possibility is to adopt a systems thinking approach to enable dialogue, participative and consultative design and evaluation of BI initiatives. Intending to take this further, future research stages will include studying further applications of BI in these contexts as well as exploring systems thinking methods and approaches to facilitate intervention and improvement of BI initiatives.

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