Defining Web 3.0: opportunities and challenges

Introduction

Many organisations define technology as a significant asset to generate income and control cost (Brynjolfsson and Hitt, 2000). The World Wide Web (henceforth referred to as the web), is recognised as the fastest growing publication medium of all time, containing well over one trillion URLs (Alpert and Hajaj, 2008). With an estimated growth rate of 566% in Internet usage in the last twelve years (Internet World Stats, 2012), the Internet has become the main source of communication worldwide. With ever increasing growth rates, the technology supporting the structure of the Internet is evolving at an even higher rate. The web, acting as an enabler for technological advancement, matures in its own respective way. Initially, there were the static informative characteristics of the early web, referred to as Web 1.0, which progressed into the more interactive experience of Web 2.0. The next phase of web evolution, Web 3.0, brings forth new opportunities and challenges. Web 3.0 will change the way people interact with devices and networks, and how companies use information to market and sell their products, and operate their businesses (Booz and Company, 2011). Organisations need to be ready and acquire knowledge about the opportunities and negative impacts arising from Web 3.0 technologies.

Research objective

The objective of this study is to define Web 3.0 and to discuss the underlying technologies; investigate the impact of Web 3.0, and its applications on business operations. In doing so, the study aims to identify opportunities and challenges arising from Web 3.0 technologies. The study proposes to provide knowledge to organisational leaders, managers, boards of directors, IT professionals, and information managers, rather than technical experts,

with regard to opportunities and negative impacts arising from the use of Web 3.0 and its applications. Thus, the study investigates the impact of Web 3.0 technologies on broad-based business operations which are applicable to most businesses and, therefore, does not focus on industry-specific operations. The research focuses on incremental opportunities and constraints specifically pertaining to Web 3.0, and not the negative impacts prevalent to Web 2.0, or other pre-existing negative impacts. It is not the purpose of this research to discuss the technologies underlying Web 3.0 in detail.

Research motivation

Web 3.0 calls for a complete reconstruction of the Internet and IT infrastructure. Organisations need to start preparing for the changes accompanying this technology before the third version of the web is fully realised, otherwise they may be unable to satisfy customer needs, capitalise on emerging trends, and seize new opportunities (Spencer, 2009). Before these changes in infrastructure are adopted, organisations need to fully understand the impact the technology will have on business operations.

Defining opportunities of Web 3.0 is difficult and needs to be investigated on an operational level to understand the impacts the technology will have on business drivers. On the whole, organisations believe that new technology will make positive contributions to their businesses, while fewer people consider the potential negative impacts (The Economist Intelligent Unit, 2013). Organisations need to consider both.

Methodology

A non-empirical study reviewing papers published in accredited research journals, articles, whitepapers, and websites was conducted. In order to accumulate knowledge, Webster and Watson (2002) argued that an effective review of historic and applicable literature needs to be performed. They criticised the Information System (IS) field for the lack of theoretical outlets due to the complex nature of assembling a literature review on interdisciplinary fields. In order to add scientific rigour to a literature review, a four stage approach as suggested by Sylvester *et al.* (2011) was employed. Each stage was repeated and performed interactively. The literature was selected within a timeline between 1996 and 2013, with the historic review updated for research conducted in 2014.

The first stage was to find articles. The initial search terms were intentionally selected to include a broader spectrum of results and included: *inter alia*, "*Web 3.0*", "*Semantic Web*", "*next generation web service*", "*Technologies driving Web 3.0*", "*impact of Web 3.0 on business processes*", and "*defining Web 3.0 technologies*". The search was enabled through the use of library books and different electronic databases, such as professional subscriptions, scholarly articles (Google Scholar), organisational whitepapers, and electronic journals, including IEEE, Gartner, Google Scholar, Elsevier, and Emerald. Due to the fact that a minimum of research has been completed on the subject, the reputational value of the articles was originally not taken into account during the selection. The search yielded a set of 110 articles and website entries.

The mapping stage was conducted next. During this stage, the original selection was narrowed down by selecting articles and readings that had a similar running theme. The similarities in the selection included the following recurring themes: *inter alia*, "*Web 3.0 and businesses*", "*negative impacts associated with Web 3.0 and Semantic Web*", "*opportunities and*

Web 3.0", "*impact of new technologies on business*", "*technologies supporting Web 3.0/Semantic Web*", and "*Web 3.0 and Semantic Web control*". This enabled the researcher to narrow down the original selection by reviewing extracts and summaries of the articles and readings. The original selection was thus reduced to 55 items.

Results were then appraised. An in-depth reading of the revised selection enabled the researcher to develop an understanding of the concept of Web 3.0 and underlying technologies, and to elaborate on the impact these technologies will have on business operations. The different concepts were annotated within the articles. The researcher compiled all annotations and generated his own conclusions through integrating, modifying, and generalising the main concepts found in the previous three stages into a single flowing document during the synthesis stage. The stages described above enabled the researcher to obtain a better understanding of Web 3.0; its impact on business operations; and new business opportunities and negative impacts accompanying Web 3.0. In order to address the research problem, the research will first define Web 3.0 as part of the literature review. A formal definition is needed to categorise the new technologies within Web 3.0. Thereafter, the impact Web 3.0 technologies will have on existing business operations is identified. The influence on business operations will give rise to new opportunities but also negative impacts. Some conclusions are provided.

Literature review

Web 3.0 is the latest evolution in Internet communication and will not only restructure Internet communication, but will also have a significant impact on crucial business drivers. Web 3.0 will rise to new business drivers and will also redefine existing drivers. The exact

interpretation of what Web 3.0 technologies entails and how it will influence the Web experience is not clear (Knublauch *et al.*, 2004).

Historic review

Historical research on the evolution of the web shows that the Internet goes through similar phases. Initial research on the web focused on defining the technology, understanding its benefits, and how it will have an impact on business environments regarding opportunities and challenges (O'Reilly, 2009). Research inquiring about user behaviour and privacy issues (Lawler and Molluzzo, 2010; Gogolin *et al.*, 2014) focusing on knowledge of personal information gathering and sharing techniques on web technologies has also been undertaken. As the web evolved and the technologies surrounding it became more popular, the focus shifted to security, especially focusing on negative impacts on business operations (Grossman, 2007; Websense, 2009).

The majority of research completed on Web 3.0 was performed by independent private organisations such as Booz and Company, Verizon, Gartner, Clearswift, and SEM Logic. Most of the research consists of whitepapers and articles with few academic peer-reviewed articles (Garrigos-Simon *et al*., 2012). Most of the articles aimed to define Web 3.0, and rarely address advantages and disadvantages arising from the use of Web 3.0 technologies. Later research into web evolution conducted by Benjamins *et al.* (2002) focused on preliminary definitions and predictions of the challenges arising from the use of Web 3.0 technologies. Related research by Lu *et al.* (2002) investigated possible opportunities and complications Web 3.0 might offer, and how an enterprise could gain business value from using these applications. More recent research has been conducted and is highlighted in the sections to come. The biggest shortcomings in the research were that it was conducted during the starting phases of web; alternatively, the research

focused on a specific element of Web 3.0 and selected underlying technological components (Kisimov, 2012). A comprehensive academic study that focuses on defining Web 3.0 and identifying the challenges and opportunities arising from the use of this technology has not been conducted. In recent times, the focus has shifted to industry-specific research on the application of Web 3.0 technology. The two largest areas of uptake of Web 3.0 include *inter alia* e-learning (Hussain, 2013; Wade *et al.*, 2013; Isaias *et al*., 2014), marketing (Garrigos-Simon *et al.*, 2012), and information management (Szeredi *et al.*, 2014).To understand the evolution of the web and what impact it will have on organisations, it helps to define the various stages of the web.

Definitions

Web 3.0 is a new concept in the domain of web evolution. Defining it will assist in classifying new and developing web technologies into the correct evolutionary genre, being Web 1.0, Web 2.0, and Web 3.0. A robust definition will also assist in distinguishing between pre-existing and new negative impacts and opportunities that arises.

Web 1.0

Web 1.0 was a platform through which information could be published in a static form, well designed with text and images. It portrayed an environment where information and data were static, and displayed with no interaction between the information and the consumer, and minimal content creators, also known as the read-only web (Rudman, 2010).

Web 2.0

O'Reilly Media first introduced the term Web 2.0 in October 2004. The consensus was that Web 2.0 was not a new development of the web, but rather an extension of the original ideals, principles, and underlying infrastructure of Web 1.0 (Anderson, 2007). In an effort to

clarify the paradigm shift, Getting (2007) described it as the greater collaboration between consumers, programmers, service providers, and organisations, which enabled them to re-use and contribute information, thereby enriching the content distributed between the collaborative parties on the web. Rudman (2010) summarised the key features of Web 2.0 sites into three components:

- Community and social: The ability of a consumer to view, create, edit, and share content by means of the web.
- Technology and architecture: Software and applications with multiple device and platform compatibility.
- Business and process: Cloud technologies, software, and resources made available on a network.

Web 3.0

Internet content is becoming more diverse with the volume of data increasing, which makes management of information more critical (Bergman, 2001). The web is becoming a platform for linked data. Data is becoming more openly available to consumers, and by making connection between similar data characteristics, the data itself becomes more valuable (Tarrant *et al.*, 2011). The web is overrun with exabytes of data, and computers still cannot automate the function of harvesting this information, or of performing complex tasks with it. The need for data structuring and integration is crucial to enable the web to evolve into its next phase. Even though Web 3.0 will be the next generation of the web, its definition varies (Farah, 2012). A variation in names is also apparent and the names include, amongst others, Web 3.0, the Semantic Web, the Transcendent Web, and the Web of Things – henceforth referred to solely as Web 3.0.

Wolfram (2010) stated that Web 3.0 is where the computer, rather than humans, generates new information. This is supported by Morris' (2011) theory that integration of data is the basic foundation of Web 3.0, and by using metadata (data within data that provides information about a data content) embedded in websites, data can be converted into useful information, and be located, evaluated, stored, or delivered by intelligent agents (IAs). IAs are software programs designed to collect information based on the users' interaction with the web and perform tasks on behalf of the user. In order for IAs to understand the information gathered, expressive languages that describe information in forms understandable by machines need to be developed (Lu *et al.*, 2002). With the development of expressive languages (such as Ontology Web Language, OWL), Web 3.0 has the capability to use unstructured information on the web more intelligently by formulating meaning from the context in which the information is published (Verizon, n.d.). Booz and Company (2011) stated that recommendation engines will focus on the habits and preferences of users and, in doing so, will produce more complete and targeted information. The information of habits and preferences used on a recommendation engine will be collected and stored in a hierarchical manner by IAs. This is what will give Web 3.0 the ability to gather, analyse, and distribute data which can be turned into information, knowledge, and, ultimately, wisdom (Evans, 2011). The key elements of Web 3.0 present in all the observations are (Verizon, n.d.):

- The **introduction of new programming languages** with the ability to categorise and manipulate data in order to enable machines to understand data and the phrases describing data.
- The capability of **obtaining contextual information** from a web search and storing it in a hierarchical manner, according to similar characteristics, for easy and specific retrieval.

- The ability to obtain information from a **bigger and wider variety of sources**, including previously walled applications.
- The **ability to create and share all types of data** over all types of networks by all types of devices and machines.

Web 3.0 will ultimately entail an integrated web experience where the machine will be able to understand and catalogue data in a manner similar to a human. The data collected will be categorised in a hierarchical manner in order to link data with similar characteristics and retrieve consumer-specific data effectively and efficiently. This will facilitate a worldwide data warehouse where any format of data can be shared and understood by any device over any network. The literature will assist in gaining insight that will be used to attempt to identify new advantages and negative impacts that might arise from the use of Web 3.0 technologies.

Findings

In order to assess the impact Web 3.0 technologies will have on business operations, the first step will be to define the different technologies associated with Web 3.0. The technologies defined will offer specific opportunities for an organisation and will also be considered when evaluating the negative impacts.

Defining technologies associated with Web 3.0

According to Berners-Lee *et al.* (2001), Web 3.0 will rely on a variety of different technologies, some of which still need to be created, while others are already being implemented on the web as we know it. In order to obtain a better understanding of what Web 3.0 consists of and how it functions, one needs to be familiar with specific terminology and understand how they interact (Figure 1).

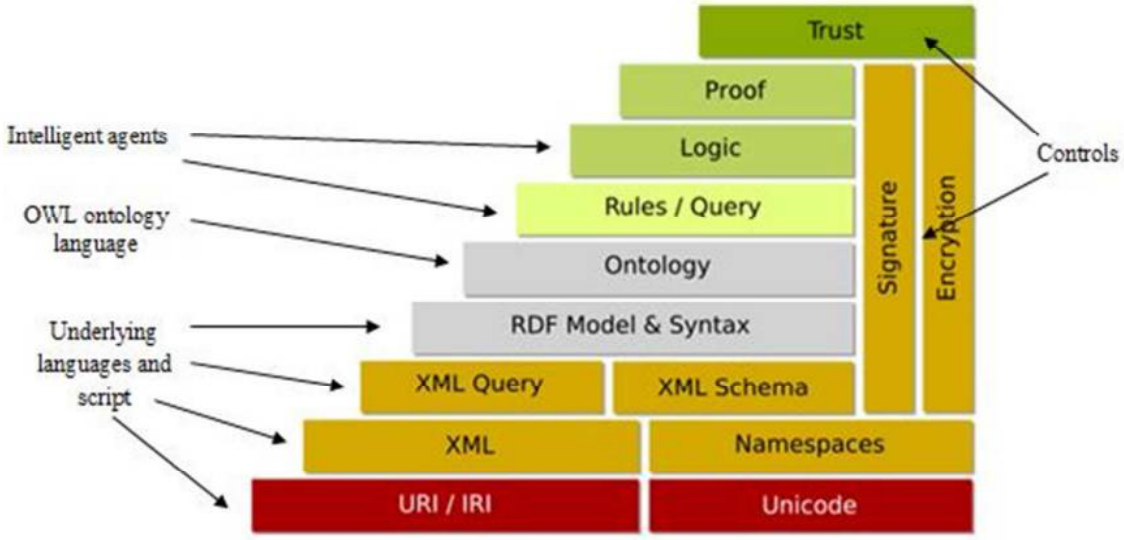

Figure 1. The technological layout of Web 3.0 (Shapovalenko, 2008)

The technology can be categorised into three subsections:

Section 1: identifiers

- **Uniform Resource Identifiers** (URI) identifies the name and location of a file or resource in a uniform format. URIs provide a standard way for resources to be accessed by other computers.
- **Uniform Resource Locator** (URL) is the address of a specific website or file on the Internet.

Section 2: Structures

- **Metadata** is a term used to describe data within data. It provides information about a certain item's content.
- **Resource Description Framework (RDF)** is a mechanism through which information about data is captured. It is a specification that defines how metadata, or descriptive information, should be formatted. It acts as a mechanism for web page writers to add semantic information to their web pages. RDF creates statements about particular resources

on the web by means of a triple expression in the form of subject-predicate-object. The subject represents the resource, while the predicate refers to an attribute of the subject, and the object is what is referred to in the predicate. This structure is the natural way to describe the vast majority of the data processed by machines (Berners-Lee *et al*., 2001; Decker *et al.*, 2000). RDF uses URI to specify subjects and predicates. After the information has been identified, the resource is located using a URL. It is clear that XML has the ability to query information in a document, while RDF has the ability to extract the "meaning" of information in a document, and query will be essential in the development of Web 3.0 (Berners-Lee, 1998).

- **Resource Description Framework Schema (RDFS)** is a set of classes with certain properties using the RDF extensible knowledge representation language, providing basic elements for the description of ontologies, otherwise called RDF vocabularies, intended to structure RDF resources. It has the ability to describe and collect a wider range of properties and relate the RDF classes and properties into taxonomies using the RDFS vocabulary.
- **Intelligent agents (IAs)** are specialised computer architecture and programming (Lewis, 2008) designed to collect information without human interaction. They can also act on behalf of the user to perform certain tasks and duties depending on the authorisation level granted to the IA by the user. The ability which OWL technologies provide to IAs will enable them to create meaningful reasoning about information on the web, which will equip IAs with knowledge about data, and increase their intelligence and mobility. IAs will be able to fulfil their assignments autonomously and precisely by migrating from one site to another, carrying their codes, data, running states, and intelligence (Lu *et al.*, 2002). IAs will act as electronic assistants by automating repetitive tasks, intelligently harvesting and summarising

complex data, and being able to learn on behalf of the user by analysing the users' interaction with the web. The information gathered from this analysis will give an agent the ability to make recommendations to the user (Gilbert, 1997) and respond to changes in its environment in a timely manner. IAs are customised or adaptive beings, able to learn from previous experience and adapt to perform their purpose in a more efficient manner. IAs are able to communicate, share and harvest intelligence from other IAs and across different machines and devices.

Section 3: Languages

- **Extensible Mark-up Language (XML)** is used to define documents with a standard format that can be read by any XML compatible application. The language can be used with HTML pages, but XML itself is not a mark-up language. Instead, it is a "meta-language" that can be used to create mark-up languages for specific applications. It allows everyone to create pieces of information, also known as tags or hidden labels that are used to describe certain parts of a website or sections of text. XML does not, however, explain what the tags are used for, which makes it hard for the script writers to use this information (Berners-Lee *et al.*, 2001). Unicode is an extensive way of defining characters electronically to ensure internationalisation of applications. It is based on similar principles as ASCII code and is used by XML to describe characters.
- **Simple Object Access Protocol (SOAP)** is a simple XML-based protocol that enables communication between different applications. Current web applications run secure protocols, though HTTP was not designed to bypass firewalls, which lessen interoperability of new applications. SOAP uses both XML and HTTP to communicate between applications and bypass firewalls.

- **Structured Query Language and Simple protocol and RDF Query Language (SPARQL)** is an RDF query language for databases, able to retrieve and manipulate data stored in RDF format. Structured Query Language (SQL) is a mechanism that enables communication with a database. It is the standard language for relational database management and has the ability to perform tasks, such as retrieving data from a database or updating a database. Due to the complexity of data storage within RDF, SPARQL was created. SPARQL has the ability to make RDF data available through a standard interface and query it, using SQL (Quilitz and Leser, 2008). According to Sowa (2009), ontology is the study of the categories of things that exist or may exist and describes their relationships in a certain domain. For the web, ontology is about extracting descriptions of web information and understanding relationships between web information.
- **Ontology Web Language (OWL)** is a mark-up language that enables a machine to process information contents on the web in a universal manner. OWL was created to give machines, instead of humans, the ability to process and read information on the web. OWL has a lot of characteristics similar to those of RDF, but is much stronger with greater machine interpretability, a larger vocabulary, and a stronger syntax. OWL will enable a web where information is categorised by machines in a meaningful manner and in a universal format that can be queried by any other script (Horrocks, 2004). OWL-S is an extended version of OWL, based on the same principles and annotation processes, but has a greater ability with respect to expressive properties, extends support for data types, enables meta-modelling, and extends annotation (Golbreich and Wallace, 2012).

The technologies discussed will form the core operatives to enable Web 3.0, and mainly consist of scripts and programming codes/languages. The required infrastructure, usage, data, and information are already available on the Web 2.0 platform, but these technologies will enable machines to better exploit the rich content available.

Opportunities and possible uses for Web 3.0

Introduction

By combining the technologies discussed, the web has the potential to become the location of every possible information resource, person, and organisation, and all the activities relating thereto (Sheth and Meersman, 2002). Through Web 3.0 and IAs with the ability to categorise and add meaning to information, processes will become more automated, producing information much faster and more precisely, at an improved level of access which will bring forth new opportunities (Bakshi and Karger, 2005).

Web services

Web services, in this context, refer to websites which not only provide static information and allow the user to interact and contribute information, but also have the ability to create new web services based on user preferences. Lu *et al*. (2002) stated that the realisation of autonomous web services will only occur once the following stages of automatic web services have been developed:

- **Automatic web service discovery** describes the ability to obtain information on web services. The ability provided by Web 3.0 to register semantic descriptions of web services on a universal repository will enable IA to harvest these descriptions and migrate between different repositories to find the desirable web service specified by the user.

- **Automatic web service invocation** implies that an IA will be able to perform basic tasks on behalf of the user depending on the parameters set for the agent. According to Hess and Kushmerick (2003), automatic Web service invocation will only be capable when each web service is described by semantic metadata which is available in a machine readable format.
- **Automatic web service composition and interoperation.** OWL technologies will provide a complex library of web services with high-level descriptions of objectives. Web service software can be written to manipulate these libraries and, together with highly specified objectives, enable automatic creation of new web services in order to achieve the objectives.

Agent-based information harvesting and distribution

Agent-based distributed computing refers to the shift in the computing paradigm from information distributed through a client/server initiative, to information harvested and distributed autonomously by IAs. According to Lange and Oshima (1999), the following advantages will be associated with the agent-based computing paradigm:

- **Reduction in network load.** IAs will allow users to package data or information and send it via the network to the host. The interaction needed to accomplish the task will be done on the host' system and not over the network, as is the case with most distributed systems.
- **Overcomes network latency.** In manufacturing processes where latency on the system is unacceptable, and machines have to adapt in real time to changes in their environment, IAs will be crucial to facilitating this.
- **Dynamic adaption.** IAs can adapt autonomously to changes in their environment. In doing so, they keep updating their configurations in order to solve this specific problem.
- **Heterogeneous characteristics.** IAs are independent of computer and transport layers, and this enables continuous system integration.

- **Robust and fault tolerant systems.** When a host within a distributed system shuts down, the agents executing on this system will be warned in advance and will have sufficient time to migrate to other hosts, which will ensure a robust system.

Search engine capabilities

Traditional search engines lack coherence in two major areas: namely, the reliability of the resources and the relevancy of the information found by the search engine. The problem occurs because documents and information are linked via hyperlinks which are easily understood by humans, but not by machines (Shaikh *et al.*, 2010). Natural language processing and Web 3.0 technologies will enable a search engine to organise information based on the context within the document and not just by the recognition of phrases.

Web 3.0 technologies will contribute to the creation of an intelligent search engine through the use of XML metadata tags and queried information will be searched. The metadata gathered by XML will then be extracted into RDF format. This will form the database from which information will be extracted. To make sure that data within this database remains relevant, the power of ontologies, such as OWL, will be implemented. The data will be queried and retrieved by the use of SPARQL (Shaikh *et al.*, 2010). By utilising the different Web 3.0 technologies, semantic interoperability can be achieved by ontologies, while XML and RDF ensure machine comprehension.

Semantic search engine enabled by Web 3.0 technologies might result in:

- **Increased re-usability of information.** According to Bürger (2008), the re-use of information will lead to significant improvements in the manner content is created and the adaptability of content on the web. This will, in effect, increase the quality and consistency of information and reduce the cost of creating, maintaining, and altering the information.

- **Advanced co-operation and expert findings.** Search engines will be able to resort to ontologies, to not just reason with queries, but also to collect prior knowledge from resources supplemented by users. Users will be able to query information by using natural language. The query will be translated into its semantic representation which will enable the engine to search semantic resources that match this query. Increased co-operation between wider ranges of resources will eliminate ambiguity and will increase relevancy and precision of search results (Melo *et al.*, 2012).
- **Knowledge exchange and time saving.** Machines will be able to convert large amounts of data into useful information at a much greater speed. The information harvested by machines will then be queried by users which will turn the information into knowledge, which will be available and has the ability to be shared between all machines and users on the web.

Business intelligence

Business intelligence (BI), or big data as described by Herschel and Jones (2005), includes all types of technologies which enable organisations to collect and analyse raw data and convert it into useful information in order to improve decision making. With the exponential growth in the availability of electronic data, the analysing of vast amounts of electronic data and the complexity thereof became problematic. Information extraction through natural language processing tools will be vital in order to be able to use the massive amounts of semantic information (Horacio *et al.*, 2007). Web 3.0 technologies, such as OWL, will enable a platform by which web resources will be representative in a heterogeneous manner. Ontology will act as the unified structure by which information and the underlying semantics are represented universally (Davies *et al.*, 2002). With the combination of metadata and ontology languages, the

web will be able to offer a more qualitative service in collecting business intelligence. Web 3.0 will give rise to the following benefits associated with the implementation of BI:

- **Reduced cost of IT infrastructure**. Cost will be reduced by eliminating investment-intense data warehouses and redundant extraction processes performed by hired personnel with domain expertise (Watson and Wixom, 2007).
- **Opportunity to increase effectiveness of e-commerce,** in particular the ability to track the users' browsing behaviour down to individual mouse clicks. Web 3.0 technologies will enable organisations to apply targeted marketing, creating a web environment where consumers receive personalised advertisements while browsing the web.
- **Time saving for data suppliers and users, and the reduction of information bottlenecks** by enabling users to extract reports when they need it without specialised support from IT or financial personnel. Ontologies will enable users to extract new reports that match their exact requirements.
- **Timely and informed decision making.** Extraction of data by machines from multiple sources with far greater efficiency and precision will support organisations in making better decisions (Watson and Wixom, 2007). Furthermore, IAs can be programmed and deployed to harvest information autonomously based on rules set by the user.

Knowledge management

Knowledge management focuses on the extraction of contextual information and rationalisation thereof through the experience and thought process of the specific end user. Knowledge management is the creation of new information based on the user's experience and understanding of specific information. This enables an organisation to gain a competitive

advantage by analysing its own experience. Knowledge management entails different tools, techniques, and processes to manage organisational knowledge and intellectual assets.

The major pitfalls associated with the implementation of efficient knowledge management systems are that organisations fail to align the system with its strategic objectives, create repositories without managing the content, and harvesting of relevant information from a variety of resources. Web 3.0 technologies will enable organisations to deploy IAs with specific parameters to perform this task. Ontologies will enable machines to structure relevant data into machine-understandable information which can be extracted by IAs. The process of knowledge management will be mainly automated and this will increase the amount and accuracy of the data that can be processed into knowledge. The following key benefits are associated with efficient knowledge management:

- **Reduced research time**. Web 3.0 technologies will enable organisations to automate the process of querying information from a multitude of sources by assigning it to IAs. With technologies like OWL, agents will have the ability to extract information from a vast array of sources that will be relevant to the specified query and, by doing so, reduce research time and cost. Furthermore, IAs will be able to store the queried results, which will enable instant recalling of specific queries.
- **Business benefits.** With effective knowledge management techniques, organisations can benefit from improved management which will contribute to organisational success, such as increased productivity, sales growth, cost reduction, improved employee development and retention, improved customer satisfaction, and expansion of social and intellectual capital with external stakeholders (Edvardsson and Durst, 2012).

eLearning and research

According to Sampson *et al.* (2004), Web 3.0 applications will enable the creation of hypermedia systems. These hypermedia systems are portrayed as silos of information with the ability to adapt to the changes in their environment. The ability for a database to adapt is a crucial factor in the area of eLearning, especially taking into account the different needs of learners to propose learning goals and learning paths, help students to orientate themselves in eLearning systems, and support them during the learning progress.

Ghalebi *et al*. (2006) believed that, with the introduction of an eLearning framework with the inclusion of ontology-based properties and hierarchical semantic associations, the possibility of creating an eLearning system with the capabilities of adapting and intelligently supporting learners is inevitable. Introducing IAs into this scenario will further enrich information created and shared by learners, and will in its universal format be integrated with homogeneous information and redistributed throughout the web. According to Koper (2004), the following benefits can be expected:

- The delivery of a time- and cost-effective, web-based curriculum with incorporated multimedia, intractability, and the ability to **adapt to the learner's specific characteristics**.
- The **presentation** of courses by a variety of authors **can be preserved**. These teaching patterns can then be shared between different authors and effective learning and teaching patterns can be created and adapted for different learning scenarios.
- Reduction in **time and cost** to develop new Learning Management Systems.

- Better and more **relevant research** can be performed on effective learning designs due to the semantic structure of courses, and the ability to autonomously compare a variety of resources with ease.

Inbound marketing

With traditional marketing, organisations tend to blindly market their product to all customers, even if they have no interest in the product, known as outbound marketing. With the growth of the Internet economy, this method is becoming obsolete, while inbound marketing is emerging. According to Prescott (2012), inbound marketing involves the distribution of information to consumers who value the information building confidence and trust between the consumer and the company. The method of advertisement is mainly in electronic format and consists of a wide range of content marketing, including blogs, videos, e-books, e-newsletters, whitepapers, and social media marketing. The main objective of inbound marketing is to target specific consumers based on their semantically-related market segments, even if they are unaware of the product. Semantic information extracted by Web 3.0 technologies can be used to target specific market segments and build an electronic relationship with consumers by personalising their economical browsing experience. The following benefits can be expected:

- **Brand awareness and credibility.** The more mediums – social networks, blogs, videos – through which brands are advertised the bigger the opportunity to reach consumers. While hits accumulate, the position on search engine lists increase. High rankings on a Google search list will subconsciously increase consumer trust which will increase brand credibility.
- **Cost reduction benefits.** Leads from inbound sources cost between 50 to 60% less than leads from outbound sources. The main reasons for this are cutting costs spent on third party marketing by using the resources available on the web instead.

- **Increased quality of leads.** The quality and sales ratio of the consumers that visit a website is much higher, due to the fact that consumers looking for a specific solution are provided with effective, informative, and relevant information they are looking for (Optify, 2013).

The main theme present throughout this section is the ability of Web 3.0 technologies to autonomously harvest data from the web and reason with data in a meaningful way. Machines adopting human-like characteristics with the ability to collect and distribute data at a relatively far greater speed and accuracy will create an opportunity for consumers to utilise the full capabilities of the web.

Negative impacts associated with Web 3.0

Introduction

Autonomous machine communication, harvesting of data, and creation of information present serious negative impacts that need consideration when evaluating Web 3.0 technologies. Rudman (2010) explained that the negative impacts associated with the different stages of web evolution are incremental. Some of these homogeneous vulnerabilities are:

- Unauthentic electronic intrusion
- Unwanted application performance due to continuous updates
- Over-reliance on services offered by third parties, or only relying on server-side security
- The loss of confidential and personal information due to malicious attacks
- Unproductive use of organisational resources
- Non-compliance with regulatory governance and the possibility of loss due to legal action
- Shortage in experienced technicians to ensure effective operation and monitoring of complicated systems and applications

The next part of the paper explains the negative impacts specifically associated with Web 3.0 technologies.

Unauthorised access to sensitive information

The ability of Web 3.0 technologies to personalise web use, and of IAs to harvest browsing history and personal information in order to automate the web experience, will bring forth a new level of privacy concerns. In order for the vision of Web 3.0 to be successfully automated, protocols need to be deployed within Web 3.0 technology in order to address security, privacy, and unauthorised modification issues (Kagal *et al.*, 2003; Nematzadeh and Pournajaf, 2008). Kumar *et al*. (2010) divided unauthorised access and data manipulation into four categories:

- **Unauthorised access**. The intrusion and capturing of sensitive information on a system by an entity without authentication. Authorisation vulnerabilities associated with Web 3.0 technologies are when no authentication whatsoever is being used or when password authentication is present, but it gets passed in plain text format through SOAP headers. Another threat is when basic authentication is being implemented, but the data is transferred over unencrypted channels or when the system accepts default passwords.
- **Parameter manipulation.** This refers to the tampering with data while it is being transferred over a network. The vulnerabilities which exist on systems are data packages that are not digitally signed or encrypted to provide privacy and tamper proofing before being transferred over a network.
- **Network eavesdropping.** This is usually accomplished by using monitoring software to obtain privileged information contained in SOAP headers. The main system vulnerabilities

include minimal encryptions on both message and transport levels and credential data stored in plain text in SOAP headers.

- **Message relay.** This type of attack enables an unauthorised person to intercept data sent over a network and relay it back to the publisher. Generally the attacker will change crucial information in the message, such as the delivery address, and then relay it back to the publisher. Vulnerabilities in a system include messages without ID numbers to ensure that duplicate messages are prevented, unencrypted messages, and messages that are not digitally signed.

Unauthorised access to confidential information has been a predominant negative impact since the development of Web 1.0. With the integration and personalisation capabilities of Web 3.0 technologies, the negative impact of unauthorised access will increase exponentially.

Hyper-targeted spam

Hayati *et al*. (2010) defined spam as the unsolicited distribution of large amounts of content to consumers without their consent. They elaborated that spam has the ability to carry infected scripts, such as malware, adware, and viruses, which can be distributed in many formats including e-mail, instant messaging, web pages, and Internet Telephony. According to Hasnain *et al.* (2012), the ultimate goal of spammers to distribute unsolicited content over networks will not be affected by the new Web 3.0 technologies, but the method of distribution and the intensity thereof will. Hasnain *et al*. (2012) and Ferrel (2008) described the methods of exploitation as follows:

- **Application pollution.** Applications running within Web 3.0 will use the entire web's resources as a database. This creates an opportunity for spammers to infect a universal

resource that acts as a specific database for a specific application. With the infection of an application's database, spam can be distributed directly inside the running application.

- **Improved ranking.** Web 3.0 technologies will empower search engine capabilities which will create an opportunity for spammers to manipulate the ranking of malicious resources by creating triples containing malicious literal values that will be able to influence term-based metrics. Complicated algorithms in co-operation with linked data are used to calculate the rank of a resource. Spammers will also attempt to exploit these algorithms by creating fake external links to resources in order to improve the resource rank.
- **Hiding.** Web 3.0 will be based on open source which will enable IAs to automatically harvest information about anti-spam software and will empower spammers to improve their method of hiding malicious content from anti-spam software.
- **Personalisation of web content** will enable spammers to gather more private and precise information about users in organisations and attack them in ways that will make differentiation from legitimate communication increasingly difficult.

Identity theft and social phishing

Phishing is a socially engineered crime through which confidential information is harvested by an unauthorised party impersonating a trusted third party (Whittaker *et al.*, 2010). A similar threat is identity theft which is the process of harvesting personal information with fraudulent intent by means of exploiting information available on electronic communications mediums (Lynch, 2005).

The main threat is the ability of script writers to exploit sensitive information distributed in metadata, described by machine understandable ontologies, and harvested autonomously by IAs. Farkas and Hunhs (2002) supported this assertion by describing an incremental threat of

inference attack which is a form of intense data mining where confidential information is harvested and disclosed by integrating non-sensitive data with metadata. With the increased integration of metadata, consumers will lose track of sensitive data available on the web and where it is stored, and this will lead to an increase in the precision and volume of inference attacks.

Autonomous initiation of instructions and malicious script injections

Web 3.0 technologies are based on different levels of languages, each with its own individual characteristics. The most common attack on web languages takes place in the subset of Query/Update languages (Orduña *et al.*, 2010). The most widely used query language in the development of Web 3.0 technologies is SPARQL. Orduña *et al*. (2010) introduced three new types of query injections:

- **SPARQL injections** are a technique used by malicious attackers to take advantage of vulnerabilities occurring in web applications by gaining unauthorised access to the back end layer of a database by passing non-validated SPARQL commands through a web application (Su and Wasserman, 2006). Attackers manipulate the execution of web application commands by structuring specific queries that enable them to harvest sensitive information within the applications' database.
- **Blind SPARQL injections.** Through blind SPARQL injections, the attacker queries the database and receives Boolean results. By querying the database repeatedly, the attacker can harvest sensitive information through true and false error messages provided by the database (Hotchkies, 2004).
- **SPARUL injections.** SPARUL is the updated version of SPARQL and allows, not only reading query abilities, but writing as well. This creates a new threat for manipulations and

extraction of data from a database, since the entire ontology can be modified through queries.

Development of ontologies

Ontologies, being the carriers of meaning of information available on the web, will need to be developed to be able to interpret unified meanings of information in order to integrate information gathered from a variety of sources. An adequate infrastructure needs to be set in place to support ontology development; mapping; annotations referring to them, control over adjustments, and creation of new ontologies.

Benjamins *et al.* (2002) explained that the major concerns that need to be addressed are the creation of kernel ontologies which will act as a unified top level dictionary. The ontologies development process will also need the necessary methodological and technological support and configuration management in order to control the creation of different versions of ontologies, and to manage the association between the ontologies and annotations.

The creation of a new technology, including ontologies, also poses the threat of exploitation due to inefficient knowledge of the subject. Like any technology in the beginning of its development phase, script writers will try to take advantage of vulnerabilities prompted by inexperience with the technology.

Proof and trust standardisation

Due to the ability of Web 3.0 technologies to autonomously harvest and integrate data and convert it into information, all statements on Web 3.0 need to be considered as claims before they can be trusted (Gil and Artz, 2007). Only when these claims have been established, should trust be put in the information provided. In order to be able to trust harvested information, the

source of the information, as well as the policies available on the source, needs to be obtained and analysed (Medić and Golubović, 2010).

IAs can use both the context and reputation of sources to determine the level of trust that can be put in a source (Gil and Artz, 2007). IAs will be able to communicate among themselves without human interaction to determine if a source can be trusted. This creates an opportunity for malicious attackers to write scripts which impersonate a trustworthy agent and enable them to perform unauthorised actions or inject harmful scripts.

Web 3.0 technologies will rely heavily on semantic tagging. Script writers can manipulate semantic tagging by providing inaccurate information and, by doing so, improve their web site ranking.

Internationalisation

New technologies arising from Web 3.0 will be affected by the negative impact of multilingualism. According to Benjamins *et al*. (2002), multilingualism will affect some of the following areas:

- **Ontologies** will be one of the cornerstones of Web 3.0 and developers will need to develop ontologies in their native language.
- **Annotation** and the description of content will be a bigger challenge since most of the web community will take part in annotating its specific content. These annotations will have to be in detail and precise in order for Web 3.0 to realise. Consumers will only be able to become contributors if proper support is created to enable them to annotate in their native language.

Many of the negative impacts identified in this section were prevalent in Web 2.0, but due to the addition of new technologies with original and unknown structures, additional negative impacts will arise.

Conclusion

Modern organisations operate in a highly technological environment where technology plays a vital part in accomplishing the objectives set by organisational management. The methods by which the underlying technologies support the organisational goals evolve continuously and rapidly. With the adoption of new technologies, developers and consumers – including organisational management – tend to focus on the benefits and ignore the negative impacts associated with the implementation of these technologies. When evaluating the impact of Web 3.0 technologies, it should not be treated as a separate or isolated technology, but rather a compilation of already existing principles amalgamated with new programs and scripts. These new technologies create an array of new opportunities:

- Overall increased collaboration between consumers, developers, and machines.
- Autonomous characteristics of Web 3.0 technologies will lighten the work load of data management and enable new, intuitive, and personalised web services.
- Web 3.0 technologies' ability to integrate and structure data autonomously will increase the accuracy and availability of searching data repositories.
- IAs harvesting personal habits and information of consumers will create a personalised web experience which will amount to countless opportunities for inbound marketing schemes.

The underlying technologies creating the opportunities are accompanied by negative impacts specifically linked to these technologies. The main negative impacts are as follows:

- Unauthorised access to sensitive data or data manipulation by unauthorised persons.
- New and more complicated electronic attacks, such as SQL injections, malware, hyper targeted spam, and Internet ranking manipulation.
- Personalisation of web content creates a situation where personal and sensitive data will be more widely available on the web, thus creating an increased negative impact of identity theft and social phishing.
- The development and standardisation of new web ontologies and languages increase the probability of releasing inferior or easily targeted software and applications due to a lack of knowledge and insufficient testing for negative impacts associated with the technology.

The research shows that it is crucial for organisations to understand the underlying infrastructure of new technologies and the opportunities they present. After obtaining a proper understanding of Web 3.0 technologies, organisations need to identify the negative impacts associated with the implementing of these technologies.

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