EFFECTIVE WEB DEVELOPMENT THROUGH QUALITY OF INFORMATION THEREBY INCREASING ITS AGILITY

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ABSTRACT: *The emergence of the Internet has had a huge impact on individuals and businesses as is the case with many great web-based information systems that we see today offer convenience, efficiency, better service and savings. Developing one can be a challenging undertaking considering the nature of the web, its unique characteristics, requirements and factors. Hence, without suitable methodology, the entire web-based development would fail. With this reason, this paper presents the application of information quality techniques into the web-based development process to improve agility. This approach will accrue significant benefits and cost savings for web development teams and organisations to effectively design and develop web-based information systems.*

Key words: Information Quality, Web Information Systems, Web-based Development, Agile Approach

1. INTRODUCTION

The Internet has changed the ways in which conventional information systems develop and work. This means that the conventional information systems have evolved into the world-wide web, which has the significant impact on society and culture. Thus, developing a web-based information system requires web development team to adapt the conventional development approach to a new methodology referred to as web-based development approach [1,20]. This web-based development brings an even more challenging work to consider the nature of the web that includes (described in Section III): -

- distinct characteristics such as customised content generation and functionality variety;
- exclusive requirements such as multilingual and web browsers; and
- factors such as stakeholders relationship and quality control projects.

Indeed, as more and more web-based information systems are being published on the web, it has forced the web development teams and organisations to re-think agile approach to web-based development [38]. This means that they need to become agile to remain competitive in the continuously and unpredictably changing markets. Agility seems rather prominent for the web development teams and organisations be capable of managing change and developing web-based information systems quickly and easily [24].

However, there are many information quality-related issues perceived on the web-based development environment thereby making the development less agile. For example: poor definition of requirements information [5] and information from clients not complete [6]. In the context of web-based development, few studies have examined the information quality but not the entire web-based development process. It is therefore important to consider having information quality techniques in the web-based development approach for cost-efficient and effective development under varying requirements of clients [34]. Accordingly, web development teams, that consist of managers, analysts, designers and developers, play a significant role in ensuring quality information by addressing its issues at each stage of web-based development not only to improve agility but also in order to satisfy clients [2].

Thus, in this paper aims to extend the information quality area of study in the context of web-based development approach to improving development agility. This paper can be broken into three sections. Section II shows how information quality, associated with its dimensions and frameworks, is relevant to apply to the context of web-based development. Section III describes the web-based development as a whole. Section IV presents the possible of putting both information quality and web-based development together to improve development agility.

2. Information Quality

Information is regarded as of high quality if it is fit for purpose as the widely used definition is 'fitness for use' [40]. Further explanation of this definition is the quality of information depends on meeting user requirements and business specifications [17]. The area of information quality is an interdisciplinary research and applied widely to various contexts. In web environment context, it has been researched widely and the importance is undeniable, since many people use the Internet on a daily basis. It is important to note that data quality and information quality are often used interchangeably.

Information quality is measured in various attributes called dimensions such as accuracy, completeness, consistency and timeliness. The famous information quality dimensions, that is taken widely as a basis for any research context, is from Wang and Strong [40] where they identified 15 dimensions and are classified in four categories as illustrated in Fig. 1.

A combination of any information quality dimensions can serve as a framework include a specific guideline to identify various issues and resolve them. There are many information quality frameworks depending on the context being studied such as healthcare, asset management and operations research. The list below is some examples: -
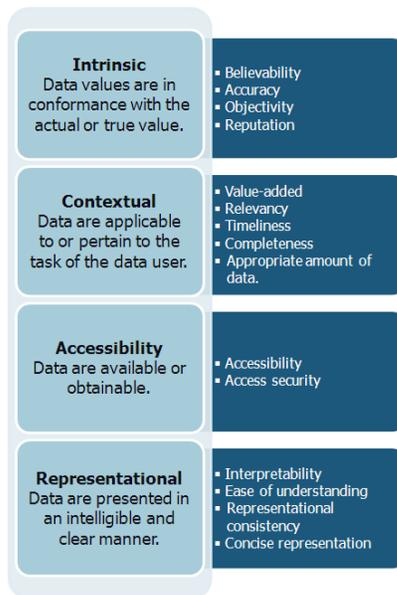
Fig. 1 Information quality categories and associate dimensions, adapted from [40]

- Information Quality Management Framework for Health Information Systems [28]
- Data Quality Framework in Asset Management [23]
- Information Quality Model for Operations [12]

Thus, the extension of information quality to the context of the web-based development approach to improve development agility seems necessary. Prior to that, the next section presents the importance of web-based information systems development approach.

3. Web-Based Information Systems Development Approach

Web-based information systems that handle information in its multiple forms such as text, image, animation, audio and video, are varied in size (from small to large scale) and complexity (from simple to complex websites). Thus, developing one need to consider its dynamic nature as every web-based information system is distinct and need exclusive requirements to develop one compared to traditional client-server information systems.

3.1 Adapt the Conventional Development Approach

Since the early computer introduced, software engineering has been practiced through applying software development life cycle (SDLC) which consists of planning, design, analysis, implementation and maintenance [14]. Interestingly, with the advent of the Internet and the world-wide web, web engineering has evolved where SDLC is adapted to cater the multidisciplinary nature of the web when developing web-based information systems [20].

A new approach namely web-based development life cycle (WDLC) is introduced in which the stages are similar to SDLC approach but with an additional stage that is the publishing stage placed between the implementation stage and the maintenance stage [1]. The publishing stage is where the web-based information systems are promoted to potential web users by applying search engine optimization. This WDLC is currently being employed by the web developers for developing web-based information systems.

3.2 Nature of Web-based Information Systems

Web-based information systems are evolutionary in nature and experience many micro and macro changes depends on its type [38]. There are nine types defined in the literature [18] in which a web-based information system can belong to: document-centric, interactive, transactional, workflow-based, collaborative, portal-oriented, social web, ubiquitous and semantic web. All of these web-based information systems are dynamic, distributed, multimedia and interactive platform for user interaction in business-to-business and business-to-consumers applications in which are more challenging to develop and maintain [25].

An agile approach to web-based development [24] is important because of the nature of web-based information systems that poses many additional challenges the way in which they developed and maintained. For instance, web-based information systems provide easy accessibility through only web browsers [19] and therefore, various web browsers should be considered when developing web-based information systems. In addition, web-based information systems provide an unprecedented comfort and convenience to web users to shop and learn plus allow businesses to expand into a worldwide marketplace [3]. Thus, the following special characteristics of web-based information systems [15] play an important role for consideration during the web-based development.

- Information sharing
- Information downloading
- Customised content generation
- Interactive communication
- Acquisition of inputs through forms
- Usability
- Functionality variety
- Efficiency

The uniqueness of web-based information systems poses exclusive requirements that need to be concerned and addressed. Some of the requirements [4] are: -

- *Multilingual* – provides easily accessible global information.
- *Web browsers* – ensure information reach to a wider audience.
- *Navigational links* – efficiently locate and access desired information.
- *Frequent maintenance* – allows up-to-date information content available.

3.3 The Factors to Consider

In order to effectively develop web-based information systems, there are some success factors necessary to consider and require more attention by the web developers. The factors are in the following: -

- *Project management strategy* – set clear project goals and manage web-based development projects [37]
- *Agile-oriented approach* – control over working schedule towards flexible work arrangements [8]
- *Information management* – ensure integrity of information and content [21]

- *Stakeholders relationship* – maintain good communication between stakeholders [27]
- *Standards and procedures* – establish standards framework [33]
- *Quality control projects* – measure the quality of the web-based development projects [35]

3.4 Challenges to the Web Developers

Four aspects of developing web-based information systems in Table 1 present unique challenges to web developers: -

Table 1 Challenges to Web Developers

Challenge	Description
Multiple programming skills and agile development practices	Web developers require multiple skills from front-end to back-end programming skills as well as capable of handling modules of several web-based development projects at any one time [16].
Unlimited accessibility and visible worldwide	Global web users with global access should be considered as the worldwide visibility of web-based information systems [29].
Platforms compatibility and dynamic content	Developing web-based information systems need to cater various web browsers in different platforms and concern about the dynamic information content and features [26].
Frequent client involvement and feedback	At each stage of web-based development requires client involvement with immediate feedbacks to complete tasks on time and to resolve any issues raised [30].

These key challenges are among the most significant, but not limited to, that is based on the nature and characteristic of web-based information systems, which need to be taken into account by web developers involved at each stage of WDLC when developing web-based information systems [29].

4. Information Quality into Web-Based Development Approach

Although there are many research studies of information quality in the web context, little research has been conducted on the web-based development context. The reason of this research is due to the fact that web developers are lack of concern the quality of development requirements and documentation when developing web-based information systems which might lead to development failure [10]. Some recent studies have worked on this web development context by looking at the quality aspects in web development methodology. For example, the data quality awareness model for web requirements analysis [13], quality-modelling framework for web design [22] and quality model life cycle to manage quality in model-driven web engineering [9].

There are many information quality dimensions for the success of web-based development but a recent study [2] has listed the following key information quality dimensions that should be considered by the web developers.

- *Accuracy* – extent to which data are correct, reliable and certified free of error.
- *Availability* – extent to which information is physically accessible.
- *Completeness* – extent to which information is not missing and is of sufficient breadth and depth for the task at hand.
- *Consistency* – extent to which information is presented in the same format and compatible with previous data.
- *Understandability* – extent to which data are clear without ambiguity and easily comprehended.

In improving the agility of managing web-based development projects, the following four important values derived from the agile manifesto [7] is being addressed through information quality. With this, having a web development team consider information quality in the process of designing and developing web-based information systems through the WDLC is really important, not just to deliver quality information but also to enable them to become more agile and productive [41].

1) **Individuals and interactions with information quality strategy** – Business people and web developers should have a common information quality strategy where its key component is to understand information stakeholders in order to work together throughout the web-based development projects [31]. With relevant standards and regulations within the strategy, can guide stakeholders in defining and communicating necessary information required for the development of web-based information systems. This approach ensures web-based development projects are delivered to a client within a specified time, on budget, without compromise.

2) **Working software with information quality assessment** – Web-based information systems should be working progressively as they are being developed with the assessment of information quality through metadata analysis, user interaction and intelligent analysis [36]. These three levels of assessment in relation to information quality are important to examine web-based information systems in order to determine if they meet certain information quality criteria. The assessment therefore, can be regarded as a tool to ensure the web-based information systems are conform to specified requirements.

3) **Customer collaboration with information quality assurance** – It is imperative to collaborate actively with customers to capture the required information accurately and completely compliance by information quality assurance [39]. This assurance serves to ensure that the web development team is accountable and developing web-based information systems with quality and in

accordance with the customer requirements. As a result, collaborate with customers on the information quality assurance of their web-based information systems is to ensure clarity, consistency and compliance of production requirements, design and implementation.

4) **Responding to change with information quality requirements** – As the web-based information systems are dynamic and always under ongoing changes, it is important that the changing requirements are of a high information quality for the client's competitive advantage [32]. The desired changes should be reviewed prior to the change of the web-based information systems for its correctness, adequacy, completeness, accuracy, and compliance with standards. Thus, this addresses the significance of information quality requirements that drive the changes f web design and development in which is better having right early in the web development project.

5. CONCLUSION AND FUTURE WORK

The development of many web-based information systems throughout all stages of WDLC is significant as the internet proliferates, to become a standard and practice for web developers to follow in order to meet the expected results through increased productivity and reduced cost. But how about the development agility to meet new needs and demands. Thus, this research has shown that having information quality techniques in the WDLC can help web developers manage with greater agility to perform the work of developing web-based information systems successfully.

The four information quality techniques that can be incorporated into an agile approach discussed in this paper are information quality strategy, information quality assessment, information quality assurance and information quality requirements. These techniques are to assure the information used in the entire web-based development is at a satisfactory level of quality by providing an information quality framework to guide. Further work will be carried out to examine these techniques through case studies [41] of web development teams and organisations which will be then followed by a discussion that and offers insights into perceptions of information quality in the web-based development. The focus will seek to examine the link between information quality and web-based development in the agile context in order to have some principles and practices in common as a reference for developing web-based information systems faster with agility.

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