ABSTRACT
In today's age, the World Wide Web is a utility used everywhere on everything portable or immobile. All these devices can be accessed and communicate with each other even if the only common thing is their platform, this has created a variety of design issues against consistency of layouts and data mismatch. Detailed analysis of Responsive Web Design (RWD) and Adaptive Web Design (AWD) in terms of usage. A Systematic Literature Review (SLR) has been used to identify 58 research works, published during 2009-2017. We identify 6 models and 9 implementation approaches for AWD and RWD. We analyze which web design is better and what types of websites can be built efficiently through these web designs. Adaptive Web Design answers the research questions proposed in the manner to claim being the most efficient, workable web design in terms of usage as compared to Responsive Web Design.

Keywords
Web design, AWD, RWD, Adaptivity, Responsiveness, Web apps.

1. INTRODUCTION
The World Wide Web (WWW) has met a great success in better communication and spreading knowledge. Ever since its birth, WWW has been central in providing insight into the digital world for all. The opportunities that this new age provided have led to many other branches of information along with the forever evolution from one software to another, one hardware to another. In short, everything is connected and the easiest connection in the past decade is the wide usage of screens, any interface with screen at its bane. This further led to advancement in the multiple types, all sorts of variations to accommodate different styles because one is never enough in this world of constant evolution. This gave birth to the demand for more of everything interface related and encouraged developers to advance into the world. Most of which can be centered upon web designers, web engineers. Directly getting into the detail of it, the latest in this look-and-fee advancement are web designs. Namely: Adaptive Web Design (AWD) and Responsive Web Design (RWD). AWD is a relatively new approach for progressive enhancement of websites that focuses on accessibility, external style-sheet, scripting technologies and view of the site against the patriarchic RWD. This allows for a uniform representation of the site over any intended medium, and platform with an improved version of pages that is also detailed to those with specifically advanced mediums for viewing and accessing functionality of basic content. Therefore, it has made quite advancement in designing as compared to previous technologies used in this field of design. Whereas RWD, a relatively old approach aimed towards fashioning variety of sites to ultimately provide the optimal interaction and viewing experience, more specifically; advanced navigation and easy reading with a minimum of panning, resizing and scrolling and interacting over a multitude of different devices to enhance accessibility, ease of use and general adaptation of crossing limitations to providing better interface.

Keeping in view the stated situation, our goal is to select latest research studies available on AWD and RWD in our proposed Systematic Literature Review (SLR). Thus, we have developed following research questions for this systematic literature review:

Research Question 1: What models and approaches have been introduced for adaptive or responsive design since 2009 to 2017?

Research Question 2: Does adaptive design wins over responsive web design?

Research Question 3: Which web design is better for what type of websites?

This SLR will provide answers of the research questions stated above.

2. RESEARCH METHODOLOGY
We have followed Kitchenham [59] in order to develop research methodology of our SLR. The research methodology has two main stages including category definition and review protocol development.

2.1 Category definition
We have organized our research into three major categories (General, AWD and RWD) for classification of each selected research which provided us ease in answering our research questions.

2.2 Review protocol
We have developed the review protocol for the study, based on the readily defined Systematic Literature Review [59]. In rejection and selection criteria we have only selected five major publication databases (i.e. IEEE, Elsevier, ACM, Tylor & Francis and Springer). We have selected research studies which lie under publication year “2009–2017”. The search terms included were (e.g. Adaptive web design, Responsive web design, Web adaptivity, Web responsiveness, Adaptive vs responsive web and Traditional web). Details of search terms can be found on [60]. Finally, after the data extraction,
we conducted a comprehensive analysis on comparison of the two web designs we worked on i.e. AWD and RWD. Details of selected researches is given in Table 1.

Table 1: Research Works and Database Details

<table>
<thead>
<tr>
<th>Database</th>
<th>Type</th>
<th>Selected Research Works</th>
<th>No. of Researches</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE</td>
<td>J</td>
<td>[12],[36],[49],[30],[15],[11],[56]</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>[3],[6],[7],[8],[15],[16],[21],[22],[23],[24],[3],[9],[31],[32],[37],[39],[43],[46],[47],[48],[52],[53],[54],[57],[58]</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>ELSEVIER</td>
<td>J</td>
<td>[3],[6],[18],[23],[35],[41],[42],[43],[44]</td>
<td>9</td>
</tr>
<tr>
<td>C</td>
<td>[13],[38],[49]</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ACM</td>
<td>J</td>
<td>[11],[17],[19],[20],[26],[34]</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>[14],[29]</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>T&amp;F</td>
<td>J</td>
<td>[2],[9],[11],[25],[27],[33]</td>
<td>6</td>
</tr>
<tr>
<td>SPRINGER</td>
<td>J</td>
<td>[10],[55]</td>
<td>2</td>
</tr>
</tbody>
</table>

3. RESULTS AND ANALYSIS

3.1 Models and Approaches identification

Different models and approaches are being used to build adaptive and responsive websites. A model is the abstract representation of software process which represents specific view of the tasks to be done for software development while an approach is a specific way of conducting software project in which we define when and how artifacts are produced. One of the most used model is SOA (Service oriented architecture). Table 2 sums up all the models whereas Table 3 summarizes the approaches used for adaptive and responsive web design in use since 2009 to 2017.

Table 2: Models Identification for AWD and RWD

<table>
<thead>
<tr>
<th>Web Design</th>
<th>Models identified</th>
<th>Number of researches</th>
<th>Research Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWD</td>
<td>Event-driven Execution model</td>
<td>1</td>
<td>[36]</td>
</tr>
<tr>
<td></td>
<td>Adaptive Modeling Language</td>
<td>1</td>
<td>[40]</td>
</tr>
<tr>
<td></td>
<td>MoDAR</td>
<td>1</td>
<td>[41]</td>
</tr>
<tr>
<td></td>
<td>OWL (Ontology Web Language) and all variations</td>
<td>2</td>
<td>[2],[18]</td>
</tr>
<tr>
<td></td>
<td>Hypermedia driven models.</td>
<td>1</td>
<td>[19]</td>
</tr>
<tr>
<td>RWD</td>
<td>OpenCV</td>
<td>1</td>
<td>[46]</td>
</tr>
</tbody>
</table>

Table 3: Approach Identification for AWD and RWD

<table>
<thead>
<tr>
<th>Web Design</th>
<th>Approaches identified</th>
<th>Number of researches</th>
<th>Research Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWD</td>
<td>SOA</td>
<td>3</td>
<td>[39],[36],[49]</td>
</tr>
<tr>
<td></td>
<td>BDI(Believe-Decision-Intention)</td>
<td>1</td>
<td>[39]</td>
</tr>
<tr>
<td></td>
<td>ITS (Intelligent Tutoring System)</td>
<td>1</td>
<td>[35]</td>
</tr>
<tr>
<td></td>
<td>Classification algorithm using decision trees and data mining.</td>
<td>1</td>
<td>[7]</td>
</tr>
<tr>
<td></td>
<td>UCMA</td>
<td>1</td>
<td>[25]</td>
</tr>
<tr>
<td></td>
<td>WCAG (Web Content Accessibility Guidelines)</td>
<td>1</td>
<td>[38]</td>
</tr>
<tr>
<td>RWD</td>
<td>WCAG 2.0</td>
<td>1</td>
<td>[2]</td>
</tr>
<tr>
<td></td>
<td>WAI-ARIA</td>
<td>1</td>
<td>[2]</td>
</tr>
</tbody>
</table>

3.2 Better web design identification

Both responsive and web have their advantages and disadvantages but in context of this paper we will prefer Adaptive web. The reason being despite fact that it requires very large lines of codes to support different device and as number of devices increases thus the lines of code. The advantage it has over responsive web is that large amount of work is already done on this platform moreover it gives the opportunity to web scientist to learn about the user needs and requirements. Anything that can be done on traditional and responsive web can be done on adaptive too. Table 4 provides the comparisons extracted from our research studies.

Table 4: Better Web Design

<table>
<thead>
<tr>
<th>Better web design</th>
<th>Number of researches</th>
<th>Research Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive web design</td>
<td>26</td>
<td>[16],[17],[18],[19],[20],[21],[22],[25],[26],[30],[31],[33],[34],[35],[36],[37],[38],[39],[41],[42],[43],[44],[45],[48],[49],[51]</td>
</tr>
<tr>
<td>Responsive web design</td>
<td>15</td>
<td>[2],[8],[9],[11],[13],[14],[23],[24],[27],[28],[29],[32],[40],[48],[52]</td>
</tr>
</tbody>
</table>

Out of 41 researches on adaptive web design, 26 of them explicitly mentioned that adaptive web design is better than responsive as well as traditional web design whereas 15 out of 17 researches based on responsive web design mentioned that responsive web design is better than other designs.
3.3 Website types identified

Table 5 highlights the prominent website types that are better with Adaptive web design rather than traditional or any other web design. On a bird’s eye view, for any type of E-Learning System Adaptive Web Design are the most appropriate. Moreover, adaptive web design includes a wide range of benefits for developers for creating Self-Adaptive Management systems, dynamic websites, information systems as well as general websites.

Table 5: Types of Websites Using AWD

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Types of websites using AWD</th>
<th>Number of researches</th>
<th>Research Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Learning System</td>
<td>14</td>
<td>[4] [5] [6] [12] [21] [22] [25] [31] [35] [42] [51]</td>
</tr>
<tr>
<td>2</td>
<td>Management System</td>
<td>1</td>
<td>[19]</td>
</tr>
<tr>
<td>3</td>
<td>Social Media websites</td>
<td>2</td>
<td>[11] [10]</td>
</tr>
<tr>
<td>4</td>
<td>Mobile Applications</td>
<td>2</td>
<td>[11] [45]</td>
</tr>
<tr>
<td>5</td>
<td>Utility Websites</td>
<td>3</td>
<td>[30] [44] [47]</td>
</tr>
<tr>
<td>6</td>
<td>Augmented and Mixed reality applications</td>
<td>1</td>
<td>[19]</td>
</tr>
</tbody>
</table>

Some of the types identified by our research studies are:

- **Learning system i.e. educational and e-commerce websites**: Adaptive design introduces the concept of individual student profile. The source of learning is also different for different user hence, there’s a concept of Adaptive Learning styles.
- **Management systems**: With adaptive design arrangement-frameworks adopt a self-adaptive concept.
- **Social websites**: Individuals share their data with friends and family on social networks like Facebook or Twitter but they are unaware of the consequences in case there’s a security breach. To create a balance, adaptive web design along with Semantic web applications is proposed where there’s a privacy and administration that considers the interests of both the user and the application.
- **Mobile applications**: Because different applications are accessed by using different devices like cell phones, tablets, etc. and Adaptive design works better with different screen resolutions as it has different designs for each device type.
- **Utility websites**: Because Adaptive web design takes shorter time for page-load, also that dimension and areas of Ad-spaces can be settled, along these lines keeping any breaking of a page’s design.
- **Augmented and mixed reality applications**: Since most of the augmented reality applications utilize a smartphone as a core component, Adaptive design is best suited for them.

4. ANSWERS TO THE RESEARCH QUESTIONS

**Research Question 1**: What models and approaches have been introduced for adaptive or responsive design since 2009 to 2017?

**Answer**: Use of 15 models and approaches has been identified by our research. As shown in Table 2 and Table 3, respectively. Mostly used model and approach is SOA (Service Oriented Architecture) as it provides flexibility, loose coupling, scalability, reusability and easier testing. The discovered approaches were found to be more in-tune, compatible with the overall purpose of the research; adaptability, compatibility and user-friendliness.

**Research Question 2**: Does adaptive design wins over responsive web design?

**Answer**: Unlike RWD, AWD doesn’t utilize liquid frameworks to convey adaptable substance over any gadget. Rather, it physically makes separate designs for predefined screen sizes and shows the suitable choice. Its outline keeps everybody on the same URL while permitting you to give a focused on, streamlined experience to portable clients. The Adaptive design assists with:

- Taking into account the requirements of various gatherings of clients concocting gadget advanced site highlights, menus, pictures, writings, and so forth.
- Conforming the site speed and page weight to suit clients on shifting network and information arranges

Analysis of second part of RQ2 gave unpredictable results. Fig 1 shows that adaptive web design still wins over responsive despite the fact that adaptive web design costs more and is high maintenance.

**Research Question 3**: Which web design is better for what type of websites?

**Answer**: When it comes to choosing a web design for your website, key is to consider the audience first. But according to our research (Table 5) AWD is most suitable for audiences of the following websites:

- Learning system i.e. educational and e-commerce websites
- Management systems
- Social Media websites
- Mobile applications
- Utility websites
- Augmented and mixed reality applications

Reason to use AWD for these websites is that it provides good user experience and transfer the information necessary for the user intent. Moreover, it provides clarity of user need and requirement to the developer/coder as well as it provide ability to build upon the existing website.
4.1 Limitations
We tried to follow SLR guidelines [59] but still there ought to be some limitations in our work. We have identified a limited set of search terms but there is a chance that we missed some key words. We have used filter 2009-17 for selection of research studies, we might have missed some important publications out of this year bound. Similarly, we have only selected five major databases for our research selection, we might have missed some researches from other scientific database engines.

5. CONCLUSION
This SLR examines the detailed analysis of Adaptive Web Design (AWD) and Responsive Web Design (RWD) for modern age web applications, accessible via different types of devices. To accomplish this goal, our SLR has identified 58 research studies published during the year 2009-2017. We have identified a total of 15 models and approaches used for the both web designs, models (6) and approaches (9). Thus, both AWD and RWD have been researched and compiled together in order to analyze each one extensively. The SLR exhibits that AWD wins over RWD even though adaptive design costs more and is complicated. This will help researchers, developers and practitioners in selection of right design and best suitable models and approaches for it to develop their web applications according to the requirements.

6. REFERENCES


[34] Yoann B., Marianne H. and Michel M. (2015), Reconciling user and designer preferences in adapting web pages for people with low vision, Proceedings of the 12th Web for All Conference (W4A’15), ACM.


