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# Modelling Techniques of Web Architecture for Improvement of Web Applications

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***Abstract*-- Web Engineering is rich in design methodologies such as OOH, OOHDM, UWE, W2000, and WebML and so on, for supporting and developing the complex task of designing web applications. These methodologies propose the construction of different models, which comprises at least conceptual model, navigation model and presentation model. Each model consists of a set of modeling elements, for example; nodes and links for the navigation model or image and anchor for the presentation model. In addition, all these methodologies define or choose a notation for the constructs that they define.**

## I. INTRODUCTION

Web Engineering Methodologies for improvement of web applications, use various notations and propose a little various development processes, it used a common metamodel as based methodologies for the web domain. Also metamodel is a best definition of the models of modeling. The relation between metamodels and their elements, with well-formedness rules, are requirements for creating a semantic web. Web engineering methods based on this common metamodels can only use part of the build provided by the metamodel. The common metamodels must be the unification of the modeling structure of popular web engineering methods permitting for their better comparison and integration [2].

Comparison is a reason to find weaknesses and strengths of the methods. We will compare elements of the metamodels between UWE, WebML and OOH, and then make an evaluation for the comparison, for finding the best methodology among them to developing web applications.

Web engineering is the application of systematic, disciplined and quantifiable approaches to the cost-effective development and evolution of high-quality solutions in the web-based applications. In web engineering there are lots of methods to develop the web applications like; UWE, OOH, WebML, OOWS, and OOHDM [1]. Though most of the Web Engineering methods define their own notation for creating models like presentation model and navigation model, Koch and Kraus stated that; in many cases it is just another notation for the same concepts, meaning they must be based on a common metamodel for the Web application area [2].

In most of the cases another notation can be used for the same concept, or furthermore, common metamodel which the basis must be used for web application area. One of the possible debatable concepts used in the web community is the concept of navigation. In this paper we describe the inclusion process design of the navigation model for two well known methods that called UWE and WebML.

Both UWE and WebML have the same concept features in metamodels; but with dissimilar process in the web applications development of that will be distinguished in this Chapter. UWE is a software engineering approach for the web applications, whose objective is to cover the entire life-cycle for the development of web application, processing an object oriented and iterative approach depended on the Unified Software Development Process (USDP) [3]. The primary concentration of the UWE method is the design that systematically used by a semi automatic generation of web applications [4].

WebML [5] came in a picture in 1998 by an Italian Politecnico di Milano research group. UML is a visual modelling language of construction, specification and documentation of systems which are used in web application domains and execution platform. It is also widely adopted by both academia and industry as a regular language for relating software systems[6].

The web engineering methods provide a number of advantages compared to ad hoc development. The web engineering methods are directed through the process of software creation, and provide a whole documentation, take into consideration the need of users, and which can be a certain quality. All these problems of web engineering methods help to decrease the costs of development, that for sure is an essential aim in the development of software[7].

In other side homepage is one of the most important pages on the website, because clearly communicates the site's purpose, show all major options available on the page and the key that showing the quality of websites. Solving the usability of homepage helps it to be elegance, clear, easy user interface and easy for understanding [8], [9].

Through comparing navigation model between UWE and WebML this paper aims at finding the weakness and the strengths of the both methods.

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Therefore in this paper in order to compare navigation model between UWE and WebML, we utilize the University Technology Malaysia's (UTM) homepage as a case study, because it is a completed homepage compare the other case studies, and it has different contents such as News, Search, Switch Languages, Information and etc. Also, it has different types such as Image and Text.

Moreover, this homepage has different modules like Flash news, Frame and Menu that linked to some application like Chat and Feedback. Briefly, UTM homepage has all models that corporate and personal homepage used, Fig. 3 shows the UTM homepage, this picture was taken on the 30th October 2012 by using Fireshot software for Google Chrome browser.

**Table II**
**Classification Type Of Modules Design Of The Utm Homepage**

| No. | Homepage's content | Type of the Modules Design | Name of Class |
|---|---|---|---|
| 1 | Logo | Image | Image |
| 2 | Head menu-Accessibility | Menu | Information |
| 3 | Head menu-My UTM | Menu | Information |
| 4 | Languages-English | Menu | Languages |
| 5 | Languages-Malay | Menu | Languages |
| 6 | Search | Search | Service |
| 7 | Top Menu 1-About Us | Main menu | Information |
| 8 | Top Menu 1-Admission | Main menu | Application |
| 9 | About Us-introduction | Sub menu | Information |
| 10 | About Us-facts & history | Sub menu | Information |
| 11 | Top Menu 2-Staff | Menu | Information |
| 12 | Top Menu 2-Alumni | Menu | Information |
| 13 | Flash News | Flash New | News |
| 14 | Begin Virtual Tour | Image | Image |
| 15 | Visitor's Counter | Counter | Service |
| 16 | Where we are | Menu | Information |
| 17 | News & Announcement | Multi data | News |
| 18 | Events @ UTM | Multi data | News |
| 19 | Find Us on-face book | Multi data | Connection |
| 20 | Find Us on- twitter | Multi data | Connection |
| 21 | Marquee Link | Marquee | Information |
| 22 | Online service | Custom Model | Service |
| 23 | Course Finder | Custom Model | Service |
| 24 | Frame | Frame | Information |
| 25 | Faculties and Schools | Custom model | Information |
| 26 | Media | Custom model | information |
| 27 | Campus | Image | Image |
| 28 | About Us-Vision & Mission | Menu | information |
| 29 | Map and Direction | Image | Image |
| 30 | Partners –KPT | Custom Model | Partners |
| 31 | Partners –Msc | Custom Model | Partners |
| 32 | Text | Custom mode | Information |
| 33 | Footer Menu-Agency Policy | Menu | Information |
| 34 | Footer Toolbar-Chat | Application | Application |
| 35 | Feed Back | Application | Connection |

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The content of the UTM homepage consists of various kinds of module design. In this chapter, we have chosen few of them, and grouped them for designing navigation models and presented them by methods as highlighted in Table II. Table II shows a sample of the type of module design, types of contents and classes for the UTM homepage content.

## II. Web Engineering Methods

Various web modelling methods have emerged in the past in the field of web engineering, which includes W2000, WebML, WSDM, OOH, UWE, OOWS, and OOHDM. Each of these methods used for the development of web pages [8]. In this paper we use three famous methods that are consisting of UWE, WebML and OOH.

### *2.1. UML-Based Web Engineering (UWE) Method*

UWE came up by 1998. The method was developed by the Web Engineering Group from the Ludwig-Maximilians-Universität München [9-10] . It is a software engineering approach based on UML [11]. It uses the UML standard notation as much as possible and defines a UML profile to specify the peculiarities that introduce web applications. The major benefit of being UML compliance is that any, CASE tool that supports the UML notation can be used to produce the UWE models [12].

*UWE Metamodel*

UWE metamodel is a design, which considered as the conservative extension of the UML metamodel, in other words, can say that the modelling elements of the UML metamodel are inherited from the UML metamodel, and they are not modified by adding new features or additions to the modelling element's class. The UWE metamodel can be customized on the basis of a profile by mapping it to a UML profile.

UWE metamodel for web applications can be created by using generic UML case tools and UML profiles or their extension , objects those are tagged and OCL restrictions [13-14], Figure 1 shows UWE metamodels.

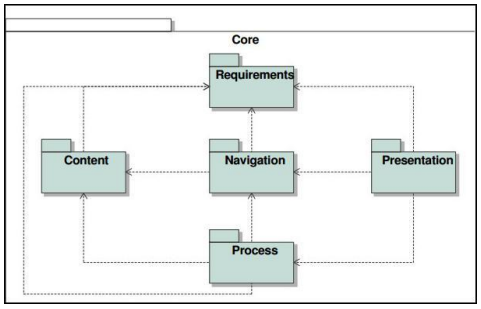


**Figure 1. UWE Metamodel [1]**

### *A. Conceptual Modelling*

The conceptual design intends to generate a conceptual model which ignores aspects of interaction, presentation and routing paths as much as possible. These features are deferred to the steps of the course-plotting and arrangement modelling. The important UML modelling elements that used in it effectively are classes, their associations and packages. These elements are defined graphically using UML notation [15].

### *B. Navigation Modelling*

Navigation design tells about the specification in which objects are defined to be accessed through some navigational structure of the web application and the ways about these object's accessibility in the access structure. The main navigation modelling elements are the navigation classes and their corresponding associated navigational links [16]. The elements that are used to design the UWE navigation model are [17-18]:

1. : Navigation Class
2. : Menu
3. : External Node
4. : Query
5. : Guided Tour
6. : Index
7. : Navigation Link

### *C. Presentation Modelling*

The presentation model is creating from navigation objects and their access primitives.

This model tells about the access primitives and their corresponding objects, which are accessible by the user. Navigation structure is transformed by presentation model into a set of models [19].

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UWE offers a number of modelling elements, which can explain the abstract user interfaces, and that is 'text,' 'form', 'image', 'audio', 'video', 'button', 'anchor' and different collections [20]. The elements that are used to design presentation model are [17-18]:

1. : Presentation Alternatives
2. : Presentation Group
3. : Iterated Presentation Group
4. : Input Form
5. : Presentation Page
6. : Tab
7. :Button
8. : Anchor
9. :Text
10. : Image
11. : Media Object
12. : Selection
13. : File Upload
14. : Customs Component
15. :Slider
16. : Text Input
17. : Image Input

### *2.2 Web Modeling Language (WebML) Method*

In 1998, an Italian Politecnico di Milano research group brought WebML [21] into attention. In web application areas and execution platform, UML is a visual modelling language of structuring, specification and documentation of systems. A distinctive language for associating software systems, it is also broadly embraced by academia as well as industry.

## III. WEBML METAMODEL

A Metamodel is the best way to model a continuously changing notation and maintain it in a homogeneous and comprehensive way [14]. There are different notations and metamodeling languages within them a set of Object Constraint Language (OCL), Meta Object Facility (MOF) and Object Management Group (OMG) for denoting metamodels [22]. A WebML is represented by four Metamodel packages as shown in the below diagram [23]: Common element, Data View, Hypertext View and Presentation View as shown in Figure 2.

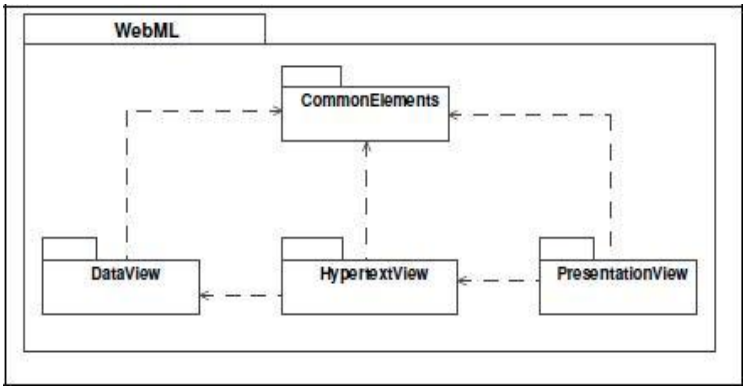


**Figure 2. The WebML metamodel packages [23]**

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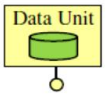
*A. Data Modeling*

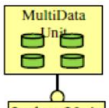
An appropriate conceptual models' adaptation to design of data is the WebML data model, as previously used in different disciplines being used, for example, database design, knowledge representation and software engineering. The Entity-Relationship data model, employed in conceptual database design, and UML class diagrams, employed in object-oriented modeling are incompatible with it.

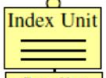
*B. Hypertext Modeling*

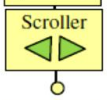
The arrangement and navigation of the site are distinctly explained through hypertext modelling. To arrangement can be beneficial to ensure which pages produce the hypertext and which content units create a page.

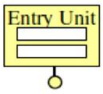
Atomic content components employed in order to publish the data explained in the data model are defined as Units. In order to compose pages in WebML, units are classified to seven types, including; data, entry, index (with its variants multi option and hierarchical), multi-data and scroller. To each unit one underlying entity is connected and is from which the unit component is calculated. The underlying entity's specification orders the object type from which unit content is extracted, for example artists, albums and so on. When it is suitable, a selector can connect to units in an optional manner. It means that the specification of a group of limitations, which specify the true underlying entity's instances, can be employed as the components of the unit at runtime. The elements or stereotypes for hypertext diagram are [21].

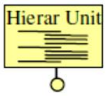
1. Data Units: 

: Data units are defined to select a mix of information, which provides a meaningful view of a given concept of the structure schema. More than one unit can be defined for the same entity or component, to offer alternative points of view.
2. Multi-Data Units: 

: Multi-data units present multiple instances of an entity or component together, by repeating the presentation of several, identical data units.
3. Index Units: 

: Index units present multiple instances of an entity or component as a list, by denoting each object as an entry in the list.
4. Scroller Units: 

: Scroller units provide commands to scroll through the objects in a container, e.g., all instances of an entity or all the objects associated to another object via a relationship.
5. Entry units: 

: Support form-based data entry. They are used for gathering input, which is typically employed to do the following: perform searches over the objects of an entity supply parameters to operations like content updates, login, and external services.
6. Hierarchical index unit: 

: In which the index entries are organized in a multi-level tree. The hierarchy is represented by a sequence of N source entities connected by N-1 relationship roles.
7. Multi-choice index unit: 

: In which each element of the list of entries is associated with a checkbox, allowing the user to select multiple objects, instead of a single one.

Links determine the site Navigation. Definition of Links is connections between the units within just one page, connections between units located in distinctive pages, and between pages.

*C. Presentation Modeling*

The orthogonal role of explaining the pages' look and feel in a site view is known as presentation. A specific model for presentation at the conceptual degree is not included in WebML, which contains methods of the standard leverages with more similarities to specialists of graphic and communication [8].

The process design of Presentation Model according to [15] consists of the following steps:

- Concerned with the look-and-feel of web pages.
- Page is the basic unit of presentation.
- A page is associated to one or more style sheets.
- Style sheets are formally expressed in XML.
- A default page style is generated for each page.

*3.1 Object Oriented Hypermedia (OOH) Method*

OOH is an initiative started in 2000 by Gómez and Cachero [7].

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OOH, was originally defined as an approximation addressed by the user requirements, object oriented-based and partially based on the standards. Based on the object-oriented paradigm, this approach provides designers with the semantics and notation necessary for the development of personalized Web-based interfaces [16].

*OOH Metamodel*

Figure 3 represents the ensuing OOH metamodel.

Layer 0 and 2 modelling necessities are realized through consisting of the packages in OOH metamodel, as same the WebML metamodel that is respectively the service package and content package. Two packages are defined in layer 1 named presentation and navigation packages. Content model of OOH depends on the UML class diagram. A description of behavioural features and common structural are represented by a class.

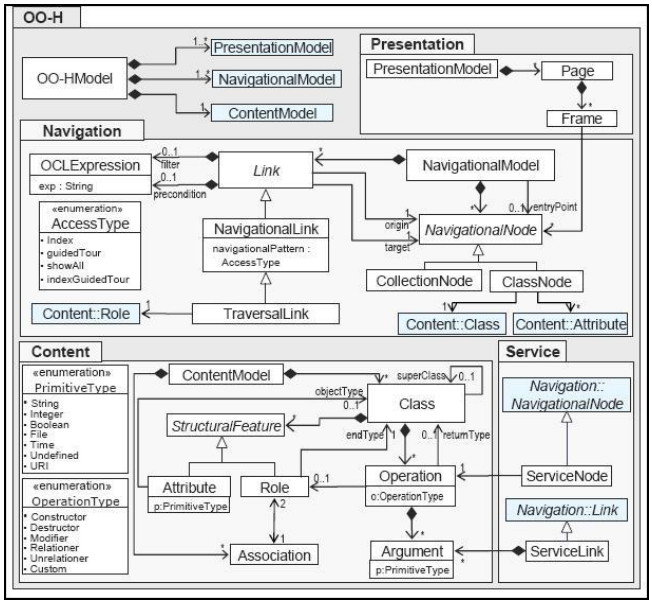


**Figure 3. OOH Metamodel [23]**

*A. Class diagram*

Class diagram has to mention that derived is stood by a slash (/) next to an attribute/method, and class-scope5 attribute/method is symbolized a dollar symbol ($) next to an attribute/method name. The mechanism UML employs for explaining enumerated kinds is the <<enumeration>> stereotype which is determined by classes. Those stereotyped classes 'characteristics depict the mighty importance of the enumerated type [27].

*B. Navigation Access Diagram (NAD)*

Navigation classes navigation targets; navigation links and collections are the principal parts of the NAD.

- *Navigation Classes:* Navigation Classes (NC) possess their grounding in the classes recognized throughout the conceptual modeling stage, and they are symbolized via a rectangle with three domains [28-29]:

- *Head:* It includes the class's name.
- *Attribute area:* The names and the attributes scope (attributes of characteristics) pertinent to the regarded agent and view are included in this area.
- *Service area:* The services with the ability to being protected by the real NAD agent, are collected by the service area. Attribute visibility are classified to three models [28-29]:
- *Always Visible (V):* All the object's views can show their value.
- *Referenced (R):* In this type of attribute visibility their value is just referenced and thus their advising needs another s in the navigation path. The accessing way of this type of attribute can change depending on the implementation environment.
- *Hidden (H):* Their value is not referenced and also is not displayed. Therefore, the single path to access them is via a system view with details.

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*Navigation Targets:* The NC are classified into Navigation Targets (NT) which is a group of NC equipping cooperatively the agent with a consistent view of the system. Association an NT to each navigation requirement of the user is the general rule. There is an associated scope in the NT: local to the actual(real)agent type and thus to the real NAD or global to the system. A rectangle that collects every class included in that view presents an NT representation through the diagrams.

*C. Abstract Presentation Diagram (APD)*

The elements APD are:

- *Tstruct:* Useable to capture the data that required to be displayed.
- *Tform:* Functional at the time that the page (apart from information) comprises calls to underlying(fundamental)logic.
- *Tlink:* The interconnection and dependencies among pages are taken byTlink.
- *Tfunction:* Client functionality that used in the different pages is collected by Tfunction.
- *Texternal:* It is employed to collect type, location and behavior of external components including images, applets that can filter the first interface.
- *Tlayout:* It is the place that catches the location of elements, and the definition of concurrent views and synchronization are captured.
- *Tstyle:* It is the place of features preservation that done by OOH, and these features are included typography or color palette for each of the interface element.
- *Twidget:* It is the place that implementation constructs are connected to different data and interaction (communication) items which are dependent on the ultimate implementation platform and language.
- *Tlogic:* It is the place that the system maintains details of implementation concerning interaction with underlying(basic) business logic ( service, parameters, connection protocol, and so on).

## IV. Comparison Between Three Methods And Evaluation Results

In the following, Table 1 shows the level of support of the model elements for developing web applications. In the table shows a comparison between metamodels of the three methods, which are UWE, WebML and OOH for supporting web applications. The following explain the type of support models design according the three metamodels:

- *Conceptual model:* In the conceptual model UWE, WebML and OOH fully support the web page content.
- *Navigation model:* In the Navigation model UWE cannot support all models in web page contents, among them WebML best method to support web page contents, but OOH also cannot fully support web page contents.
- *Presentation model:* In the Presentation model, three methods are good to support the presentation but cannot fully support, which OOH showed a weak support.

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**Table 1.**
**Comparison between elements UWE, WebML and OOH**

| No. | Model Elements | Content Model | | | Navigation Model | | | Presentation Model | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | UWE | Web ML | OOH | UWE | Web ML | OOH | UWE | Web ML | OOH |
| 1 | Text | ● | ● | ● | ◑ | ● | ● | ● | ● | ● |
| 2 | Image | ● | ● | ● | ◑ | ● | ● | ● | ● | ● |
| 3 | Menu | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 4 | Hierarchical index | ● | ● | ● | ◑ | ● | ● | ◑ | ● | ● |
| 5 | Query | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 6 | Input form | ● | ● | ● | ◑ | ● | ● | ● | ● | ● |
| 7 | Multi choice | ● | ● | ● | ● | ● | ◑ | ● | ● | ● |
| 8 | slider | ● | ● | ● | ○ | ● | ◑ | ● | ● | ○ |
| 9 | Custom component | ● | ● | ● | ● | ● | ◑ | ● | ● | ● |
| 10 | File up loader | ● | ● | ● | ○ | ○ | ◑ | ● | ● | ○ |
| 11 | Button | ● | ● | ● | ○ | ○ | ◑ | ● | ● | ○ |
| 12 | Media Object | ● | ● | ● | ◑ | ○ | ◑ | ● | ● | ○ |
| 13 | Anchor | ● | ● | ● | ● | ● | ● | ● | ● | ○ |
| 14 | Selection | ● | ● | ● | ○ | ● | ● | ● | ● | ○ |
| 15 | Button | ● | ● | ● | ○ | ◑ | ◑ | ● | ● | ○ |
| 16 | Tab | ● | ● | ● | ○ | ○ | ◑ | ● | ● | ○ |
| 17 | page | ● | ● | ● | ○ | ● | ◑ | ● | ● | ○ |
| | | | | | | | | | | |
| Not support | | ○ | Partially support | | ◑ | Fully support | | ● | | |

Three methods, including OOH, UWE, and WebML have usability design metamodels, and present efforts are restricted to the demonstration of the concept of the first access of them. In addition, there is a restriction to the number of issues, which are different techniques must succeed in a small group of fundamental characteristics of Web applications.

According to Table 1 the WebML is the best method among the three methods for development web applications, and UWE is a good method but lower than WebML. OOH is the lowest method for development web applications.

## V. Conclusion

In this paper, we compared UWE, WebML, and OOH methods, through the current elements of the metamodels, to support web applications as showed in Table1.

This comparison showed WebML is best to support web applications among them, also UWE can be well supported web applications, but OOH can week support web application compare UWE and WebML, after the design navigation model for ca case study by UWE, WebML and OOH, we make a comparison between them as showed in Table3, we got the same results. This comparison helps the designers how and which time chooses which method in web engineering for development web applications.

We recommend for the researcher for extend our idea through design more than one case study of navigation model and presentation model. Also, they can extend our comparison by used all methods of web engineering. We recommended for the researchers to enhance the web engineering methods weaknesses through the mechanism for adding new elements of metamodels.

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