Multi-criteria Decision-Making Based Approach for Selecting Optimum Framework in Enterprise Resource Planning

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Abstract

Human resource management is a comprehensive system that tries to integrate all the tasks and departments in an organization using a single computer system that can meet the special needs of these departments. They help programmers to complete their web application quickly and with minimal involvement. With the increasing development of web applications and the use of unique features of HTML 5, many possibilities are available to web programmers. In this paper, four advanced and applied frameworks are introduced and compared with the best frameworks of the previous research. Then we proposed multi-criteria decision-making based approach for selecting optimum framework in enterprise resource planning. To demonstrate the applicability of the proposed approach, it is tested on different category of originations. Results show that our proposed approach is more applicable in different companies.

Keywords: enterprise resource management, Angular, Ember, Laravel, Symfony.

1. Introduction

resource management is a well-known concept that is defined in the management and implementation of projects. Enterprise resource management is used in the form of software products that are defined by the term enterprise resource management system. Since the management system is progressing in parallel with information technology, ERP has entered the field and is developing faster than other software systems. ERP systems are often used as a system for integrating information and company resources [1].

Due to the growing trend of globalization and increasing competition in the world markets, most companies will inevitably be forced to join the world markets. For this reason, organizations need to find better business solutions with flexible and reliable structures. According to the characteristics of ERP, this technology can play an effective role in reducing costs, increasing production and improving customer service [2].

Today, in organizations the use of information systems, which is one of the achievements of information technology, has become a necessity topic. They are encouraged to use this new technology as much as possible, which depends on the policy and thinking of the senior managers of the organization [3].

Frameworks are software components designed to support the development of dynamic websites, web applications, web services, and web resources. Designers of frameworks seek to provide ease, speed, accuracy and security for programmers. Based on this view, prominent software companies produced products such as JavaScript, PHP, Python,

and Ruby to be used to improve the quality and efficiency of software in global markets.
The rest of this paper organized as follows: section 2 describes relevant definitions. Key features of ERP discussion in section 3. In section 4 we studied about reasons for ERP implementation. Introducing advanced frameworks reviewed in section 5. Section 6 includes introducing type of organizations, proposed multi-criteria decision-making based approach and results. Finally, section 7 presents the conclusion.

2. Transient State of CB Opening

2.1. ERP

ERP is a commercial software package whose purpose is the integration of information and its flow between all departments of the organization, including finance, accounting, human resources, supply chain and customer management [4].

2.2. Framework

A framework is a set of codes, libraries and classes that help programmers to create their web applications faster and more flexible. Frameworks with specific methods and functions, which allow to the programmers for providing a unified and standardized system by using fewer commands and more order [5].

3. Key Features of ERP

Considering what systems can be classified in the category of ERPs, it is a very important issue that is mentioned in Table 1 of the features, along with their importance coefficients [6].

Table 1: ERP features

item	description	Importance coefficients
Database integrity	All modules use the database in an integrated way	3
Software integrity	Not only each module is related to a common database, but also related to other modules of the system	2
Valid and successful experiences	Optimizing, configuration of processes and information flow in a specific industry where the experience of information flow and its optimized and tested processes have led to the improvement of the quality of the organization.	4
process orientation	WFMS standard and the possibility of defining, controlling and monitoring and managing processes at the level of all modules	2
Comprehensiveness and the possibility of planning all the resources of the organization (materials, manpower, production, ...)	The most important point of separation between conventional systems and ERPs is the possibility of comprehensive planning and forecasting of resources.	5

3.1. The new generation of ERP

Customer integration is the main concept of ERP III technology in ERP systems. ERP III adapts itself to the latest and most sophisticated IT achievements. ERP III focuses not only on real customers but on all possible customers.

Advanced analytical marketing is one of the key features of ERP III. For example, it classifies collecting information about the IP address of Internet users, showing their geographic location, or information about the search engines used by users relative to the device they used to search the ERP systems website. The feature that improves ERP III versus to ERP II is the constant updating of software in the field of designing and analysing software systems, especially in the field of business and commerce.

ERP III technology, whose concept is being developed and exploited in global markets, is focused on the implementation of new technologies such as cloud computing and GRID implementation in ERP systems [1].

4. Reasons for ERP Implementation

The main aim of all organizations is improving the level of productivity through the optimal use of their resources. Based on the following reasons, this issue is becoming more important [6].

a. Market pressure as the engine of movement and change
b. Global economy and global communication
c. Limitation of resources
d. Increasing competition
e. Faster response to customer market needs.
f. Reducing costs through inventory management
g. The possibility of managing small and diverse suppliers

5. Introducing Advanced Frameworks

Some of advanced frameworks listed in Table 2 and described in next sub-sections.

5.1. Angular.js

Companies such as Google, Nike, General Motors and the Guardian news site support this framework. One of the important reasons that the mentioned companies have turned to this framework is that this framework is not only very flexible, but also the desired changes can be made very quickly in the application written with this framework. In addition, Angular.js gives developers more options than other frameworks to write and test their code and find errors before they become big bugs and fix them. One of the features of the Angular.js framework is that it uses special terms that are specific to this framework, and the reasons for its popularity are this. In addition, Angular.js has features that no other framework has [7].

Table 2: Advanced frameworks

Framework	Initial Release	Last Release	License	Operating System	Written in
Angular	2010	2016	MIT	Cross-platform	JavaScript
Ember	2011	2016	MIT	Cross-platform	JavaScript
Laravel	2011	2016	MIT	Cross-platform	PHP5
Symfony	2005	2016	MIT	Cross-platform	PHP5
Django	2005	2015	BSD	Cross-platform	Python
Ruby on Rails	2005	2016	MIT	Cross-platform	Ruby

In Angular, you can show data by defining components. The data in the component classes can be used and accessed automatically to show in the format or how to control how it is presented. Angular works equally well not only in Type Script but also in Dart, ES6, ES5. A group of coordinated components have divided their responsibilities and tasks in applications. In this framework, the components reference the templates in a separate file, which indicates that Angular framework uses inline templates. By defining types that communicate the developer's goal with other developers, it helps to find problems in the code and allows IDEs to be used for further development, modification, and coding. Every panel in the Angular framework that can be seen is stored in memory and can be verified. Those panels that cannot be seen are left hidden, but they will definitely not be accessible in memory. Another feature that can be used in this framework is querying a component from another component. These queries are updated automatically, even if a panel is added. This action allows the components to work with the **"ng for"** feature without having any special knowledge of it [8].

The size of this framework is 39.5 KB and since the framework is an independent framework and does not use libraries such as jQuery or Handlebars, its size has not increased and is stable [9,13].

Angular has special testing tools, for example, it uses Karma for unit testing [10]. It also uses Protractor to perform End-to-End testing [11]. The Angular framework has a lot of emphasis on tests. Programmers believe that if they learn Angular, it is like

learning the future of JavaScript. One of the important and valuable features of Angular is DOM (Document Object Model), which is one of the reasons for Agular's popularity.

5.2. Ember.js

Discourse, Zendesk, Groupon, LivingSocial and Square applications are some famous examples that use this framework. According to the main developers of this framework, when you view a site, you can easily determine whether Ember is used or not. Sites that use the Ember framework load and run very quickly. The Ember framework is a suitable choice for large projects, but it is not a suitable choice for small projects due to its heavy volume [7]. In order to solve the previous problems and provide advanced modularity, the Ember framework has presented a new version to the market, which also optimizes the Codebases in this version. In summary, it can be mentioned that if in a project, there is a need for a framework with stability and simple update capability, the Ember framework can be a suitable option [12].

The ember framework has the title of one of the largest frameworks. The size of the ember framework alone is 90 KB [9]. Since ember is not an independent framework and uses jQuery and Handlebars libraries, its volume has increased and reaches 136.2 KB [9,13].

The ember framework is a powerful JavaScript framework whose features include the following:

- Auto-updating Handlebars Templates
- Components
- Loading data from a server
- Routing

The first feature ensures the user that the HTML remains up-to-date even if the underlying model changes. Regarding the second feature, which is Components, the user is allowed to create Application-specific HTML tags for himself. The third feature makes it possible to use two-way Data-Bindi, this feature gives the programmer the ability to create data packages and transfer them like JSON. Finally, the Routing feature, which can only be found in a few high-level frameworks, is related to the functions of working with URL and addressing at different levels of the program [14].

5.3. Laravel

Laravel is an open-source PHP framework designed by Taylor Otwell to develop PHP web applications based on MVC architecture. Laravel is developed and supported under the MIT license in a repository on GitHub. According to the developers, in December 2013 and 2014, it was mentioned as the most popular PHP framework. In simple terms, Laravel is a practical tool for PHP developers to create their codes faster and more efficiently [15]. Laravel framework has instructions and how to write good and professional code. With the tools provided by this framework, you can create great web applications. One of the good points to consider in the Laravel framework is that it has implemented the Migration tool well, that is, the current database can be changed to another database software [16].

The word ORM (Object Relational Mapping) refers to a set of techniques that provide programming capabilities for data conversion between non-object-oriented systems and object-oriented programming environments and to use facilities such as Inheritance is used from ORM. In the Laravel framework, which has ORM facilities, it uses the Eloquent method, which inherits the newer and more logical ORM codes and entities. In case of unit testing, Laravel framework uses PHP Unit to ensure the functionality of that small part and verify its functionality [17].

Regarding templates, Laravel uses Twig and Blade respectively, which is one of the powerful features of PHP, these templates are Java templates [18].

5.4. Symfony

The Symfony framework is one of the most well-known PHP frameworks that has unique features. The most important feature in working with Symfony is the complete mastery of its settings. Also, this framework includes a regular directory structure and supports external libraries. This framework has tools to fix program bugs in a practical way. A number of programmers believe that Symfony isn't suitable for small projects, the reason for this belief is because of the large and detailed structure of this framework. So, this framework will be more suitable for large projects, the most important reason of which is that a large number of simultaneous requests are executed for each operation [16].

Symfony framework has an ORM tool that uses Doctrine and Propel methods. The best way to install Symfony is to use the Official Symfony Installer, because it allows the user to choose their new projects based on any desired version. This framework uses PHP Unit for unit testing like Laravel, this tool has a complex structure, but in terms of security, it includes all XSRF, XSS, and SQL Injection features [17, 19].

5.5. Django

This high-level framework is designed in Python for the web, which provides the possibility of designing and creating web applications very quickly and easily. This framework is open source and is available to users for free [20].

Django makes it easy to create dynamic websites. A high-level framework provides many programming items automatically and provides them to the programmer. It also has shortcut and simple methods for performing various actions. Therefore, the programmer does not need to write additional and time-consuming codes in Django. It prevents the creation of programs with mixed and incorrect relationships. By using this feature, the program is divided into independent and separate parts, each of which can be changed independently without the need to apply changes to the rest of the parts, and they are related to each other using clear and optimal relationships. The main features of this framework include the following:

- A system for validation and serialization of HTML forms
- An independent and small web server that is used to test the program during its development

- An information hiding framework for reuse or cache that provides different cache methods
- Supporting middleware tools that provide the possibility of executing desired functions and commands in different parts of processing a request
- An internal dispatcher that allows different parts of a web application to receive different signals and events
- The internationalization system that even provides places to translate different parts of Django into different languages
- A system for sequencing and serialization that provides the possibility of working with all types of data based on XML and JSON and in general AJAX
- A system for developing template engine capabilities

New features of Django after the update are follow:

- An expandable authentication system
- A dynamic and dynamic management interface
- Tools for creating RSS and Atom
- Flexible and expandable commenting system
- Tools for generating Google Sitemaps
- Security tools to prevent cross-site request forgery attacks
- Template libraries that allow the use of light and small markup languages such as Textile and Markdown

5.6. Ruby

The Ruby language was introduced by Yukihiro Matsumoto. His goal was to create a language that would provide a balance of functional programming and command programming to the programmer.

The main features of the Ruby language are:

- object orientation
- Four levels of variable field of view including: global, class, instance and local
- Exception handling
- Support for iterators and closures (based on the exchange of code blocks)
- Local support for regular expressions (similar to Perl) at the language level
- Operator overloading
- Automatic garbage collecting from the memory
- High portability
- Partnership support of multi-threading on all platforms using green threads
- Shared libraries/DLLs on most platforms
- Introspection, reflection and meta-programming
- Large standard library
- Dependency injection support
- Continuations and generators

Ruby is slower compared to many compiled languages (like any other interpreted language) and also compared to major scripting languages like Perl and Python. However, in future versions of Ruby, it will be compiled as bytecode and run on YARV. Currently, the memory used in programs written in Ruby is less than the memory used in the same programs written with Perl and Python [21].

6. Evaluation of Frameworks

In this section, advanced web frameworks that can be used in ERP are compared based on the evaluated algorithm. Considering that Apache ofBiz and JBoss Seam frameworks used in small organizations and it is not possible to update them in large organizations, for this reason they are removed from the competition with advanced frameworks. The indicators of the mentioned frameworks will be ineffective due to the complexity and ambiguity in the comparisons. The main and fundamental features are briefly presented and reviewed. The method of valuing the frameworks is considered in the range of 0 to 10, the range of 7.1 to 10 is optimal, the range of 5.1 to 7 is medium to high, the range of 2.1 to 5 is medium to low, and the range is 0 to 2 is a minimum. Based on the research conducted in the statistical population based on the questionnaire, interview of these numbers has been assigned according to the merit of the frameworks in the field of feature parameter, and by using the MCDM algorithm, which will be mentioned later, the frameworks will be compared and the best framework will be selected. Organizations will be selected based on this.

6.1.Introduction of organizations

In this section we describe about 3 types of company. We divide them by scale, complexity of their process and other resources.

Table 3: Evaluation of the characteristics of frameworks

Feature	Angular	Ember	Laravel	Symfony	Ruby	Django
Update	**9**	**8**	**8**	**8**	**7**	**6**
Open Source	**10**	**10**	**10**	**10**	**10**	**10**
Flexibility	**8**	**6**	**7**	**8**	**6**	**5**
Database	**10**	**10**	**10**	**10**	**10**	**10**
Fast Design	**8**	**7**	**8**	**5**	**2**	**3**
Speed	**8**	**7**	**8**	**7**	**5**	**5**
Security	**7**	**6**	**7**	**6**	**4**	**5**
MVC	**8**	**9**	**7**	**8**	**5**	**5**
Ajax	**7**	**8**	**6**	**9**	**6**	**6**
ORM	**6**	**8**	**9**	**7**	**5**	**5**
Modularity	**7**	**8**	**7**	**9**	**7**	**7**
DRY	**7**	**8**	**8**	**8**	**7**	**7**
Unit test	**8**	**8**	**7**	**7**	**5**	**5**
End-to-End test	**8**	**8**	**6**	**7**	**1**	**2**
template	**8**	**6**	**7**	**7**	**5**	**5**
documentation	**8**	**7**	**8**	**7**	**5**	**6**
Admin panel	**9**	**8**	**8**	**8**	**6**	**7**
I 18 N & L 10 N	**7**	**8**	**7**	**9**	**6**	**6**

C1: Suitable framework in large organizations

In this group, organizations need wider, more complex tasks, human resources, security and speed. In these organizations, due to global competition, software updates and fast design are more important. Due to high costs and lower risk tolerance, such organizations need software with a lower error rate and software testing before its implementation.

C2: Medium-sized organizations tending to large

In this group, organizations need better security and the importance of database-based parameter is more. Due to the increasing progress of these organizations, updating the software is also of great importance. The parameter of documentation in this group of organizations is important because of recording documentation for better progress and expansion of the organization.

C3: medium organizations

In this group, the flexibility parameter is more important than other organizations and the need for individual characteristics is more in these organizations. In this group of organizations, due to the lack of cost, the software's open-source parameter and its low error rate are more important.

6.2. Algorithm

To choose the best framework according to the characteristics and the organization that will be used there, the following algorithm is proposed. This algorithm is based on decision-making on several criteria [22].

In this algorithm, the functions are divided into two categories, main and secondary functions, and according to the time conditions and the needs of the organizations at that time, parameters with high importance are included in the main function and parameters with low importance are included in the secondary function. Due to the tough competition between organizations, the advancement of facilities and the ease of use in integrated software, framework manufacturers are looking to provide the best products. Some parameters are also removed due to their less important characteristics in this period of time. Companies that build frameworks provide them with special features to attract users. For this reason, it is possible to challenge the common features of advanced frameworks and evaluate them according to the research done, and choose the suitable framework for different organizations using the MCDM algorithm. The algorithm includes the following steps:

First stage

Each of the functions presented in table 3 is checked and the weight W_i is given to each of them based on the importance of that function in the system, which is a value range between 0 and 10. Therefore $w = \{w_1, w_2, \ldots, w_n\}$, where n is the number of functions ($n = 18$), the sum of w_i will be equal to 60.

Second stage

Each parameter is weighted based on its importance, and in different organizations, this coefficient is changed according to their needs, and the most important parameter in different organizations is assigned 10, and the least important parameter in different organizations is 0. Therefore, depending on the importance, the parameters get a weighting factor in the range of 0 to 10.

Third level

The final evaluation of each x_k framework is possible using the Eq. 1.

$$V(x_k) = \sum_{i=0}^{n} w_i v_i(x_k) \quad (1)$$

In above Equation, parameter $v(x_k)$ is value of evaluation in group i, w_i is the weight of group i, n is the number of groups.

Fourth stage

Each framework has an evaluation value $v(x_k)$ for each of the organizational groups, so the best framework for the desired organization is the one that has the highest grade.

6.3. Results

According to the obtained information and experts' opinions based on questionnaires and interviews, each framework was evaluated based on different criteria and the most suitable framework for each group was obtained. Table 4 shows Evaluation results obtained by proposed algorithm. By using the obtained data, the appropriate framework can be obtained for the mentioned organizations. Due to the result of the algorithm and the better performance of the Angular framework, this framework is suggested as the most suitable framework for large organizations.

Table 4: Evaluation results based on the algorithm

Frameworks	C 1	C 2	C 3
Angular	8.01	8.00	7.95
Ember	7.08	7.46	7.76
Laravel	7.71	7.65	7.61
Symfony	7.75	7.81	7.85
Django	6.00	5.91	5.90
Ruby	5.80	5.75	5.58

Conclusion

Organizational resource management is a well-known concept that is defined in the management and implementation of projects. In this paper, an efficient approach based multi-criteria decision-making for selecting optimum framework in enterprise resource planning presented. We studied some popular ERP frameworks likes Angular, Ember, Laravel and etc. Then we described three types of originations (C1, C2 and C3). To demonstrate the ability of proposed methos, we Evaluate above frameworks in three types of originations. The results show that our proposed methods are applicable for selecting optimum framework in large scale companies.

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