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Performance Evaluation of Location-Based Advertising using Web Application Performance Testing (WAPT)

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***Abstract*—Marketers around the globe are certain of location-based advertising which is the most exciting mobile marketing for 2016, according to a recent Internet Advertising Bureau (IAB) UK [1] study cited by digital marketing stats round-up. Location-based advertising technology can help the customers understand the classified ads, location–based advertising web forums and customer's behavior. On the other hand this technology develops a new approach to individual advertisements-oriented websites design and implementation. Moreover the technology can also be beneficial to the classified ads websites niche market research, particularly in order to understand the main competitive characteristics and current market situation. The research outcomes can provide recommendations on how to evaluate and increase the performance or access time of the location-based advertising technology compare to traditional classified ads technology. For the purpose of the performance evaluation, the LoadComplete framework [2] based on Selenium Web-Driver API is employed. Performance metrics are then collected using WAPT simulation [3]. Location-based advertising achieves better results by reducing item-search time to half compare to the legacy ads. It helps to save network bandwidth as well as beneficial to a faster-improving mobile marketing turn-around time.**

***Keywords*—location-based advertising; mobile marketing; performance evaluation; WAPT simulation; LoadComplete framework.**

I. INTRODUCTION

The study of location-based advertising technology can, from one side, help us understand the classified ads/ location-based advertising web boards customer's/user's behavior and from other side, to develop a new approach to individual advertisements-oriented websites (location-based) design and technologies. Location-based services are set to be a national strategic plan as described in [4]. Query execution over location-based services has been optimized for the execution using data mining theory [5]. Customer behavior analysis in Internet marketing using GPS-based mobile applications had been investigated as written in [6]. Customer analytics in [6] have adopted GPS-based applications into their accounts, which are different perspective from location-based ads on the website. The study of location-based orientation somehow can also be beneficial in the classified ads websites niche market understanding, particularly in understanding of the main competitive characteristics and current market situation overview. Moreover, the research can provide recommendations on how to evaluate and increase the performance and access time of the location-based advertising technology as well as traditional classified ads technology. The research can also be useful for understanding the technical difficulties which can probably be faced by the developer teams during the similar projects developing, particularly in applying the modern frameworks technologies. The assumptions and results of simulations can be useful for future researches on the similar and related topics as well. Furthermore, researcher proposes that the location-based individual-oriented advertisements technology can be a community-forming factor, as it will increase the amount of personal contacts within particular location. If the model of location-based individual advertising can prove its potential and can be successful on market, it can form a basis for another study related to that. The user behavior for location-based social media can be found in [7].

The current situation on the existing advertising websites and mobile projects leads the researcher to make this study and apply the new approach to the market: location-based advertising website. Currently, the main players on the worldwide individual advertisements-oriented web-boards market, such as http://craiglist.org, https://www.classifiedads.com/ and http://ebay.com are using the classified ads/auction approach as a method of individual advertisement on web-sites. Also, there are a lot of local projects such as (for Thailand): http://www.bangkokpost.com/classifieds/,http://classifieds.thaivisa.com/, http://www.bahtsold.com/, etc., using the same approach. Moreover, we can mention about the local social-networks groups (such as Facebook groups, twitter groups, etc.) created for the individual users advertisements placement. However, these groups are also non-location-based search methods.

The researcher proposes that current approach to the technology of the individual advertisements placement has an existing lack of time-efficiency for the location-oriented search needs of those web-boards projects users. It is suggested that the location-based individual advertising system can help fulfill this lack. As the foundation for the location-based individual user search process, Google maps API is proposed.

II. LOCATION-BASED-ADVERTISING

As the concept of location-based individual-oriented advertising web-service is new, not much scientific/market research has been done covering this topic, but a short overview on those, can still be provided. There are a number of existing academic researches and market-analyzing articles describing the abstract possibility and possible implementation of the location-based advertising for smart devices i.e. smartphones, tablet pc, etc. Thereby, to support this study and to get deeper understanding of the concept of location-based advertising, the researcher wants to start from the mobile-devices based implementations researches. The analytical media articles, such as [8] and many others gives a better understanding about the possible benefits the private & non-private companies and organizations can get from mobile location-based advertising. The study of location-aware content [9] analyzed that a possible implementation of the method providing a location-based advertising for mobile devices is comprising of receiving content and metadata associated with the content from the mobile device, the metadata comprising a geographical identification of the content; and sending location-based information to the mobile device based on the geographical identification of the content. The study and method described in [10] which is implementing a method for automatically notifying a user of an offer, the method comprising: analyzing the first electronic message contains information related to the offer, automatically determining a description of the offer from the first electronic message; automatically determining a geographic location associated with the offer; automatically sending a second electronic message to the user, which is contains at least a portion of the description of the offer. However, the concept of location-based individual advertisements working as a website, which was implemented by the researcher and available for public access [11], seems not to be covered by the previous academic researches or industry-related media.

III. WAPT SIMULATION

As the methodological framework for tests and simulations, WAPT [3] has been chosen. According to it, following activities list was executed:

A. Identify Test Environment

For the purpose of the performance testing and data evaluation, the researcher chooses a "LoadComplete" testing framework [2] which is based on Selenium Web-Driver API as the test environment.

B. Identify Performance Acceptance Criteria

Following by the main criteria of this research, the scenario's execution result's 'Errors Count' parameter value = 0 is identified as the only one significantly required performance acceptance criteria.

C. Plan and Design Tests

As the technical performance evaluation, the following tests were configured and executed:

scenario 1. Location-based search (search for advertisements related to particular location).

scenario 2. Particular existed item search.

scenario 3. Area search (search for advertisements in wider range. i.e. district).

scenario 4. Individual advertisement publishing.

As the location-based advertisements oriented model is new for the individual advertisement market and doesn't have a known implementation as a web-service, the researcher created a web-service, implementing a model of location-based individual-oriented classified advertisements. The created web-service is available at [11]. To create this web-service, a researcher used "Spring MVC" framework for building the back-end side of the service and "Spring Security" for its security/authentication service, "AngularJS" framework for the front-end interface creation. The researcher suggests comparing the created service to the current big players on the local market of Thailand's online individual advertisements. http://bangkok.craiglist.org and http://bathsold.com was chosen for the comparison.

The following abbreviations will be used in future:

website a. http://plimpa.com
website b. http://bangkok.craiglist.org
website c. http://bathsold.com

The following testing scenarios was configured and executed to perform each of the tests:

Website:	Testing scenario:	Testing scenario algorithm:
website a	Scenario 1.	1. Open http://plimpa.com main page 2. Navigate to /map page 3. Zoom to the random existing location 4. Examine the list of the items bounded to randomly chosen location
	Scenario 2.	1. Open http://plimpa.com main page 2. Navigate to /map page 3. Zoom to the random existing location

		4. Open 'search around' modal dialog 5. Form the request with the random existing item's name 6. Examine the search results
	Scenario 3.	1. Open http://plimpa.com main page 2. Navigate to /map page 3. Zoom to the random existing location 4. Open 'search around' modal dialog 5. Form the request with the random existing item's name 6. Examine the search results
	Scenario 4.	1. Open http://plimpa.com main page 2. Navigate to /login page 3. Fill the login form with the existing account data and submit the login request 4. Navigate to /map page 5. Chose random location on the map and open the advertisement publishing modal window 6. Fill the advertisement information and submit the request to publish an advertisement.
website b	Scenario 1.	1. Open http://bangkok.craiglist.org main page 2. Navigate random existing category page 3. Form the search request containing random existing location name 4. Examine the list of the items resulted from search
	Scenario 2.	1. Open http://bangkok.craiglist.org main page 2. Form the request with the random existing item's name 3. Examine the search results
	Scenario 3.	1. Open http://bangkok.craiglist.org main page 2. Form the request with the random existing item's name 3. Form the request with the random existing item's name and region parameter 4. Specify the random existing district in the search request and submit it. 5. Examine the search results
	Scenario 4.	1. Open http://bangkok.craiglist.org main page 2. Navigate to login page 3. Fill the login form with the existing account data and submit the login request 4. Navigate to advertisement posting page 5. Choose and submit the random advertisement posting type 6. Choose and submit the random advertisement posting category 7. Fill the advertisement data such as title, description, and price. 8. Submit the advertisement request
website c	Scenario 1.	1. Open http://bathsold.com main page 2. Select the random category name and region name (i.e. 'Bangkok') 3. Form the search request containing random existing item name 4. Form the search request containing random district name 5. Examine the resulting list.
	Scenario 2.	1. Open http://bathsold.com main page 2. Form the search request containing random existing item name 3. Examine the search results
	Scenario 3.	1. Open http://bathsold.com main page 2. Form and submit the search request containing random existing item name and random category name 3. Form and submit the search request parameters specifying the random existing region name and the random existing district's name. 4. Examine the search results
	Scenario 4.	1. Open http://bathsold.com main page 2. Navigate to login page 3. Fill the login form with the existing account data and submit the login request 4. Navigate to advertisement posting page 5. Choose and submit the random advertisement posting type 6. Choose and submit the random advertisement posting category

		7. Fill the advertisement data such as title, description, and price 8. Submit the advertisement request

D. Configure Test Environment

Following testing environment configuration has been used for the testing scenarios execution:

Hardware:

- Intel(R) Core(TM) i7-2600 CPU @ 3.40GHz (8 CPUs), ~3.4GHz
- Memory: 8192MB RAM
- NVIDIA GeForce GTX 560
- 60GB SSD drive

Software:

- Windows 7 Ultimate 64-bit
- "LoadComplete 4" software as the Selenium-Web Driver based testing environment.

E. Implement Test Design

The researcher ensured that the test environment is correctly configured for metrics collection. Any active virus-scanning on load-generating machines during testing is turned off to minimize the likelihood of unintentionally skewing results data. Simple usage scenarios were executed firstly to validate the Web server. The problems and performance bottlenecks which were identified during simple usage scenarios executions were identified and fixed.

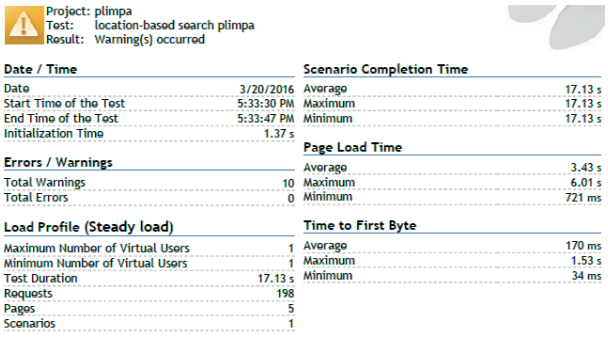
F. Execute Tests

All the test scenarios mentioned above were executed successfully and the tests results data has been stored in the format supported by the test environment software (Win 7 OS, LoadComplete 4), which became available for analytical purposes afterwards.

G. Analyze, Report, and Retest

The following data is resulted from the executed tests:

Scenario 1:

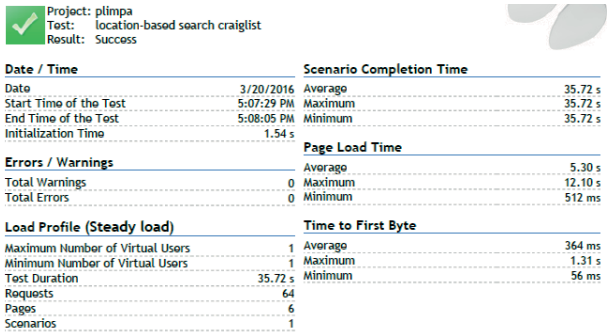


Project: plimpa
Test: location-based search plimpa
Result: Warning(s) occurred

Date / Time	
Date	3/20/2016
Start Time of the Test	5:33:30 PM
End Time of the Test	5:33:47 PM
Initialization Time	1.37 s
Errors / Warnings	
Total Warnings	10
Total Errors	0
Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	17.13 s
Requests	198
Pages	5
Scenarios	1

Scenario Completion Time	
Average	17.13 s
Maximum	17.13 s
Minimum	17.13 s
Page Load Time	
Average	3.43 s
Maximum	6.01 s
Minimum	721 ms
Time to First Byte	
Average	170 ms
Maximum	1.53 s
Minimum	34 ms

Website A.

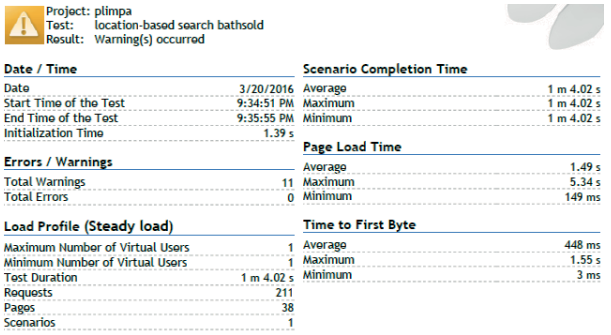


Project: plimpa
Test: location-based search craiglist
Result: Success

Date / Time	
Date	3/20/2016
Start Time of the Test	5:07:29 PM
End Time of the Test	5:08:05 PM
Initialization Time	1.54 s
Errors / Warnings	
Total Warnings	0
Total Errors	0
Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	35.72 s
Requests	64
Pages	6
Scenarios	1

Scenario Completion Time	
Average	35.72 s
Maximum	35.72 s
Minimum	35.72 s
Page Load Time	
Average	5.30 s
Maximum	12.10 s
Minimum	512 ms
Time to First Byte	
Average	364 ms
Maximum	1.31 s
Minimum	56 ms

Website B.



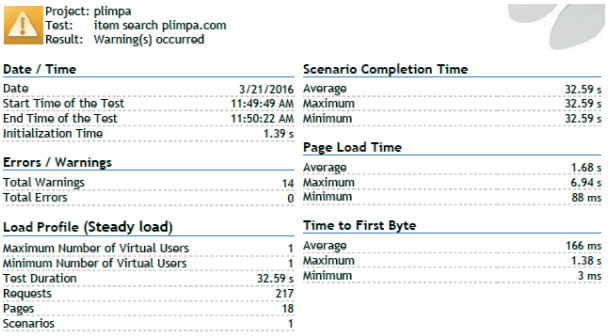
Project: plimpa
Test: location-based search bathsold
Result: Warning(s) occurred

Date / Time	
Date	3/20/2016
Start Time of the Test	9:34:51 PM
End Time of the Test	9:35:55 PM
Initialization Time	1.39 s
Errors / Warnings	
Total Warnings	11
Total Errors	0
Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	1 m 4.02 s
Requests	211
Pages	38
Scenarios	1

Scenario Completion Time	
Average	1 m 4.02 s
Maximum	1 m 4.02 s
Minimum	1 m 4.02 s
Page Load Time	
Average	1.49 s
Maximum	5.34 s
Minimum	149 ms
Time to First Byte	
Average	448 ms
Maximum	1.55 s
Minimum	3 ms

Website C.

Scenario 2:

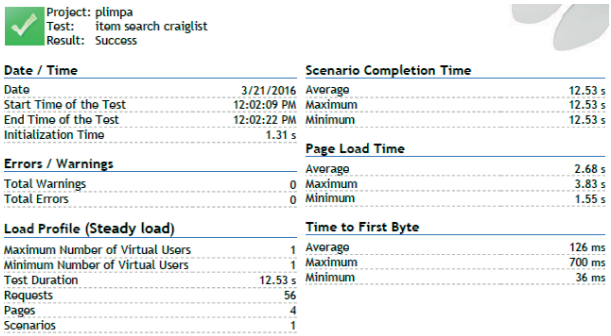


Project: plimpa
Test: item search plimpa.com
Result: Warning(s) occurred

Date / Time	
Date	3/21/2016
Start Time of the Test	11:49:49 AM
End Time of the Test	11:50:22 AM
Initialization Time	1.39 s
Errors / Warnings	
Total Warnings	14
Total Errors	0
Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	32.59 s
Requests	217
Pages	18
Scenarios	1

Scenario Completion Time	
Average	32.59 s
Maximum	32.59 s
Minimum	32.59 s
Page Load Time	
Average	1.68 s
Maximum	6.94 s
Minimum	88 ms
Time to First Byte	
Average	166 ms
Maximum	1.38 s
Minimum	3 ms

Website A.



Project: plimpa
Test: item search craiglist
Result: Success

Date / Time	
Date	3/21/2016
Start Time of the Test	12:02:09 PM
End Time of the Test	12:02:22 PM
Initialization Time	1.31 s
Errors / Warnings	
Total Warnings	0
Total Errors	0
Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	12.53 s
Requests	56
Pages	4
Scenarios	1

Scenario Completion Time	
Average	12.53 s
Maximum	12.53 s
Minimum	12.53 s
Page Load Time	
Average	2.68 s
Maximum	3.83 s
Minimum	1.55 s
Time to First Byte	
Average	126 ms
Maximum	700 ms
Minimum	36 ms

Website B.

Project: plimpa
Test: item search bathsold
Result: Success

Date / Time	
Date	3/21/2016
Start Time of the Test	12:05:16 PM
End Time of the Test	12:05:52 PM
Initialization Time	1.41 s

Errors / Warnings	
Total Warnings	0
Total Errors	0

Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	35.54 s
Requests	274
Pages	18
Scenarios	1

Scenario Completion Time	
Average	35.54 s
Maximum	35.54 s
Minimum	35.54 s

Page Load Time	
Average	1.74 s
Maximum	5.92 s
Minimum	162 ms

Time to First Byte	
Average	292 ms
Maximum	2.18 s
Minimum	32 ms

Website C.

Scenario 3:

Project: plimpa
Test: item search plimpa.com
Result: Warning(s) occurred

Date / Time	
Date	3/21/2016
Start Time of the Test	11:49:49 AM
End Time of the Test	11:50:22 AM
Initialization Time	1.39 s

Errors / Warnings	
Total Warnings	14
Total Errors	0

Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	32.59 s
Requests	217
Pages	18
Scenarios	1

Scenario Completion Time	
Average	32.59 s
Maximum	32.59 s
Minimum	32.59 s

Page Load Time	
Average	1.68 s
Maximum	6.94 s
Minimum	88 ms

Time to First Byte	
Average	166 ms
Maximum	1.38 s
Minimum	3 ms

Website A.

Project: plimpa
Test: area search craiglist
Result: Success

Date / Time	
Date	3/21/2016
Start Time of the Test	12:15:24 PM
End Time of the Test	12:15:41 PM
Initialization Time	1.34 s

Errors / Warnings	
Total Warnings	0
Total Errors	0

Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	17.19 s
Requests	19
Pages	4
Scenarios	1

Scenario Completion Time	
Average	17.19 s
Maximum	17.19 s
Minimum	17.19 s

Page Load Time	
Average	1.51 s
Maximum	4.14 s
Minimum	540 ms

Time to First Byte	
Average	111 ms
Maximum	499 ms
Minimum	32 ms

Website B.

Project: plimpa
Test: area search bathsold
Result: Warning(s) occurred

Date / Time	
Date	3/21/2016
Start Time of the Test	12:22:08 PM
End Time of the Test	12:22:54 PM
Initialization Time	1.38 s

Errors / Warnings	
Total Warnings	9
Total Errors	0

Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	45.70 s
Requests	120
Pages	30
Scenarios	1

Scenario Completion Time	
Average	45.70 s
Maximum	45.70 s
Minimum	45.70 s

Page Load Time	
Average	1.11 s
Maximum	3.28 s
Minimum	95 ms

Time to First Byte	
Average	425 ms
Maximum	1.45 s
Minimum	2 ms

Website C.

Scenario 4:

Project: plimpa
Test: advertisement posting plimpa
Result: Warning(s) occurred

Date / Time	
Date	3/21/2016
Start Time of the Test	12:59:09 PM
End Time of the Test	1:00:56 PM
Initialization Time	1.45 s

Errors / Warnings	
Total Warnings	19
Total Errors	0

Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	1 m 47.07 s
Requests	243
Pages	10
Scenarios	1

Scenario Completion Time	
Average	1 m 47.07 s
Maximum	1 m 47.07 s
Minimum	1 m 47.07 s

Page Load Time	
Average	2.46 s
Maximum	9.45 s
Minimum	9 ms

Time to First Byte	
Average	131 ms
Maximum	1.41 s
Minimum	5 ms

Website A.

Project: plimpa
Test: advertisement posting craiglist
Result: Warning(s) occurred

Date / Time	
Date	3/23/2016
Start Time of the Test	3:53:22 PM
End Time of the Test	3:56:36 PM
Initialization Time	1.42 s

Errors / Warnings	
Total Warnings	18
Total Errors	0

Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	4 m 22.49 s
Requests	347
Pages	34
Scenarios	1

Scenario Completion Time	
Average	4 m 22.49 s
Maximum	4 m 22.49 s
Minimum	4 m 22.49 s

Page Load Time	
Average	7.45 s
Maximum	57.44 s
Minimum	383 ms

Time to First Byte	
Average	568 ms
Maximum	1.93 s
Minimum	26 ms

Website B.

Project: plimpa
Test: advertisement posting bathsold
Result: Warning(s) occurred

Date / Time	
Date	3/23/2016
Start Time of the Test	3:53:22 PM
End Time of the Test	3:56:36 PM
Initialization Time	1.42 s

Errors / Warnings	
Total Warnings	18
Total Errors	0

Load Profile (Steady load)	
Maximum Number of Virtual Users	1
Minimum Number of Virtual Users	1
Test Duration	3 m 14.27 s
Requests	347
Pages	34
Scenarios	1

Scenario Completion Time	
Average	3 m 14.27 s
Maximum	3 m 14.27 s
Minimum	3 m 14.27 s

Page Load Time	
Average	4.89 s
Maximum	57.44 s
Minimum	383 ms

Time to First Byte	
Average	259 ms
Maximum	1.93 s
Minimum	26 ms

Website C.

IV. RESULTS AND ANALYSIS

All the test scenarios were executed using the single user actions emulation mode. As the Key factors for the results comparison, the researcher decided to use “average scenario completion time”. The following table represents a comparison between the testing scenarios executions results for each of the individual-oriented advertisements web services.

Based on the data which is presented in the performance evaluation comparison table (Table 1), in this research results are divided into 2 groups:

1. location-based individual-oriented advertisement service (http://plimpa.com)

2. non-location-based individual-oriented advertisement service (http://bangkok.craiglist.org, http://bathsold.com)

After this, the comparison between location-based individual-oriented advertisement service and non-location-based individual-oriented advertisement service has been made.

TABLE I:AVERAGE WEB-SERVICE'S SCENARIO COMPLETION TIME (SECONDS)

SCENARIO / WEB-SERVICE	LOCATION-BASED SEARCH	PARTICULAR EXISTED ITEM SEARCH	AREA SEARCH	INDIVIDUAL ADVERTISEMENT PUBLISHING
PLIMPA.COM	17.13	32.59	32.59	107.07
BANGKOK. CRAIGLIST.ORG	35.72	12.53	17.19	263.49
BATHSOLD.COM	64.02	35.54	45.70	194.27

TABLE II : AVERAGE WEB-SERVICE'S CATEGORIES SCENARIO COMPLETION TIME (SECONDS)

SCENARIO / WEB-SERVICE	LOCATION-BASED SEARCH	PARTICULAR EXISTED ITEM SEARCH	AREA SEARCH	INDIVIDUAL ADVERTISEMENT PUBLISHING
LOCATION-BASED	17.13	32.59	32.59	107.07
NON-LOCATION-BASED	49.87	24.03	31.44	228.88

V. CONCLUSION

From the data represented in Table 2, the researcher defined following conclusions:

- Location–based individual-oriented advertisement online services are providing significantly (65.6%) faster location-based search efficiency than the traditional ones
- Location–based individual-oriented advertisement online services are performing similar results for the purposes of particular existed item search (8.6%) slower.
- Location–based individual-oriented advertisement online services and the traditional ones are having almost the same results for the area search scenario execution
- Location–based individual-oriented advertisement online services are shown significantly faster performance of the Individual advertisement publishing (53.2%) faster. For this particular result, the researcher has to mention that based on the researcher's subjective expertise knowledge and experience in research subject, the data may be different for this performance index, as if it were more Location–based individual-oriented advertisement online services and the traditional ones to test, because this index significantly depends on the particular project's posting algorithms and the load/performance optimization.

As the result of this research article on performance evaluation of location-based individual-oriented advertisement board, the researcher suggests, that the concept of location-based individual-oriented advertisement board has been proven from the side of its performance viability, especially for the case of location-based search purposes. The researcher also continues this study by implementing the model to the current market of the individual-oriented advertisement boards.

The concept of location-based individual-oriented advertisement board can also be a base for further studies of its performance evaluation and optimization, marketing and technological implementations. The researcher suggests that different technological implementations of the model may increase the key performance of location-based search. Also, the researcher suggests that the product and its marketing strategies implementations may be significantly different applying to different countries local markets.

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