

Performance Measurement of E-commerce Website using Fuzzy Logic

Dr. Saurabh Mishra¹, Dr. Lokendra Kumar Tiwari², Dr. Arun Singh³

¹Assistant Professor, IIT-Allahabad

²Assistant Professor, Ewing Christian College, Allahabad

³Assistant Professor, GL Bajaj, Greater Noida

ABSTRACT - In this paper, fuzzy logic based optimization technique has been applied to measure the web quality performance. In literature web assessment scale, web optimization technique, web quality model, web information system engineering, web metrics and analytic hierarchy process are available. Majority of them has given models for the web quality by ensembling one or more above mentioned methods. It is clear that web quality model discussed above is not uniform in nature and vary upon the applications are in use. Any websites irrespective of their usage would need a defined recipe of ingredients like- accessibility, navigation, content, interoperability, security and interface. Variables may be interrelated with each other and may prevail upon other and are considered as a control variable. These control variables are taken into consideration for optimization technique applied. The paper introduces the concept of shifting web performance based on dynamic decision making over the various control variables by changing their weight within time-in period in a real time system. When weight can be changed dynamically in variables depending on the response of the users or by the system, then concept of optimization technique will be applied. Simplex method for fuzzy variable linear programming has been applied to this particular case study. Project Six Pap tool has been used for the formulation of control variables.

Key words: Fuzzy optimization, Performance measurement, Quality parameters.

I. INTRODUCTION

Internet has proven one of the important and effective channel for distributing information and services. Websites has been popular medium for buying and selling over the internet. E-commerce became popular for its convenient and efficient services to the consumers worldwide. E-commerce is an effective vehicle for reducing cost, increasing value chain efficiency and revenue generation through branding at reasonable cost (Williams et al.,2009) [1]. E-commerce business is growing day by day and traditional companies are shifting themselves from brick & mortar to online environment. The resultant is growth of competitive environment within the segment. E-commerce service providers need to be prepared to meet these challenges arising

out of competition and has been matter of concern for academia and of researchers as well. The website of e-commerce companies is unique and is single point of interaction through the customers. Maintaining the quality of e-commerce website is very crucial because modern e-commerce websites are more complicated than ever before. The quality of website is directly linked with the performance of the e-commerce website. Poor quality of website may result poor visitor experience which leads to less visit and may result poor sales. Studies show that 35% of visitors abandoned the website that takes page load time more than 3 seconds.

II. LITERATURE REVIEW

Quality evaluation of website has been taken into consideration by many authors and marketers. The quality of website is based on criteria's like content, real-time support, product search, ordering, payment process, security provisions, reliability, security, design, ease of search, speed, price information, description of product, assurance and quick responsiveness etc. The quality of the website has been evaluated for academic, branding, bookstore, retail and for commercial websites. [3]

Author's evaluated quality of website to measure the performance of e-commerce business; the performance of the e-commerce is directly linked with quality of the website. Author's & researchers used web assessment scale, web optimization technique, web quality model (WQM),[6,7,8] web information system engineering, web metrics, analytic hierarchy process , performance model approach (PMA) and quality evaluation method to measure & assess the quality of the website.[4,5]

Website quality evaluation analysis is given in table.1 [9-26]. From the table we can find numbers of attribute taken into consideration by various authors. Analysis enabled to identify the key attributes for e-commerce websites. Most of the authors emphasized quality of such items like Navigation, Interface, Content, Reliability, Speed, Feedback, Aesthetic & design etc.

Navigation was discussed 47%, interface 16%, content 79%, reliability 26%, accessibility 37%,transaction pages

26%,security 26%,speed 26%,SEO 16%,feedback 26%,interoperabilty 16% and presentation 32% respectively.

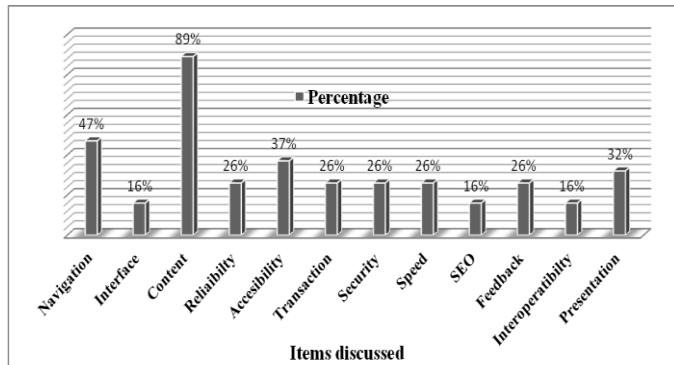


Figure: 1

The numbers of variables discussed by the authors was to optimize the website and are the key drivers for measuring the performance of the e-commerce websites in general. The performance of the e-commerce websites measured by the authors were only to improve the functionality and others aspects of the website. The measurement was not directly linked with the monetary performance of the website and it was assumed by the authors & researchers that improving the key features of the website will increase the financial performance. Intangible benefits have been considered by the authors in their research and tangible benefits were out of their scope which includes both financial benefits and revenues. The performance of the website has direct link with the ROI of the website and none of the author considered the development of the web site.

The development cost includes both set-up cost and running cost of the e-commerce websites. Set-up cost and running cost has been key barriers to development of online technologies. The development cost of the website has direct impact on the ROI of the website and hence will affect performance of the e-commerce website. [Mishra et al. 2012] [27]. Cost optimization of the e-commerce website is not discussed by any of the authors. The current paper discusses how to optimize the development cost of the e-commerce websites to increase the ROI and to yield tangible benefits as well. The design & development cost of the website is expensive and is based on the structure of the website. Website design and development includes web development, web design, and website re-development, re-design of website, website maintenance, logo design, web hosting, SEO service and domain design.

III. E-COMMERCE WEBSITE ATTRIBUTES

To indent key attributes preferences of e-commerce websites of the Indian consumer a survey was done. In the survey the

sample size was 530. Out of which 249 have been removed from data owing to have incomplete information, 281 respondents turned up. Key to quality of the website has been identified from user's perspective. In the survey key attributes were given as an option to the users to choose as an important factor to improve the quality of the website. Attributes for the performance of e-commerce website discussed by various authors are given in table 1.

The attributes which were taken into consideration were interface, content, reliability, accessibility, transaction pages, security, speed, SEO, feedback, interoperabilty, presentation, WSM, information quality, site map, domain, web optimization, ease of use, interface & aesthetic & features and navigation. Out of 19, 10 attributes were taken into as an important factor for the e-commerce websites. These features are content, navigation, interoperability, accessibility, security, interface & aesthetic, SEO, transaction and feedback. Content is king which deals with the structure of e-commerce website. It includes not only data but also text, image, video and necessary information in details. Interoperabilty Attributes of the software that enable to interact with specified system applications. Accessibility for a website is if anyone regardless of economic, geographic or physical circumstances is able to access it [Good, 2008][28]. In other words accessibility defined as the ease for the people with disabilities, people from different geographical regions and people having different internet connections. Security is one of the important features of e-commerce website. Most of the security breaches happened at end points i.e. the local networks. The e-commerce security needs to be addressed not only at the business site but also on user's site. Web site design and development cost includes cost of layout design, SEO, content, shopping cart, link page and cost of manpower involved along with R & D, up gradation and maintenance cost. The costing for the e-commerce design and development has been taken from various sources. The costing has been taken from the:

1. Professionals Developers
2. Freelancer
3. Offshore

Average design and development cost has been taken into consideration, which includes R & D cost, man hour and maintenance cost. The detailed features have been taken for design and development. The cost optimization of the e-commerce website has been done with help of fuzzy optimization technique which is fuzzy logic based. A simplex method for fuzzy linear programming problem has been applied for study in consideration.

Table1: Website quality evaluation analysis

Dimension Model by	Navigation	Interface	Content	Reliability	Accessibility	Transaction pages	Security	Speed	SEO	Feedback	WSM	Interoperability	Presentation	Aesthetic & Design	Information quality	Ease of use	Site map	Domain	Web optimization
Merwe and Bekker, 2003	+		+	+		+							+	+	+	+	+		
Petra et al., 2004		+	+				+			+				+	+				
Charles et al., 2006			+		+	+	+	+					+	+	+			+	
Banegil et al., 2004	+		+		+			+						+					
Chung et al., 2005										+									
Coyle & Thorson, 2001		+																+	
Lee 2001									+		+								
Liu et al., 2000			+			+	+	+						+		+			
Bauer and Scharl, 2000	+		+		+					+	+								
Coral et al., 2005	+		+	+									+				+		
Ghandour et al., 2011	+		+			+			+			+		+	+				
Pont et al., 2003					+					+								+	
Graja et al., 2001	+		+					+											
Ana Carolina Rossi, 2012			+						+		+		+	+					+
Datla et al., 2005			+							+			+	+	+			+	
Aleem et al., 2007			+	+			+	+						+					+
Xiaoyi Wu, 2008	+		+		+	+							+	+					
Rababah et al., 2010	+		+	+	+		+					+			+				
R Shrivastava et al., 2012	+	+	+	+	+							+		+		+			

3.0 COST OPTIMIZATION USING FUZZY LINEAR PROGRAMMING

E-commerce development cost has been key concern for the marketers and for developers as well. The development cost is based on the performance criteria of the e-commerce websites. Performance attributes of the e-commerce website is rely upon the attributes of the website. The attribute options are: content, navigation, interoperability, accessibility, security, interface & aesthetic, SEO, transaction and feedback.

The cost optimization policy is also intended to investment in terms of time and other resources like man hour, money etc. The characteristics of each quality option is shown in table 2.

Table 2: Quality options for e-commerce website

Qualitative and quantitative characteristics of e-website							
Website attributes	Development cost US\$	R & D cost US\$	Upgrade & maintenance cost	Man hours	Website performance	Performance grade	
C Content (x1)	3758	258	High=3	13	High	A	
N Navigation (x2)	1500	200	Medium=2	6	High	A	
I Interoperability (x3)	450	26	Low=1	8	Low	C	
WSM Website with rich search mechanism (x4)	374	12	High=3	4	Low	C	
A Accessibility (x5)	1100	60	Medium=2	9	Medium	B	
S Security (x6)	747	130	High=3	11	High	A	
IA Interface & Aesthetic features (x7)	1870	85	Low=1	20	Medium	B	
SEO SEO (x8)	2899	145	High=3	31	Medium	B	
T Transaction (x9)	374	95	Medium=2	4	High	A	
F Feedback (x10)	748	45	Medium=2	8	Low	C	

Table 3: Key dimensions

E-commerce website	Key dimensions										
	C	N	I	WSM	A	S	IA	SEO	T	F	
Low performance	1.15	1.15	2.2	2.1	1.6	1.7	1.9	1.85	1.3	2.5	≥ 1
Regular performance	2.05	2.65	2.2	2.3	2.25	2.4	1.9	1.85	1.95	2.55	≥ 3
High performance	2.85	3.2	1.8	2.6	3.2	3.25	2.2	3.05	2.45	2.85	≥ 5

The website can be modeled with these equations:

$$1.15 X_1 + 1.15 X_2 + 2.2 X_3 + 2.1 X_4 + 1.6 X_5 + 1.7 X_6 + 1.9 X_7 + 1.85 X_8 + 1.3 X_9 + 2.5 X_{10} \geq 1 \dots \dots \dots (a)$$

$$2.05 X_1 + 2.65 X_2 + 2.2 X_3 + 2.3 X_4 + 2.25 X_5 + 2.4 X_6 + 1.9 X_7 + 1.85 X_8 + 1.95 X_9 + 2.55 X_{10} \geq 3 \dots \dots \dots (b)$$

$$2.85 X_1 + 3.2 X_2 + 1.8 X_3 + 2.6 X_4 + 3.2 X_5 + 3.25 X_6 + 2.2 X_7 + 3.05 X_8 + 2.45 X_9 + 2.85 X_{10} \geq 5 \dots \dots \dots (c)$$

$$X_i \geq 0 \dots \dots \dots (d)$$

Where $i= 1, 2, 3$. These inequalities shown above represent the restrictions on our control variables X_i ,

$1 \leq i \leq 3$. We want to minimize the total development cost of the e-commerce websites designed. For that the equation:

Table 4: Control variables

X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀
4019	1702	477	389	1162	880	1956	3047	471	795

$$F(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}) = 4019 X_1 + 1702 X_2 + 477 X_3 + 389 X_4 + 1162 X_5 + 880 X_6 + 1956 X_7 + 3047 X_8 + 471 X_9 + 795 X_{10} \dots\dots\dots(e)$$

In the above equation

$$\text{Min } Y = C X$$

$$\text{And } AX \geq R, X \geq 0$$

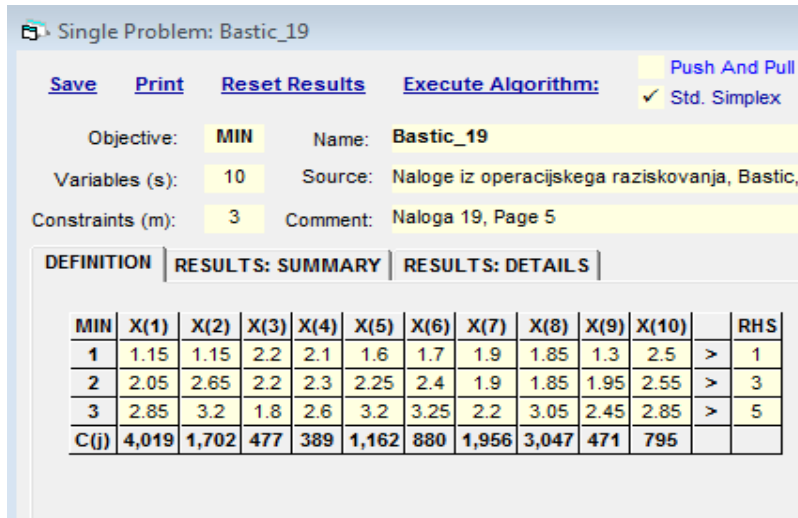


Figure 4: Project Six Pap interface for defining FLP

S U M M A R Y

Status: OPTIMAL
 Degeneracy: NO
 Test to constraints: OK
 MIN: 748.0769
 BVS: [4, 11, 12]
 x(1) = 0
 x(2) = 0
 x(3) = 0
 x(4) = 1.9231
 x(5) = 0
 x(6) = 0
 x(7) = 0
 x(8) = 0
 x(9) = 0
 x(10) = 0
 Number of iterations: 5
 Number of additions/subtractions: 578
 Number of multiplications/divisions: 741
 Number of loops: 715
 Number of decisions: 635

IV. CONCLUSION AND ANALYSIS

In the present research paper key quality parameters for the performance of the e-commerce website through website quality analysis have been identified. The research presented solution for specific quality parameters with cost optimization. Table 2 suggests quality measurements in such case may range between 'low to 'high'. The cost effectiveness also leaves room for considering other quality model in the same or similar quality measurement. From table 3 it can be interpreting that if the present website quality parameters fail to deliver the required functionalities at the desired level of quality then there are other alternate models to try. Both table 2 and 3 is not exhaustive and more than one alternate performance model can exist at the same range.

The presented technique has been able to find one set of solution leading, low to high performance measure, where depending upon the requirement the performance model may be chosen. The control variables are either crisp or fuzzy, but the present technique is able to convert each one into crisp value.

The Web quality is defined here in the forms of performance and performance is dependent on the control variable values obtained. The values of control variables indicated the minimum level of quality parameters the model must meet at the specified optimal cost e.g. $x_4 = 1.9231$. Whenever the cost gets increased the control variable may result in improved values.

A major limitation of the method is to apply the technique for a particular model one at a time. The technique does not divulge the base model and its alternative in one go but the tool is required to be run again and again to generate a comparative table to have an optimized solution and its best cost effective alternative. The values of control variable are crisp subject to interpretation of the user into fuzzy. Somehow the fuzziness captured in the problem gets blunt with the crisp value treatment.

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