International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-3, Issue-5, May 2017
ISSN: 2395-3470
www.ijseas.com

Analysis on the transitional impacts of Digitalization using Modified Fuzzy DEMATEL

[1]M.Meenakshi.,[2]P.Vijiyalakshmi.,[3]Nivetha Martin.,[4]P.Pandiammal

[1,2] Department of Mathematics, PSNA CET, Dindigul.

[3]Department of Mathematics Arul Anandar College (Autonomous), Karumathur

[4]Department of Mathematics, GTN Arts College, Dindigul

Abstract

Presently our nation is witnessing the technological revolution. The process of information communication takes place in nano seconds with the advancement of social networks, even the conventional transaction of cash is getting modified into cashless payment these days. People feel closer with each other inspite of being apart from one another. These hi-tech changes are the resultant of the integration of digital facets. The unification of these facets is Digitalization which plays a crucial role in developing technology oriented planet. In this current scenario people are getting adapted to the mechanisms of Digitalization very easily and they indeed strongly believe that this would definitely result in high transitions. The inculcation of digitalization will surely end in transitions in all aspects, and this paper mainly aims in finding the most significant transitional impact using Decision making trial and evaluation laboratory (DEMATEL) technique with Hexagonal fuzzy numbers. In this paper the modified method of Fuzzy DEMATEL is used to minimize the complexity in computations.

Keywords: Digitalization, Transitional impacts, Hexagonal fuzzy number, DEMATEL

1. Introduction

The transitional impacts of Digitalization has many dimensions, it has made the human to serve all his needs at his own pace, it has also paved way for the emerge of several opportunities to be at the doorsteps of an individual. These impacts are interrelated and they are highly influential. The effects of digitalization in several fields were analyzed by the respective experts. In general the transitional impacts have not been ordered or ranked using any scientific method. This paper aims to determine the significant impacts. Decision making and inference analysis is quite difficult in the existing uncertain environment. To draw precise conclusions from imprecise situations the concept of Fuzzy Set theory is employed. The quantification of linguistic variables interms of fuzzy numbers assist in the elimination of vagueness.[4] The method DEMATEL also follows the same strategy. The pioneer of this method is Hwang & Yoon in the year 1981 and it

has origin in Geneva research centre of the Battelle Memorial Institute. This method was further developed by many researchers by using different types of fuzzy numbers. In this paper the method DEMATEL is used with Hexagonal fuzzy numbers, which is of higher order.

The paper is structured as follows: section 2 consists of the basic definitions; section 3 contains the methodology; section 4 comprises of the adaptation to the given problem; section 5 concludes with the results and discussion.

2. Fundamental Concepts

This section contains the basic and essential definitions pertaining to this research work [2]

Fuzzy Set

Let *X* be a nonempty set. A fuzzy set *A* in *X* is characterized by its membership function A: X $\rightarrow [\mathbf{0}, \mathbf{1}]$, where A(x) is interpreted as the degree of membership of element *x* in fuzzy A for each $x \in \boldsymbol{X}$

Fuzzy Number

A fuzzy set $\widetilde{\boldsymbol{A}}$of the real line R with membership function $\mu_A\,(x)\colon R \rightarrow [0,1]$ is called fuzzy number if

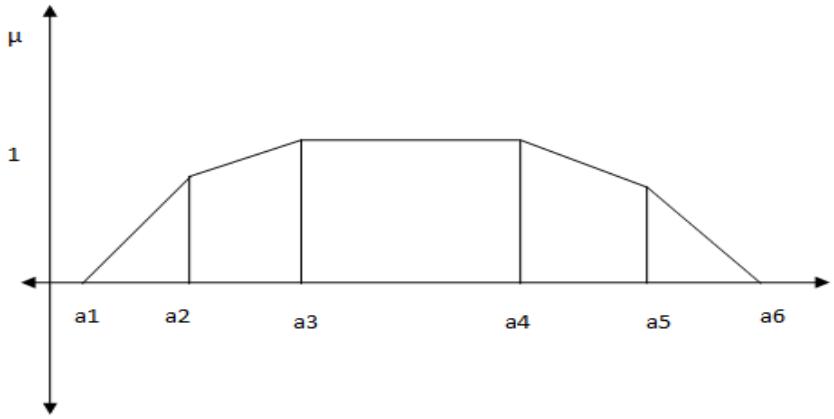
i) A must be normal and convex fuzzy set;

ii) the support of $\widetilde{\boldsymbol{A}}$, must be bounded

iii) $\boldsymbol{\alpha_A}$must be a closed interval for every $\boldsymbol{\alpha} \in [\mathbf{0}, \mathbf{1}]$

Hexagonal fuzzy number

A hexagonal fuzzy number is specified by 6 – tuples, H = (a1,a2,a3,a4,a5,a6) such that all ai's are real numbers and a1≤a2≤a3≤a4≤a5≤a6 where the membership function is



$$\mu(\tilde{A}x) = \begin{cases} \frac{1}{2}\frac{x-a1}{a2-a1} \; for \; a1 \leq x \leq a2 \\ \frac{1}{2} + \frac{1}{2}\frac{x-a2}{a3-a2} \; for \; a2 \leq x \leq a3 \\ 1 \quad for \; a3 \leq x \leq a4 \\ 1 - \frac{1}{2}\frac{x-a4}{a5-a4} \; for \; a4 \leq x \leq a5 \\ \frac{1}{2}\frac{a5-x}{a6-a5} \; for \; a5 \leq x \leq a6 \\ 0 \quad \text{otherwise} \end{cases}$$

3. Methodology

The method DEMATEL is primarily used to confer about the inter impact between the factors considered. The steps involved in this method are as follows [1,4]

(1) Factors fj's related to the problem are taken for study based on N-expert's consent. The initial uncertain direct relation matrix F is formulated with the entries as linguistic variables quantified by the hexagonal fuzzy numbers, stating the inter-relation between the factors considered.

(2) The normalized uncertain group direct-relation matrix G is determined from the aggregated individual opinion matrices with the usual method.

(3) The total relation uncertain matrix T is determined by Y $(I-Y)^{-1}$ after defuzzifying G to Y

(4) The degree of influential impact Ri and the degree of influenced impact Ci is found by aggregating R's and C's.

(5) The aggregate weights are found for each factor by $\frac{\sum_i Ri+Ci}{\sum_i \sum_j Ri+Ci}$

4. Adaptation to the Study

Digitalization has brought and it will bring vast transitions in all spheres such as social, political, economic and in environment. The transitional impacts in accordance to the expert's opinion are listed as follows

F1 Economic Strength

F2 Societal well being

F3 Effective governance of the nation

F4 Automation and Instance

F5 Globalization

The inter influence amidst these factors are represented as the opinion matrix with linguistic variables as its elements.

Expert – I	F1	F2	F3	F4	F5
F1		VH	VH	VL	H
F2	M		H	L	M
F3	H	H		M	VH
F4	H	H	H		VH
F5	VH	VH	VH	M	

Expert – II	F1	F2	F3	F4	F5
F1		H	H	L	VH
F2	M		H	VL	H
F3	VH	H		M	H
F4	H	VH	H		VH
F5	H	H	H	H	

The quantification of these linguistic variables in terms of hexagonal fuzzy numbers is given as below

The linguistic values of the Hexagonal Fuzzy number are

Very Low	(0,0.05,0.1,0.15,0.2,0.25)
Low	(0.15,0.2,0.25,0.3,0.35,0.4)

Medium	(0.3,0.35,0.4,0.45,0.5,0.55)
High	(0.45,0.5,0.55,0.6,0.65,0.7)
Very High	(0.65,0.7,0.75,0.8,0.9,1)

The Direct Relation fuzzy matrix F

	F1	F2	F3	F4	F5
F1	(0,0,0,0,0,0,0)	(0.55,0.6,0.65,0.7,0.78,0.85)	(0.55,0.6,0.65,0.7,0.78,0.85)	(0.08,0.125,0.175,0.225,0.275,0.325)	(0.55,0.6,0.65,0.7,0.78,0.85)
F2	(0.3,0.35,0.4,0.45,0.5,0.55)	(0,0,0,0,0,0,0)	(0.45,0.5,0.55,0.6,0.65,0.7)	(0.08,0.125,0.175,0.225,0.275,0.325)	(0.375,0.425,0.475,0.525,0.575,0.625)
F3	(0.08,0.125,0.175,0.225,0.275,0.325)	(0.45,0.5,0.55,0.6,0.65,0.7)	(0,0,0,0,0,0,0)	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.08,0.125,0.175,0.225,0.275,0.325)
F4	(0.55,0.6,0.65,0.7,0.78,0.85)	(0.45,0.5,0.55,0.6,0.65,0.7)	(0.55,0.6,0.65,0.7,0.78,0.85)	(0,0,0,0,0,0,0)	(0.65,0.7,0.75,0.8,0.9,1)
F5	(0.55,0.6,0.65,0.7,0.78,0.85)	(0.55,0.6,0.65,0.7,0.78,0.85)	(0.55,0.6,0.65,0.7,0.78,0.85)	(0.375,0.425,0.475,0.525,0.575,0.625)	(0,0,0,0,0,0,0)

The normalized direct relation fuzzy Matrix G

	F1	F2	F3	F4	F5
F	(0,0,0,0,0,0,0)	(0.17,0.18,0.2,0	(0.17,0.18,0.2,0	(0.025,0.038,0.0	(0.17,0.18,0.2,0.

1		.22,0.24,0.26)	.22,0.24,0.26)	54,0.069,0.084,0 .1)	22,0.24,0.26)
F 2	(0.09,0.11,0.123, 0.138,0.154,0.16 9)	(0,0,0,0,0,0,0)	(0.138,0.15,0.1 69,0.18,0.2,0.21 5)	(0.025,0.038,0.0 54,0.069,0.084,0 .1)	(0.12, 0.13,0.23,0.16,0. 176,0.192)
F 3	(0.025,0.038,0.0 54,0.069,0.084,0 .1)	(0.138,0.15,0.1 69,0.18,0.2,0.21 5)	(0,0,0,0,0,0,0)	(0.09,0.11,0.123, 0.138,0.154,0.16 9)	(0.025,0.038,0.0 54,0.069,0.084,0 .1)
F 4	(0.17,0.18,0.2,0. 22,0.24,0.26)	(0.138,0.15,0.1 69,0.18,0.2,0.21 5)	(0.17,0.18,0.2,0 .22,0.24,0.26)	(0,0,0,0,0,0,0)	(0.2,0.215,0.23,0 .25,0.27,0.31)
F 5	(0.17,0.18,0.2,0. 22,0.24,0.26)	(0.17,0.18,0.2,0 .22,0.24,0.26)	(0.17,0.18,0.2,0 .22,0.24,0.26)	(0.12, 0.13,0.23,0.16,0. 176,0.192)	(0,0,0,0,0,0,0)

The defuzzified normalized fuzzy matrix Y

	F1	F2	F3	F4	F5
F1	0	0.2103	0.2103	0.061	0.2103
F2	0.1309	0	0.174	0.061	0.179
F3	0.061	0.174	0	0.1309	0.061
F4	0.2103	0.174	0.2103	0	0.242
F5	0.2103	0.2103	0.2103	0.179	0

The total relation uncertain group direct – relation fuzzy matrix

	F1	F2	F3	F4	F5
F 1	0.2351236	0.4751817	0.486122	0.24575989999 999998	0.4343867

F2	0.308992999999999996	0.248080199999999997	0.404103399999999995	0.213212399999999997	0.36484264
F3	0.217943099999999997	0.345124099999999993	0.2058543	0.234816399999999998	0.238386849999999998
F4	0.468390399999999993	0.5158034	0.5568353	0.226546299999999998	0.522219779999999999
F5	0.843204971	0.933337974	1.001435785	0.2195999482	0.937457072799999999

Weightings of the factors

I	**Influential Impacts**	**J**	**Influenced Factors**	**Weights**	**Final Weight of the factor**	**Rank**
R1	1.87	C1	2.07	W1	0.181483	3
R2	1.53	C2	2.51	W2	0.186089	2
R3	1.24	C3	2.654	W3	0.179364	4
R4	2.28	C4	1.14	W4	0.157531	5
R5	3.93	C5	2.49	W5	0.295716	1

Results and Discussion

From the above table it is very clear that the factor F5, Globalization is the most influential impact of Digitalization, followed by societal well being and so on. The ranking of the factors clearly explicates that the transitions of digitalization would be higher and it would pave way for the overall development of the nation as a whole. The significant of all these transitions is Digitalization.

In this paper the modified method of fuzzy DEMATEL is employed which made the computations and the inference process feasible.

References

1. Bharadwaj, N., "Investigating the Decision Criteria used in Electronic Components Procurement," Industrial Marketing Management, 33, 317-323 (2004).

2. Chan, F. T. S., N. Kumar, M. K. Tiwari, H. C. W. Lau, and K. L. Choy, "Global Supplier Selection: a Fuzzy-AHP Approach," International Journal of Production Research, 46(14), 3825-3857 (2008).

3. Da Silva, R. V., G. Davis, and P. Naude, "Assessing Customer Orientation in the Context of Buyer/Supplier Relationships using Judgmental Modeling," Industrial Marketing Management, 31, 241-252 (2002).

4. Kim, Y., "Study on Impact Mechanism for Beef Cattle Farming and Importance of Evaluating Agricultural Information in Korea Using DEMATEL, PCA and AHP," Agricultural Information Research, 15(3), 267-280 (2006).

5.Gebauer, H., Worch H. and Truffer B. (2012). Absorptive capacity, learning processes and combinative capabilities as determinants of strategic innovation. European Management Journal, 30, 57-73.

6. Lee, Y. -C., T. -M. Yen, and C. -H. Tsai, "Using Importance-Performance Analysis and Decision Making Trial and Evaluation Laboratory to Enhance Order-Winner Criteria – A Study of Computer Industry," Information Technology Journal, 7(3), 396-408 (2008).

7. Liou, J. J. H., G. -H. Tzeng, and H. -C. Chang, "Airline Safety Measurement Using a Hybrid Model," Journal of Air Transport Management. 13, 243-249 (2007).

8. Ho, Y.C., Fang, H.C. and Lin, J.F. (2011). Technological and design capabilities: is ambidexterity possible? Management Decision, 49 (2), 208 – 225.