Evaluation of Acceptable Weight of Bag For Students in School: A Fuzzy Logic Approach

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Evaluation of Acceptable Weight of Bag For Students in School:

A Fuzzy Logic Approach

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Abstract - Overweight schools bags will bring additional stress and fatigue to primary and junior secondary students. The Department of Health recommends that, as a precautionary measure, students should avoid carrying school bags which exceed 15% of their body weight for long periods of time. Around 60 per cent of Indian schoolchildren may suffer back pain by carrying schoolbags. For example, a heavy bag that's slung over one shoulder can, over the 12 years of schooling, cause chronic back problems that linger into adulthood. Risks include muscle strain, distortion of the natural 'S' curve of the spine and rounding of the shoulders. The low back pain as a result of carrying of school bag by students has necessitated the attention given to the determination of limits of weight of school bag carrying by students in the school. It was however noted by that no Occupational Safety and Health organization exist regarding what constitutes the maximum acceptable or safe weight of school bag. After this observation, several researchers have worked on the subject of weight of school bag using three main approaches namely: Physiological, Psychophysical and Biomechanical. Author has applied the Fuzzy logic approaches for setting weight limit (WL) of school bag to be carried by students in school in the analysis the strengths and the weaknesses with the height are taken in to consideration. The approach may probably lead to reduce the problem of low back pain of students caused by heavy weight of school bag.

Keywords - Low back pain, Weight limit (WL), School bag, Fuzzy logic.

I. INTRODUCTION

The optimal weight of school bag varies with height and strength of Students. So to obtain the appropriate value of weight of school bag authors has taken various data from school and try to estimate the optimal weight of school bag for each age group of students for minimizing the low back pain problem caused by heavy weight of school bag carried by students.

II. DATA COLLECTION

To collect data we went to Central Public school, thatipur, Gwalior. Based on data collected from the school the range of weight limit of school bag for different height groups were decided.

TABLE I : DATA COLLECTED FROM SCHOOL

S.N.	STUDENT NAME	CLASS	HEIGHT (C.M)	WEIGHT OF BAG (KG)
1	SAKSHI SHARMA	1	103	3.0
2	RAJ NEGI	1	113	2.5

S.N.	STUDENT NAME	CLASS	HEIGHT (C.M)	WEIGHT OF BAG (KG)
3	VIPIN	1	115	3.6
4	PRAJAKTA JATAV	2	116	2.8
5	BABLI SINGH	2	118	3.5
6	SHIV PRATAP	2	122	3.8
7	ISHIKA GOYAL	3	100	4.0
8	SHALNI	3	120	4.5
9	AJAY PATHAK	3	134	5.0
10	AMAN	4	123	3.0
11	VINAY YADAV	4	125	5.5
12	SHARSHTI SHARMA	4	137	4.0
13	RUDRA PRATAP	5	127	4.4

S.N.	STUDENT NAME	CLASS	HEIGHT (C.M)	WEIGHT OF BAG (KG)
14	RAHUL GURJAR	5	135	5.0
15	INDRAJEET	5	147	4.5
16	ANJALI	6	131	9.0
17	PARM SINGH	6	134	8.0
18	UMESH	6	140	9.5
19	URVASHI	7	138	8.5
20	YOGESH	7	143	9.0
21	GOPI YADAV	7	148	10.0

III. METHODOLOGY

A. Fuzzy Logic:

After collecting data from Central Public school, thatipur, Gwalior. Now Fuzz Logic is applied to optimize the weight limit of school bag. These successful applications are attributes to the fact that fuzzy system is knowledge based or rule-based system. We have applied this technique to find out the acceptable weight of school bag for Students according to their height and class.

B. Flow Chart:

Data collection

↓

Defining Linguistic Variable

↓

Fuzzifyng   the Variable

↓

Determining Membership Function

↓

Appling If-Than Rule

↓

Defuzzification with COG Method
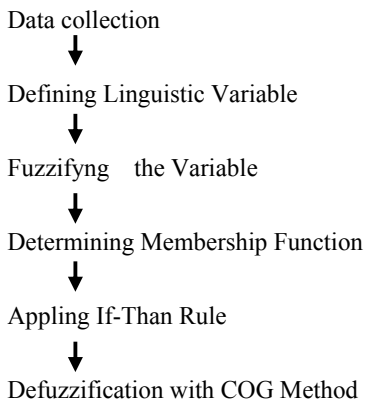
C. Acceptable weight of school bag:

For evaluating the acceptable weight limit of school bag for students in school according to their height and class, inputs are height and class in the fuzzy controller then fuzzifing the inputs (developing fuzzy set), applying "if- then" rule and defuzzifuying out put results.
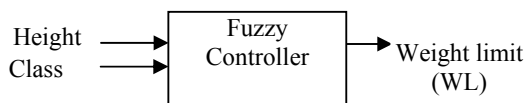

Fig.1

D. Linguistic Variable:

Height and class of Student are interpreted as the linguistic variables which have some of linguistics values as follow.

1) Height:

Very law height (VL)(<100), Lower height (L)(90-110), Upper low height (UL)(100-120), Middle height (M)(110-130), Upper middle height (UM)(120-140), High height (H)(130-150), Upper high height (UH)(140-160),Very high height (VH)(>150).

2) Class:

Very low(VL)(<2), Low(L)(0-4), Medium(M)(2-6), High(H)(4-8), Very high(VH)(>6).

3) Output Weight limit:

Very Low (VL)(<2), Low (L)(1-3), Upper Low (UL)(2-4), Lower Medium (LM)(3-5), Medium (M)(4-6), Upper Medium (UM)(5-7), Lower high (LH)(6-8), High (H)(7-9), Upper High (8-10),Very High (VH)(>9).

E. Fuzzy Sets:

Fuzzy sets are prepared between height (in cm) and DOM (degree of membership), class and DOM
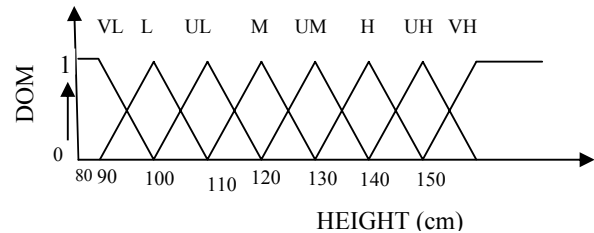

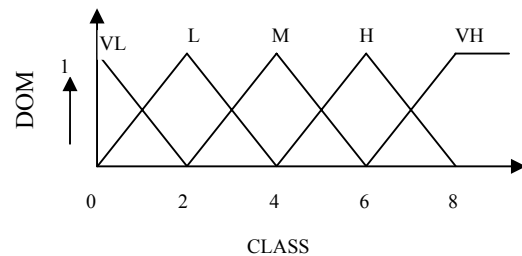HEIGHT (cm)

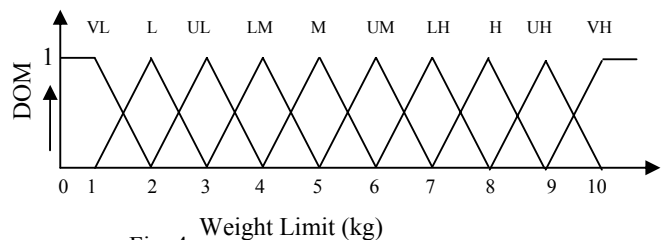Fig. 2

CLASS

Fig. 3

Weight Limit (kg)

Fig. 4

F. Fuzzification of Inputs:
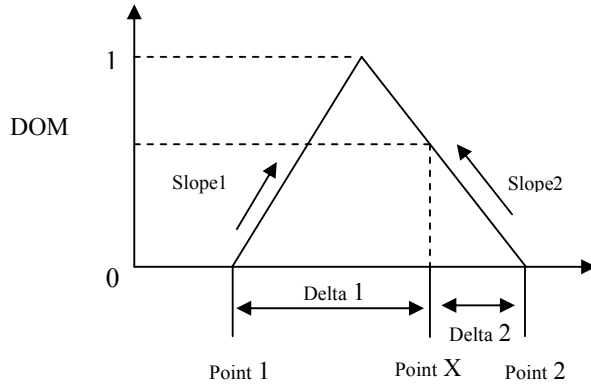
Following formula is utilized to compute the member ship value of antecedents

Fig. 5

Degree of membership for triangle:

$$\mu(X) = Min \begin{bmatrix} delta1 \times Slop1 \\ delta2 \times Slop2 \\ Max \end{bmatrix}$$

Where delta 1 = Point ×–Point 1

And delta 2 = Point 2 – Point ×

If   delta 1 $\leq$ 0

delta 2 $\leq$ 0

Then degree of membership = 0

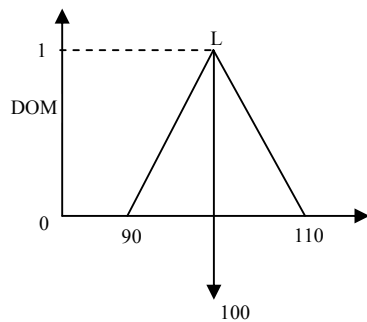Let normalized value of height X = 100 then qualifying fuzzy set are shown here

Fig.6

Fuzzy membership function of X for L

delta1 = Point X– Point 1

= 100– 90 = 10

delta2 = Point 2 – Point X

= 110 – 100 = 10

Slop 1 = 1/10 = 0.1

Slop 2 = 1/10 = 0.1

There for degree of membership function for L

$$\mu_L (X) = Min. \begin{bmatrix} 10 \times 0.1 \\ 10 \times 0.1 \\ 1 \end{bmatrix} = 1$$

The membership of function X with other fuzzy sets namely VL, UL M, UM, H, UH, VH, is zero (Since value of either delta 1 or delta 2 is -ve i.e. $\leq$ 0).

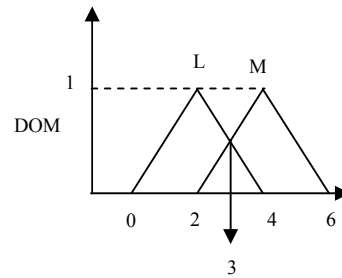Let normalized value of class X = 3 then qualifying fuzzy set are shown here.

Fig.7

Fuzzy membership Function of X for M

delta1 = Point X– Point 1

= 3 – 2 = 1

delta2 = Point 2– Point X

= 6 – 3 = 3

Slop 1 = 1/2 = 0.5

Slop 2 = 1/2 =0 .5

There for degree of membership function for M

$$\mu_M (X) = Min. \begin{bmatrix} 1 \times 0.5 \\ 3 \times 0.5 \\ 1 \end{bmatrix} = 0.5$$

Fuzzy membership function of X for L

delta 1 = X– Point 1

= 3 – 0 = 3

delta 2 = Point 2– X

= 4 – 3 = 2

Slop 1 = 1/2 = 0.5

Slop 2 = 1/2 = 0.5

There for degree of membership function for X

$$\mu_L (X) = Min. \begin{bmatrix} 3 \times 0.5 \\ 1 \times 0.5 \\ 1 \end{bmatrix} = 0.5$$

There for membership function of X with remaining fuzzy sets namely VL, H, VH, is zero (Since value of either delta 1 or delta 2 is -ve i.e. ≤ 0)

G. If than Rule:

- If Height is L and Class is V L then load const. is VL.

- If height is L and class is L then load const is L.

- If height is L and class is M then load const is UL.

- If height is L and class is H then load const. is LM.

- If height is L and class is VH then load const is M.

- If height is UL and class is VL then load const is L.

- If height is UL and class is L then load const is UL.

- If height is UL and class is M then load const is M.

- If height is UL and class is H then load const. is UM.

- If height is UL and class is VH then load const is UL.

- If height is M and class is VL then load const is UL.

- If height is M and class is L then load const is LM.

- If height is M and class is M then load const is M.

- If height is M and class is H then load const. is UM.

- If height is M and class is VH then load const is LH.

- If height is UM and class is VL then load const is LM.

- If height is UM and class is L then load const is M.

- If height is UM and class is M then load const is UM.

- If height is UM and class is H then load const. is LH.

- If height is UM and class is VH then load const is H.

- If height is H and class is VL then load const is M.

- If height is H and class is L then load const is UM.

- If height is H and class is M then load const is LH.

- If height is H and class is H then load const. is H.

- If height is H and class is VH then load const is UH.

- If height is UH and class is VL then load const is UM.

- If height is UH and class is L then load const is LH.

- If height is UH and class is M then load const is H.

- If height is UH and class is H then load const. is UH.

- If height is UH and class is VH then load const is VH.

For measured the value of Height X = 100 and class X = 3 the fuzzy membership values for fuzzified inputs are shown here.
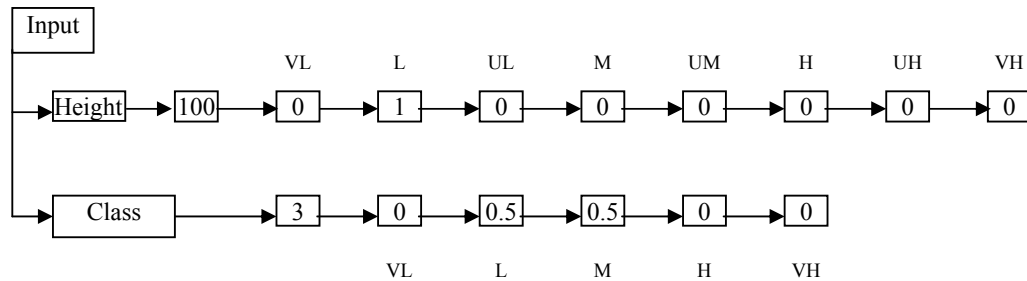

Fig. 8

H. Rule Strength Computation:

Rule strength's are obtained by computing the minimum of the membership function of antecedents.

Rule1: Min (1, 0) = 0, Rule2: Min (1, 0.5) = 0.5, Rule3: Min (1, 0.5) = 0.5, Rule4: Min (1, 0) =0, Rule 5: Min (1, 0) =0

I. Defuzzification:

Center of gravity method is applied to defuzzify the output. Figure shows the computation of C.G. for two competing outputs of rule 2, rule 3 with strength 0.5, 0.5. According to rule-2 output is L and according to rule-3 output is M.
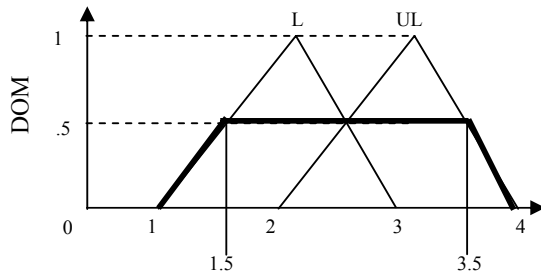
Fig. 9

TABLE II : CALCULATION FOR AREA

Area Segment No.	Area	$\overline{X}$	A $\overline{X}$
1	$\frac{1}{2} \times 0.5 \times 0.5 = 0.125$	1.33	0.167
2	$0.5 \times 2 = 1.0$	2.5	2.5
3	$\frac{1}{2} \times 0.5 \times 0.5 = 0.125$	3.67	0.458
4	$\sum A = 1.25$		$\sum A\overline{X} = 3.125$

$$X = \frac{\sum A\overline{X}}{\sum A} = \frac{3.125}{1.25} = 2.5$$

IV. RESULTS

Acceptable weight of bag for students of school avoid back pain problem pertaining to bag lifting is not constant. But it depends on the height and class of Student.

TABLE III : TABLE FOR WEIGHT LIMIT

Height (cm)	Weight Limit (WL) in kg						
	class 1	class 2	class 3	class 4	class 5	class 6	class 7
100	2.0	2.0	2.5	3.0	3.5	4.0	4.0
110	3.0	3.0	3.5	4.0	4.5	5.0	5.0
120	4.0	4.0	4.5	5.0	5.5	6.0	6.0
130	5.0	5.0	5.5	6.0	6.5	7.0	7.0
140	6.0	6.0	6.5	7.0	7.5	8.0	8.0
150	7.0	7.0	7.5	8.0	8.5	9.0	9.0

V. ACKNOWLEDGEMENT

REFERENCES

[1]. W. Karwoski, 1982, A fuzzy set based model on the interaction between stresses involved in manual lifting tasks, PhD Dissertation Lubbock: Texas Tech University Dempsey P.G., A critical review of biomechanical epidemiological, physiological criteria for designing Manual Materials Handling tasks, Ergonomics, 1998, 42(1), p. 73-88.

[2]. S.H. Rodgers, J.W. Yates, A. Garg, 1991, The Physiological basis for manual lifting guidelines, National Technical information Service, Report Number 91-227-330.

[3]. S.H. Snook, 1978, The Design of Manual Material Handling Tasks: Ergonomics, London, Taylor and Francis.

[4]. S.H. Snook , C.H.C. Irvine, 1967 Maximum Acceptable Weight of Lift, American Industrial Hygiene Association Journal, 28, p. 322-239.

[5]. S.H. Snook, V.M. Ciriello, 1991, the design of manual handling tasks: revised tables of maximum acceptable weight and forces, Ergonomics, 34, p. 1197-1213.

[6]. V.M. Ciriello, S.H. Snook, A.C. Blich, Wilkinson P.L., , 1990The effects of task duration on psychophysically-determined maximum acceptable weights and forces, Ergonomics, 33, p. 187-200.

[7]. V.M. Ciriello, S.H. Snook, 1993 G.J. Hughes, Further Studies of Psychophysically determined maximum acceptable weights and forces, Human Factors, 35, p. 175-186.

[8]. S. Singh, R.S.Yadav, D.Singh, ,2010 "fuzzy inference mechanism and rule induction algorithm for performance evaluation" proceeding of national conference on advances and trends wave based computing (ATWVC-2010) organized by department of computer science and applications, M.G.Kashi Vidhyapeeth, Varanasi, India. PP 86-93.

[9]. R.S. Yadav, S.Kumar, 2009 "the effective utilization of fuzzy logic approach for student academic performance evaluation" M.Phil dissertation,YOMOU, Nashik.pp 6-7.

[10]. T. Jason English & Gray S. Nelson "Manual lifting: Historical sources of current standards regarding acceptable weights of lift"

[11]. S. Donald Bloswick, "Estimation of stresses associated with manual material handling tasks: Back compressive force" Ph.D.,P.E.,CPE,University of Utah.,Ergonomics (chap 54), Patty's Industrial Hygiene and Toxicology, 5th ed. Vol.4, New York: Jhon Wiely and sons, 2000.

[12]. Li Yuan Zhou, Qing Hang Zhang, EE Chon Teo "effect of dick height wedge angle on lumbar spin under axial compressive force", WACBE World Congress on Bioengineering 2007. Bangkok, Thailand.

[13]. F. Edward Owens, Ronald Hosek, "Spinal buckling loads and curvature", The 2nd Annual Advances in Conservative Health Care conference, Lombard, IL, Oct., 1983.

[14]. A. F. Ian Stokes, "Analysis and simulation of progressive adolescent scoliosis by biomechanical growth modulation"

[15]. J.C.Lotz, A.H. Hsies, A.L. Walsh, E.I Palmer and J.R. Chin, "Mechanobiology of the intervertebral disc", Orthopadic Bioengineering Laboratory, University of Califomia, San Francisco, CA 94143-0514, U.S.A.

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