Research Paper

doi.org/10.5281/zenodo.10264279

VLEARNY Journal of Business
1 (1) 2024 **(Jan-Mar)**, 4-14, https://vlearny.com/journal/

Submitted: 03 September, 2023
Accepted: 5 December, 2023

COMPUTATION OF PLANTS' HAPPINESS SCORE: A NEW HORIZON OF URBAN PLANNING AND MANAGEMENT

Dr. Sumit Saha
Associate Professor, Dayananda Sagar Business School (DSBS), Bangalore, Karnataka, India

Arvind Perumbeti
consultant of Urban Planning Development, and research scholar of Kuvempu University, Bangalore, Karnataka

Abstract

Purpose – Happiness is the index that maps the overall tree/plant mechanism. Society's responsibility towards plant life has become all the more relevant at present. Recent advances in various sciences and technologies, and tools put to them for the betterment of society culminates in a better understanding of the life system of the plant itself.

Design/methodology/approach – The logical truthing is done through statistical tools.

After confirmatory factor analysis deleting the outliers by the 'Mahalanobis Distance Test', a new scale is created and validated. A total of 350 samples with .722 KMO value, and 33 variables finally researchers came up with a model after performing Exploratory Factor A

Findings – The application of any model depends upon the basic premises. If the premises on which it is being built is in the right direction, the application of it becomes all the more relevant to society. In this study, it is basically on the happiness of a plant. The merrier the plant the better the environment. If the tree is not in distress, it attracts pollinators, pollinators sparkle flowering, flowering generates fruiting, and fruiting invites birds and animals. They in turn help the plant/tree to be vibrant. The vibrant trees bring a cleaner environment and society benefits. The saga goes on.

Research limitations/implications – The internal reliability test is conducted in this study. The Index prepared is applicable further towards a better environment. Cities are economic powerhouses and more than 80 per cent of worldwide GDP is generated within their boundaries. The Happiness Index of a Plant is developed, and this can be an indicator for the UN and other agencies as the parameter while giving grants/loans and other funding.

Originality/Value – It is different from the Happiness index developed for people, as they are based on people's responses. Plants/trees are being muted their responses are to be observed and visualized to sketch the happiness. There is no similar work done by others in this area in specific.

Keywords

Happiness Index of Plants, Factor Analysis, Mahalanobis Distance test, Multivariate Analysis, Environmental science, Urban planning, Agriculture Management, Business Strategy

Citation: Saha, S., & Perumbeti, A. (2023). Computation of Plant's Happiness Score: A new horizon of urban planning and management. VLEARNY Journal of Business, 1(1), 4–14. https://doi.org/10.5281/zenodo.10264279

INTRODUCTION

The Happiness. Such a pleasant feeling, overwhelming and divine. Nature benefits human health. Human health is governed by nutritional, biological, chemical, or psychological inputs. The environment has a direct impact on those living in it, and ill health results from ignorance of the environment. The thrust of happiness stems from the behavioural aspects of any being; plants and the mute community are no exception. Behaviourism is determined by the surroundings, where the exogenic factors play a major role. The environmental determinants impact Plants' life in a good way. Plant life, either aquatic or terrestrial, is integral in maintaining a healthy environment on the globe. They are home to many species. Today its betterment, protection, preservation, and sustenance are being debated as the climate has become the forefront of all the policy decisions being taken at the world level. Healthiness is, in its narrower sense, boxed into health. Is health alone an indicator that drives one to happiness/well-being/quality of life (the interchangeable terms of being Happy)?

A Plant's entire gamut of happiness, closely or loosely, can bring under the following, though a detailed mechanism is called for. It aimed to measure the behaviour of plants on Health, Life span, Diversity & resilience, Community spread, and Environmental factors. To box the Happiness/well-being/ quality of life, these areas are to be leafed through and understood in a manner that one can easily assess.

"Taking a cue" is analogy can and needs to work for plants to determine their well-being. Humans and animals can move when required, but plants cannot move when the situation changes. Well-being is a desired effect of Happiness in a stressful and deteriorating environment. There needs to be a common metric to measure a plant's well-being. Well-being has to pervade the essences of all the determinants imbibed under Happiness's umbrella. In this context, efforts are made to gauge the many elements that provide essentials in this direction.

The questions that come into debate….

- Whether plant health is the sole indicator for the analytical approach to Happiness.
- The HDI and GNH, along with the Secondary data, rely heavily on Primary data.
- How do we elicit Primary data from the Plants? It is not possible. Then what should be the approach?
- Can we moderate/or acquire required Information from Secondary data/ the inputs required for the Happiness Index of Plants, hitherto referred as HIP?
- What are the parameters for defining the envelope of HIP?

The significant factors that determine the Plant's umbrella of happiness stem from gathering the relevant information.

The paroxysm (uncontrollable outburst) of developmental activities around the world throwing up innumerable challenges in protecting the environment. In checking the advancement of deterioration, the only cheaper arsenal is preserving, protecting, and promoting plant life.

The VTA (Visual Tree Assessment) is considered as per the Arborist's way of assessment. It has primarily relied on non-destructive/ non-invasive methods. It revolves around the Tree Characteristics, Tree Health, Tree Defects, Site conditions, and targets (the uses around. In order to have a comprehensive approach Diversity & resilience, Community spread, and Environmental Factors are also being assessed as part of HIP.

The very essence of the study is to develop a format to assess the Happiness index of plants with inspired content of the Human Happiness index. In the cases of the plants, observation points make the data inputs. Collection of the individual traits of sampled size is tabulated and cross-analysis is done. The behaviourism of plants is taken as the indicator in developing the Happiness Index of Plants, referred to here as HIP.

LITERATURE REVIEW

The literature review is to understand the subject of Happiness among Plants. As already envisaged the realm of Happiness is understood and rated based on the Primary survey.

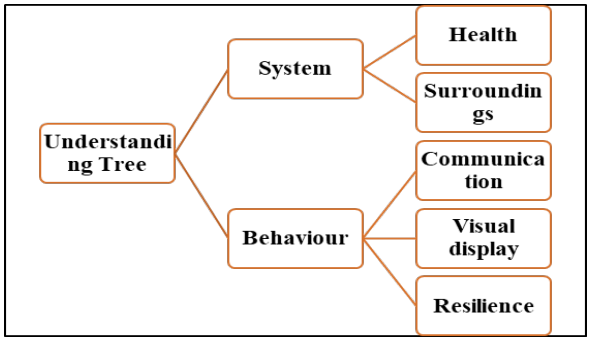
To provide background and context related to the issue under study, there are no direct references but various studies in Plants Health. Since health is one of the stretchers in the umbrella of Happiness. The rest are mined and tabulated.

To evaluate the fate and global distribution of contaminants in the food chain, plants can serve as models. Polychlorinated biphenyl

uptake and metabolism in plants, by William R. Lower, Ye Qiuping, Shubender Kapila, and Ravi K. Puri. (via Vivek Puri) Forests provide a variety of services at the local, national, and global levels and cover approximately 30% of the world's land mass (FAO, 2010). They are an essential component of life on Earth (Alfaro et al., 2014).

According to Taka et al. (2015), various plant species are indicators of biodiversity; Siddig et. al (2016). Woody species are thought to be related to forest biodiversity or ecosystem function because they provide microhabitats such as tree cavities for other taxa (Remm and Lhmus, 2011; Larrieu , other (2018); Paillet et. al (2018); Herzinsel and Co. 2019, Resources for food (Moleman et al. 2006; Bässler et al. 2010; Felton and Co. 2010) and structural change (Lutz et al. 2013) and microclimate control (Nepstad et al. 1994; Martin and Co.(2001); Rambo and North. Meakem et. al (2009) Nutrient cycle (Nepstad et al., 2018) 1994; Meakem and Co. 2018). For these reasons, wood species diversity often shows agreement between taxa (Howard et al. 1998; Kati and Co. 2004; Barlow et. al (2007) and some feature trees are intended to serve as indicators of biodiversity. In addition to trees and shrubs, they can represent forest diversity and ecological function (Mölder et al.). 2008; Baeten and Co. 2009; Dulac 2012). To find indicator species, it is important to screen a wide range of plant species.

Figure 01: Understanding Tree



Inspirational subject source:

The reports of the United Nations on happiness are the main source to trigger the interest in finding ways to state the happiness of Plant life, which otherwise, cannot express within one experience. What plants experience is reflected by the appearance of the Plant.

The Happiness Index is a comprehensive survey of well-being, aspects of sustainability and resilience (Laura Musikanski et al of Happiness Alliance), the evolving concept of subjective well-being: The multifaceted nature of happiness (Diener, Ed Scollon et al), "An outline of 'Happiness Index". A 5 Page document by (Ms. Hetal N. Bhinde) and Human Development Reports 2020 (UNDP) are in a way outlined the forward for this study. These documents have shown the strides of international agencies in finding issues and attending to them in a very pragmatic manner. In addition, behaviourism was very well explained by Elizabeth A. Minton, et al (2014).

Plant life:

The studies enveloped a fresh insight into assessing information from the extensive material available regarding plant life. It is often experienced that after leafing through the material the relevant subject matter is confined to one or two paras. However, the enriching material, in fact, threw open doors of new avenues in orienting initial thinking on the project. The parameters are drawn from the material concerning plant life starting from the basic requirements of plant growth, complexities of plant growth, Pollution, native systems and to the ecological management of forests. There were many indicators to assess but to boil down to 33 relevant indicators which is the focus for VTA has come from the following literature.

The following table gives a brief literature reading on the study.

OBJECTIVES AND SCOPE

It is to establish that the experiment on an area with a random sampling method the parameters identified in treating the wellbeing of a tree. The objectives of the study are, as emphasized earlier to assess the happiness of mute beings, i.e., Plants. As earlier reiterated, they are being observed in to form of imaging their behaviour, traits, and appearance, at the time of the study.

Objectives:

a) Preparation of criteria, at the Macro level.
b) To conceptualize the framework and Hypothesis
c) To arrive at measurable factors leading to arriving at parameters at two level

d) To Mine the vast information and document it in such a way as to pave way for empirical evidence.
e) To create a mechanism for understanding the empirical applications of Plant happiness as a continuum so as to present a logical root path for the development of the **index** thereby generating a process for the Application tool.

The Scope of the Study:

The scope has been restricted to visual observation of plants and deciding the levels of well-being of the Plants. Accordingly, it can be bracketed into the Macro level of information gathering. The sample sites chosen are eight urban stands, situated in Bangalore. It has a plant community that needs an assessment on the lines based on the objectives.

Table 1: Initially identified determinants for the study
(The determinants are two levels. The Root and the Shoot.)

S. No	Name	S. No	Name
1	Grade Change.	18	Decline /dieback crown.
2	Excessive Water.	19	Spacing between trees.
3	Poor water holding capacity.	20	Absence of nesting/ birds/ animals.
4	Exposed Tree flares absence.	21	Absence of pollinators.
5	Compact Soil.	22	'V' shaped branches.
6	Light soil colour.	23	Unnatural tree leaning.
7	Polluted Water source .	24	Presence of parasite plants .
8	Oddities at the base/root collar	25	Termite soil sheeting.
9	Oddities above the base(Trunk)	26	Exotic species.
10	Girdled roots.	27	Competition among own species.
11	Insect infestation.	28	Air pollution.
12	Tree wounds.	29	Noise pollution.
13	Fluid seepage on trunk.	30	Poor sun light.
14	Peeling of the bark.	31	Urban area.
15	Dead branches.	32	Location on busy road.
16	Sick leaves.	33	Amongst the exotic species.
17	Poor tree crown.		

Research Gaps & Theoretical Contribution:

1. No previous study to find out the relationship between the health of the plants and their happiness.
2. There is a definite need to find out a predictive model to quantify the happiness of the plants.

HYPOTHESES

H1: The health of a plant alone is not the major force behind its Happiness of a plant.

This statement has certain conjectures. While doing the empirical work the deduction that can be drawn by a factor or number of Factors. In the conclusion, this will be addressed.

H2: Parameters can be drawn to provide an empirical model for defining and deciding the HIP (Happiness index of a Plant).

The methodology adopted is Factor analysis. It gives a direction as Index is nothing but an exploratory output and the analysis treads in that direction.

H3: An Atlas of Happiness of plants is possible.

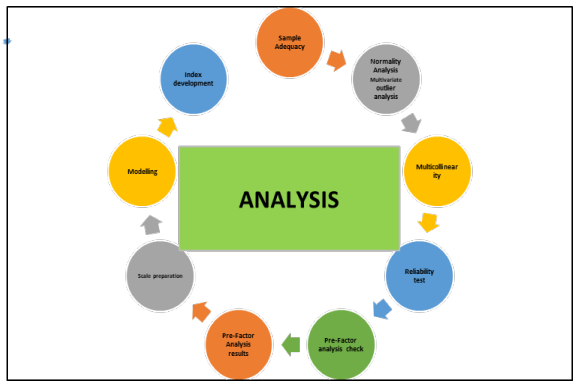
Here that the successful analogy of output, nevertheless, demonstrates the possibility of such preparation. The very essence of the study envelops the collecting reading material regarding the observation mechanism by looking at a plant and drawing the state of happiness of the observed plant. The collection of such data is arrayed in such a way that the possible course to the objectives is achieved.

DATA ANALYSIS

The questionnaire accommodated 33 queries observing 354 trees closely. The Analysis of

any sampling is a major output in the direction of logical conclusions.
The Analysis part played a major role in directing the study to a logical conclusion. The data analysis is done through SPSS.

Figure 02: Data Analysis Methodology



Scale & Sample Size:
The scale preference is: Likert Scale. The Questionnaire is being designed for parametric tests since it is possible to find true parameter values in Factor Analysis.

Sample adequacy:
Through KMO and Bartlett's Tests. The 354 samples have been test for adequacy of the Samples. The Kaiser-Meyer-Olkin (KMO) Test is to check, whether the data is suited for Factor Analysis. It is the checking of the sampling adequacy for each variable in the data and for the complete data.

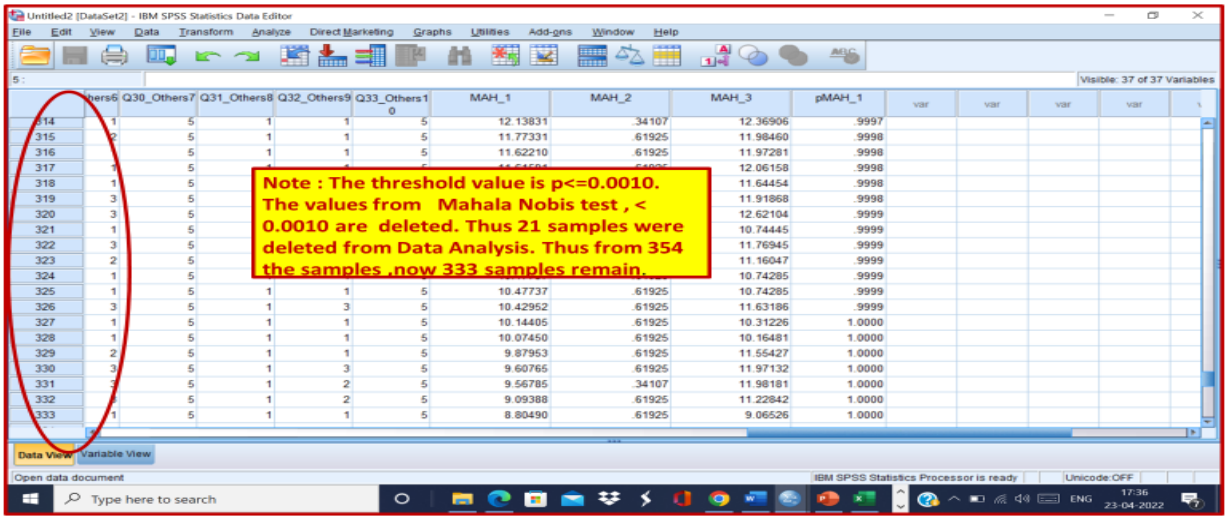
Table 02: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy: 0.722
Bartlett's Test of Sphericity, Approx. Chi-Square: 6735.736
Degrees of freedom: 528
Significant value: 0.001

In total of 354 samples, KMO 0.722 which is >.70 value and the Anti-image value of 33 variables (88% of the variables carry >0.5 which is adequate for factor analysis.

Figure 03: Analysis

Figure 04: Mahalanobis Distance Test output



Multivariate outlier analysis:

This analysis, examine the relation amongst variables. The Significance value, which is an ideal value is close to 0, and any value > 0.05 reflect that there is no significant relationship between the variables in this dataset.
The data need to be cleaned by way of deleting the outliers. Through the Mahalanobis Distance test in SPSS, outliers are identified and removed from the data. Thus, the assessed multipliers of the data do not form part of the Data Analysis and are removed in their entirety from the data.

The study chose to Mahalanobis Distance test to find any outliers. The data has been run and there were 21 outliers that were deleted from the dataset. The expression in SPSS was 1-CDF.CHISQ(MAH_1,33). Generally, it is intended that the Mahalanobis Distance test

(threshold value p <= 0.0010, Tabanchinick & Fiddle 2013). As envisaged earlier once outliers were removed from the dataset, they would not be part of the Data analysis.

Multivariate Normality Analysis:

There are two main methods of assessing normality: graphically and numerically. Graphical methods do have lack of objectivity and in addition one need to have vast experience in comprehending and interpreting the data. In this case, we do it Numerically. The skewness and Kurtosis value determine the normality of the data.

Having 33 individual factors, the review planned to do a multivariate ordinariness examination (Sumit Saha and Subhasree Kar, 2021). According to Kim (2013), the Kolmogorov–Smirnov and Shapiro–Wilk tests are "unreliable" with large samples, or more than 300. They are, in essence, too "sensitive." According to Mayers (2013, p. 53), the skewness and kurtosis values should be cut off at 1.96 for samples smaller than 50, 2.58 for samples 51 to 100, and 3.29 for samples greater than 100. The values of kurtosis, skewness, and descriptive analysis are all 3.29. So clearly information is ordinary. Additionally, Peter Samuels' (ResearchGate) alternative viewpoint asserts that the absolute size in relation to the standard errors is relevant to skewness and kurtosis. The better guideline is it ought to be not as much as two times their normal blunders. Due to the fact that the exact value rises above 2 for small sample sizes, twice the value is, incidentally, a better estimate than 3.29. The size of 334 (which includes 21 outliers removed from 354 samples) is taken into account for data analysis; Consequently, it is decided to follow Peter Samuels rather than awarding a value of 3.29 for better focus. Skewness and Kurtosis have standard errors of 0.266 and 0.134, respectively. As a result, when we double the value, we get 0.532 for kurtosis and 0.268 for skewness, which are acceptable values to consider when determining the normality.

Multicollinearity:

The 26 variables were run for Multicollinearity and it was found that Q 29 and Q 30 were found to be having values > 0.9. Q 28 and Q 29 have VF value > 10 and Tolerance Values is <0.1. In this case, Q 29 is figured in both the readings and the rest were appearing once. However, for an influence on diversity, part Q 30 is retained. Moreover, Noise pollution (Q 29) is discreetly covered with Air pollution but has an influence of its own and hence decided to retain both.

Reliability Analysis:

The Happiness is a latent variable and the following factors are the result of reduction through reliability analysis and the rotation. The following Rotation matrix amply demonstrates that of the 33 variables picked for defining the Happiness the following. The following are the variables which ran for Factor Analysis: The first run resulted in the Cronbach's Alpha at 0.565,which is very poor. After application of reduction the second run is made.

Table 05: Item- Total Statistics & Reliability Statistics

Item-Total Statistics

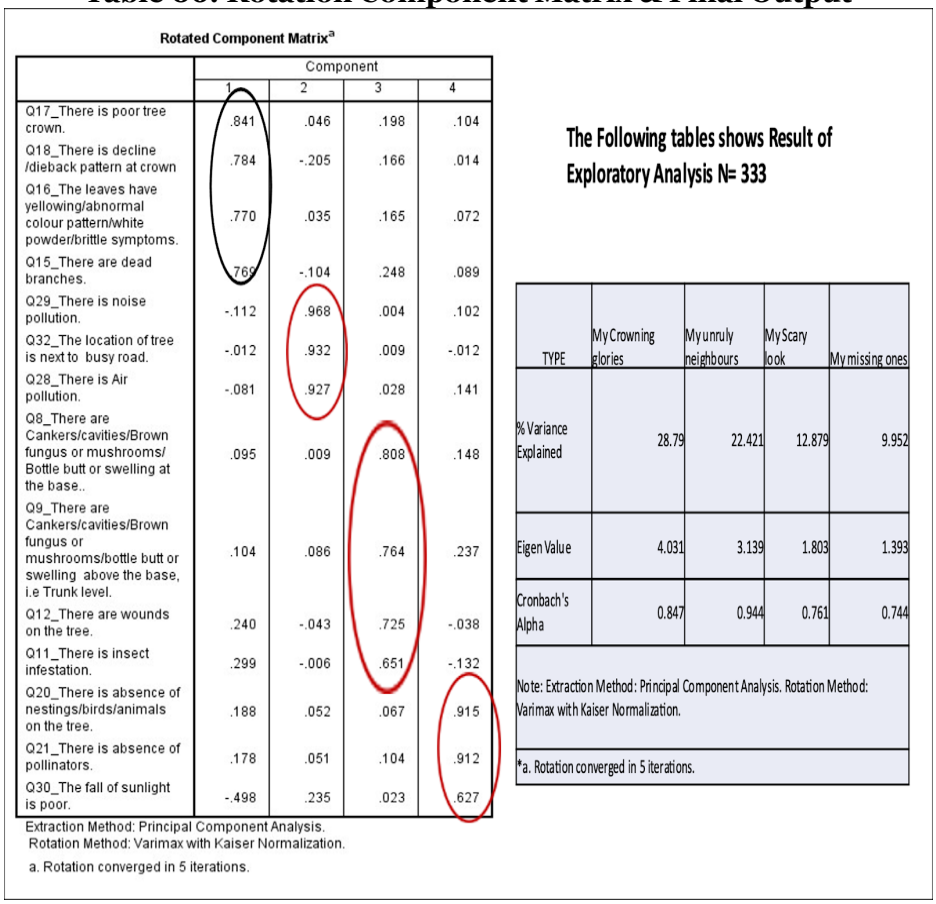
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q8_There are Cankers/cavities/Brown fungus or mushrooms/ Bottle butt or swelling at the base..	47.26	39.432	.416	.734
Q9_There are Cankers/cavities/Brown fungus or mushrooms/bottle butt or swelling above the base, i.e Trunk level.	47.06	39.484	.478	.730
Q11_There is insect infestation.	47.42	40.997	.331	.742
Q12_There are wounds on the tree.	47.28	41.080	.354	.741
Q14_There is peeling of the bark.	47.33	39.883	.351	.740
Q15_There are dead branches.	47.11	40.740	.350	.741
Q16_The leaves have yellowing/abnormal colour pattern/white powder/brittle symptoms.	46.99	40.822	.367	.740
Q17_There is poor tree crown.	47.23	39.285	.449	.731
Q18_There is decline /dieback pattern at crown	46.82	42.146	.238	.749
Q20_There is absence of nestings/birds/animals on the tree.	46.93	39.269	.419	.734
Q21_There is absence of pollinators.	46.87	39.675	.446	.732
Q28_There is Air pollution.	47.86	37.238	.431	.732
Q29_There is noise pollution.	47.89	37.757	.420	.733
Q30_The fall of sunlight is poor.	46.03	42.478	.059	.777
Q32_The location of tree is next to busy road.	48.25	37.939	.381	.738

Reliability Statistics

Cronbach's Alpha	N of Items
.753	15

The Cronbach's Alpha value resulted in 0.753, which is a more reliable factor grouping that can run for Exploratory Factor Analysis.

Table 06: Rotation Component Matrix & Final Output



Rotated Component Matrix[a]

	Component			
	1	2	3	4
Q17_There is poor tree crown.	.841	.046	.198	.104
Q18_There is decline /dieback pattern at crown	.784	-.205	.166	.014
Q16_The leaves have yellowing/abnormal colour pattern/white powder/brittle symptoms.	.770	.035	.165	.072
Q15_There are dead branches.	.769	-.104	.248	.089
Q29_There is noise pollution.	-.112	.968	.004	.102
Q32_The location of tree is next to busy road.	-.012	.932	.009	-.012
Q28_There is Air pollution.	-.081	.927	.028	.141
Q8_There are Cankers/cavities/Brown fungus or mushrooms/ Bottle butt or swelling at the base..	.095	.009	.808	.148
Q9_There are Cankers/cavities/Brown fungus or mushrooms/bottle butt or swelling above the base, i.e Trunk level.	.104	.086	.764	.237
Q12_There are wounds on the tree.	.240	-.043	.725	-.038
Q11_There is insect infestation.	.299	-.006	.651	-.132
Q20_There is absence of nestings/birds/animals on the tree.	.188	.052	.067	.915
Q21_There is absence of pollinators.	.178	.051	.104	.912
Q30_The fall of sunlight is poor.	-.498	.235	.023	.627

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

The Following tables shows Result of Exploratory Analysis N= 333

TYPE	My Crowning glories	My unruly neighbours	My Scary look	My missing ones
% Variance Explained	28.79	22.421	12.879	9.952
Eigen Value	4.031	3.139	1.803	1.393
Cronbach's Alpha	0.847	0.944	0.761	0.744

Note: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

*a. Rotation converged in 5 iterations.

The Hypothesis runs:

At this juncture, the Hypothesis setting in the initial chapters to be revisited. The studies in all its perception get initiated with a notion. The motion of the notion needs to run along with a logical approach. There is this need to empirically draw the inputs and apply them.

In the said Hypothesis, at the initial round, it was briefly mentioned, which runs as under.

1) **The health of a plant alone is not the major force behind its Happiness of a plant.**

This statement has certain conjectures. While doing the empirical work, the deduction can be drawn by a factor or number of Factors. In the conclusion, this will be addressed. The null hypothesis in this case is not rejected.

2) **Parameters can be drawn to provide an empirical model for defining and deciding the HIP (Happiness index of a Plant).**

The methodology adopted is Factor analysis. This itself gives a direction as Index is nothing but an exploratory output and the analysis treads in that direction.

3) **An Atlas of the Happiness of Plants is possible.**

Here that the successful analogy of output, nevertheless, demonstrates the possibility of such preparation.

In a statistical environment, the above does not carry a bearing. The 33 variables, which were set in the beginning as it undergoes transformation due to reduction analysis, the variables get reduced and in the final, as seen only 14 factors figured with 4 groups. The paras and supra accentuate it. For example, the variables in relation to one another, based on the statistical model gives a fair picture of their strength and influence.

A chart is prepared and shown (Appendix-1). It demonstrates the Null Hypothesis status with regard to the strong RELATIONSHIP between variables. It is very much evident that with regards to a strong relationship with another 25% of the factors bear the Null Hypothesis being NOT REJECTED. This proves that among the 14 factors heavily leaned to support the general hypothesis that HIP is possible.

In a scientific environment, sentiments do not work and it is often the analysis and

results that show valid conclusions. For example, when the study started, the following were of active drivers: Health, Life span, Diversity & resilience, Community spread and Environmental factors.
As literature was collected and the methodology outlined all were split into parameters and 33 items were drawn. Further, by way of reliability tests (pre-factor analysis), there was a further reduction in the variables. Exploratory factor analysis explored the underlying structure of Happiness. It resulted in 4 groups with 14 items. The groups by way of their characteristics, resulted in an identity, through which the Hypothesis was understood.

The first hypothesis is looked into by way of understanding the underlying structure that is close to the statement.

There are environmental factors in the Group "My unruly neighbours".

- The statement: The surroundings of the plant affect its Happiness.
  - All environmental items of this group consisting of Q 28, Q29, and Q 32 results read 0.458, 0.158 and 0.310 respectively. All are > 0.05----The Null Hypothesis is not rejected.
- Likewise, if the statement is "The poor tree crown has a significant relationship with Environmental factors".
  - Q.17(Poor Tree Crown) relation with the Environmental factors in the final cluster of "My unruly neighbours" Q 28, Q29, and Q 32. The results read 0.458, 0.158 and 0.310 respectively. P-value > 0.05; The Null Hypothesis is not rejected.
- The statement trunk of a plant indicates unhappiness.
  - Q9. Of all the 13 factors 3 have results of >0.05.10 have < 0.05. Taking the majority conclusion, in a way----The Null hypothesis is rejected.
- The statement: There is a significant influence of sunlight on the Happiness of a plant. In this case, of all the 13 factors 2 have a score of > 0.05, 1 <0.05 and rest are zeroes----The Null hypothesis not rejected.

The second Hypothesis, that parameters can be drawn to provide an empirical model in defining and deciding the HIP (Happiness index of a Plant). The scale prepared for the HIP and analysis conclude affirmatively the statement.
The third Hypothesis that Atlas of Happiness is possible is proven with the model. This instrument by assessing through HIP enable in the preparation of Atlas for Green Happiness zones. It can be for towns, districts, Regions, States and even Countries. Thus, the Hypothesis with which it started is given to consideration.

The naming of the Final Factors:

Finally, the study has got **FOUR** different and distinct factors. The grouping is as under for the Factors. (1) My Crowning glories (2) My unruly neighbours (3) My Scary look and (4) My missing ones. These factors' names were given based on their characteristic visual appearance.

Table 07: Final Exploratory Factor Analysis Result

Statements	Component			
	My Crowning glories	My unruly neighbours	My Scary look	My missing ones
Q17. _There is poor tree crown.	**0.841**			
Q18. _There is decline /dieback pattern at crown	**0.784**			
Q16. _The leaves have yellowing/ abnormal colour pattern/white powder/brittle symptoms.	**0.77**			
Q15. _There are dead branches.	**0.769**			
Q29. _There is noise pollution.		**0.968**		
Q32. _The location of tree is next to busy road.		**0.932**		
Q28. _There is Air pollution.		**0.927**		
Q8. _There are Cankers/cavities/ Brown fungus or mushrooms/ Bottle butt or swelling at the base.			**0.808**	
Q9. _There are Cankers/cavities/ Brown fungus/ mushrooms/bottle butt/ swelling above the base, i.e., Trunk level.			**0.764**	
Q12. _There are wounds on the tree.			**0.725**	
Q11. _There is insect infestation.			**0.651**	
Q20. _There is absence of nesting/birds/animals on the tree.				**0.915**
Q21. _There is absence of pollinators.				**0.912**
Q30. _The fall of sunlight is poor.				**0.627**
% Variance Explained	**28.79**	**22.421**	**12.879**	**9.952**
Eigen Value	**4.031**	**3.139**	**1.803**	**1.393**
Cronbach's Alpha	**0.847**	**0.944**	**0.761**	**0.744**

Note: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

*a. Rotation converged in 5 iterations.

Modelling, Index development:
Model building is a methodical structure of process. Most of the objectives towards the common goal of the approaches is standardization of the process. It helps to prepare a platform to garner the resources needed to prepare and maintain a model. In this process, not any important step to be missed out. A predictive model is stands on

clean data, proper variable selection, Data validation, model validation and model delivery. A four-factor model is found to be the most defensible factor structure.

THE MODEL AND COMPUTATION OF PLANTS' HAPPINESS SCORE

Plant's Happiness = = f(14 identified determinants)= f(4 identified factors);

1. a constant value: β0, intercept; an total error term: è ; indicator average value: Xi with factor loading score: βi , weighted scoring (Saha et al., 2021).

Plants' Happiness Score = β0+ i=114 βi. Xi + è = β0+38.06135 + è;

The succeeding tables give the analytical observations.

Table 08: Score calculation table

S. No	Statement	Component B_i	Mean ($\bar{x}_1$)	$\Sigma \bar{x}$ (Component multiplied by Mean)
1	Q17. _There is poor tree crown.	0.841	3.37	2.83417
2	Q18. _There is decline /dieback pattern at crown	0.784	3.77	2.95568
3	Q16. _The leaves have yellowing/ abnormal colour pattern/white powder/brittle symptoms.	0.77	3.6	2.772
4	Q15. _There are dead branches.	0.769	3.48	2.67612
5	Q29. _There is noise pollution.	0.968	2.7	2.6136
6	Q32. _The location of tree is next to busy road.	0.932	2.35	2.1902
7	Q28. There is Air pollution.	0.927	2.73	2.53071
8	Q8. _There are Cankers/cavities/ Brown fungus or mushrooms/ Bottle butt or swelling at the base.	0.808	3.34	2.69872
9	Q9. _There are Cankers/cavities/ Brown fungus or mushrooms/bottle butt or swelling above the base, i.e., Trunk level.	0.764	3.53	2.69692
10	Q12. _There are wounds on the tree.	0.725	3.32	2.407
11	Q11. _There is insect infestation.	0.651	3.18	2.07018
12	Q20. _There is absence of nesting/birds/animals on the tree.	0.915	3.66	3.3489
13	Q21. _There is absence of pollinators.	0.912	3.73	3.40176
14	Q30. _The fall of sunlight is poor.	0.627	4.57	2.86539
	$\Sigma \bar{x}$			38.06135

Prepared model:

HIP (Plants' Happiness score) = 38.06135 + β0 + error

The Constant (β0) and the error figures may be calculated after Confirmatory Factor Analysis (CFA). However, the model prepared is workable and have scope for giving the index numerically.

RESEARCH APPLICATION

The Index prepared is applicable for further, as said in the beginning, towards a better environment.

As an instrument to assess the state of the tree/plant population and whether they need attention to improve or not. The tree population is in the thousands, in urban areas year-wise assessment and budget allocation will be a herculean task and the index prepared, if applied, gives a clearer picture of the tree in distress.

In the same vein, the HIP can be prepared for the reassessment of Reforestation/Afforestation works undertaken in the wild, by the forest department. This reduces time and expenditure. The adage which goes "a stitch in time saves nine" is amply demonstrated in this scenario.

The Climate change programs by the countries are pushed in the direction of more greening, and at the same time, the agencies require to vet the developmental initiatives and write success stories. This instrument by assessing through HIP enables the preparation of Atlas for Green Happiness zones. It can be for towns, districts, Regions, States and even Countries.

Cities are economic powerhouses and more than 80 per cent of worldwide GDP is generated within their boundaries (The World Bank 2019, report). Global ranking of cities, in terms of the Happiness Index of a Plant, can be developed with a minimal survey. This can be an indicator for the UN and other agencies as the parameter while giving grants/loans and other funding.

In furtherance of the study as a conclusion:

With the increased number of Trees in an effort to green the environment, the protection of plants and trees has become all the more important. The HIP is so developed that the users, who can be individuals, organizations and government authorities can utilize the index with minimal effort and staff.

They can easily, by sampling, assess the tree's distress.
As already enumerated the model has given the scale and the Constant and the error to be calculated. Thus, the scope is presently limited to the calculation of the same. Further, the agencies involved in the greening programmes alter it to limit to the detailing of groups as per requirement. It is once again brought in here that the group nomenclature is aptly done to easily earmark the required itemization.

The Groups best illustrate the items.

1. **My Crowning Glories**:
- Poor tree crown.
- Decline /dieback crown
- Sick leaves
- Dead branches.

2. **My unruly neighbours**
- Noise pollution.
- Location on busy road.
- Air pollution.

3. **My Scary look**
- Oddities at the base/root collar.
- Oddities above the base (Trunk).
- Tree wounds.
- Insect infestation.

4. **My missing ones**
- Absence of nesting/birds/animals.
- Absence of pollinators.
- Poor sunlight.

THE SCOPE OF THE RESULTS

It is wider for further demonstration of each component subgroup for a detailed micro assessment. In the view of this, the present study analyses the preparation of index and further ubiquitous applicability in different domains and the sky is the limit in this direction. The empirical study in this effort is restricted to the Visual study/ observation. I ventured in to a microscopic environment there is definitely, barrier less environment to further exploration. Moreover, it is brought out that there is Sample adequacy and many increased numbers may not result in a change of the TS (Total Score) that is realized in the study. The Happiness performance score is i.e., **38.06135 + β0 + error.**

LIMITATIONS

1. In this study, no moderator and mediator effects are analysed.
2. Different agricultural business can be benefited from this Happiness Score calculation.
3. Exact 'Plants' Happiness Score' maybe calculated after adjusting, confirmatory factor analysis, and model forming.

CONCLUSION

Application of any model depends upon the basic premises. If the premises on which it is being built is in the right direction, the application of it becomes all the more relevant to the society. In this study it is basically on the happiness of a plant. The merrier the plant the better the environment. If the tree is not in distress, it attracts pollinators, pollinators sparkle flowering, flowering generates fruiting, fruiting invites birds and animals. They in turn help the plant/tree to be vibrant. The vibrant trees bring the cleaner environment and the society benefits. The saga goes on.

The growing interests of researchers in exploring the functioning of green prompted other disciplines of sciences to share their expertise for a better society. The green research is ably supported by remote sensing, GIS, bioinformatics, machine learning, advanced analytics, simulation, etc. The development and testing of models in the green domain prompts every other discipline to collage in to their field with emergent advance version of tools. A model application never goes in vain. In case where there are follies Confirmatory Factor Analysis steps in to do course correction. The externalities are minimized.

REFERENCES

Assessment of Trace Metals Concentration in Tree Barks as Indicator of Atmospheric Pollution within Ibadan City, South-West, Nigeria, Ikechukwu P. Ejidike. (Hindawi journal, Published 28 Oct 2015).

Comprehensive assessment of soil quality for landscape and urban management. ELSEVIER. Robert R. Schindelbeck et al.

Exploratory Factor Analysis and Structural Equation Modelling (Volume III. Evaluation, Methodology, and Interdisciplinary Themes. Part 10. Quantitative Analysis.

Genetic considerations in ecosystem restoration using native tree species.

Forest Ecology and Management, Elsevier. 333. 2014.

Global to local genetic diversity indicators of evolutionary potential in tree species within and outside forests. Lars Graudal et al (Elsevier. 333. 2014).

Gary J. Ockey. "Hypothesis Formulation In: The SAGE Encyclopaedias of Communication Research Methods".

Happiness Index Methodology, Journal of Social Change, 2017, Volume 9, Issue 1, ©Walden University, LLC, Minneapolis, MN.

Hugh W. Pritchard, "Innovative approaches to the preservation of forest trees", Elsevier. 333. 2014

"An outline of 'Happiness Index", Journal of Social & Scientific Research, April-June 2017 Vol.03 Issue 03, PP-31, (I) ISSN: 2454-3187 PIF: 1.364.

Richard Bruce Allison, Xiping Wang and Christopher A. Senalik (2020), "Methods for Nondestructive Testing of Urban Trees", Forests MDPI, Published: 16 December 2020.

Plants for Environmental Studies, Edited by Wuncheng (Woodrow) Wang, Joseph W. Gorsuch, Jane S. Hughes, Lewis Publishers.

Takashi Hirayama, Kazuo Shinozaki (2010), "Research on plant abiotic stress responses in the post-genome era: past, present and future", Plant Journal.

Research Article 'A Framework for Quantifying Resilience to Forest Disturbance' Timothy Bryant et al.

Saha, S (2023)," Measurement of the threshold values of Sales Performance Factors: A Formative Scale Construction in Onyx", The Journal of Indian Management and Strategy, Vol 28 No 01, pp. 13-20; DOI No.10.5958/0973-9343.2023.00002.9

Saha, S. and Kar, S. (2021b), "Salespersons performance predictor model: An exploratory factor analysis", The Journal of Indian Management and Strategy, Vol. 26 No. 01, pp. 25-33; DOI: 10.5958/0973-9343.2021.00003.X

Saha, S. and Kar, S. (2021), "Computation of sales performance score and key cross-functional factors: a performance dynamics in IT/ITES", American Journal of Business, Vol. 36 No. 01, pp. 3-19; https://doi.org/10.1108/AJB-08-2020-0138

René I. Alfaro (2014), "The role of forest genetic resources in responding to biotic and abiotic factors in the context of anthropogenic climate change", Elsevier. Pp-333