

**International Conference on Agribusiness and
Food Industry in Developing Countries :
Opportunities and Challenges**

IIM Lucknow

**Spatial Location Modeling of
Rural Retail Outlets using
Optimization Technique**

By
Ashutosh Roy & Brajesh Kumar
IIM Ahmedabad

Rural Market - facts

- Total 6,34,000 villages in India
- According to the NCAER (National Council for Applied Economic Research)
 - Number of middle and high-income households
 - In rural India - 80 million to 111 million by 2007.
 - In urban - 46 million to 59 million by 2007.
- Rural Market
 - **Packaged consumer products:** More than Rs. 2000 crores
 - **Market for Non-food items:** Rs. 20000 crores growing at 2.5% p.a.
 - **Consumption of pesticides:** 68,000 tonnes, growing at 12%p.a.

Share of rural consumption

- **Share of Rural market in overall consumption**
- **Toiletries**
 - Safety Razor Blades 48%
 - Premium Soaps 24%
 - Tooth Paste 20%
 - Hair Oil 20%
- **OTC products**
 - Cold Analgesic 42%
 - Antiseptic Creams 28%

Rural Retail Growth

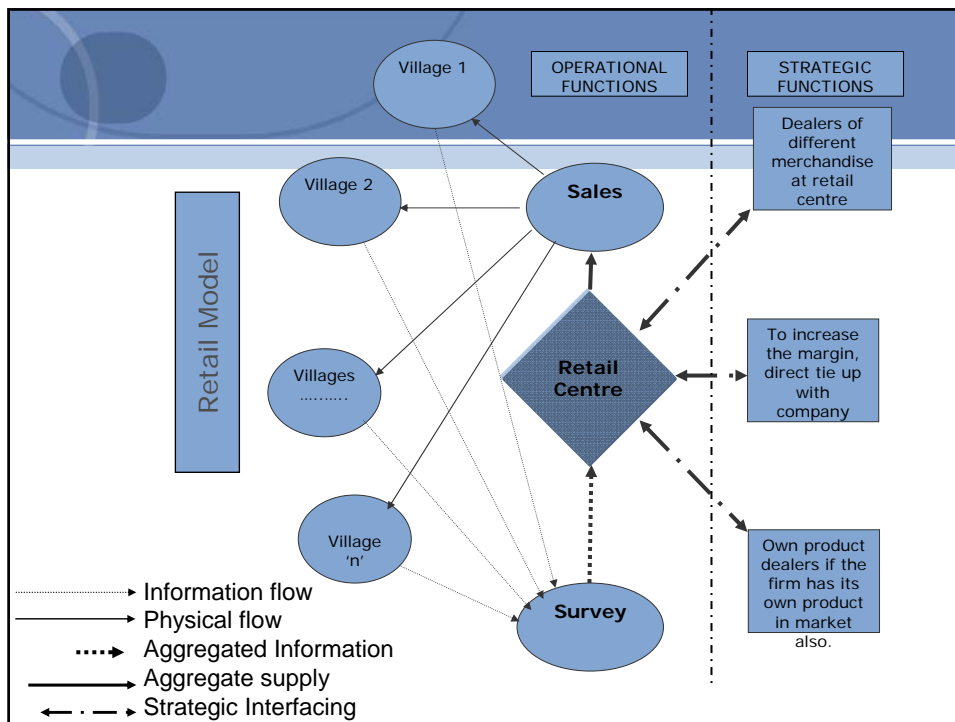
'000 Outlets	1993	1996	2001
Urban	2,693	3,074	3,800
Rural	5,364 (67.02%)	6,633 (68.33%)	9,800 ↑ (72.05%)
Total	8,003	9,707	13,600

Rural Retail Success

- **Key Elements for the success of Rural Retails**
 - **Availability**
 - trade-off between the cost of distribution and incremental penetration
 - **Affordability**
 - Low disposable incomes
 - Dependent of vagaries of monsoon
 - **Acceptability**
 - Customization versus standardization of the consumer proposition
 - Lower Price and Lower margin
 - **Awareness**
 - urban market companies use multi channel
 - Only 57% percent of rural population can be reached through traditional mass media
 - Customized treatment by marketers is required

Adhar Case Study - Introduction

- Godrej opened rural retail stores across the country under the "Aadhar" brand name.
- At present total of 11 Aadhar centers are functioning
- Located in 7 states
- In October 2004, one Aadhar centre has been opened in Prantej (Near Ahmedabad).
- The oldest Aadhar which was established 1 yrs ago, near Pune has reached of turnover of around 1 crore.



Motivation of Aadhar

- The fundamental driving idea behind Aadhar business model is to provide
 - Necessary services to farmer and rural population
 - Right agricultural Inputs
 - Required Input on right price at right time.
 - To provide other FMCG products and household durables at reasonable price

Products Handled – At Aadhar

- Agricultural inputs
 - Seeds, fertilisers, machineries, pesticides from group company Godrej Agrovet as well as from other companies
 - Animal feed
- FMCG Products
- Consumer Durables

Decision Making

- What items and SKUs should be stocked
- What quantity should be stocked
- Arranging farm visits and of experts
- Coordinating with other company dealers
- Training to extension workers

Information Collection

- **Government resources-**
 - About socio economical aspects of village and farmers
 - Average cost of cultivation
- **Input dealers – To estimate the Input market**
 - Company Information
 - Dealer Information
- **Village People (at present 35 villages are under coverage) –**
 - Cropping pattern
 - Cost of cultivation
 - Current practices

Extension Services

- **Extension services**
 - Technology demonstration
 - Controlled cultivation (to show the effect of a new molecule and practice)
 - Farm visits by trained extension workers, Result demonstration
 - Spot demonstration
 - IT enabled services
 - Commodity prices in different state mandis
 - Weather information
 - Information about new farming practices
 - Information about new seeds and other inputs

Sales

- **Sales**
 - Farmer use to come in morning and in late evening for buying required inputs
 - At basement FMCG products are also available for villagers convenience
 - Aadhar centre is functioning as one stop solution for rural consumers and farmers

Issues of concern

- What factors should be considered for deciding a location for outlet
 - What is the relative importance (rating) of these factors
 - How to decide for
 - location for outlets
 - total number of outlets to be opened
- For covering maximum market at minimum cost??.

Business Index Development

- Approach (causal model development)
 - Latent Variable Demand (in terms of value)
 - Proxy – value of annual purchase of input + annual spending + animal feed purchase
 - Explanatory variables
 - Households attributes
 - Production related attribute
 - Village Attribute
 - Based on OLS estimate, weightage of factors has been decided

- **Production related data**
 - operational land area in ha (AREA)
 - % irrigated area (PCIR)
 - Cropping intensity (in %) (CROPINT)
 - % of GCA devoted to cash crops (PCCASH)
- **Household Asset holding Data**
 - Index of luxury items used (LUX)
 - Index of deposit holding with Post Office/Banks/Coops/NBFCs/Chit funds/SHGs (DEPO)
 - Index of familiarity with gramsevak /extension officer (EXTEN)
 - No. of milch animals per head (PMILK)
 - No. of goats, sheep, pigs & poultry birds per head (PMEAT)
 - Per head annual provisional expenses in Rs. (PPROVI)
 - % of income from trade & services (PCTSR)

Explanatory Variables

- **Village Attributes**
 - % household engaged in non-farm, business & services - PCNBS
 - Male literacy rate in village - MLIT
 - Distance in Kms to nearest market - MARKET
 - Distance of bus route- BUS
 - Distance of pucca road – PUCCA
- **Household Attributes**
 - Annual per head income in Rs. (PY)
 - Maximum level of male education (MEDU)
 - Maximum level of female education (FEDU)
 - Household size in numbers (HSIZE)
 - % of actual working population (PCWORK)

Note : Many variables appeared candidate of serious collinearity

Business Index formulation

Business Index.

- where N = number of households
- W_i = weightage of i^{th} factor
- V_i = value of i^{th} factor
- n = sample size

$$BI = \frac{N}{n} * \sum_{n=1}^n \sum_{i=1}^m w_i * V_i$$

Trial Run on Sample Data

- Village's Attribute Data of 28 villages

		Standardized Coefficients	t	Sig.
	Std. Error	Beta		
(Constant)	3718.293		-.525	.605
PBOVINE	1831.304	.321	1.788	.088
PUCCA	1431.145	-.871	-1.787	.088
BUS	1378.402	.793	1.671	.109
MLIT	54.189	.350	1.685	.106

- 25 Household's Attribute Data

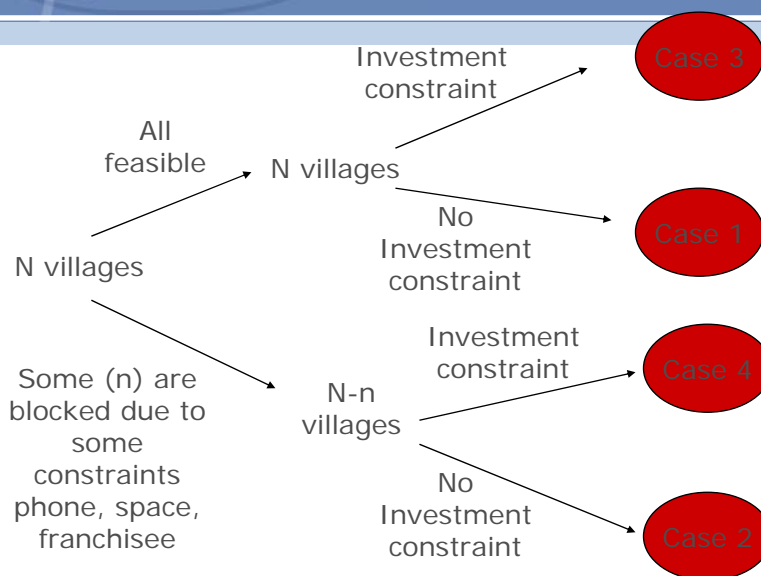
	Unstandardized Coefficients, B	Std. Error	t	Sig.
(Constant)	1260.182	1238.558	1.017	.322
CROPINT	2518.510	535.883	4.700	.000
PCCASH	-23.151	28.205	-.821	.422
PVPROD	.239	.113	2.125	.048
PMILK	-2006.363	1729.643	-1.160	.261
PCTSR	1.743	1.552	1.123	.276
MEDU	-2.526	435.575	-.006	.995

Index calculation

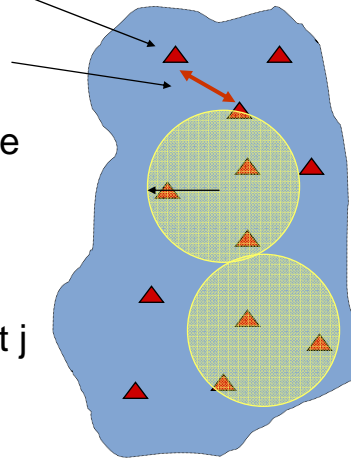
- Based on regression coefficient weightage would be given to factors for getting Business Index of a village
- This weightage would be varying in some extreme cases. (generally they will follow the same pattern)
- Index of a village would be used as “Business Lucrative” parameter.

Location and Number of outlets Problem

common constraint across all cases is distance



- D_j = Business Index at village j
- d_{ij} = distance between village i and village j
- C = Allowable covering distance
- N_i = set of candidate villages from where i^{th} village could be served
- $x_j = 1$ if retail outlet is located at j
0 if not



Case -1

To cover all area, with minimum no. of outlets with constraint of allowable inter village distance, no investment constraint

$$\text{Min} \sum_{j=1}^N x_j$$

$$\sum_{i \in n_j} x_i \geq 1$$

$j = 1$ to N (all locations)
 N_j = set of nodes from where node j could be served
 $x_j = 1$ or 0

Case - 2

$$x_j = 0$$

For all locations which are not feasible

Case -3

To cover maximum business index, with minimum no. of outlets with constraint of allowable inter village distance, with investment constraint

$$\text{Max} \sum_{j=1}^N BI_j x_j$$

$$\sum_{j=1}^N x_j \leq P$$

$$\sum_{i \in n_j} x_i \geq 1$$

$j = 1$ to N (all locations)

$N_j =$ set of nodes from where node j could be served

$x_j = 1$ or 0

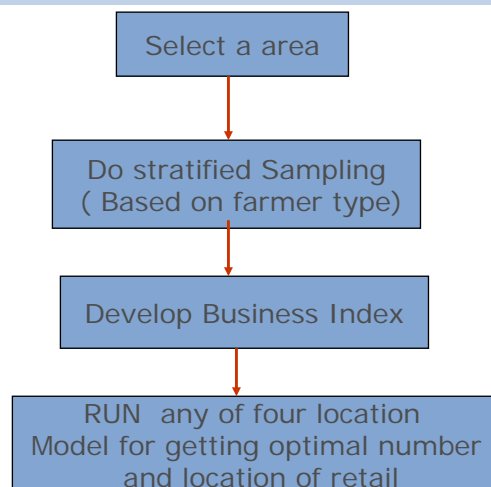
$P =$ Available investment for P outlets only

Case - 4

$$x_j = 0$$

For all locations which are not feasible

Execution Plan



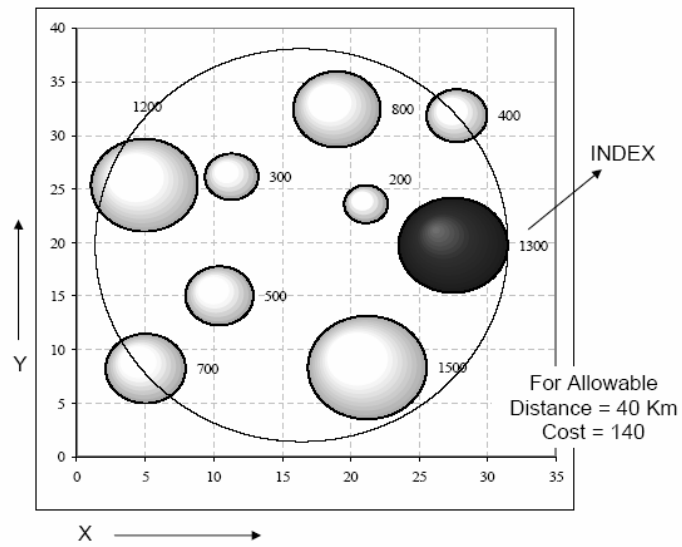
Spatial location of villages, Business index with set Up cost at that location

Villages	x cord	y cord	Index	Cost
Vil1	21.23	8.40	1500	200
vil2	4.93	25.40	1200	500
Vil3	19.00	32.40	800	300
Vil4	11.32	26.10	300	150
Vil5	5.05	8.30	700	160
Vil6	21.16	23.60	200	190
Vil7	10.41	15.00	500	150
Vil8	27.51	19.80	1300	140
Vil9	27.76	31.80	400	600

Distance Matrix of Villages

	Vil1	vil2	Vil3	Vil4	Vil5	Vil6	Vil7	Vil8	Vil9
Vil1	0.00								
vil2	23.55	0.00							
Vil3	24.10	15.72	0.00						
Vil4	20.29	6.43	9.93	0.00					
Vil5	16.18	17.10	27.85	18.87	0.00				
Vil6	15.20	16.33	9.06	10.15	22.22	0.00			
Vil7	12.67	11.76	19.40	11.14	8.58	13.77	0.00		
Vil8	13.02	23.26	15.20	17.37	25.23	7.40	17.76	0.00	
Vil9	24.29	23.71	8.78	17.40	32.68	10.53	24.15	12.00	0.00

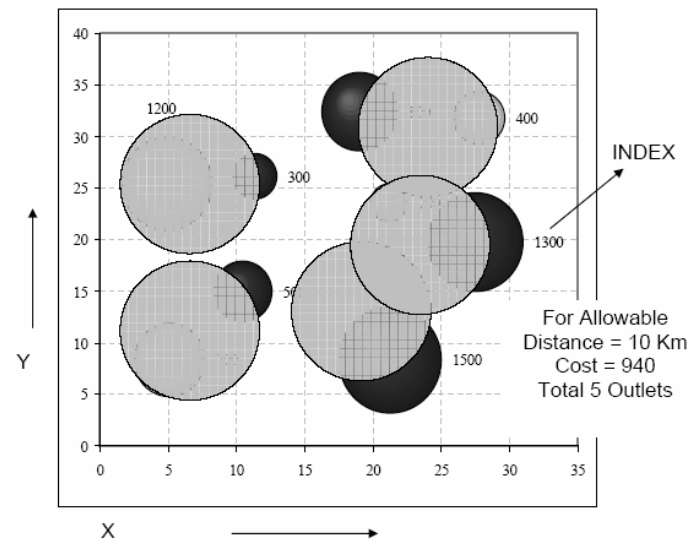
Simulation Run - I



Bigger encompassing circle covers all the markets and optimal location is dark bubble with Business index 1300.

Scenario I – Allowable Distance = 30 Km

Simulation Run - II



Five encompassing circle covers all the markets and optimal locations are dark bubbles with Business index 1300, 800, 300, 500 and 1500.

Scenario II – Allowable Distance = 10 Km

Simulation Result

Villages	x cord	y cord	Index	Cost	Scenario I Allowable Distance 30	Scenario II Allowable Distance 10
Vil1	21.23	8.40	1500	200	0	1
vil2	4.93	25.40	1200	500	0	0
Vil3	19.00	32.40	800	300	0	1
Vil4	11.32	26.10	300	150	0	1
Vil5	5.05	8.30	700	160	0	0
Vil6	21.16	23.60	200	190	0	0
Vil7	10.41	15.00	500	150	0	1
Vil8	27.51	19.80	1300	140	1	1
Vil9	27.76	31.80	400	600	0	0

Concluding Notes

Issues regarding modeling has been addressed

- Data Requirement:
 - Model could be validated with dataset available at working Aadhar centre
 - Some basic data is available at census report
 - Like village population, literacy , sex ratio etc.
 - Inter village (or for convenience inter block as unit of analysis) distance data would have to be in place
 - Above data is required if we assume that , coverage of villages is constrained by distance.
- Some Customization based on Data availability and constraint could be handled on case by case basis

Thank you

Thank you
&
Suggestions??