Understanding the Performance of Unorganized Retail in India Under Normative and Pandemic Scenarios Using an Agent Based Simulation Approach

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Cite as:
Kumar Suman, Sarkar Siddhartha, Raveendran Jayasree, Balaraman Vivek (2021), Understanding the Performance of Unorganized Retail in India Under Normative and Pandemic Scenarios Using an Agent Based Simulation Approach. *Proceedings of the European Marketing Academy*, 50th, (94688)

Paper from the 50th Annual EMAC Conference, Madrid, May 25-28, 2021

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Abstract:

Unorganized retail forms a significant thread in the socio-economic fabric of India. Called Kirana Stores, they have an outsized share of retail in the food and general product categories. While prominent, they also face hurdles in terms of access to credit, working capital constraints, and competition from organized retail. These challenges were further exacerbated due to the national COVID-19 related lockdown. Against this backdrop, we use agent based modelling and simulation to study the operations of Kirana stores and their ecosystem during both normal times and during a pandemic like circumstance. The aim is to understand the differences in operational factors and decisions that lead to optimal performance under different circumstances. We use simulation outcomes to elicit implications for the product mix and credit options which lead to optimal performance and identify effective strategies for better resilience during a pandemic scenario.

Keywords: Unorganized Retail, ABMS, COVID-19

Track: Methods, Modelling & Marketing Analytics

1. Introduction

Unorganized retail represents a significant thread in the rural socio-economic fabric of India. Unorganized retail units, called "Kirana" Stores, are the equivalent of Mom-n-Pop Stores and these merchandise retail units have an outsized share of the food and general product category (staples, groceries, FMCG, pharmacy etc.). There are around 15 million Kirana stores in the country with a share of 70% of the total merchandise retail basket (Khare, 2014). However, in recent years organized retailers have been making inroads in India, increasing competition and raising the question of survival of traditional retail stores. In addition, this year, there was also a Black Swan event in the form of the COVID-19 pandemic. India enforced a 21-day national lockdown in March 2020, with further mini-lockdowns all of which had a significant impact on unorganized retail stores. Given their ubiquity and key role in the Indian economy we need to study Kirana stores under both normal and pandemic like circumstances, to understand the factors at play and how they affect business outcomes under different circumstances. Unfortunately, the informal sector including unorganized retail has not been much studied leading to challenges in terms of availability of data, validated models and measurements. In recent years, agent-based modelling and simulation (ABMS) has been used as a powerful tool to understand operations of various systems where there are constraints in availability of data. We also take recourse to this technique to model and study both the normative operations of a prototypical Kirana store in its ecosystem and the operations during the pandemic and use the simulation to analyse key operational factors and their impacts on business outcomes.

2. Review of Literature

India is known as the *'Nation of Shops'* with Kirana stores occupying a prominent position. Kirana stores operate in less than 500 ft^2 area, are primarily family-owned tiny retailers, operate with low cost structures and are spread across 5000 towns and 600,000 villages (Khare, 2014). Customers prefer these stores because of location proximity, convenient timings, personal relationships, availability of credit, and home delivery options (Khare, 2014). Small retailers' competitive strength lies in the social shopping experience they offer to consumers (Baron et al., 2001). They have high flexibility in deciding their marketing mix and tailoring it to local consumer needs and preferences. The performance of retail store operations have been analysed by assessing the replenishment of inventory (Sharma et al., 2019), assortment of product in the store (Mishra and Ansari, 2013), customer orientation (Eroglu et al., 2011), and sales promotion (Sarkar et al., 2016). However, they also face hurdles in terms of working capital constraints,

access to formal credit facility and competition from organized retail. It may be noted that there is a dearth of studies on unorganized retailing specifically from a modelling perspective in emerging economies. A study in this setting is Jerath et al. (2016) who build a theoretical model of unorganized and organized retailing by modelling key characteristics such as retailers, consumers, and product categories. Sharma et al. (2019) use a nested logit approach to model the distribution strategies and their effects on market demand for various brands. However, existing literature does not address models of unorganized retail in the context of developing markets. Our paper represents an attempt to redress this gap.

3. Operations of a Kirana Store

3.1 Normal operations of a Kirana store

Normal operations of a Kirana store include deciding on product mix, supplier choices, facilities, services provided, working on the customer relationship, and strategies to deal with competition. With appropriate trade-offs between variety, depth of SKUs, costs and service levels, retailers try to satisfy customers' demand. A retailer chooses suppliers based on credit facility, buy back of stock and stock replacement time (Sinha, et al., 2016). Retailers expect better margin from suppliers, product recommendations and risk sharing in terms of buyback or returns. The stores replenish inventory frequently in smaller quantities due to space constraints and retailers adopt various strategies to remain competitive, such as providing discounts, attractive display boards, payment facilities and home delivery service.

3.2 Challenges imposed by the pandemic

With the advent of COVID-19 and the consequent lockdown, the constraints faced by the stores include: panic buying by consumers (Pathak and Warpade, 2020), supply chain disruptions and resultant difficulties in maintaining stock levels, fulfilling additional demand, restricted time in store operation, customers' reaction on out of stock (OOS) situation, employee absenteeism, liquidity issues, and need for loans from financial institutions (Jerath et al., 2016).

4. Model Description

We model the operations of prototypical Kirana store using an ABMS approach under both normative and in lockdown situations. The model consists of three entities – retailer, customer and supplier. Preliminary qualitative interactions (n=5) were conducted among urban unorganized retailers and data was obtained on daily demand, margin for product categories, product details, price and customer footfall. At the start of a day, the store opens and customers who have a shopping need visit their primary retailer. If credit option is given, a customer may choose to buy goods on credit, else via cash. At end of the day retailers check their inventory levels. Based on their inventory control strategy and cash availability they decide to replenish

stock. Upon receiving the stock from the supplier, payment is done via cash or post-dated cheque (PDC) and preference is given to PDC. At the end of every month, various costs incurred, net monthly profit, sales are calculated. Other key parameters such as extent of customer demand met and working capital are tracked on monthly basis. The key decisions taken by a retailer include product mix, replenishment of stocks, providing credit to a certain % of customers and opting for a loan to meet financial needs (Figure 1a).

Customer characteristics: Using a representative expenditure data of urban customers (Sarkar et al. 2016), we estimate the average monthly demand per household. We calculated customer preference for a retailer based on three significant factors – proximity, convenience (product availability) and credit facility (Dhayanithi et al 2004), where, P_c *- preference rank of retailer* x *for a customer* C, w_i *- the weight for each of the preference factors,* n *- total number of preference factors,* $R_{c,i}$ *- relative order of the retailer* x *with respect to the ith factor.*

$$\mathrm{P_c}\ (x_j\ ) = \sum_{i=0}^{n} w_i\, R_{c,i}(x_j) \qquad (1)$$

The weight convenience and credit facility have nearly identical weights (3.34 and 3.35 respectively) whereas location proximity comes in third with a weight of 4.11. The relative order R_c can be identified via sorting the retailer for each factor (e.g. proximity). When a customer goes for purchasing stocks, he chooses the first retailer based on the preference rank. In case their requirements are not met at first store, they visit to next preferred shop, and the search continues until requirements are met or he/she has visited all nearby stores.

Stock replenishment: Each retailer has one primary supplier for inventory supplies. The cost of goods can be paid by cash or credit (post-dated cheque) depending on the option provided by the supplier. A retailer finds an alternate supplier in case a supplier does not offer credit supply.

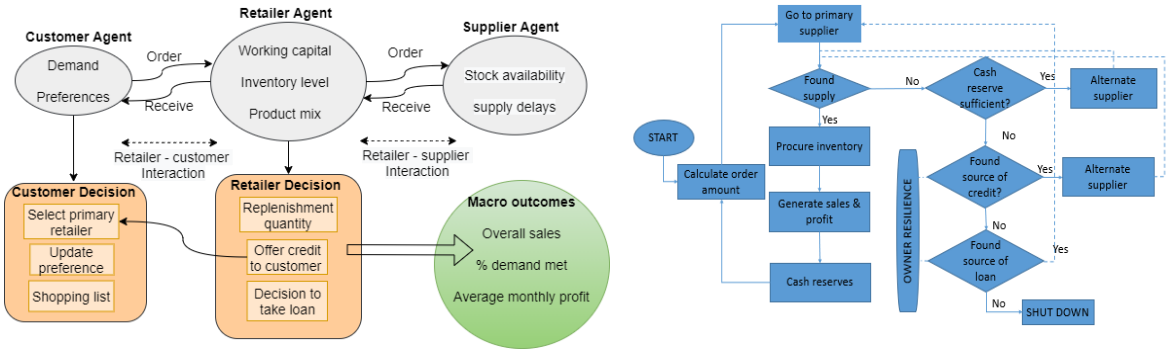

Figure 1: (a) Conceptual model of the Agent based simulation, (b) Retailer decision flow for replenishment

The retailer monitors the inventory at specific intervals and replenishes stock at the end of the interval (indicated as replenishment cycle). In general, the replenishment cycle is 7 days for

all product categories except for *grocery* (4 days) and *bakery & milk* (everyday). Table 1 provides details on replenishment cycle and days of inventory kept for each category.

Product categories: Products are bucketed into fewer categories in the model to simplify the replenishment and buying process without losing out on validity. The categories include – Grocery, Food & beverages, Frozen & dairy, Laundry & cleaning, confectionery & personal care. Within each category, there are sub-categories and are differentiated by the profit margin and buying frequency (See Table 1). Frequency of customer visits (see Table 1) to Kirana stores for different product categories is obtained from Amaresha (2014).

Category	***Product / Items***	***Visit Frequency * (Normal / lockdown)***	***Average margin#***	***Days of inventory***	***Replenishment cycle***
Grocery	Rice, Flour	1	7	7	4
	Pulses, Spices, Sugar, Salt	2 / 1	10		
	Edible Oil	2 / 1	5		
Food & Beverages	Tea, Coffee	2 / 1	6	15	7
	Soft Drink, Juice	3	8		
Frozen and Dairy	Butter, Cottage Cheese	3	6	2	1
	Bakery, Milk	4	12-14		
Laundry & Cleaning	Bath Soap, Washing Soap, Detergent, Cleaner, Shampoo, Toothpaste	1	8	30	7
Confectionery	Toffee, Chocolates	3	7	30	7
Personal Care	Body Lotions, Perfume Hair Conditioners, Deodorant	1	15-20	30	7

*Customer visits: Monthly = 1, Bi-Weekly = 2, Weekly = 3, Alternative Day = 4 #Percentage

Table 1: Category details - Frequency of visits, margins and inventory management

Key outcome parameters: Key performance parameters of a retailer (WC, net profit and sales) are generated on monthly basis. The net monthly profit is calculated based on the category monthly sales with their respective margin and various operating expenses. Working Capital (WC) is calculated as the difference between its current assets (inventories, cash at hand and receivables from customers), and its current liabilities (payables to suppliers, loan instalments and operating expenses). Customer footfall is also tracked for every store.

As model elements and parameters are based on data gathered from survey and relevant past literature, thus it maintains a notion of validity.

5. Simulation Setup, Experimentation and Results

We model a prototypical region of 1 km x 1 km comprising 1000 households (with one customer from each household), 25 Kirana retail shops and 5 suppliers. The distribution of customers was done uniformly within the area and retail shops are located equidistantly within the environment. The model is written in the GAMA modelling and simulation platform version 1.8 (Taillandier et al. 2016). In the normative business scenario, each cycle of the simulation was for a virtual period of 6 months. The lockdown scenario was simulated for a period of 15 months (where the lockdown was introduced at 5^{th} month for a duration of 4 months and activities are monitored for the subsequent 6 months). While for the lockdown scenario the

duration was 15 months where each cycle/tick in the simulation corresponds to one day. Each store was initialised with different levels of WC (between INR 10000 to INR 60000) and we discuss the distribution later in the paper. Inventory levels for different product categories are calculated as a product of average demand per day and number of days for which stock is needed. The credit offered to customers was varied from 0% to 30%. Each scenario was run 10 different times. The aim of the experimentation is to (a). Identify optimal retailer performances by product mix and credit options in normative scenario, (b) Understand impact of various constraints in normative as well as lockdown scenarios and (c) test the efficacy of identified strategies towards better resilience in the business. For some analysis, retailers were segregated into low, medium and high WC groups to assess the differentiated impact on each group.

5.1 Experiments in normative and pandemic scenarios

5.1.1 Normative scenario

The normative scenario considers retailers having enough resources for procurement, credit purchase facility, steady customer demand and suppliers delivering goods on time. We first track monthly sales for each product category where a retailer keeps all the identified product mix. We see that *grocery* has the highest sale volume followed by *frozen & dairy* category, whereas *food & beverages* and *confectionery* seem to have lesser sales (See Figure 3).

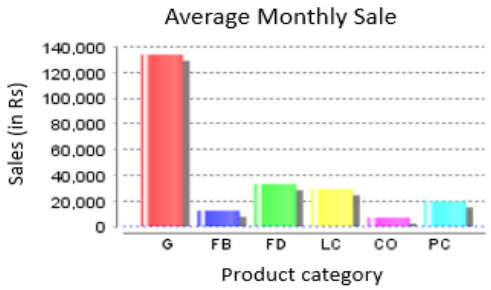

Figure 3: Monthly sales for product categories

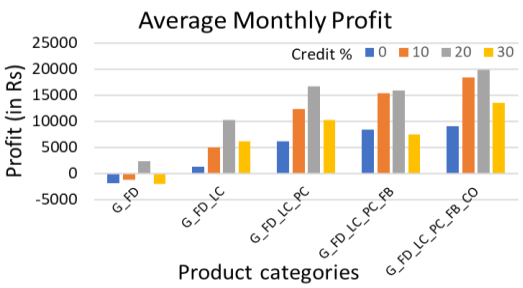

Figure 4: Profit with increasing credit sale and number of products

We monitor a retailer's monthly profit with varying the number of product categories and extent of the credit sale. Competitors are assumed to have all product categories and provide credit to 10% of customers. The retailer starts with an initial WC of INR 50000. We can infer from the simulation results in Figure 4 that the retailer generates more profits if the store keeps more product categories as well as provide credit-based sales (Figure 4). However, not every product category increases the profit by same amount. Adding *food & beverages* in the product mix does not seem to improve the situation, while adding *personal care* products has a significant positive impact due to its higher margin. Similarly, offering credit sale to 20% of

customers seems to be optimal, with higher values (30% and above) leading to decline in net monthly profits. When retailers keep most of the product categories, the 10% and 20% credit options have comparable outcomes.

Secondly, to identify optimal percentage of customers for whom credit sales can be offered, we conducted an additional analysis by segregating retailers into two groups: Group 1 with lesser WC (mean ~25000) and Group 2 with higher WC (mean~50000). Simulation results show that the optimal % for offering credit sales for Group 1 is for 10% of customers and Group 2 can afford offering credits to 20% of its customers (Figure 5).

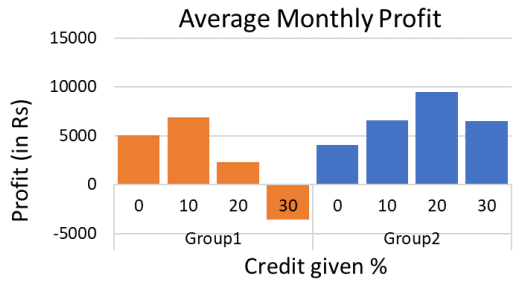

Figure 5: Profit with increasing credit sale for two retailer groups

For next set of analysis, we have kept the all products categories available at each retailer.

5.1.2 Introducing constraints in normal retail operations

We estimate the impact of two constraints on store performance during the normative scenario in the following experiments.

(A) Delay in supplies: We see that an impact of supplier delays on profit to be more for retailers in Group1. There is a noticeable drop in the profit levels for this group compared to Group 2 with higher WC. For an average delay of 1 and 2 days, profit dropped by 9.4%, and ~40% respectively. The reason for such differentiated impact between two groups is due to the fact Group 2 retailers having higher WC & inventory space can maintain additional stock as buffer while for Group 1, WC and space limitations leads to higher out of stock situation.

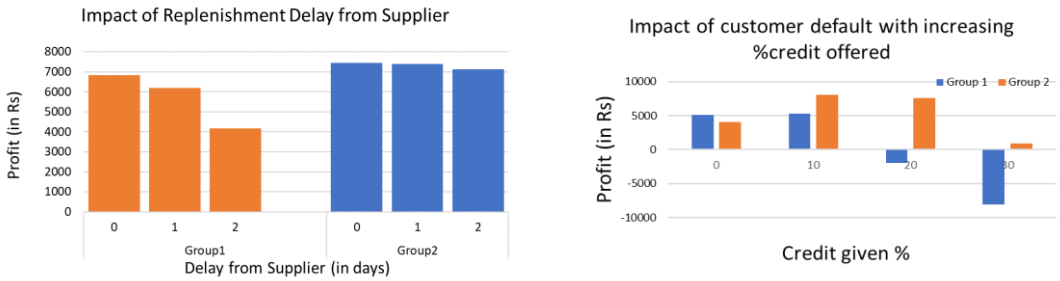

Figure 6a: Profit decreases due to a). replenishment delays and b). customer payment default

(B). Customer credit defaults: In this experimental scenario we introduce customer payment defaults as a constraint, where retailers are unable to realize payments from a certain percentage of customers (10%) to whom credit sales are offered. We see that higher the credit

offered, higher the negative impact of customer defaulting on credit payment for Group 1 (Figure 6b). We now examine whether taking short-term business loans can improve the situation. To assess this, retailers were given an option to avail the short-term loan of INR 50,000 to INR 100,000 with interest rate of 15% based on the monthly sales. Simulation results show that Group 1 retailers having availed the loan option saw increased profit by 16-20%.

5.1.3 COVID-19 lockdown scenario

The constraints considered in the model for lockdown scenario are - disruption in supply chain (less than 7 days' worth of stocks provided compared to 15-20 days in normal situation) and absence of credit supplies to the retailer. Additionally, we consider a spike in demand for *grocery* and *bakery* products up to 40%. Customers also visit stores less frequently during lockdown (as given in Table 1).

Figure 7: a) Monthly profit, b) number of store visits per trip c) Extent of customer demand met in normal vs lockdown

Lockdown was introduced at the 5th month and duration for lockdown was kept at 4 months. We segregated the retailers into three groups- Group 1, 2 & 3 having WC as low, medium and high (INR 15000, INR 30000 and INR 50000) respectively to analyse performance in the lockdown scenario. We see a significant drop in the profit levels for Group 2 and 3, while also interestingly observe a marginal increase in profits for Group 1 (Figure 7a). This phenomenon could be attributed to the fact that customers visit more stores including those there were not initially preferred resulting in increased footfall and sales. Figure 7b depicts differences in customer visits, which is >90% before lockdown and 70% during the lockdown approximately 22% of customers are seen to visit three or more stores per trip during the lockdown. Moreover, the extent of demand unmet goes up to 26% in the lockdown situation due to greater out of stock compared to 4% in the normal scenario. (Figure 7c).

5.2 Effective strategies for resilience in lockdown

Given a lockdown scenario, we look at resilience of a Kirana shop, which is defined as an ability to recover from losses or adapt operations to survive the lockdown. Strategies considered in the model include, (A) Capping the credit facility option for customers: While offering credit

to 20% customers was a favourable condition for retailers with good WC in normative situations (Figure 5), it likely has a negative impact on retailer performance during lockdown where there are restricted supplies and limited credit-based supply. The Figure 8a depicts the variations in profit levels with different levels of credit offered. From the chart we can see that the optimal values are 5% for Group1 and 10% for Group 2 & 3 which suggests that retailer should refrain from giving higher credit sales.

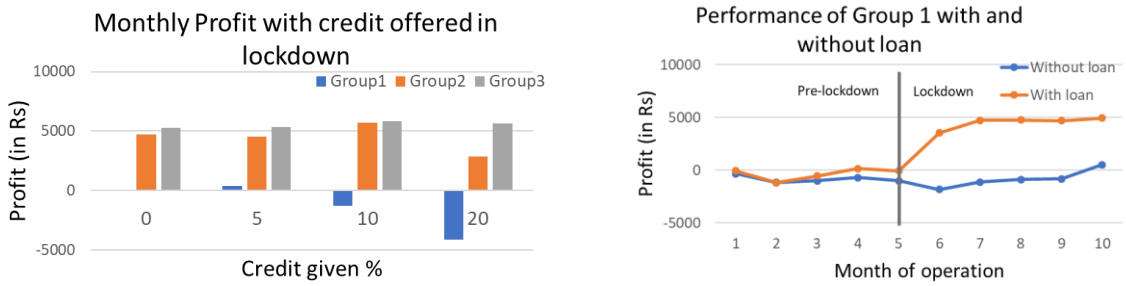

Figure 8: Lockdown situation a). reducing credit sales in lockdown b). availing loans c). alternative sources of supply.

(B) Availing loan option: The availing loan during lockdown is seen to significantly improve the situation for retailers having low working capital (Group 1) as seen in Figure 7b. This shows that, during lockdown there is a possibility to revive an under-performing store who can now cater to additional customer demand generated during the lockdown. It is thus highly pertinent to have financial assistance provided to Group 1 retailers to enable resilience.

6. Conclusion and Discussion

The impact due to the pandemic would apply to the whole Indian economy but most notably in the unorganized sector. Within this, we have modelled the functioning of unorganized retail, focusing on the operations of a Kirana shop in normal and pandemic situations. In the normal scenario, Grocery has the highest sale volume followed by frozen food category, whereas personal care and confectionaries seem to have lesser sales. Adhering to 10% as credit limit offered to customers help the retailer to maximise profits. In the lockdown scenario, we find that there is a significant drop in the profit levels of well performing stores during the lockdown, the model also discovers an improvement in profits for stores which have not been performing well earlier. We attribute this to increased number of customer visits to stores which may not be their preferred stores either due to increased purchases or unavailability of products in their preferred stores. There are implications from resilience and financial assistance point of view in this scenario.

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