BROWSING OR BUYING: ADDING SHOP DYNAMICS AND ADDITIONAL MALL VISIT CONSTRAINTS IN REGIONAL VERSUS CITY MALL SIMULATIONS

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ABSTRACT
The attraction of shopping malls as a retailing structure can be explained by the interrelationships that exist between stores and the benefits these provide consumers. Malls can provide centers or anchors, (department and supermarkets) and reasons to prolong a shopping trip (such as coffee, snacks and meals), which benefit in an ecological sense other retailers. This paper extends the work by Duncan, Bossomaier, D'Alessandro, & Murphy (2015b) by including different distributions of shops versus entertainment /service options which model the trade-off of a consumer staying longer.
Our results show that smaller regional malls with their distribution of shops biased to larger consumer expenditure are more vulnerable to economic shocks than are larger city malls with a distribution of shops catering for mid-consumer expenditure. The results suggest that the decline in the number of shops in the services category may be a lead indicator for the sudden collapse of regional malls.

Keywords: complex systems, retail shopping malls, regions, cities, tipping points, social networks.

1. INTRODUCTION

Shopping malls, are an important part of any developing and advanced economy. In the United States, for example, there are over 50000 shopping centers and malls, which contribute an estimated 2.3 dollars in sales and 75% of all non-automotive consumer sale (Miller & Washington, 2011). Shopping malls are surprisingly similar across the world: A mall in Rio de Janeiro looks inside just like a mall in Sydney or Paris, with the same brands and structure. Thus it is reasonable to suppose that malls have effectively evolved to an optimal layout and balance of retail options (Yuo & Lizieri, 2013) However, there is evidence that shopping malls have been slowly disappearing in the developed world. Davidowitz (Peterson, 2014) predicts half of all shopping malls to fail within the next 15 to 20 years. Major US retailer Sears closed some 300 stores since 2010 (Peterson, 2014) and the investment in malls fell in the US from a high 175 million square feet in 2002 to 50 million square feet in 2011 (Miller & Washington, 2011). Malls in lower and middle class areas are expected to suffer the most (Peterson, 2014).

2. LITERATURE REVIEW

The choice between online versus traditional retail bricks and mortar buying behavior has been a topic of much debate over the last decade. Reasons for purchasing online rather than in-store include convenience (Rohm & Swaminathan, 2004), lower prices (Junhong, Chintagunta, & Cebollada, 2008) and greater choice (Liu, Burns, & Hou, 2013). Factors which inhibit online purchasing are:

1. Risk of fraud (Huang, Feng, Fan, & Lin, 2012)
2. Lack of trust (Toufaily, Souiden, & Ladhari, 2013)
3. and the presence of incomplete information about the retailer (Dennis, Jayawardhena, & Papamatthaiou, 2010).

Reasons consumers like to go to shopping malls include comfort, entertainment, diversity, mall essence (or atmospherics), convenience, and luxury (Ammani, 2013; El-Adly, 2007). Other studies have conceptualized the mall experience of consumers as being either seductive, acting as interactive museum, a social arena, and functional means of obtaining of goods and services (Gilboa & Vilnai-Yavetz, 2013). Mall attendance has also been linked to a personality trait of fashion orientation (Michon, Chebat, Yu, & Lemarié, 2015). Research from India, suggests that anchor stores (supermarket and department stores), or one-stop shopping, are an important driver for mall patronage (Swamynathan, Mansurali, & Chandrasekhar, 2013). There are also benefits (increased traffic and complementary sales) for other retail chains collocating with anchor stores in shopping centers.

Stores which provide benefits to consumers, and help retain them longer in malls are food and beverage outlets. US research suggests about 7% of consumer go to malls primarily for food and these venues encourage consumers to stay on average an extra 45 minutes in a mall, and will double their spend on to an average of $98.40 per trip (Miller, 2011, p. 112). It would therefore seem that the success of a mall depends on the interrelationships between three types of stores; anchors (which attract consumers to the mall for functional reasons, such as grocery shopping and help generate mall traffic and externalities; attractors (fashion and speciality retailers which entice consumers for more discretionary spends; retainers, such as coffee shops and food outlets, which make the consumer stay longer in the mall and so increase their discretionary spend.

While the economic impacts of malls are well understood malls can contribute to community benefits in regional areas:

- They provide a destination, especially in regional, or poor neighborhoods, where other leisure options might be limited (West & Orr, 2003).
- They provide retail and service jobs with additional support jobs in mall management and maintenance (Bernat, 2005).
- They may contribute to a sense of well-being and satisfaction of consumers (El Hedhli, Chebat, & Sirgy, 2013).

Note that these community benefits, have lead some commentators to suggest that regional malls are commercially more viable than those in urban centers, partly also because of their different structures and their fostering of consumer loyalty (Bodamer, 2011). Given these community and economic benefits, there is need to investigate how regional shopping centers can be designed to attract and retain consumers so that a greater amount of purchases occur locally and malls remain in good health. But regional shopping malls like all other shopping centers face increased competition from online retailers.

It is for both economic and social reasons that we have conducted research on previous simulations of mall behavior (Duncan, Bossomaier, & D'Alessandro, 2014; Duncan, Bossomaier, D'Alessandro, French, & Johnson, 2015a; Duncan et al., 2015b). In this study we extend our research with the use of additional empirical data and the further modelling of mall behavior. To start with an accurate representation of the retail landscape, we collected data on regional and suburban malls from two mall chains in Australia, the Stockland and Westfield chains. The information was downloaded from the respective websites of the chains at: http://www.stockland.com.au and http://www.westfield.com.au/. Regional malls are typically an order smaller than suburban and urban malls.

3. THE SIMULATION MODEL

A Matlab simulation was constructed of a regional mall based around the mall designs from Stockland and Westfield mall chains examined in a previous paper (Duncan et al., 2015b). The model has four development stages:

1. Stage 1 was discussed in (Duncan et al., 2015b). It comprises a model of customers and shops across different retail sectors and examines profitability of mall under different scenarios.

2. Stage 2 increases the model complexity to allow parametrization with spatial data (transport costs etc) and data from the Australian Bureau of Statistics on income distributions and retail preferences.

3. Stage 3 will compare four regional centers: Orange, Wagga-Wagga and Albury with Bathurst. Only Bathurst currently has a significant, purpose built mall.

4. Stage 4 will takes results from the previous stages and develops a general turn- key simulator, which may be used by investors, town councils and other stakeholders in mall development.

The customers are represented by an agent, denoted i. Customers are randomly connected to other customers and exchange information about their retailing experiences through these social networks. The more links within the networks of customers the more effectively information about retailing alternatives can pass through the customers.

After the calculation of all the customer's experiences, the customers then share the experiences across their social networks. To calculate the sharing of information about retailers, each agent calculates a weighted average of their own experience with each type of retailer this time step with the experience of each of their network neighbors. The weight given to the neighbor's experience is [0-1].

To the social network model we improve on the random decision to visit the mall as follows: The decision to go to the mall is based on two parameters

- The time since last in the mall, t. We use a day as the of unit of t
- The decision to visit the mall is based on the customer experience, denoted by X_j
- The customer experience in the mall is represented by the following equation:

$$X_j(v) = \zeta X_j(v-1) + (1-\zeta) p_j / p_{max} \quad (1)$$

Where:

Xj= customer j experience of the mall.

v = visit to the mall.

ζ= hysteresis factor, momentum factor of the history of past visits to the mall.

P_j = path length (length of a mall visit)

P_{max}= maximum possible path length (maximum possible time in the mall).

Pj and Pmax are the path length for this visit compared to the maximum. The ratio is identical in value to the fraction the daily opening hours the customer is present in the mall. We assume the longer the time spent in the mall therein the positive the experience.

The path length undertaken by an agent in the model depends upon the availability of entertainment, (in this case cafes and takeaway foods). We that a customer / agent would need a break every 4 ticks (one tick representing 15 minutes, or 1 hour in total). Without such an opportunity for refreshment we argue, the customer stops and the path length (time in the mall) terminates, as the agent (customer) gets hungry and thirsty and goes home. This is given by the following equation:

$$P_j = \max(P) \; s.t. \sum_{i=1}^{P} \delta_{ic} \leq floor\left(\frac{P}{b}\right) + 1 \quad (2)$$

Where Pj= Path length of customer j

δ_{ic}= Kronecker delta of coffee shop count.

b= break in the path for refreshments and entertainment, set at 5 ticks.

We generate for each customer in the mall a random path, with a maximum 15 minute visit to trip length, say 20 ticks (5 hours). Now generate a random path, with a step every tick. We define a parameter b (for break) which is the amount of time one can visit shops without a break in the entertainment (ie food, coffee, etc) domain. So we now run cumulative sum of the number of entertainment slots in the path and if the number of ticks divided by b is greater than the number of e stops, then the path terminates. Thus with b=5 then if at tick 19 one has passed 4 e stops then the path continues. 20 is okay (ticks/b=4) but 21 (ticks/b=4.2) and the path terminates.

If the entertainment options (coffee shops) falls too low then the retail sales will fall, because the residence time in the mall will go down. If the customer's experience includes a dead shop, the experience is decreased by a penalty factor β, which is set at 0.95 for all customers through-out the simulation.

The customer also has a bricks and mortar preference Ψ_j(q) for each retail category, q. If the purchase in a shop does not go through it is decreased by β (because the shop is unoccupied or there is bad service). Whether a purchase goes through depends on the consumer profile for category q, denoted by ϕj(q), and the shop service factor sq for shop category q. This is a constant factor representing price, competitiveness, brand range, customer service and so on.

The customer experience is initialized to a value of between 0.8 and 1 according to:

$$X_0 = 0.8 + 0.2r \quad (3)$$

Where r is a uniformly generated random number in [0-1]

Disposable income is incremented every pay period, in this case 14 days.

The probability of going to the mall on any day, $\emptyset_j$ for customer, j is defined in terms of these parameters and the faction of occupied shops in the mall, ς. If some shops in the mall are unoccupied, this decreases the desirability of the mall. The mean of mall experiences in our model is also defined by a social network effect (5).

$$\emptyset_j = \arctan(t_j \bar{X}_j \beta_j \varsigma \Psi_j) \quad (4)$$

$$\bar{X}j = \lambda Xj + (1-\lambda) \sum_{k \in U_j} X_k \quad (5)$$

Where:
$\bar{X}_j$ = mean of personal and social network mall experiences
X_j = personal mall experiences
λ= weight of personal experience versus that of a social network.
U_j = social network of customer j.

We simplify the shop's behavior to simply requiring it to meet a revenue target, *R*. If this number is not met, the shop collapses. This threshold will be different for the different retail categories. A coffee shop for example, may require more transactions than a clothing / fashion outlet in order to break-even and this is also represented in the model.
The model also included the dynamics of the mall break-even point, centered around the following equation:

$$\alpha P\bar{c}\,\frac{T_s}{T_v}Nc = RN_S \qquad (6)$$

Where:

α = External financial and economic pressure on the mall. A higher number representing more challenging financial and economic conditions.

P = Maximum path length of the customer in the mall, a path length consisting of 15 minute intervals for shop visits. In this case 40 possible visits in a 10 hour day

$\bar{c}$ = Average item cost, for each of the six types of stores.

T_S = Shop clock rate, or time at the mall over a given period.

T_v = Time between mall visits

N_c = Number of consumers

Ns= Number of shops

R= Revenue target.

In essence, equation three models the effect of online success, which reduces the success of the mall, as a greater number of customers are needed to shop in the mall. The path length in the mall is influenced by the desirability of the mall as shown by the mall random path, which is influenced by the availability of entertainment and shopping options. Of course, equation 1, shows the probability of visiting the mall in the first place a feedback is dependent on the attractiveness of the mall as defined by number of shops, entertainment options and the occupancy rate, which depends on shops meeting the breakeven and therefore number of shops and available attractions. The parameters in the model are shown in table 1

Table 1: Parameters in the model

Variable	**Values**
α	0.70, 1.4
P	40
N_c	1000, regional mall 6000 for city mall.
Ts	Shop check rate, 90 days.
Tv	30 days
$\bar{c}$	As per the ABS retailing categories these were set at; Food retailing \$150, Household goods/ electrical \$250, Clothing and footwear, \$100, Department stores \$200, Cafes, restaurants and takeaway food \$10, Other retailing services \$50.

Empirical shop distribution and mall size

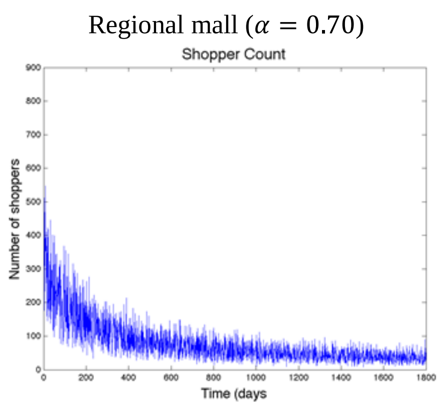
	City Mall	**Regional Mall**	
Food retailing	2%	7%	2%
Household goods /electrical stores	4%	7%	4%
Clothing, footwear and personal accessory retailing	34%	24%	34%
Department stores	1%	3%	1%
Cafés, restaurants and takeaway food services	21%	18%	21%
Other retailing and services	38%	42%	38%
Mall size	**300**	**50**	

4. RESULTS

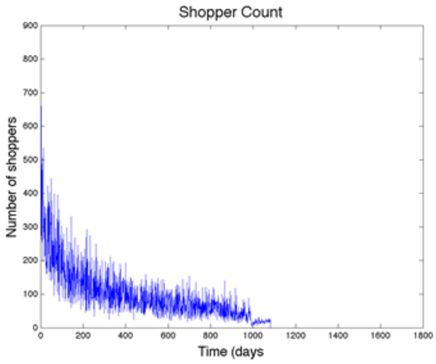
The results of the model run for the conditions of a city mall, taken from secondary research compared with that of a smaller regional mall are shown in panels 1 for number of customers, and 2 for types of shops. The large mall simulation was run with 6000 customers, 300 shops and to take into account the different sizes of the mall, the regional mall simulation was run with 1000 customers with 50 shops. All simulations were run until the mall was no longer functioning (it had no customers and therefore no shops). Note that increase in financial difficulty did not alter the results for city malls, so only the higher financial levels of stress are shown here.

As can be seen in panel 1 and 2, regional malls are very vulnerable to external shocks (greater financial and economic difficulties). The results for α=1.4 showed an early collapse of patronage with other retailing and services (lime green line) falling as the result of reduced customer visits in time 10, followed by the other shop types in time 12, with cafes and takeaway food services surviving a little longer to time 13 at a higher rate (see blue line). The same cannot be said for larger city malls. The results as shown in panel 3, show a stable distribution of shops over time, even with the decline of customers over that time period. These results suggest that larger city malls act more as a sustainable ecosystem for consumers, even in times of financial difficulty. The reason being that the large mall size allows a greater absolute measure of diversity of options and builds greater robustness in the mall, via virtue of the availability of retail options.

Panel 1: Customer results for regional malls for α=0.70,1.4.

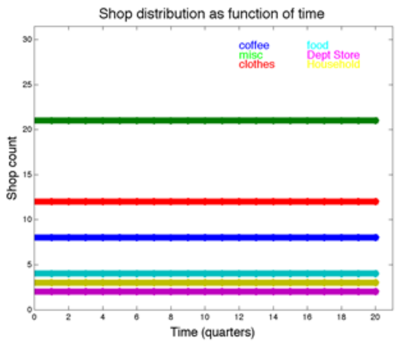


Regional mall (α=1.4)

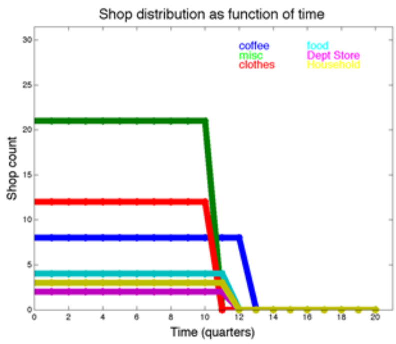


Panel 2: Shop distribution results for regional malls $\alpha = 0.70, 1.4$

Regional mall ($\alpha = 0.70$)



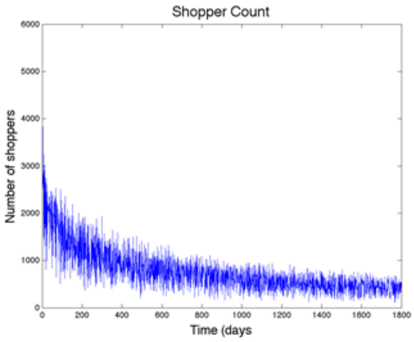
Regional mall ($\alpha = 1.4$)



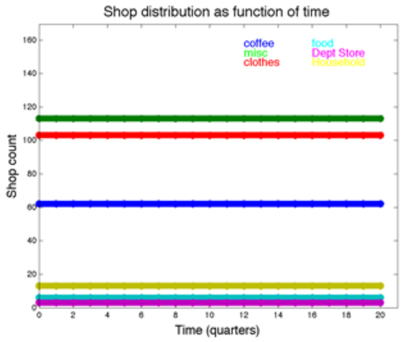
The higher proportion of cafes and takeaway foods in a larger city mall, probably encourages consumers to stay longer, and the personal clothing and fashion stores which exist in city malls in much greater proportions in city malls (34 to 24%) respectively, means purchases that are the mid-level of $100 per trip, make the design of city malls more sustainable to hard economic times. In regional malls, there are higher proportions of shops at the larger end of the consumer expenditure curve, which means that this mall design, is sensitive to any changes in consumer patronage dramatically changing the retail landscape.

Panel 3: Customer and Shop distribution results for City malls ($\alpha = 0.70$ & $\alpha = 1.4$).

Customer results



Store results



5. DISCUSSION

Understanding the dynamics of mall behavior is a good example of the application of complex systems thinking to an issue of great economic and social concern. As suggested in the results, regional malls are more vulnerable to economic shocks. In order to counter this regional malls may wish to become first bigger centers in order to survive. Town planners and regional mall managers need to carefully plan for a mix of shops closer to what would be found if possible in larger city malls. Towns in close proximity may even wish to share the distribution of shops (or specialize) across areas of retailing. The sudden decline in the number of shops in retailing and other services sector in a regional mall may also be an early warning alarm that the mall is in serious risk of dramatic decline.

Of course no simulation model is ever complete and 100% realistic. In this case we have not used empirical data representing the differing consumer expenditure profiles, or market segments that exist in both regional and urban areas. Our categories of retail types, although based on ABS and government classifications are quite broad, and so the model may not yet simulate all the complexities of retailing. We have also not included competition between malls, or centers. Nevertheless we believe this simulation to be an important step in the process of understanding, predicting and then managing the complexities of retailing in both cities and country areas. Future work will add these refinements.

Future research could widen the application of the model developed here to include differing consumer expenditure profiles, a more granular description of retail types, include inter-mall competition and finally could even include changes in nearby population and demographic structure. The challenge here is not only to model these factors in future but also to have access to wide range of parameters (such as a detailed item cost, and shopping behavior of consumers). This may be quite possible in the future in the age of big data.

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