Design of the optimal company development strategy using multi-agent modeling

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Abstract

The study is aimed at determining the optimal strategy for the development of the company in terms of increasing the number of loyal customers using multi-agent modeling methods. The constructed model takes into account not only the main characteristics of the company's customers, but also a set of market tools available to the company at various stages of its existence to attract customers. The multi-agent model developed using the platform NetLogo can also be applied in other domains characterized by a high concentration of analogous (competing) entities (agents, goods, companies).

Keywords

Competition model, multi-agent modelling, customer behavior model

1. Introduction

Agent-based models (ABMs) have great prospects for research in socio-economic systems. One of the most interesting areas of work in the framework of multi-agent modeling is the study of competition between different agents [2]. Many real business scenarios, ranging from the bidding model to the supply chain organization model, can be expressed as a competition of agents in the ABMs [3]. Analytical models make it possible to obtain illustrative results, but one has to pay for clarity by introducing additional assumptions into the model, such as: an infinite population size, limiting the number of possible behavior strategies, ignoring the spatial structure of the population [4].

A separate agent (firm) is usually described in competition models as follows [3]: the agent's sensory system provides perception of the external world from the field of view of the agent and supplies the agent with information about his inner state. The agent is oriented in space. The agent has the "forward" direction relative to which its field of vision is oriented, and the actions they take are defined. The agent's field of view consists of 4 cells: one the cell in which the agent is located, as well as the cells located in front of the agent, on the right and to the left of the agent. In its field of view, the agent can see other agents and interact with them. Each firm is capable of running a set of certain actions (programs) to improve its performance [4].

In this case, we mean by performance the ability of a company to satisfy the needs of its customers. The greater the number of such customers, the higher the performance of the company. This is fully consistent with the principles of the sales companies, which are the main focus of this work and the main task of which is to attract the maximum number of customers and satisfy their needs, taking into ac-count limited production capabilities [12, 13].

As for the agent-client, it usually is modeled as a randomly-moving agent that can either transact with a company if certain conditions are met, or it can avoid transaction otherwise.

This behavior of the agent corresponds to psychological studies of the behavior of customers who have the following features [15, 16]: 1) they can only purchase goods in organizations that they know about, 2) to find such organizations, customers use various sources of information, while the type of

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information source does not guarantee 100% contacting the organization, but affects the likelihood of contact. Thus, a model can be obtained that describes the dependence of the probability of a client contact on the type of information source. However, within the framework of the current study, the task of constructing such a model is not set. Only its probabilistic (random) nature is essential.

The client may incorporate different preference characteristics that aim to model its probability to interact with certain agents firms [5].

However, the question of researching the company's development strategy to at-tract the maximum number of customers remains the most relevant. In the literature, there are 2 directions of company development: intensive and extensive. The extensive way means expanding the scale of production and/or expanding the sales market in order to attract new customers [3]. The intensive way involves the use of market tools for the development of the company, for example, promotions or work with the level of service [5].

Other classifications of types of company development are also possible in terms of the number of customers (or other indicators) [13, 16]. For example, uniform growth implies a constant increase in the number of customers over time [13]. The "miracle of growth" [14] is expressed in a sudden increase in the number of customers of the company, caused by some factors, sometimes biased. Such miracles occurred during the pandemic and were associated with the growth of companies providing various remote technologies (Zoom [17], etc.). In addition, there may be negative examples of the collapse and death of companies as a result of various external (economic crisis, reduced purchasing power of customers) [13] or internal factors (high staff turnover) [12]. However, all these types of development, in fact, come down to how the company carries out a campaign to attract new customers and satisfy their needs [12]: using a banal increase in production capacity (or a market niche), or using available market tools, thereby realizing extensive or intensive development mentioned above.

However, taking into account the long-term development strategy, the issue of combining these development paths for the company to reach the peak of its development (in other words, its maximum productivity under conditions of fixed production possibilities) remains controversial. For example, in [6] it is noted that the constant use of the same tools leads to a decrease in their effectiveness, and even has a negative effect on the development of the company.

On the other hand, the simultaneous use of various instruments is expensive and bears certain risks on the financial performance of the company. An example of such a negative use of market tools is the experience of Friends Reunited, which tried to expand the volume of promotions without increasing production capacity, as a result, faced with server crashes and the loss of half of the customers [5].

Thus, we will try to combine in this study the experience of several companies, both successful and unsuccessful, in order to model the optimal strategy for the development of the company. The inclusion of negative scenarios for the development of the company distinguishes this work from the study [11], in which the authors analyze only positive scenarios for attracting clients to organizations. In contrast to this approach, we believe that in order to build an effective customer acquisition strategy, it is necessary not only to maximize the use of the most effective tools, but also to minimize the use of those that have a negative impact.

At the same time, we rely on the conclusions obtained by the authors of the work [12], which describes the most common tools for attracting company customers, as well as the possible effect of attracting them and the degree of its decrease over time with constant use.

This work is structured in the following way. In the Section 2 we summarize the possible actions the company can take to attract new customers and develop itself and the details of the developed multi-agent model. Section 3 demonstrates the analysis of the behavior of the model with different parameters. Section 4 presents the simulation results and conclusions from the work, continuing in the Conclusion.

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2. Agent-based competition model description

Based on the idea that the main source of income and functioning of the company is to attract customers, in the developed model, two types of agents are distinguished: firms and clients.

To identify the characteristics of each agent types, we analyze existing psychological research in the field of market relations. In accordance with the confirmed Croom et al. hypotheses [7], the essential characteristics taken into account by the buyer in the process of making a purchase decision are the amount of free cash and the expected level of service (goods quality). In addition, the presence of a positive experience of interaction with the company has an impact [1]. In this case, we are not talking about the formal belonging of the client to the company's loyalty pro-gram, but about the number of successful purchases that take place between specific client and specific company.

On the part of the company, the following characteristics can be determined: the price of a good (or a service), the quality of the services provided, the size of the discount for various categories of customers (in the case of the model being created, we will consider one averaged parameter not to complicate the model), the loyalty of the company's customers. By loyalty, we understand, as in the case of a client, the number of successful interactions between a company and a client. Most often, three categories of customer loyalty are distinguished [7]: random customer (who made one purchase), potentially loyal (made a repeat purchase) and loyal (made more than two purchases).

Based on the prerequisites above, **Client** is modeled with the following **properties**:

- ***client budget*** (the number that customer owns and ready to spend on the product – constant number indicating that client has approximately the same amount of money to spend each time on the same product);
- ***service-level*** (the number 1-low-level, 2-mid-level, or 3-high-level indicating the client's preference in service-level provided by firms).

The "client" agent is aimed to have few characteristics and possibilities in the model proposed, as we focus mainly on firms and their behavior. Some customer-related logic is incorporated into firms to make it more representative on the level of the firm.

The "firm" agent is modeled with the following characteristics:

- ***product-price*** (indicates the base price of the product for the client);
- ***service-level*** (indicates the level of service the firm is able to provide for the clients);
- ***n-success/n-refused*** (two additional parameters to indicate the number of successful and unsuccessful transactions of each firm with each client);
- ***first-category/second-category/third-category*** (parameters to store information about what customers buy only one, twice, and more than twice times in each firm);
- ***loyalty-discount*** (the number (percent) to apply as discount to the product-price for loyal customers);
- ***n-loyal-success*** (indicates the number of transactions that implied loyal customers and usage of discount).

At the start of the model working, the number of companies is created in the model world. The model world is a graphical space divided into separate squares (patches) in which various agents can be located and along which they can move (depending on the behavior model) in different directions. In fact, this is a top view of the three-dimensional space familiar to the user.

The number of companies is specified by the user in the interface. Each company has a different size, unique color, "house" shape, and the set of parameters: product price (ranges are specified by user in the interface), service level (can be either randomized or set to the first service level by user in the interface), n-success/n-refused parameters (set to 0 at the start), first-second-third categories of the customers (set to 0 at the start), and finally the number of discount (set to 0 at the start), and the number of transactions with loyal clients (as well 0).

Customer is initialized with a random budget from the specified by the user range in the user interface. And then, each customer is initialized with the random level of service preference. The number of customers can be set in the user interface as well.

In this case, we consider the development of the company over time, therefore, in order to better understand the influence of various factors on the development of the company, we use a discrete time model that divides the time horizon into stages of equal duration (hereinafter referred to as a turn or a tick). This is expedient from the point of view that 1 tick can correspond to different time fragments, allowing the model to be applied for different time horizons (from 1 day to 1 year or more).

Each turn customers are randomly moving in the model world and start a transaction with companies around. Additionally, during this function we check for every 2000 ticks to allow companies to start

their programs. There is another condition for stopping the model after 50000 ticks as well. This option is available for users in the interface, so the model can be run either in infinite mode or with the restriction with 50000 ticks only.

In this case, this duration of the company's development was chosen based on general statistics that the average life cycle of a company is 10 years (before an acquisition or merger) [11, 13] and during each year up to 2-3 different activities can be carried out on average to develop company [12, 15]. Thus, if 50000 ticks correspond to 10 years, then there are 5000 ticks per year and an average of 2-3 events can be held during the year (~2000 ticks per event).

To implement this behavior of agent-clients and agent-companies, we use the tools of the NetLogo 6.2+ platform [9]. This platform was chosen due to the simplicity of language means of expression, as well as due to the realizing the truly independent behavior of agents required in the competition model [10].

The main customer-firm interaction logic is written under the transaction function (Figure 1) that aims to check if a certain client is able to buy a specific product of the specific company. So, first of all we check for every client if they stepped in the area of a certain company. If a customer is in the area of a certain company, they are able to transact. The transaction is successful if client's budget and preference level match companies' product price and service-level. The transaction is not successful if customers' budget is not enough for the product, or customer's and firm's service-level do not match. In order to match, customers' budgets should be more or at least the same as product price. As for the service-level, it should be the same or less than the company's service-level offered.

There is another additional logic happening in the transaction function. Each customer can get a discount if they are in the third category list (makes a third or larger successful purchase in this firm). For the company after the transaction, the corresponding value of n-successful or n-refused is incremented. The customer's client category is evaluated in the transaction function as well. If a customer buys a product for the first time, they are placed into the first-category list. All these steps are called customer loyalty management in the model.

```
to make-transaction
  ask customers-on companies [
    set color random-range 20 30
    let customer-who who
    let customer-offer constant-budget
    let customer-preference-service-level preference-service-level

    ask companies-here [
      ifelse member? customer-who third-category
      and customer-offer >= ( product-price - ( product-price * loyality-discount ) )
      [ set n-success n-success + 1
        set n-loyal-success n-loyal-success + 1 ]
      [
      ifelse customer-offer >= product-price
      and customer-preference-service-level <= service-level
      [ set n-success n-success + 1
        ifelse not member? customer-who first-category
        [set first-category lput customer-who first-category ]
        [ ifelse not member? customer-who second-category
          [ set second-category lput customer-who second-category ]
          [ if not member? customer-who third-category
            [ set third-category lput customer-who third-category ]
          ]
        ]
      ]
      [ set n-refused n-refused + 1 ]
      ]
    ]
  ]
end
```

Figure 1: The listing of the function defining the behavior of the Clients

As we specified previously, each 2000 ticks each company is able to run specific programs to increase client engagement and to perform better than competitors. This logic is incorporated under the start-customer-programs function. Each company is able to run certain programs by chance or if certain conditions are met. These pro-grams are: start-marketing-programs and start-client-loyalty-programs.

Marketing programs are applied randomly with equal probability each. There is a chance to change the product price (change-price), increase service-level (train-employees), and to change the company infrastructure by adding another building into the firm network (add-other-buildings).

Obviously, in reality, these activities are not carried out simultaneously and can take a long time. However, the flexible definition of the duration of a tick in real time units, given above, allows us to abstract from the actual duration of certain events, and concentrate on the effect of them, which is the main interest of this study.

The price of the product is changed to the higher price or to the lower price depending on the situation in a certain company. If the number of successful transactions is twice or more than the number of unsuccessful ones, then the company randomly increases the product price by the range of 2-8%. Otherwise, when the company has no good successful/unsuccessful transactions ratio, it decreases the product price by the same amount randomly. Note that the company is not able to set the product price out of the ranges specified by the user in the user interface.

Another option in the set of marketing programs is training of the company employees. If the company has only first and second category clients, and its service-level is not the highest possible, it is capable of increasing its service-level by one.

The third option for the company in the marketing programs set is adding another building to the firm. For now, we restricted this number to only adding two possible buildings in the model code, but it can be simply changed if needed. A new building is marked with the same color as the parent company and it inherits some parent company characteristics, such as product-price and client information (who is loyal and who is not). The service-level of the child company is less by one than the parent company. The child company is placed near the parent company area of vision randomly. The company can be created only if the parent company has the number of successful transactions more than 1000 (referred to in the literature as the threshold of stability of the company in the region [8]).

In addition to marketing programs each company is able to start a loyalty pro-gram. If the company has no discount for third-category customers, it is able to set such value randomly in the range between 2-8% per one product. The range in this case is taken symmetrical to the possible range of price increases, since the loyalty program implies the creation of more profitable or maintaining current conditions for loyal customers.

As can be seen, this structure of the model is fully consistent with the previously identified provisions in the trading markets and satisfies the most general principles of the competitive struggle of companies.

3. Agent-based competition model behavior analysis

Our model supports several user interactions and presetting scenarios. The user can set (Figure 2) the number of clients and firms to be in the model world. This is the reason why we call this model n-based. The user can set upper and lower bounds of the client's budget and product price. These numbers will be used as ranges for random generation while creating agents. The user can specify the model running mode: infinite or strict with 50000 ticks (it is usually enough for the model performance and results getting). The user can manipulate starting company service-level as well.

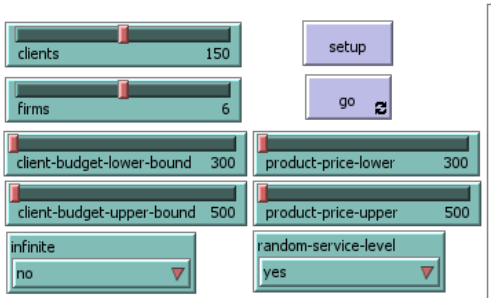


Figure 2: User controllers for the agents' parameters

In our case, the number of competing companies is limited to 10, so we add 10 monitors for each company to track one of the key parameters - number of successful transactions as well. Note that some of the monitors may have N/A value, as there may be a different number of starting firms from 4 to 10

firms. For example, in the current example, the number of companies is 6, so companies 7 through 10 have a N/A parameter value (Figure 3).

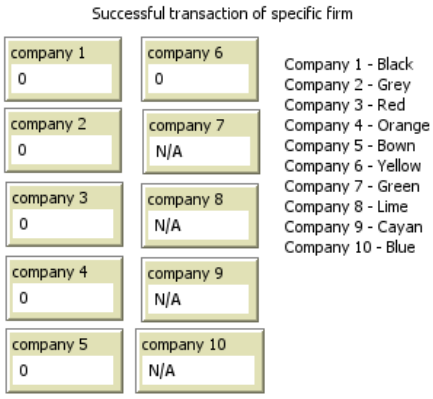


Figure 3: Firms monitors

To track the dynamics of key parameters, we use plots indicating the mean number of clients in each group across all firms, the mean number of all clients in each company (Figure 4) and the sum of successful transactions across each company (Figure 5).

On all these charts (unless otherwise specified), the x-axis shows the number of ticks that have passed since the start of the model.

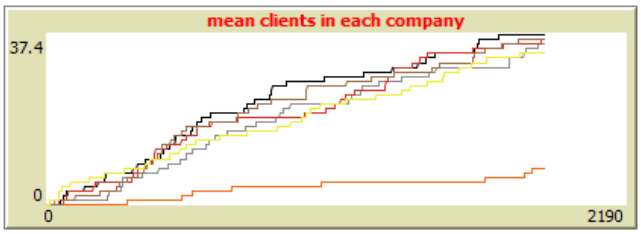


Figure 4: Mean number of all clients in each company monitor

Basic model preset is the following: 150 clients; 6 firms; each client owns a budget in the range of 300-500; each product costs in the range of 300-500; model is finite (=50000 ticks); company service-level is randomized. With such a base preset, all companies are growing step by step.

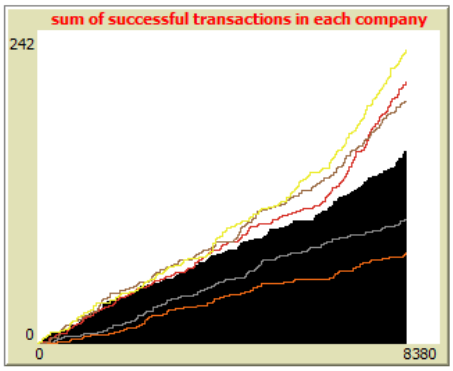


Figure 5: The sum of successful transactions across each company monitor

Several companies are at the top by the number of successful transactions, while others are at the bottom or at the middle (Figure 6 - left). The first figure shows that most of the companies have the biggest group of first-category customers, while second-third category customers are small groups. By the mean number of clients and the sum of successful transactions, the brown company leads with service-level 2 out of 3 possible. Black and red companies are competing below the top one. The gray company is far from the bottom too. Orange and yellow companies are the last.

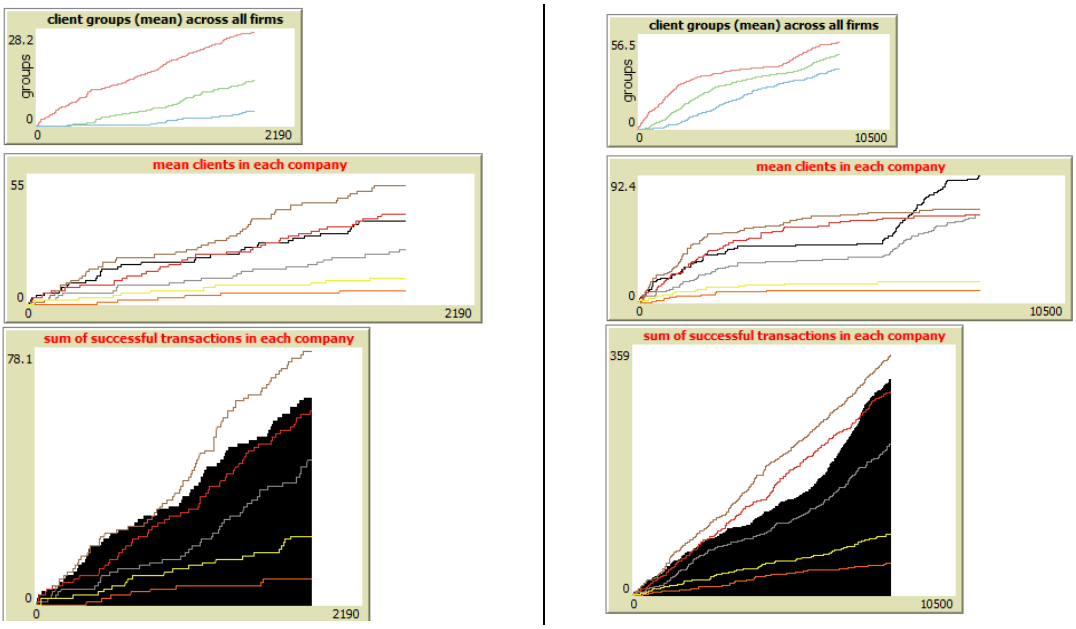


Figure 6: Basic model behavior

Let us switch to the first round of companies running their programs (Figure 6 - right). We can see that the number of mean clients by group is increased for the second client group. So, the second category is coming closer to the first-category. The third category steadily increases, but experiences a greater separation from the second category.

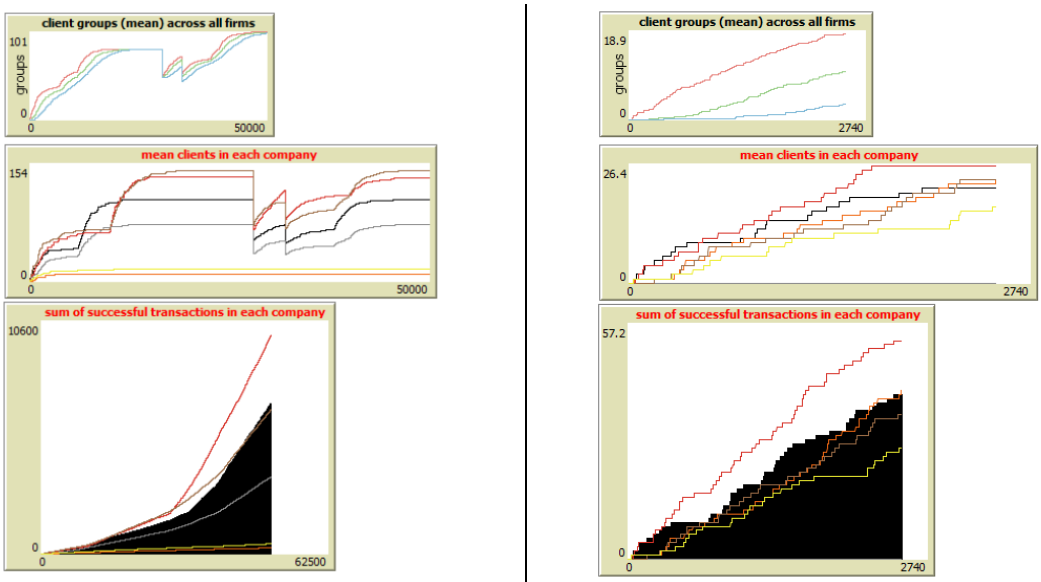
As for the mean number of clients in each company, the red company is almost catching the brown one, that might be caused by the result of using some programs and attracting new customers. As for the black company, its programs are not that efficient, so the progress is not that visible, and the gray company is almost catching the black one now. As for the yellow and orange companies, they stay approximately on the same level of operation results.

After two-three companies programs run by each firm (Figure 6 - right), we can see that the black company got a dramatic increase in customers attendance and successful transactions approved as well and now this company is almost leading. If we inspect brown and black companies more specifically, we will see that the black company increased its service-level during the last iterations to the highest level 3, while brown company remained on the same level with just slightly changed product price to the highest number. As we can see on the second figure above, the black company got a lead by the mean clients parameter.

Continuing this behavior of the model, we can observe that for some period of time almost each company has the same number of client categories in it (Figure 7 - left). It means that almost all customers visited all companies twice or more. As for the companies' competition, we can see that the brown and red companies took the lead from the black company by adding new buildings to their networks. This competition may take a long time to watch after, but let us show the remaining interesting part of the model activity.

At the same time, this period is not stable for companies, as the use of marketing tools continues. At the end of the modelling, we can observe the following picture (Figure 7 - left). Several decreases can be seen on the figures. Those are the times when companies introduce new buildings and expand their network. The resulting score is the following: the red company leads the market even though it was not at the top of the market during model execution. This company got the lead by quickly introducing two new buildings and achieving maximum service-level at two out of three buildings. As for the black and brown companies, they remain in second place as they did not upgrade service-level and the product price in those companies was too high in com-parison to the red company. As for the orange and yellow companies, they had the highest product price, so their client base was not that big, but if we see the total number of money received, those companies will be near the other companies with their popular products. Looks like yellow and orange companies found their niche product and client base and felt comfortable in those circumstances.

The base running scenario is different every time, so different companies can compete at different levels depending on the programs they choose and the place in the world that they occupy. After more than 10,000 runs of the model with unique parameters, we have identified the following most interesting scenarios.



Basic model behavior after several rounds of the marketing programs

Model behavior with the product price too high for customers

Figure 7: Model behavior

If we set the same service-level for all companies at the start, we will see the following statistics (Figure 8). All companies are competing with each other the same way, as with the random service-level, but this competition remains longer than with the random service-level option. We tend to think that random service-level is a more realistic parameter for this model, as companies appear in different times and their service-levels are not the same. Still, we can see that the brown firm took a chance to run a successful program and they first introduced two new buildings with the highest service-level that led the firm to success.

If we set the product price ranges too high for customers to pay, we will see that companies are staying at the same level of successful transactions over time regard-less of any other parameters such as service-level (Figure 7 - right).

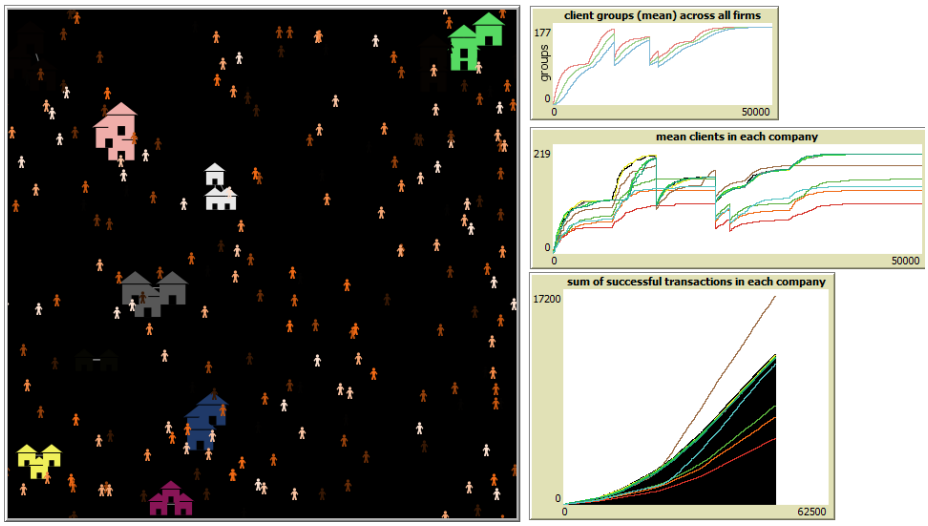


Figure 8: Model behavior with the same service-level for all companies

4. Agent-based competition model analysis

Given the results of the modeling with different parameters one can note several interesting trends and scenarios. First of all, each base run with preset parameters shows us base competition of the companies and during that competition some of the companies take a lead by adding other buildings or by increasing service-level, while other companies remain on the same level, constantly struggling between each other and trying to adjust product pricing. Some interesting runs show the cases when some companies with highest prices avoid expanding and changing price level due to the comfort zone or niche reached. Those companies may remain with the same parameters during the whole model run, but their transactions ratio and total amount of income received will still be compatible.

On the other hand, different manipulations with product pricing and customer budget may lead to interesting results too. If we set the highest product pricing ranges possible, we get the longest competition between companies during the whole run. Only up to the middle-end of the run some companies are able to take a distinct lead in the market. If we start with the same service-level for all companies, we will get the longest companies development time and sometimes there is not enough time for the model to start showing companies development in the 50000 ticks timeframe. That is, we recommend a random service-level preset for the world, as it models a more real-life situation on the market.

Interpreting the results of more than 10,000 experiments with the model, we can state that the most optimal strategy for an enterprise is a strategy based on the following rule. At the beginning of the development of the company, it is necessary to adhere to the basic strategy, which consists in maintaining the initial level of service and price. If the company does not increase the number of loyal customers, then it is necessary to reconsider the level of quality by sending employees for advanced training, or by changing production technologies. When the company begins to form a community of loyal customers, it is necessary to increase production volumes. This is understandable and effective from the point of view that at the moment when a company has a community of loyal customers, its quality level is sufficient to attract new customers. And this requires new production facilities.

On the other hand, when the amount of capacity is increased (at least 2 times), the company can start using other marketing tools - loyalty programs and improving the quality of services. These tools at earlier stages show less efficiency, since the company only acquires loyal customers, and from the current point in time, the task of not attracting customers, but retaining them, becomes critical for it.

It is important to pay attention to the fact that the initial price of the goods does not have such a big effect as the level of quality. In most experiments, at the end of the model (or from a certain point, about 49,000 ticks from the start), companies with the highest price of the product and low customer coverage or companies with a lower price and maximum customer coverage showed similar revenue results.

At the same time, even in the case of an identical level of service, the price had an effect only at the initial moment of the model's operation; at subsequent moments, the companies were forced to revise the price, which led to market volatility as a whole, preventing the company from creating a stable loyal customer community.

These conclusions also lead us to the idea of the need to support ongoing activities at the level of the company's IT infrastructure and its processes. At the initial stages, it is extremely important to use convenient and user-friendly ways of communication with customers and no savings on product quality (even if this leads to a higher cost and, as a result, price). As can be seen from most experiments, the high initial quality of the goods (and services) provided provides the greatest increase in loyal customers and allows further focus on loyalty tools.

In addition, it is necessary to ensure the integration of all company processes and regularly improve the level of education of employees, as this is a guarantee of maintaining product quality over time.

Finally, it seems expedient to introduce full-fledged CRMs that support real-time monitoring of the loyalty of the company's customers and timely use of the necessary tools to increase it.

5. Conclusion

Thus, in this paper, a multi-agent model of competition of various companies in the market was considered. The model can provide different scenarios on the same parameters presets, but overall those

scenarios will follow the same trend. Some companies lead the market by expanding their business and upgrading service-level, while other companies struggle with each other in the price wars.

Based on the results of the experiments, an optimal development strategy for companies was found, combining the tools of both an extensive and intensive expansion.

These results are somewhat different from existing views on the strategy of companies based on the principle of price fairness in terms of product quality [7, 8]. In particular, according to the data obtained, the price of the goods has an impact only at the initial moment of the company's development, ultimately not significantly affecting the results of the company's work in terms of the number of attracted customers and profits.

In addition, the results obtained complement the ideas expressed in [15, 16], not only confirming the need to use tools that maximize the number of company customers, but also determining the degree of effect (both positive and potential negative) of various tools at different stages of the company's development.

The critical factor for winning in the competition is the quality of the product, which must develop over time, providing new customers to the company and allowing, in combination with marketing tools, also to revise the price of the product, with-out compromising the number of loyal customers.

A possible development of this work may be the transfer of its results to the field of enterprise engineering. The results of our work show that a series of simulation experiments allows us to determine the key elements of the organization's strategy, therefore, in the future, the issue of automatic generation of strategy description arti-facts (fragments of models of the organization's structure or behavior) based on the results of simulation modeling deserves attention. For example, the results of simulation modeling can serve as the basis for the formation of a list of the most important elements of DEMO models.

6. References

[1] Gupta et al., Information technology and profitability: Evidence from Indian banking sector. International Journal of Emerging Markets 13(5) (2018) 1070-1087.

[2] S. Karthikvel, C. Samydoss, Organizational contention and confrontation to sustainable development: a socio-economic prospective. Shodh Sanchar Bulletin 10 (38) (2020) 69-73.

[3] H.C. Martins, Competition and ESG practices in emerging markets: Evidence from a difference-in-differences model. Finance Research Letters 46A (2022).

[4] D. Pennerstorfer, B. Yontcheva, Local market definition in competition analysis: An application to entry models. Economics Letters 198 (2021).

[5] T.J. Richards, S.F. Hamilton, K. Yonezawa, Retail Market Power in a Shopping Basket Model of Supermarket Competition. Journal of Retailing 94(3) (2018) 328-342.

[6] S. Sun, W. Wang, Analysis on the market evolution of new energy vehicle based on population competition model. Transportation Research Part D: Transport and Environment 65 (2018) 36-50.

[7] S. Croom, K. Fritzon, N. Brooks, Personality differences and buyer-supplier relationships: Psychopathy in executives, gender differences and implications for future research. Journal of Purchasing and Supply Management 27 (4) (2021).

[8] T.E. DeCarlo, J.D. Hansen, Examining buyers' negative word-of-mouth intentions following suspected salesperson transgressions. Industrial Marketing Management 102 (2022) 35-44.

[9] NetLogo platform, 2022. URL: https://ccl.northwestern.edu/netlogo/.

[10] N.H. Jaafar, A. Ahmad, M. Ahmad, M. Hamid, The Belief-Desire-Intention Architecture of Sincere Software Agent Environment. TEM Journal 10 (4) (2021).

[11] A. Timoumi, M. Gangwar, M.K. Mantrala, Cross-channel effects of omnichannel retail marketing strategies: A review of extant data-driven research. Journal of Retailing 98(1) (2022) 133-151.

[12] S.R. Agrawal, D. Mittal, Optimizing customer engagement content strategy in retail and E-tail: Available on online product review videos. Journal of Retailing and Consumer Services 67 102966 (2022).

[13] M.R. Winkler, K. Lenk, D.J. Erickson, M.N. Laska, Retailer Marketing Strategies and Customer Purchasing of Sweetened Beverages in Convenience Stores. Journal of the Academy of Nutrition and Dietetics 122 (11) (2022) 2050-2059.

[14] S. Shuqair, D.C. Pinto, F. Cruz-Jesus, A.S. Mattila, P.F. Guerreiro, K.K. Fung So, Can customer relationships backfire? How relationship norms shape moral obligation in cancelation behavior. Journal of Business Research 151 (2022) 463-472.
[15] M.S. Hossain, M.F. Rahman, Detection of potential customers' empathy behavior towards customers' reviews. Journal of Retailing and Consumer Services 65 102881 (2022).
[16] M. Mitrega, V. Klézl, V. Spáčil, Systematic review on customer citizenship behavior: Clarifying the domain and future research agenda. Journal of Business Research 140 (2022) 25-39.
[17] Zoom Video Communications, 2022. URL: https://zoom.us/.