

An agent-based Model to Study Customers' Engagement with Brands from a Service-Dominant Logic Perspective

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Abstract—We present an Agent-based Model to study customers' engagement with brands from a Service-Dominant Logic perspective. Customer Engagement has gained attention recently in the study of customer loyalty as a process that enables to understand and measure the impact of the depths of customers emotional responses to consumption situations on their intention to retain with a particular brand. However, there is no adequate research that deeply investigate the process of engagement, especially in dynamic, competitive and complex market environments. We address this research gap by creating an agent-based artificial market model. In doing so, we base our model on *Service-Dominant Logic*, which offers a novel lens to look at markets and their interactions and on the *customer engagement process model* of Bowden to implement customers engagement with a brand. This paper basically presents a logical discussion on the formulation of the model and some initial outcomes.

I. INTRODUCTION

Why customers leave brands is an interesting question of all time. In competitive markets, it is possible to see very often the collapses of once giant firms despite their attempts to improve the features of their brands. Even though researchers generally agree that the customer loyalty is the driving force behind their repeat purchases, there is no consensus on what causes loyalty [1]. Traditionally, loyalty has been seen as caused by customers' satisfaction on a brand, determined by the extent of confirmation/disconfirmation of expectations [2]. However, this popular and widely used ideology has been challenged by research that points out even the satisfied customers will defect [3]. Research on *affect*, such as *customers' delight* [4], has attempted to overcome some of the limitations of these purely cognitive approaches by drawing a distinction between mere satisfaction, and stronger and more positive emotional responses toward consumption [1].

The concept of *engagement* describes an emotional attachment of someone with something, which has been linked to a number of positive consequences in the management literature [1]. For example, Enrique et al. [5] recognizes the importance of proper conceptualization and evaluation of

website engagement of online consumers. Moreover, employee engagement is argued to be positively related to individuals' attitudes, intentions and behaviors [6], and subsequently to business results such as job satisfaction, low absenteeism and high organizational commitment and performance [7]. This leads to the suggestion that the study of customer engagement with brands would help answering the critical question of what causes customer loyalty. For this endeavor, Bowden [1] proposes a conceptual framework of the process of customer engagement, which incorporates satisfaction into a much richer process model of engagement that causes loyalty.

However, the process of engagement and its impact on customer loyalty needs to be studied in a dynamic and competitive environment with complex interactions among service providers and customers in order to attain a better understanding. This emphasizes the need of developing simulation models of artificial markets, in which customer engagement with service providers occurs dynamically based on the outcomes of individual interactions among market entities. Thus, *Agent-based Modeling* approach [8] proves to be a potential candidate in this endeavor.

The agent-based model presented in this paper represents an artificial market based on the concepts of *Service-Dominant Logic*, which has recently emerged as an alternative mindset to the traditional *Goods-Dominant Logic* [9]. The Service-Dominant logic (S-D Logic) views markets as *systems of resource integrating actors* who exchange competences in the form of services. Thus, the S-D logic rejects the distinction between goods and services by viewing every offering (i.e. a tangible product or an intangible service) as a means of delivering a service [10]. Moreover, S-D logic's recognition of value as being co-created at the time of use instead of being exchanged at the time of purchase makes it a suitable approach to study the impact of emotional responses of consumers at consumption situations on their loyalty. In other words, the co-created value at the time of use would influence the emotional attachment of consumers with service providers.

The artificial market represented by our agent-based model comprises customer and service provider agents of one particular service. Each service provider agent is assumed to represent a particular brand in the market. The agents are designed as *service systems*, which is an abstract term used in *Service Science, Management and Engineering (SSME)* [11] to define actors in a market environment based on S-D logic [12]. Thus, a brand is considered as a service provider agent in a particular market. Consumption choice decisions of customer agents are hence based on their loyalty with each service provider at a situation of choice, which is implemented as stemming from a continuous process of engagement. We use the *customer engagement process model* presented by Bowden [1] as the basis to implement the process of engagement of customer agents. Using this artificial market model, we intend to study the process of customer engagement and emergence of loyalty in dynamic and competitive markets. The objective of this paper is to explain the modeling details through a logical discussion.

The subsequent sections of this paper are organized as follows. In *section two*, we review some relevant literature for this research and in *section three*, we present a hypothetical use case scenario of service system interactions from the hotels industry to enhance the clarity of the agent-based model. The next section, *section four*, contains the details of our model. In *section five* we present some basic simulation results of our model while *section six* provides a conclusion with implications for future work.

II. LITERATURE REVIEW

This section contains the literature relevant for the work presented in this paper. Since this is an interdisciplinary research, we brief the necessary concepts of all relevant domains.

A. Agent-based Modeling

Agent-based modeling takes the generative approach in social science, in which a generativist looking forward to explain the emergence of macroscopic societal regularities, such as norms or price equilibrium, would like to know how the decentralized local interactions of heterogeneous autonomous agents could generate the given regularity [8]. Generally, the interdependency, emergence and non-linearity inherent in the underlying processes make it difficult for humans, unassisted by computer simulations, to effectively reason about the consequences of actions in a complex system [13]. An agent-based model enables to generate a would be world [14], in the form of a computer simulation, in which a group of heterogeneous, autonomous, bounded rational agents interact locally in an explicit space [8]. The creation of such silicon surrogates of real-world complex systems allows researchers to perform controlled repeatable experiments on the real McCoy [14].

Artificial markets has been a popular and emerging form of *agent-based social simulation*, in which agents represent consumers, firms or industries interacting under simulated market conditions [15]. According to Zenobia et al. [15],

there are several promising applications of artificial markets such as forecasting future market behavior, exploring market dynamics, conducting massively parallel market analysis, gaming organizational strategies for volatile new markets, and profiling products and services which do not currently exist, but which markets are poised and ready to accept. Furthermore, the recent proliferation of *social networks* have boosted the interest of studying the *diffusion of innovations* through agent-based modeling. For example, Lee et al. [16] studies pricing and timing strategies such as *time to market* and *time to discount* of a new product using agent-based simulations of behavioral consumers. Consumer agents of that model make purchase decisions for a new product referring to the characteristics of the current product they use and to the recommendations of the peers in their social network. However, Baptista et al. [17] argues although a number of agent-based models of consumer behavior have been proposed in recent years the advantages of this approach are yet to be fully grasped by the business simulation community. This statement can be related in particular to the emerging domain of *service-dominant logic* as only a handful of agent-based models have been developed based on service-dominant logic.

B. S-D Logic and Service Systems

Service-Dominant logic is regarded as the provider of the right perspective, vocabulary and assumptions for modern service research [11]. It adopts the systems approach to the study of markets by defining markets as systems of resource integrating actors who interact by exchanging services and co-creating value [10]. The difference between Service-Dominant logic and the traditional Goods-Dominant logic involves a philosophical discussion on value in the foundation of economics [18]. According to Vargo et al. [18], the traditional Goods-Dominant logic focuses on the value-in-exchange where as the Service-Dominant logic focuses on the value-in-use. Thus, the firms that believe in Goods-Dominant logic would focus on producing goods (or its intangible counterpart - services) in surplus with embedded value and distributing that surplus to maximize profits through economies of scale. In contrast, firms that adopt a Service-Dominant logic mindset would focus on increasing adaptability, survivability and system wellbeing through competitive value propositions that primarily involve applied operant resources (i.e. knowledge and skills) and support realizing value in use. Table 1 presents the foundational premises of Service-Dominant logic and Table 2 presents a comparison of Service-Dominant logic and Goods-Dominant Logic.

According to Service-Dominant logic, a service is an exchange of resources either in tangible or intangible form [9]. In other words, any tangible or intangible offering in the market is a means of offering a service by one actor to another. Central to S-D logic is value co-creation, in which it argues that value cannot be added to a service upfront but has to be co-created by the beneficiary at the time of use [12]. More precisely, in a service interaction, the service provider makes a service offer using its resources through a value proposition

TABLE I
 FUNDAMENTAL PREMISES OF SERVICE-DOMINANT LOGIC

Premise ID	Fundamental Premise
FP1	Service is the fundamental basis of exchange
FP2	Indirect exchange masks the fundamental basis of exchange
FP3	Goods are a distribution mechanism for service provision
FP4	Operant resources are the fundamental source of competitive advantage
FP5	All economies are service economies
FP6	The customer is always a co-creator of value
FP7	The enterprise cannot deliver value, but only offer value proposition
FP8	A service centered view is inherently customer oriented and relational
FP9	All social and economic actors are resource integrators
FP10	Value is always uniquely and phenomenologically determined by the beneficiary

and the customer (beneficiary) co-creates the value of that service with the help of resources possessed by him or her. This new mindset of S-D logic has been acknowledged as having a staggering potential to continue to be a catalyst for important research in the field of services [19].

The abstract notion of *service system* [12] enables defining actors of service markets based on S-D logic. In other words, a market could be viewed as a population of interacting service systems of different kinds. According to Maglio et al. [11], anything ranging from individuals, firms and agencies to worlds and planets could be a service system. A service system is characterized by a value proposition, which helps it to agglomerate its resources in different dimensions and interact with other service systems by exchanging resources [12]. Hence, a market comprising service providers (firms) and their customers could be viewed as a platform, on which *service provider service systems* interact with *customer service systems* co-creating value.

The process of interaction between two service systems has been presented as a model of ten possible outcomes in the ISPAR (Interact-Serve-Propose-Agree-Realize) model [12]. In the ISPAR model, an interaction can be either a service interaction or a non-service interaction. Service interactions are value co-creation interactions where each service system engages in three main activities: (1) proposing a value co-

TABLE II
 COMPARISON OF GOODS-DOMINANT LOGIC AND SERVICE-DOMINANT LOGIC ON VALUE CREATION

	Goods-Dominant Logic	Service-Dominant Logic
Value driver	value-in-exchange	value-in-use or value-in-context
Creator of value	Firm, often with input from firms in a supply chain	Firm, network partners and customers
Process of value creation	Firms embed value in "goods" or "services", value is 'added' by enhancing or increasing attributes	Firms propose value through market offerings, customers continue value-creation process through use
Purpose of value	Increase wealth for the firm	Increase adaptability, survivability, and system wellbeing through service (applied knowledge and skills) of others
Measurement of value	The amount of nominal value, price received in exchange	The adaptability and the survivability of the beneficiary system
Resources used	Primarily the operand resources (i.e. tangible resources)	Primarily operand resources (i.e. intangible resources such as knowledge and skills), sometimes transferred by embedding them in operand resources-goods
Role of firm	Produce and distribute value	Propose and co-create value, provide service
Role of goods	Units of output, operand resources that are embedded with value	Vehicle for operand resources, enables access to benefits of firm competences
Role of customers	To 'use-up' or 'destroy' value created by the firm	Co-create value through the integration of firm provided resources with other private and public resources

creation interaction to another service system (proposal), (2) agreeing to a proposal (agreement), (3) realizing the proposal (realization). A non-service interaction may involve a welcoming behavior such as exchanging pleasantries on the street or an unwelcoming behavior such as committing a crime. Non-service interactions basically acts as determinants of future value co-creation interactions. Figure 1 is an illustration of the ISPAR model.

C. Customer Engagement

In today's highly dynamic and interactive business environment, the role of *customer engagement (CE)* in co-

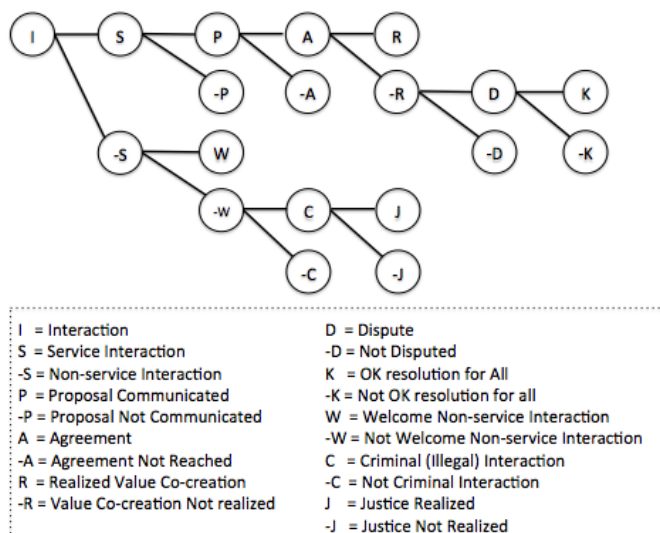


Fig. 1. The ISPAR Model of Service System Interactions

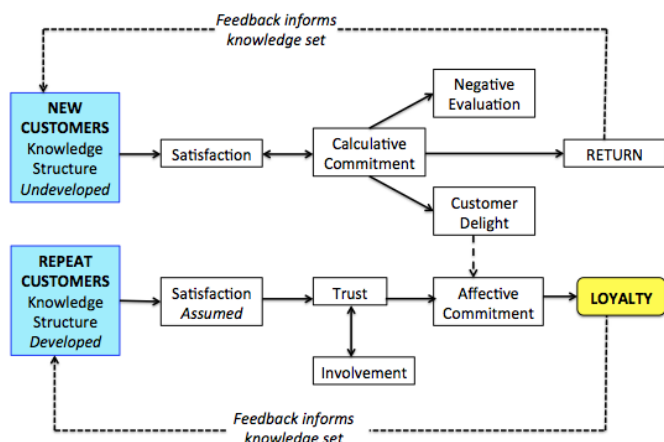


Fig. 2. Customer Engagement Process Model

creating customer experience and value is receiving increasing attention from business practitioners and academics alike [16]. While comprehensively reviewing the available literature on *engagement* to date, Brodie et al. [20] derives five fundamental propositions that define the conceptual domain of customer engagement from a relationship marketing and S-D logic perspective. The five fundamental propositions of CE derived by [20] are elaborated in Table 3.

The customer engagement process model, shown in Figure 2, depicts the formation of *loyalty* through affective commitment towards a service provider [1]. The model clearly differentiates the new customers and repeat customers. A new customer usually possess an ill developed knowledge structure about a service provider compared to a repeat customer who has a rather developed knowledge structure with previous experience. A new customer tends to evaluate different attributes of a service (from a particular service provider) when evaluating a consumption experience, which determines his

or her satisfaction and intention to return. Hence, *calculative commitment* is the extent to which a new customer evaluates the attribute level outcomes of a service. A positive overall evaluation of attribute level outcomes causes *customer delight*, which would help originating an *affective commitment* in the new customer. Experience of a new customer with a service provides a feedback, which enhances the knowledge structure of that customer about the particular service provider. A repeat customer on the other hand has a well developed knowledge structure about the service of a particular service provider. Hence his or her satisfaction is assumed. The satisfaction of a repeat customer of a service provider helps developing *trust* on that service provider. The trust helps developing an emotional bond between the repeat customer and the service provider strengthening the *affective commitment* and *involvement* with the particular service provider. The affective commitment strengthens the *loyalty* of the repeat customer with the service provider while giving feedback to improve his or her knowledge structure about the service of that particular service provider.

III. A HYPOTHETICAL USE CASE SCENARIO OF SERVICE SYSTEM INTERACTIONS

In order to enhance the readability of the paper, here we present a hypothetical case from hotels industry, which helps understanding the structure of a market from a service-dominant logic perspective.

In hotels industry, the market comprises two types of entities. Those are the hotels (i.e. service providers) and the tourists (i.e. customers). According to the service system abstraction [12], each hotel and each customer of a particular tourist destination are *service systems*, which can interact with another service system such as another hotel or another customer.

The hotels at a particular destination could be categorized based on a certain set of attributes, which resembles each hotel in to a particular profile such as *a star hotel, a budget hotel, eco hotel, cruise*, etc. In other words, the profile of a hotel reflects its resource possession and their utilization on each attribute, in order to maintain a particular service standard. Hence, a hotel's profile is its value proposition to the prospective customers. Similarly, the tourists visiting a particular destination too have such profiles such as *back packers, mass tourists, naturalists*, etc. Such profiles are determined by evaluating a certain set of attributes that resemble a tourist. In other words, a profile reflects the level of resources that the tourist possesses along each attribute of his or her profile. Hence, the customer profile of a tourist is his or her value proposition to interact with prospective hotels.

Once a tourist decides to visit a particular destination, he or she may consider a hotel o stay at during the visit. There, the tourist will ask fellow tourists or follow Internet forums to find out the best place that is most likely to match with his profile (i.e. budget, interests, preferences, etc.). If it is a repeat visit, the tourist may already have some options in mind with a certain level of affection towards each of those options, which

TABLE III
 FUNDAMENTAL PROPOSITIONS DEFINING THE CONCEPTUAL DOMAIN OF
 CUSTOMER ENGAGEMENT (CE)

FP ID	Description	Justification
FP1	CE reflects a psychological state, which occurs by virtue of interactive customer experiences with a <i>focal agent / object</i> within specific service relationships	<ul style="list-style-type: none"> The focal agent / object a customer interacts with may be a brand, product or organization Focal CE behaviors that have a brand- or firm-focus extend beyond transactions / purchase Two-way interactions generating CE may occur within a broader network of customers, stakeholders, and other actors in specific service relationships
FP2	CE states occur within a <i>dynamic iterative process</i> of service relationships that co-creates value	<ul style="list-style-type: none"> CE processes may range from short- to long-term, relatively stable to highly-variable processes typified by CE levels varying in complexity over time CE occurs within specific service relationships comprising networked agents including customers, organizations and other stakeholders that co-creates value
FP3	CE plays a <i>central role</i> within a <i>nomological network</i> of service relationships	<ul style="list-style-type: none"> Required relational CE antecedents include "participation" and "involvement" which may also extend to coincide, or occur concurrently, with CE Other potential relational antecedents may include "flow" and "rapport" CE relational consequences may include "commitment", "trust", "self-brand connections", consumers' "emotional attachment" to focal brands, and "loyalty" The iterative (cyclical) nature of the service relationships process implies that specific CE relational consequences may extend to act as CE antecedents in subsequent CE (sub-) processes and/or cycles
FP4	CE is a <i>multidimensional concept</i> subject to a context- and / or stakeholder-specific expression of relevant cognitive, emotional, and behavioral dimensions	<ul style="list-style-type: none"> The relative importance of the particular cognitive, emotional, and/or behavioral CE dimensions varies with the specific CE stakeholders involved (i.e. engagement subject, e.g. customer; engagement object, e.g. brand) and/or the set of situational conditions, thus generating distinct CE complexity levels
FP5	CE occurs within a specific set of situational conditions generating differing <i>CE levels</i>	<ul style="list-style-type: none"> Specific interactions between a customer and a focal agent/object and other actors within specific focal relationships may generate different levels of cognitive, emotional and/or behavioral CE intensity, depending on specific CE stakeholder (e.g. customer, brand) and contextual contingencies driving particular CE levels

makes his decision faster and less costlier. The main concern in selecting a place to stay would be how likely the selected place would help making the visit a pleasant experience. From a service-dominant logic perspective, this is called the potential to *co-create value*. Once, a hotel is selected, a tourist would approach the selected hotel for a booking. This could be considered as the beginning of an interaction between two service systems, which may take any of the paths explained by figure 01.

The hotel may ask for a security, for example the credit card number, and if satisfied with the credibility of the customer,

will agree to reserve a room for the tourist. Once the tourist arrives at the hotel and starts his or her vacation, he or she may realize value on each attribute of the hotel's offering. This realization of value at the time of use is called *value co-creation* in service-dominant logic. Notably, the realization of value depends not only on the hotel's offering but also on the profile of the tourist. For example, if the tourist has a limited budget he or she may not be able to enjoy some services offered by the hotel. Or else, if the tourist does not possess certain competences, such as the ability to swim, he or she may not be able to get the better of some facilities on the hotel's offering. Thus, two tourists with different profiles will realize two different levels of value from the same offering.

However, the realized value at the end of the stay would affect the loyalty of the tourist towards that hotel as well as the desire to recommend the hotel to another tourist.

IV. THE AGENT-BASED MODEL

This section contains the details of our agent-based model. This model is based on our method to develop agent-based models based on the *service system abstraction* and the *ISPAR model of service system interactions*.

A. Structure of Agents

The agents of our artificial market model belongs to either of two main entities namely *service providers* and *customers*. Each agent has a value proposition through which they interact with the agents of the opposite entity. A service provider agent's value proposition reflects its service level, i.e. the level of competence and resources that the service provider is possessing in different attributes of the service. A customer agent's value proposition is the levels of resources in different aspects of its profile such as knowledge, demographics and psychographics. Customer agents use these resources to co-create value by interacting with the value propositions of the providers.

A value proposition could be defined as a combination of value creating attributes [21]. More precisely, service systems mobilize their resources into these attributes and develop their competences along them. For example, 'providing Internet access to guests' could be one attribute of a hotel's value proposition in the tourism market. Thus, we represent a value proposition as a combination of N such attributes. A given attribute is set to be at a particular state out of D possible states, where D could include integers as 0, 1, 2, ... For example, providing Internet access could be done by different ways such as setting up Wi-Fi zones inside hotel premises, giving access on request at a charge, giving in-room Wi-Fi access to all residents, etc. States of all N attributes thus make one particular state of the service system class and there could be D^N possible states for the given service system class. Hence, a given instance of that class could be at any of these states. For example, if we define the value proposition of hotels as $N = 5$ and $D = 2$, hotel A's state could be 10101 where as hotel B's state could be 01010. This reflects the differences of resources and competences of the two instances

of the same class. In other words, if two hotels are identical in every aspect, they should bear the same state string. Similarly, two customers having identical profiles is synonymous to two instances of the customer class bearing the same state string. The individual value creating attributes are considered as contributing to the overall value perceived through the value proposition [21].

Apart from these market entity agents, there is a *controller agent*, which executes various runtime tasks such as reporting, adding-removing agents, etc.

B. Realizing Value Co-creation

According to Spohrer et al. [12], a service interaction between two service systems results in co-creation of value. We define a utility landscape for both service system entities considering their service interactions with the opposite entity. This utility landscape enables a given instance of a particular service system class to perceive (co-create) the utility (value) of a given service interaction with an instance of the opposite class.

In a service interaction i ($i \in I$) involving two instances a customer - x ($x \in X$) and a service provider - y ($y \in Y$), the perceived utility of x ($= U_i^x$) could be represented by Equation 1. In this representation, X denotes the entity of customers where as Y denotes the entity of service providers.

$$U_i^x = \frac{\sum_{n=0}^{N_Y-1} u_i^n}{N_Y} \quad (1)$$

Here, N_Y denotes the number of value creating attributes of the value proposition of entity Y and u_i^n denotes the utility contribution of the attribute n of Y 's value proposition to the overall utility perceived by x in the interaction i . A similar equation could be written to determine the perceived value of the instance y in the same interaction.

Co-creation of value involves resources of both parties of a given interaction. Hence, the individual utility contribution of a given value creating attribute depends not only on its own state but also on the states of few other attributes of the same entity as well as the opposite entity. For example, the perceivable value from the attribute *Internet accessibility* at a hotel would depend not only on the type of accessibility provided but also on the structure and materials used to build its rooms (internal) as well as whether the customer possesses a laptop and whether (s)he knows how to connect it to the network (external). In order to incorporate this feature, we impose a dependency structure on each attribute, which links each attribute to other attributes of the same entity as well as the opposite entity. We base this dependency structure on the *Kauffman's NKCS architecture* [22].

In this dependency structure, we set each value creating attribute as depending on K number of other attributes of the same entity and C number of attributes of the opposite entity. According to this dependency structure, the utility contribution u_i^n of equation 1 could be elaborated as in equation 2.

$$u_i^n = f(d_i^n, (d_i^1 \dots d_i^K)_Y, (d_i^1 \dots d_i^C)_X) \quad (2)$$

Here, d ($\in D$) denotes the state of a particular attribute at the interaction i . According to this representation, u_i^n could be drawn from $D^{(1+K+C)}$ different state value combinations. Thus we define a function to determine the individual utility contribution a given attribute based on combinations of state values of its own and the attributes it depends on. The function to draw the utility contribution u_i^n of equation 2 could be written as in equation 3.

$$(f^n)_Y : \{0 \dots D - 1\}^{1+K+C} \rightarrow R \quad (3)$$

Here, $(f^n)_Y$ is the function that determine utility contribution of attribute n of entity Y at different state value combinations of a length of $(1+K+C)$. D is the number of states. R is drawn from the uniform distribution. For example, if $K = 2$, $C = 2$ and $D = \{0, 1\}$, the two state value combinations 10001 and 01110 would give $10001 \rightarrow R_1$ and $01110 \rightarrow R_1$, where $R_1, R_2 \in R$. In the system, we maintain a table containing the utility contribution of each attribute at all possible state value combinations.

C. Making a Choice: Selecting a Service Provider based on Engagement

The customer agents in our model make a choice decision based on their *loyalty* (L) towards each available service provider. The core determinant of loyalty is the *affection* (A), which is an emotional tie between a customer and a service provider. This is shown in equation 4. The whole process is developing loyalty is considered as the process of engagement. In any case if a customer agent has no positively affected service provider (s)he makes an evaluation, based on some prioritized attributes, on the expected utility with previously unvisited service providers to make a decision.

$$A \rightarrow L \quad (4)$$

Further we could represent trust as the measure of the satisfaction as shown by equation 05. Here, *delight* is also considered as a part of satisfaction. In other words, a customer could be *not satisfied*, *satisfied* or *satisfied with delight*. Even though [1] limits delight only to new customers, we consider attempts to delight the repeat customers as vital as delighting the new customers.

$$T = S \quad (5)$$

Here we consider satisfaction as the conformity of the utility of the service to the expectations of the customer. A customer agent has an *expected utility contribution* from each attribute of a service provider's value proposition. Hence, satisfaction becomes a measure of the differences between the *delivered utility* (U) and the *expectation* (E) at each attribute of the service provider's value proposition, which is shown by equation 06.

$$S = \frac{\sum_{i=1}^N (U_i - E_i)}{N} \quad (6)$$

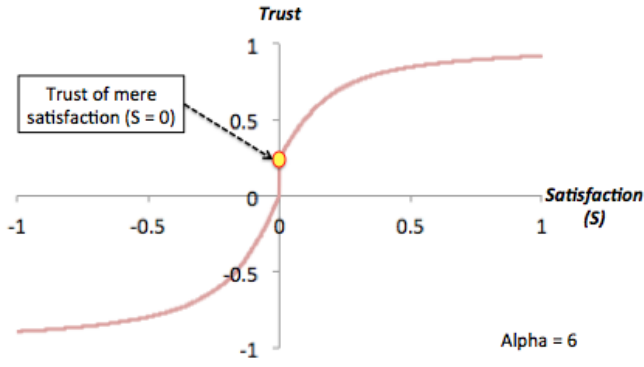


Fig. 3. Curve of the Trust Function (Equation 07) with $\alpha = 6$ and $P = 0.25$

Thus, we could consider that the customer is satisfied when $S = 0$, satisfied with delight when $S > 0$ and not satisfied when $S < 0$. In order to determine a trust quantity based on the value of the satisfaction, we define an inverse tangent function as shown in equation 07 below. There, P is a controllable parameter, which determines the trust contribution at mere satisfaction (i.e. $S = 0$).

$$T = \begin{cases} 2(1 - P/\pi) \tan^{-1}(\alpha S) + P & : S \geq 0 \\ 2(1/\pi) \tan^{-1}(\alpha S) & : S < 0 \end{cases} \quad (7)$$

The resulting curve from this function with $\alpha = 6$ and $P = 0.25$ is depicted by figure 3. Here, the parameter α controls the steepness of the curve. After each service interaction, customer agents generate a trust quantity based on their satisfaction level with the service provider based on this curve. According to Bowden [1], *trust* acts as the major determinant of *Affection* or rather *affective commitment*, which is a holistic or aggregate judgement about a service provider that leads to a greater desire to remain with that service provider, invest in it and word-of-mouth recommendation. Hence, we consider the trust quantity resulting at each service interaction (episodic trust) to be altering the level of affective commitment of the respective customer towards the respective service provider. Based on this idea, we formulate the construct *affective commitment* - A of a given individual towards a service provider as the average trust generated through all service interactions to date between the said individual and the service provider. This formulation is shown in equation 08.

$$A_x^y = \frac{\sum_{i=1}^Q T_x^y}{Q} \quad (8)$$

Here, A_x^y is the affection of customer x towards a particular service provider y , T_x^y is the episodic trust generated by x towards y and Q is the number of service interactions between x and y to date.

However, in reality, peer recommendation has an impact to one's trust towards a service provider. From a S-D logic perspective, a peer recommendation could be viewed as a non-service interaction that occurs between peers. According to

Spohrer et al. [12], non-service interactions act as determinants of future service interactions. Thus we alter equation 8 taking the effect of the strength of peer recommendations on one's affection towards a service provider. The modified equation is shown by equation 9. There, W_x^y denotes the strength of all recommendations that customer x has received from his/her peers about the service provider y .

$$A_x^y = \frac{\sum_{i=1}^Q T_x^y}{Q} + W_x^y \quad (9)$$

We consider the effect of a recommendation on an individual to be proportionate to the distance to the recommending peer. In other words, a recommendation from a peer with a close profile would be more effective than a recommendation of a peer with a more distant profile. Based on this conceptualization, we define the quantity W_x^y of equation 9 as shown by equation 10.

$$W_x^y = \frac{\sum_{j=1}^Z \frac{1}{b\beta}}{Z} \quad (10)$$

Here, the fraction $\frac{1}{b\beta}$ denotes a recommendation by a peer and the quantity b denotes the distance between the individual x and the recommending peer. β is a control parameter. Z denotes the total number of recommendations received by customer x towards the service provider y . Thus, the equation 09 could be re-written as in equation 11.

$$A_x^y = \frac{\sum_{i=1}^Q T_x^y}{Q} + \frac{\sum_{j=1}^Z \frac{1}{b\beta}}{Z} \quad (11)$$

As per the equation 01, a customer's loyalty towards a service provider is determined by his / her affection towards that service provider. Thus, when a customer agent is about to make a choice, he/she first evaluates his/her loyalty towards each service provider with a positive affection based on the equation 12.

$$L_x^y = \frac{A_x^y}{\sum_{i=1}^M A_x^i} \quad (12)$$

Here, L_x^y is the loyalty of customer x towards service provider y . M denotes the number of service providers with positive affections. Hence, one's loyalty towards a specific service provider is the share of affection owned by that particular provider in that particular customer.

Once the loyalty is computed for each service provider with positive affections, the respective customer is able to go for his/her most loyal service provider. However, in our opinion, there still is a chance that the customer may go for the next best alternative, especially when the customers loyalty to the most loyal service provider is not sufficiently large compared to that to the next most loyal service provider. Hence, the final decision of the customer agent is taken according to the process depicted by figure 4. There, E and F are the most loyal service provider and the next most loyal service provider respectively. As a result of this process, when the

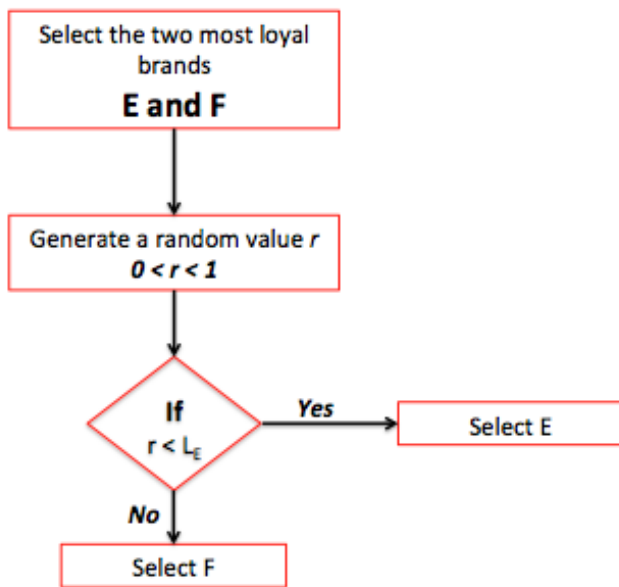


Fig. 4. Process of Making a Choice between the Most Loyal and Next Most Loyal service providers (Equation 07) with $\alpha = 6$ and $P = 0.25$

loyalty towards a service provider is higher, there exists a higher chance for that service provider to be selected.

D. State Variables

This section contains the details of the important state variables of the two types of agents of our model.

1) *State Variables of Customers*: The most important state variable of the customer entity is the *current state*. The current state of an individual customer agent is the current states of all attributes of their value proposition. In other words, the current state is synonymous to the current customer profile of that customer. For example, if the *number of attributes in the customer entity's value proposition* ($N_{customer}$) is 5 and the *number of states* is 2, a given customers current state, which has been set randomly, could be 10010. Differences in current states distinguishes customer agents from each other in terms of their customer profiles. When customer agents learn and adapt to market conditions, they dynamically change their current states by moving to neighboring states.

Another important state variable of customers is the *expectation*. This could be explained as the expected utility from a service at the time of use [1]. Initially, we set the expectations of individual customers randomly within a range of $0 - h$ ($0 < h < 1$), where h is controlled by a parameter (*Customers' adequate margin*). However, customer expectations usually grows with experiences, especially with delightful experiences [4]. Therefore, we set the expectations of individual customers to grow by a certain quantity given by a parameter (*Expectation growth rate*) at each successful value co-creation.

Table II contains descriptions about the other important variables of customers.

TABLE IV
 OTHER IMPORTANT VARIABLES OF CUSTOMERS

Variable Name	Type	Description
Available Providers	List	The known service providers of the customer agent
Affection with Providers	List	The Affection details of each known provider
Priority Attributes	Integer Array	The most important attributes of the service providers' value proposition to the customer agent
Need Probability	Double	Probability of getting a need for the service at a given time step
My Neighbors	List	The customer agents are placed on a grid. The customer agents on the neighboring grids of a given customer becomes neighbors (peers) of that agent

TABLE V
 OTHER IMPORTANT VARIABLES OF SERVICE PROVIDERS

Variable Name	Type	Description
My Check Attributes	Integer Array	The states of these attributes of customers' value proposition are checked before agreeing to serve
Interaction Number	Integer	Determines the total number of service interactions to date. This is used for reporting purpose
My Customer Relationships	List	Keeps the track of individual relationships with each customer

2) State Variables of Service Providers:

Similar to the customer agents, the *current state* and the *expectation* are the two most important state variables of service providers. The *current state* of a service provider determines the current service level of that particular brand. In other words, it determines the levels of competences and resources the service provider possesses in different aspects of its service. If the it number of attributes in the service provider entity's value proposition ($N_{serviceprovider}$) is 5 and the *number of states* is 2, a given service provider agent's current state, which is set randomly, could be, for example, 10101. Differences in current states distinguishes service providers from each other in terms of their capabilities and possession of resources.

Similar to the expectations of customers, service providers too have an expected utility in a given service interaction. This determines the type of customers that a particular service provider is expecting for the mutual benefit of both parties. The expectations of individual service provider agents are initially set randomly in the range $0 - v$ ($0 \leq v \leq 1$), where v is an input parameter (*Providers' adequate margin*).

Table III contains the details of the other important variables of service providers.

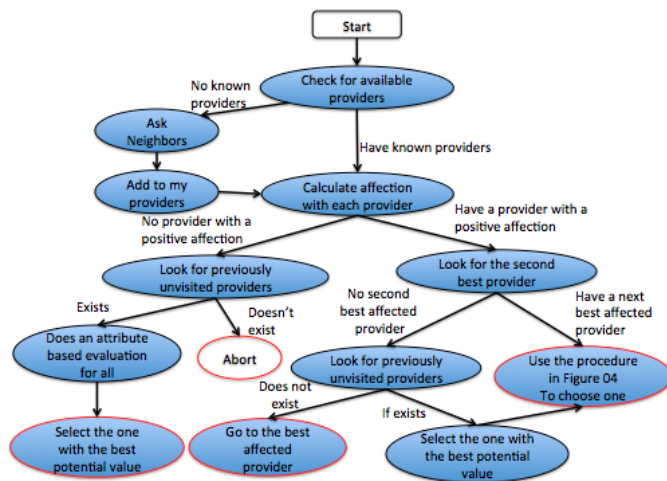


Fig. 5. Process of Selecting a Suitable Provider

E. Process Overview

This section describes the basic processes of the model.

1) *Getting a Service Need*: The market process in our model starts with getting a service need by individual customer agents. Getting a service need is controlled by a probabilistic value generated by the controller agent. According to this probabilistic value, an appropriate percentage of customers get the need for the service at a given time step.

2) *Selecting a Suitable Provider*: Selection of a suitable provider is generally based on the loyalty of customers towards each service provider. However, there exists exceptions in cases when there are no known service provider agents to the customer agent or when the customer agent have no positive affection towards any of the known service provider agents. The process of selecting a suitable service provider is illustrated in figure 05.

According to the figure 05, when a customer agent gets a service need, it checks for any known service provider agent. If any such agent does not exist, the customer agent asks its neighbors (peers) about any available providers and updates its knowledge about available service providers. The customer then calculates its affection with each of the providers in the memory based on the equation 11. In this case, if a service provider with a positive affection could not be identified, customer agent does an attribute based evaluation on its priority attributes for all previously unvisited service providers and selects the one that has the highest potential value. Otherwise it looks for the second-most affected service provider for comparison. If a second-most affected service provider could also be found, the customer uses the procedure in figure 04 to choose one of the two. Otherwise it looks for any previously unvisited service providers. If one such exists, it makes a choice between that provider and the most affected provider using the procedure in figure 04. Otherwise the agent stick to the most affected service provider.

3) *Interacting with the Selected Provider*: Once the customer agent selected a suitable service provider, it starts a

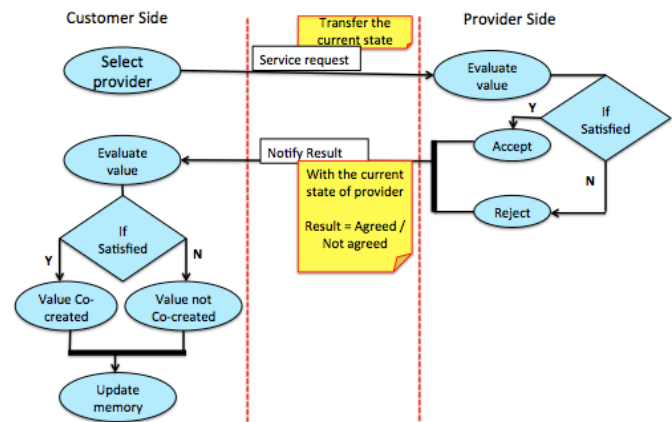


Fig. 6. Process of Interacting with the Selected Provider

service interaction with that provider by sending a service request. Through the service request, the service provider agent gets to know the current state of the customer agent. In case of a new customer, the provider agent does an evaluation on the check attributes to see if the customer is eligible for the service. For example, a hotel may ask for a proper identification certificate from its guests unless the guest is a regular customer of the hotel. The service provider agent then evaluates the service request by determining its value on each attribute of the customer's value proposition in that interaction based on equation 03. It next compares the value of each attribute with its expectations to determine its total satisfaction in the particular interaction. If the total satisfaction is positive, the service provider agrees to serve or rejects the offer otherwise. In case of an acceptance to serve, the customer agent on the other hand calculates its satisfaction and updates its memory based on the result. This process is typically based on the *Service Interaction* branch of the ISPAR model in figure 01 and it is further illustrated in figure 06.

4) *Making a Recommendation*: In case if the customer agent is delightfully satisfied with the service (i.e. satisfaction > 0), it makes a recommendation of the service to all of its neighbors. This recommendation contains the current state of the recommender, hence the peers could calculate the distance between them and the recommender in order to update their *recommendation strength* component given by equation 10 with regard to the service provider being recommended.

5) *Learning and Adaptation*: Whether customers and service providers learn and adapt is depending on an input parameter. In case of customers, if the parameter for learning and adaptation is set to *true*, they attempt to learn and adapt by looking for a better state among their *one-mutant neighboring states* [], which is more likely to give them a better satisfaction with a given service provider. Once a provider is selected, the respective customer agent checks with its neighbors about their previous value co-creation experiences with the same provider. If the agent could find better value co-creation experiences by its neighbors than its current expected value, it moves one

step (*i.e. moving to one of the one-mutant neighboring states*) towards the current state of the nearest neighbor with a better experience. This is synonymous to the process of trying to be like someone who seems co-creating more value with the same product.

In case of service providers, if the parameter for learning and adaptation is set to *true*, service provider agents try to serve their customers better by moving to better states in their *one-mutant neighborhood*. Here, the service provider agents periodically monitors the number of service interactions *sales volume* at a given time step. If a decline in sales volume is monitored compared to the previous figure, the respective service provider agent check its potential performance at its one-mutant neighboring states in consultation with *a selected number of top customers*. If a better state that is more likely to enable its customers to co-create better value, it moves to that state. This is synonymous to the process of firms trying to improve themselves by continuously discussing with its best customers.

F. Implementation

We implement this model using the social simulation development environment *Repast*. The important parameters of the system are introduced in table 04 with a short description and the initial (default) values.

Apart from these basic parameters, we implemented an option of categorizing the *service providers* and *customers* into two distinct segments called *high end* and *low end*. In this differentiation, utility landscapes are adjusted in such a way that the *high end customers* get higher utilities with *high end providers* and the low end customers get higher utilities with *low end providers*. The reason for this discrimination is to emphasis the importance of selecting the right customers and also to cope with the reality, where such discrimination usually exists.

1) *Emergence*: The emerging pattern that we are mainly interested here is the formation and evolution of customers' affection towards service providers. Thus we depict the macro-level variation of average affection of customers towards each service provider.

V. SIMULATION RESULTS

One of our main interests is to find out how affection towards a service provider changes with time due to the process of customer engagement. Thus, we plot affection against time in the graph in figure 7. To generate this graph, we used 10 simulation runs, each of which having only one service provider and different random seeds, and got the average affection at each time step. According to this graph, the affection towards a service provider initially goes through a hype but declines thereafter gradually with time towards a stable point. As shown in Figure 8, this general shape of the curve didn't change when the number of providers were increased to two, except that due to first mover's advantage, one provider out performed the other.

TABLE VI
 IMPORTANT PARAMETERS OF THE SYSTEM

Parameter Name	Description	Default Value
CustomerN	The number of attributes in customer entity's value proposition	10
ProviderN	The number of attributes in the service provider entity's value proposition	10
K-Value	The number of other attributes of the same entity that a given attribute depends on	2
C-Value	The number of other attributes of the opposite entity that a given attribute depends on	2
No. of Customers	The number of customer agents	1000
No. of Providers	The number of service provider agents	2
No. of States	The number of states that the attributes can be at	3
Customers' Adequate Margin	The upper margin of the initial expectations of customers	0.40
Providers' Adequate Margin	The upper margin of the initial expectations of service providers	0.40
Customer Learns	Whether the customer learns and adapts	<i>true</i>
Provider Learns	Whether the service provider learns and adapts	<i>true</i>
Expectation Growth Rate	The percentage growth of expectation at a successful value co-creation	0.05
Need Probability	The probability to getting a service need by a customer at a given time step	0.25
Alpha	The α value of equation 07	6
Beta	The β value of equation 10	50000
Trust of Conformity	Component <i>P</i> of equation 07	0.25
Innovation Frequency	How frequently does the service providers check their sales performance if <i>Provider Learns</i> is set to <i>true</i>	10

In fact, this result corresponds with a common observation with new offerings where lots of attention being drawn at the particular offering through reviews, discussions, recommendations, etc generated through delightful experiences of the early users. However, as customer expectations grow with firsthand experiences with the offering, the trust towards the particular offering in the population of its customers gets lowered gradually towards an equilibrium point.

A. Selecting the Right Customers

Next we increase the number of service providers to two; one high-end provider and one low-end provider. 99% of

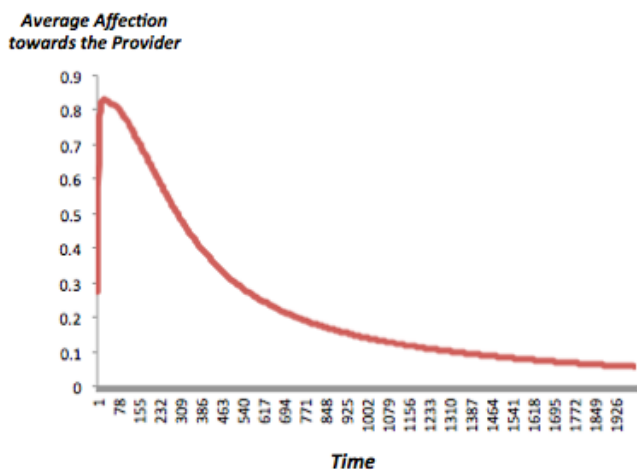


Fig. 7. Change of Average Affection Towards a Provider over Time

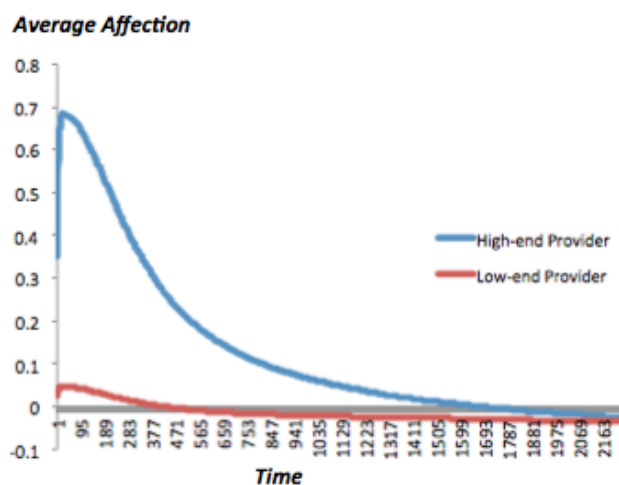


Fig. 9. Change of Average Affection Towards a Provider over Time : A high-end provider and a low-end provider in a market of mainly high-end customers

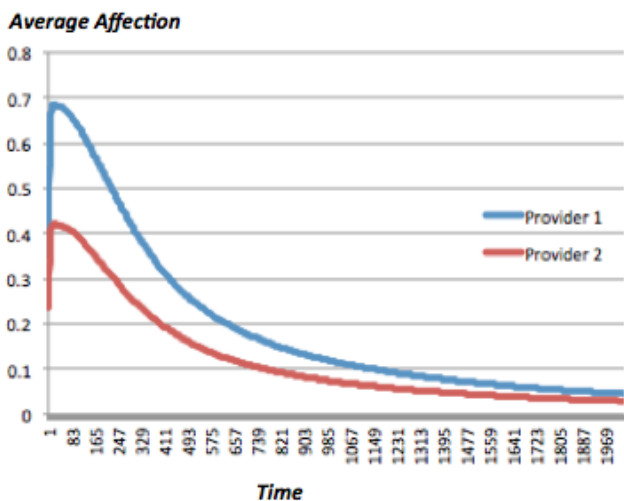


Fig. 8. Change of Average Affection Towards a Provider over Time : With Two Competing Providers

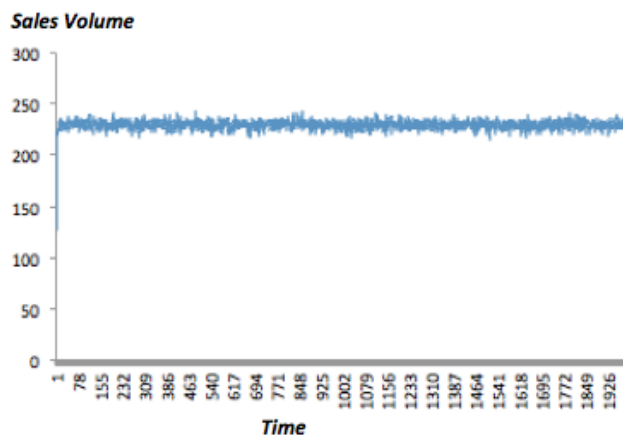


Fig. 10. Change of Sales Volume over Time in spite of Changing Affection - The case of one service provider

the customer population comprises high-end customers. As it could be precisely predicted, the high-end provider outperformed the low-end provider by a huge margin. This is shown by the graph in figure 09.

B. Impact of Affection on Sales Volume

Our next interest is to see if there is any impact on the sales volume due to the change of affection among the customers. Here we consider sales volume at a given time step as the total number of service interactions occurred during that time period. We plot the sales volume of the service provider corresponding to the figure 07 at each time step as shown by the graph in figure 10. Apparently, the change of affection shows no impact on the sales volume as it continues steadily throughout the time period concerned.

One probable reason for this pattern would be that the expectation growth rate is not adequate to make a significant

impact on the sales volume despite the declining customers' affection towards the service provider. To get this clarified, we plot the same graph for six different expectation growth rates, i.e. 0.02, 0.05, 0.07, 0.10, 0.12 and 0.15, selected arbitrarily. The corresponding graph is shown in figure 11. Notably, the sales volume drops over time when expectation growth rate increases. This too complies with the general observation that the offerings get outdated soon when the customers' expectations in the given industry grows fast. For example, offerings in the *Information and Communication Industry* get obsolete much faster than those in any other industry due to fast growing customer expectations. On the other hand, this result could support the discussion when and where to delight customers [4] by suggesting that delighting customers in industries with fast growing customer expectations may negatively affect the sustainability of service providers.

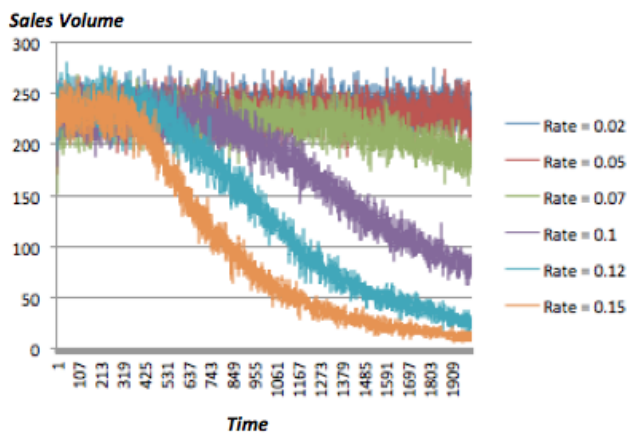


Fig. 11. Change of Sales Volume over Time in spite of Changing Affection - The case of one service provider at different expectation growth rates

VI. CONCLUSION

The prime objective of this research is to find new insights on the issue of customers leaving service providers despite their attempts to improve the service. In this endeavor, we take a novel approach by initiating an interdisciplinary inquiry that involves *agent-based modeling*, *customer engagement*, and *service-dominant logic*. The increasing attention received by the role of *customer engagement* from the business practitioners and academics in co-creating customer experience and value stimulated us to further inquire the phenomenon in a dynamic and interactive setup to achieve our prime objective. The dynamic and interactive nature of the market environment being concerned demanded the capabilities of *agent-based modeling and simulation*, which has a reputation in successful modeling of *complex adaptive systems*. In doing so, we first created the agent-based model as an artificial market environment of a particular service as a system of service provider and customer agents and this paper contains the logical formulation of the model together with some initial outcomes.

Our next step is to use this model as a tool to achieve our prime objective. There we intend to conduct our analysis in both micro and macro levels to identify some critical properties and sensitive parameters that lead customer agents to switch service providers. Given that the model has been formulated logically with respect to latest research in customer engagement and service-dominant logic, we believe that it would enable us to gain some interesting insights in our future work.

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