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# Dynamics of Customer Engagement

**Eman Abo Elhamd[1*], Hamed M. Shamma[2], Mohamed Saleh[1] and Ihab El-Khodary[1]**

[1]*Department of Operations Research and Decision Support, Cairo University, Cairo, Egypt*
[2]*Department of Management, The American University in Cairo, Cairo, Egypt*

## Abstract

Customer Engagement Value (CEV) is a crucial concept for measuring the comprehensive value of a customer without overvaluation or undervaluation. CEV consists of four main components that comprehensively capture the transactional and non-transactional behavior of a customer within a firm. Traditional models contributed to measuring the value of each CEV's component separately. Only a few researchers contributed to constructing a comprehensive framework for CEV to combine its components altogether. Meanwhile, these previous models either were theoretical or utilized gamification concepts for describing the relationship between a firm and its customers. The objective of this paper is to design a more realistic and comprehensive framework that captures CEV's components' relationships using a non-linear model. The elasticity parameters the determine the effect of each component in this non-linear model are determined using an online survey. These parameters are plugged in a system dynamics model that its relationships are formulated based on that non-linear model. The proposed CEV's system dynamics model is applied only using imperial data. It proved the significance of both purchasing and non-purchasing components in CEV. It is recommended to be applied to real-life data to confirm its effectiveness.

**Keywords:** Customer Engagement Value (CEV) • Customer Lifetime Value (CLV) • Customer Referral Value (CRV) • Customer Influencer Value (CIV) • Customer Knowledge Value (CKV) • System Dynamics (SD).

## Introduction

Customer Engagement Value (CEV) is a concept of measuring the customer's comprehensive value within a firm. The real value of that customer does not include only the purchasing behavior but also a set of other behavioral characteristics. As mentioned, CEV consists of four main components, demonstrated in Figure 1. Customer lifetime value (CLV) is the first of these components. It measures the purchasing behavior of a customer. While, the non-purchasing behavior is measured using three components (*i.e.*, Customer Referral Value (CRV), Customer Influencer Value (CIV), and Customer Knowledge Value (CKV)).

Customer Lifetime Value (CLV) is the most significant factor that captures the purchasing behavior of a customer. Hence, it is on top of the crucial measurements in direct marketing as it helps in measuring the profitability of each customer [1-5]. Hence, CLV measures the monetary value of each interacting customer with the firm. On another hand, as demonstrated in Figure 1.

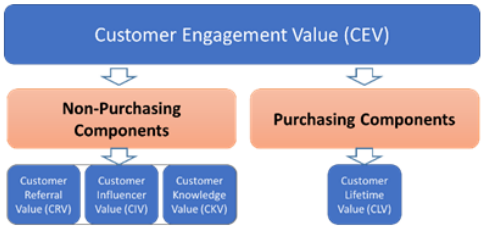


**Figure 1.** CEV components.

The non-purchasing behavior components are Customer Referral Value (CRV), Customer Influencer Value (CIV), and Customer Knowledge Value (CKV). The factors are not directly related to valuing the monetary value of the customers through their purchases but to valuing the customers according to their non-transactional and non-monetary activities. CRV mainly measures the ability of a customer to refer the company or its products to their friends (Kumar et al. 2010). Those referrals have a crucial effect in reducing the acquisition costs and increasing future revenues [6]. CIV represents the value of a customer within his network measured by information sharing through Word of Mouth (WOM) [7]. The latter directly influences customer satisfaction and affects the purchasing decision of the prospect. Finally, CKV measures the customer's feedback. It

[*]***Address to Correspondence:*** *Eman Abo Elhamd, Department of Operations Research and Decision Support, Cairo University, Cairo, Egypt; E-mail: e.aboelhamd1@gmail.com*



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also measures the likelihood of a customer to give innovative ideas that directly contributed to the development of the product or the process of a firm. Hence, it is important for the firm to measure these ideas and to relate them to the loyalty of the customer, the profitability of the firm, and even in the development of new products. Developing models for CEV is of interest to both researchers and practitioners. The former compete in developing models that capture the interactions between CEV's components. They also were interested in measuring how these components collectively measure the value of a customer within a firm. The problem is that so far the existing models are either theoretical or depend on applying the gamification concept, and this is up to the best of our knowledge. This theoretical nature of the existing models limits their applicability in real-life business situations, and even the models that depend on gamification concept are not robust enough to be implemented in real-life cases [8]. Gamification is defined as applying game mechanisms and principles in non-gaming environments for better engagement and motivation of the participants using challenges and rewards. On another hand, system dynamics is the process of understanding the non-linear behavior of complex systems. There are two types of system dynamics diagrams, each of which suites certain types of problems. First, stock and flow diagram, and second causal loop diagram. Figure 2 merges both types. As demonstrated in Figure 2, the main components of stock and flow diagram are stocks and flows, while, the main elements of causal loop diagrams are causality relationships. The most common relationship in system dynamics is the cause and effect relationship, represented in the causal loop diagram. This relationship can either be reinforcing (represented by "R" symbol) or balancing (represented by "B" symbol) [9]. In a reinforcing relationship, the increase of one variable leads to an increase in another variable which consequently increases the 1st variable, and so on. Also, the decrease of a variable leads to a decrease of another variable, which consequently decreases the first variable, hence, all the variables in the relationship move in the same direction either up or down together. This is not the case of balancing relationships, where the increase of a certain variable decreases the second variable. Reinforcing and Balancing loops are presented in Figure 2. Meanwhile, there are many other common factors between stock and flow and causal loop diagrams including internal feedback loops or sometimes called causal loops. There are also table functions and time delays (represented by two horizontal lines *i.e.* between In-flow and Variable-2 in Figure 2). CEV's components depend on many variables that the researchers compete in classifying them to multiple dimensions classified these factors into (Personal Factors, Interpersonal Factors, Message Characteristics, and Situational Characteristics) [10]. While, classified these factors as (Behavioral, Attitudinal, and Network). Table 1 blends the contributions of and classifies these independent variables according to their related source (*i.e.* Firm-Specific Characteristics, Customer Specific Characteristics, and Product Specific Characteristics.

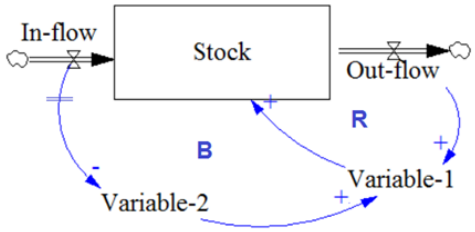


**Figure 2.** Stock and flow and causal loop diagrams.

| Dimensions | CLV | CRV | CIV | CKV |
|---|---|---|---|---|
| Firm Specific Characteristics | Retention Rate | Discount Rate | Number of Reviews | # of Feedback Channels |
| | Acquisition Rate | Cost of Referral | Number of Positive Reviews | First Response Time |
| | Acquisition Costs | Marketing Revenue | Number of Negative Reviews | Response Time |
| | Service Costs | Price of an Item | | |
| | Up-Selling | Cross Buying | | |
| | Cross-Selling | | | |
| Customer Specific Characteristics | RFM | Income | Tendency to recommend | Probability to Provide Feedback |
| | Purchasing Frequency | Age | Level of interaction | Level of interactions |
| | #of Purchased Items | Region | Frequency of using Social media and blogs | Life Style |
| | Value of the Purchases | Life Style | Number of connections | Taste |
| | Probability of repeat buying o being alive | Gender | Level of influencing | Education Level |
| | Age | Taste | - | Age |
| | Gender | Educational Level | - | Region |
| | Standard of Living | Referral Rate | | Income |
| | Region | # of Purchased Items | - | Churn Probability |

| | | | | | |
|---|---|---|---|---|---|
| | | Churn Probability | RFM | | - |
| | | Taste | Value of Purchases | - | - |
| | | Income | #of Non Referral Customers | - | - |
| Product Characteristics | Specific | | #of Successful Referrals | - | - |
| | | Price of the product | Product Returns | Rate of the product | Number of received feedback notes |
| | | Product Discount Rate | | Number of defects | |

**Table 1.** Affecting Variables in CEV Components.

Figure 3 demonstrates the dynamics of the components mentioned in Table 1. It also relates CEV components to each other, defining the type of relationship and type of loop between these components [11]. This relationship loop can be Reinforcing (if all the signs inside the relationship are (+)) or Balancing (if the relationship contains at least a single (-) sign)). For instance, the relationship between CLV and CRV is reinforcing as both components are either increasing or decreasing together. That is the more the value of CLV of the customer, the more loyal the customer expected to be and hence, the more willing to contribute in referral programs and consequently the more than the value of CRV [12]. Meanwhile, the relationship between CLV and CKV is balancing, as these two components do not necessarily go in the same direction; as high CLV customers have a good fit with the products, hence, little feedback to give, and low CLV customers have little knowledge about the product and hence, won't be able to give feedback. Figure 3 demonstrates the main steps of the proposed system dynamics model also tackled these relationships but in a different way.

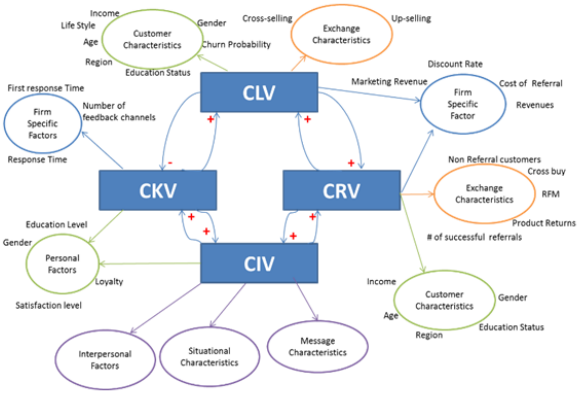


**Figure 3.** System Dynamic Model for CEV components.

On the other hand, formulated a multiplicative non-linear model to describe the interactions of a system dynamics' components. They stated that the effect of the independent variables on the dependent variable might be formulated using Equation (1). Where Y is the dependent variable, $Y^*$ is the standard value of this dependent variable, and $X_1,\ldots X_n$ are the set of independent variables. The effect of each independent variable on the dependent variable is calculated using Equation (2). Meanwhile, Equation (2) could be represented in detail in Equation (3) Where $\varepsilon_i$ represents a set of elasticity parameters that determine the influence of each independent variable ($X_i$) in the dependent variable (Y) [13].

$$Y = Y^* * effect\ of\ X_1\ on\ Y * effect\ of\ X_2\ on\ Y * \ldots effect\ of\ X_n\ on\ Y \quad (1)$$

$$Effect\ of\ X_i\ on\ Y = f\left(\frac{X_i}{X_i^*}\right) \quad (2)$$

$$Effect\ of\ X_i\ on\ Y = \left(\frac{X_i}{X_i^*}\right)^{\varepsilon_i} \quad (3)$$

The work in this paper builds on the work of both [14]. The former studied the relationships between the components of CEV from a theoretical perspective. While, the latter, combined ANN and simulation [15]. In this paper, this theoretical perspective gap is filled by applying a system dynamics model to simulate the interaction between CEV's components and how every component affects the others. These interactions are captured in a non-linear model that drives the system dynamics model. The elasticity parameters of the non-linear model that indicate the effect of each component on CEV is determined using an online survey. The rest of this paper is divided as follows; Section-2 lists the work that has been done by other researchers and introduces the motivation behind the work of this paper. Section-3 demonstrates the proposed framework in detail. Section-4 presents the experimental results. While Section-5 lists the managerial implications of the proposed framework. Finally, the last section, Section-6 concludes the whole paper, highlights the research limitations, and lists the future research directions [16].

## Literature Review

This section is devoted to listing the related work to the work in this paper; mentioning their work, limitations, and how each of the previous work differs from the work in this paper. The researchers contributed to this area of research either by constructing theoretical models that describe the dynamism of the relationship between firms and their customers using system dynamics models. Another group of researchers contributed by working on more practical gamification models, with the help of gaming concepts and techniques. Both of these two groups are illustrated during this section and summarized in Table 2 examined customer engagement and its drivers through a proposed framework. They mainly focused on virtual customer environments. Their model was validated using partial least squares structural equation modeling and applied on three samples of real customers from the Dutch Telecom industry. Their study proved the significance of the cognitive, personal, hedonic, and social integrative benefits on boosting customer engagement. Meanwhile, their model missed some variables that might be significant as well, including customer characteristics. Also, their model was not generalized and applied only to telecom [17]. Showed the effect of system dynamics in driving materials insights that help in decision making. Following this, applied system dynamics on telecom, precisely in mobile

technology. They deployed a unique dataset that addressed engagement and purchased for mobile apps. Their interesting finding was that the effect of customer disengagement for the app had a long-term stronger effect than the customer's engagement. Meanwhile, they included only specific dimensions for measuring customers' engagement and this limited the generalizability of their model's results. contributed to combining system dynamics in analyzing the measurements and management of SMEs. Their model had a set of reported results on a real small business. Their model and its experimental results were well presented; yet, lacked generalizability. Also, built a simulation model to analyze customer engagement in SMEs. Meanwhile, their simulation model proved that SMEs faced a set of operational difficulties caused by globalization. This required the SMEs to invest more resources to develop market adaptability and to enhance the overall service capabilities and consequently increase market competencies. Meanwhile, their model focused only on controllable factors and excluded a lot of external yet significant factors, such as government policy and exchange rate. A second crucial limitation was that the number of interviews they conducted was a bit limited; meanwhile, they justified this by the fact that the interviews required a lot of time and effort [18-20]. Designed a 2 × 2 matrix for the customer engagement process that analyzed the crowding effects based on the monetary incentives. Yet, their model still needs to be more complex by involving more actors and more relationships to capture the complexity in the reality tried to conceptualize the value of customer engagement behavior in some sort of value co-creation. They focused on a multi-stakeholder service system. They applied their conceptual model in a form of case study that focused on public transport service systems. On top of their findings was that firms should focus more attention on the resources that the customers can contribute to, explore the potential to engage diverse stakeholders around a common cause, and think of ways that provide opportunities for more value co-creation. Their model was well presented yet, had a set of limitations including the lack of generalizability of its findings. On the other hand, illustrated the definition of gamification, how it operates, and its effect on customer engagement. They focused on three main aspects in the gamification process mainly; motivational affordance, gameful experience, and value realization introduced a game design mechanism to simulate the behavior of the customer within the firm. Their model enhanced users' participation and data gathering. But the generalizability was not obvious there, as it was only applied and tested in the Water management field. Also, studied how gamification boosted customer engagement. They analyzed how it can increase hope and consequently increase engagement and digital sales. Their interesting work still needs generalization; as it focused only on online purchasing channels. Another limitation was their focus on digital context only without touching the non-digital contexts presented empirical gamification insights for the engagement of online customers. Their analysis was based on the data of Samsung Nation. The main limitation of their work was that it didn't afford the expected level of generalizability. A bit far from the previously mentioned work, built a "management flight simulator". It would help managers to understand the dynamic interrelations between the organization's profitability and investment in people competence. They also mentioned how to use this to build long and strong relationships with customers [21]. Also, designed a strategic engagement framework between firms and their customers. Meanwhile, their model was sensitive to the quality of the input data that might affect its results whenever being inaccurate or not reliable utilized the Service-Dominant (S-D) logic to design a customer engagement framework that integrated three components (*i.e.* customer knowledge sharing, customer learning, and customer resource integration). They concluded by presenting the theoretical and managerial implications of their framework. Meanwhile, their framework was theoretical and did not include insights for the disengaged customers. On the other hand, and contributed to injecting artificial neural networks into simulation models. They utilized ANN as a function approximation to learn the relationships between the components of system dynamics. These relationships were represented in highly non-linear differential equations. The work in this paper builds on the work of who designed a framework of CEV components. The goal of this paper is to build a practical and comprehensive CEV model in light of that one designed. It also utilized the non-linear model formulated by to drive the relationships of CEV's components in the proposed system dynamics model.

| Paper Title | Contribution Type |
|---|---|
| Benefitting from virtual customer environments: An empirical study of customer engagement | System dynamics |
| Connecting strategy and system dynamics: an example and lessons learned | System dynamics |
| The dynamics of consumer engagement with mobile technologies | System dynamics |
| Combining system dynamics modeling and management control systems to support strategic learning processes in SMEs: a Dynamic Performance Management approach | System dynamics |
| Dynamics and drivers of customer engagement: within the dyad and beyond | System dynamics |
| Modeling the impact of service innovation for small and medium enterprises: A system dynamics approach | Simulation |
| A gamification framework for customer engagement and sustainable water usage promotion | Gamification |
| Hook vs. hope: How to enhance customer engagement through gamification | Gamification |
| An investigation into gamification as a customer engagement experience environment | Gamification |

| | |
|---|---|
| Building a knowledge-based strategy a system dynamics model for allocating value adding capacity | Others |
| Customer engagement in a big data world | Others |
| SD logic–informed customer engagement: integrative framework, revised fundamental propositions, and application to CRM | Others |
| The role of customer engagement behavior in value co-creation: a service system perspective | Others |
| Causally interpretable multi-step time series forecasting: A new machine learning approach using simulated differential equations | Simulated differential equations |
| Finding the Loops that Matter | System dynamics+machine learning |

**Table 2.** Contributions in Customer Engagement Value.

## Proposed Framework

This section illustrates the proposed CEV's system dynamics model. The relationships of CEV's components are formulated using a multiplicative non-linear model. The latter depends on a set of elasticity parameters as stated in Equation (3). These parameters are determined using an online survey. While the non-linear model is illustrated in subsection-3.1. Finally, subsection-3.2 presents the proposed system dynamics model that depends on the formulated non-linear model. Figure 4 demonstrates the steps of implementing CEV's system dynamics model that depends on the input relationships determined by the non-linear model [22].


**Figure 4.** Steps of the proposed CEV'S framework.

## CEV's non-linear model

This subsection presents the proposed CEV's non-linear model based on the multiplicative non-linear model proposed by Sterman et al. and presented in Equations (1-3). This non-linear model depends on the multiplicative method. The latter depends on the power-law or log-linear model, where the effects are specified as power functions of the normalized inputs. Equation (4) demonstrates the CEV's non-linear model. Where the exponent $\varepsilon_{1j}$ is the elasticity of the dependent variable (*i .e.,* CEV) with respect to the normalized independent variables (*i .e.,* CLV, CRV, CIV, and CKV). The value of ε differs from one CEV component to another, this is why *j* takes values (1,2,3 or 4) in case of CLV, CRV, CIV, and CKV respectively. While, refers to the index of the 1st equation of CEV and its components nonlinear equations. All the input variables are dimensionless due to the normalization process. The effect of CLV on CEV is calculated either using a tabular form or analytically as illustrated in Equation (5).

$$CEV = Standard\ CEV * Effect\ of\ CLV\ on\ CEV * Effect\ of\ CIV\ on\ CEV * Effect\ of\ CRV\ on\ CEV * Effect\ of\ CKV\ on\ CEV \quad (4)$$

$$CEV = CEV_0 + \left(\frac{CLV}{CLV_0}\right)^{\varepsilon_{11}} * \left(\frac{CRV}{CRV_0}\right)^{\varepsilon_{12}} * \left(\frac{CIV}{CIV_0}\right)^{\varepsilon_{13}} * \left(\frac{CKV}{CKV_0}\right)^{\varepsilon_{14}} \quad (5)$$

The non-linear model of CLV is presented in Equation (6). Each of the independent variables in Equation (6) needs to be normalized as mentioned in Equation (7). The exponent $\varepsilon_{2l}$ is the elasticity of CLV with respect to the normalized independent variables (*i .e.,* Churn probability). Where takes values from 1 to 12 according to the number of independent variables of CLV in Equation (6) and 2 refers to CLV as the 1st CEV component.

$$CLV = Standard\ CLV * effect\ of\ Churn\ Probability * effect\ of\ Avg.Propensity\ to\ Consume * effect\ of\ Income * effect\ of\ RFM * effect\ of\ Product\ Discount\ Rate * effect\ of\ Probability\ of\ Repeat\ Buying\ or\ Being\ Alive * Item's\ Price * effect\ of\ Item's\ Cost * effect\ of\ Marketing\ Revenue * effect\ of\ Retention\ Rate * effect\ of\ Acquisition\ Rate * effect\ of\ UpSelling\ Ratio * effect\ of\ CrossSelling\ Ratio \quad (6)$$

$$CLV = CLV_0 * \left(\frac{\text{Churn Probability}}{\text{Churn Probability}^0}\right)^{\varepsilon_{21}} * \left(\frac{\text{Avg.Propensity to Consume}}{\text{Avg.Propensity to Consume}^0}\right)^{\varepsilon_{22}} * \left(\frac{\text{Income}}{\text{Income}^0}\right)^{\varepsilon_{23}} * \left(\frac{\text{RFM}}{\text{RFM}^0}\right)^{\varepsilon_{24}} * \left(\frac{\text{Product Discount Rate}}{\text{Product Discount Rate}^0}\right)^{\varepsilon_{25}} * \left(\frac{\text{Item's Price}}{\text{Item's Price}^0}\right)^{\varepsilon_{26}} * \left(\frac{\text{Probability of Repeat Buying or Being Alive}}{\text{Probability of Repeat Buying or Being a live}^0}\right)^{\varepsilon_{27}} * \left(\frac{\text{Item's Cost}}{\text{Item's Cost}^0}\right)^{\varepsilon_{28}} * \left(\frac{\text{Marketing Revenue}}{\text{Marketing Revenue}^0}\right)^{\varepsilon_{29}} * \left(\frac{\text{Retention Rate}}{\text{Retention Rate}^0}\right)^{\varepsilon_{210}} * \left(\frac{\text{Acquisition Rate}}{\text{Acquisition Rate}^0}\right)^{\varepsilon_{211}} * \left(\frac{\text{UpSelling Ratio}}{\text{UpSelling Ratio}^0}\right)^{\varepsilon_{212}} * \left(\frac{\text{CrossSelling Ratio}}{\text{CrossSelling Ratio}^0}\right)^{\varepsilon_{213}} \quad (7)$$

Equations (8,9) present the non-linear model of CRV. Equation (8) demonstrates the calculations of CRV with respect to the effect of each of its independent variables. The exponent $\varepsilon_{3r}$ is the elasticity of CRV with respect to the normalized independent variable (*i .e.,* Referral rate). Where *r* takes values from 1 to 11 according to the number of independent variables of CRV in Equation (9) and the value of in $\varepsilon_{3r}$ refers to CRV as a 2nd component of CEV.

$$CRV = Standard\ CRV * effect\ of\ Referral\ Rate * effect\ of\ Avg.Propensity\ to\ Consume * effect\ of\ Income * effect\ of\ Purchases\ Profits * effect\ of\ CrossBuying\ Costs * effect\ of\ Successful\ Referrals\ Rate * effect\ of\ Unsuccessful\ Referrals\ Rate * effect\ of\ Discount\ Rate * effect\ of\ Marketing\ Profits * effect\ of\ Cost\ of\ Referral * effect\ of\ Cost\ of\ Product\ Returns \quad (8)$$

$$CRV = CRV_0 * \left(\frac{\text{Referral Rate}}{\text{Referral Rate}^0}\right)^{\varepsilon_{31}} * \left(\frac{\text{Avg.Propensity to Consume}}{\text{Avg.Propensity to Consume}^0}\right)^{\varepsilon_{32}} * \left(\frac{\text{Income}}{\text{Income}^0}\right)^{\varepsilon_{33}} * \left(\frac{\text{Purchases Profits}}{\text{Purchases Profits}^0}\right)^{\varepsilon_{34}} * \left(\frac{\text{CrossBuying Costs}}{\text{CrossBuying Costs}^0}\right)^{\varepsilon_{35}} * \left(\frac{\text{Successful Referrals Rate}}{\text{Successful Referrals Rate}^0}\right)^{\varepsilon_{36}} * \left(\frac{\text{Unsuccessful Referrals Rate}}{\text{Unsuccessful Referrals Rate}^0}\right)^{\varepsilon_{37}} * \left(\frac{\text{Discount Rate}}{\text{Discount Rate}^0}\right)^{\varepsilon_{38}} * \left(\frac{\text{Marketing Profits}}{\text{Marketing Profits}^0}\right)^{\varepsilon_{39}} * \left(\frac{\text{Cost of Referral}}{\text{Cost of Referral}^0}\right)^{\varepsilon_{310}} * \left(\frac{\text{Cost of Product Returns}}{\text{Cost of Product Returns}^0}\right)^{\varepsilon_{311}} \quad (9)$$

CIV's non-linear model is presented in Equations (10,11). The effect of each independent variable in Equation [10] is calculated in Equation (11) $\varepsilon_{4i}$ is the elasticity of CIV with respect to the normalized independent variable (*i .e.,* Receiver's avg. propensity to consume). Where i takes values from 1 to 16 according to the number of independent variables of CIV in Equation (11). The value of 4 in $\varepsilon_{4i}$ refers to CIV as a 3rd component of CEV.

$$CIV = CIV_0 * \left(\frac{\text{Receiver's Avg Propensity to Consume}}{\text{Receiver's Avg Propensity to Consume}^*}\right)^{\varepsilon_{11}} * \left(\frac{\text{Receiver's Income}}{\text{Receiver's Income}^*}\right)^{\varepsilon_{12}} * \left(\frac{\text{Receiver's assurance need}}{\text{Receiver's assurance need}^*}\right)^{\varepsilon_{13}} * \left(\frac{\text{Receiver's Perception}}{\text{Receiver's Perception}^*}\right)^{\varepsilon_{14}} * \left(\frac{\text{Level of Loyalty}}{\text{Level of Loyalty}^*}\right)^{\varepsilon_{15}} * \left(\frac{\text{Level of Trust}}{\text{Level of Trust}^*}\right)^{\varepsilon_{16}} * \left(\frac{\text{Sender's Credibility}}{\text{Sender's Credibility}^*}\right)^{\varepsilon_{17}} * \left(\frac{\text{sender and receiver Common Interests}}{\text{sender and receiver Common Interests}^*}\right)^{\varepsilon_{18}} * \left(\frac{\text{Probability of Availability}}{\text{Probability of Availability}^*}\right)^{\varepsilon_{19}} * \left(\frac{\text{Probability of Accessibility}}{\text{Probability of Accessibility}^*}\right)^{\varepsilon_{110}} * \left(\frac{\text{Product's Price}}{\text{Product's Price}^*}\right)^{\varepsilon_{111}} * \left(\frac{\text{Product's Cost}}{\text{Product's Cost}^*}\right)^{\varepsilon_{112}} * \left(\frac{\text{Message Type}}{\text{Message Type}^*}\right)^{\varepsilon_{113}} * \left(\frac{\text{Perceived Risk}}{\text{Perceived Risk}^*}\right)^{\varepsilon_{114}} * \left(\frac{\text{Message Spirit}}{\text{Message Spirit}^*}\right)^{\varepsilon_{115}} * \left(\frac{\text{Sender's Voice Tone}}{\text{Sender's Voice Tone}^*}\right)^{\varepsilon_{116}} \quad (10)$$

$$CIV = CIV_0 * \left(\frac{\text{Receiver's Avg Propensity to Consume}}{\text{Receiver's Avg Propensity to Consume}^*}\right)^{\varepsilon_{11}} * \left(\frac{\text{Receiver's Income}}{\text{Receiver's Income}^*}\right)^{\varepsilon_{12}} * \left(\frac{\text{Receiver's assurance need}}{\text{Receiver's assurance need}^*}\right)^{\varepsilon_{13}} * \left(\frac{\text{Receiver's Perception}}{\text{Receiver's Perception}^*}\right)^{\varepsilon_{14}} * \left(\frac{\text{Level of Loyalty}}{\text{Level of Loyalty}^*}\right)^{\varepsilon_{15}} * \left(\frac{\text{Level of Trust}}{\text{Level of Trust}^*}\right)^{\varepsilon_{16}} * \left(\frac{\text{Sender's Credibility}}{\text{Sender's Credibility}^*}\right)^{\varepsilon_{17}} * \left(\frac{\text{sender and receiver Common Interests}}{\text{sender and receiver Common Interests}^*}\right)^{\varepsilon_{18}} * \left(\frac{\text{Probability of Availability}}{\text{Probability of Availability}^*}\right)^{\varepsilon_{19}} * \left(\frac{\text{Probability of Accessibility}}{\text{Probability of Accessibility}^*}\right)^{\varepsilon_{110}} * \left(\frac{\text{Product's Price}}{\text{Product's Price}^*}\right)^{\varepsilon_{111}} * \left(\frac{\text{Product's Cost}}{\text{Product's Cost}^*}\right)^{\varepsilon_{112}} * \left(\frac{\text{Message Type}}{\text{Message Type}^*}\right)^{\varepsilon_{113}} * \left(\frac{\text{Perceived Risk}}{\text{Perceived Risk}^*}\right)^{\varepsilon_{114}} * \left(\frac{\text{Message Spirit}}{\text{Message Spirit}^*}\right)^{\varepsilon_{115}} * \left(\frac{\text{Sender's Voice Tone}}{\text{Sender's Voice Tone}^*}\right)^{\varepsilon_{116}} \quad (11)$$

Finally, CKV is the fourth component of CEV. Its non-linear model is presented in Equations (12,13). Where the value of *k* in $\varepsilon_{5k}$ ranges from 1 to 12 according to the 12 independent variables of CKV. The suffix of 4 in $\varepsilon_{5k}$ refers to CKV as the 4th component of CEV.

$$CKV = Standard\ CKV * effect\ of\ Yearly\ Profit\ of\ Applying\ The\ Proposed\ Feedback * effect\ of\ Yearly\ Cost\ of\ Applying\ the\ Feedback * effect\ of\ \#\ of\ Feedback\ Channels * effect\ of\ Response\ Time * effect\ of\ First\ Response\ Time * effect\ of\ Probability\ to\ Give\ Feedback * effect\ of\ Interaction\ Level * effect\ of\ Education\ Level * effect\ of\ Probability\ of\ Feedback's\ Applicability * effect\ of\ Message\ Sprit * effect\ of\ Positive\ words\ ratio * effect\ of\ Negative\ words\ ratio \quad (12)$$

$$CKV = CKV_0 * \left(\frac{\text{Yearly Profit of Applying The Proposed Feedback}}{\text{Yearly Profit of Applying The Proposed Feedback}^*}\right)^{\varepsilon_{51}} * \left(\frac{\text{Yearly Cost of Applying the Feedback}}{\text{Yearly Cost of Applying the Feedback}^*}\right)^{\varepsilon_{52}} * \left(\frac{\text{\# of Feedback Channels}}{\text{\# of Feedback Channels}^*}\right)^{\varepsilon_{53}} * \left(\frac{\text{Response Time}}{\text{Response Time}^*}\right)^{\varepsilon_{54}} * \left(\frac{\text{First Response Time}}{\text{First Response Time}^*}\right)^{\varepsilon_{55}} * \left(\frac{\text{Probability to Give Feedback}}{\text{Probability to Give Feedback}^*}\right)^{\varepsilon_{56}} * \left(\frac{\text{Interaction Level}}{\text{Interaction Level}^*}\right)^{\varepsilon_{57}} * \left(\frac{\text{Education Level}}{\text{Education Level}^*}\right)^{\varepsilon_{58}} * \left(\frac{\text{Probability of Feedback's Applicability}}{\text{Probability of Feedback's Applicability}^*}\right)^{\varepsilon_{59}} * \left(\frac{\text{Message Sprit}}{\text{Message Sprit}^*}\right)^{\varepsilon_{510}} * \left(\frac{\text{Positive words ratio}}{\text{Positive words ratio}^*}\right)^{\varepsilon_{511}} * \left(\frac{\text{Negative words ratio}}{\text{Negative words ratio}^*}\right)^{\varepsilon_{512}} \quad (13)$$

## System dynamics model of CEV

The proposed CEV system dynamics model is a comprehensive model that combines all CEV components. The inputs to this model are the non-linear relationships formulated in subsection 3.2, and the elasticity parameters that are determined in subsection 3.1. The rest of this section presents the proposed system dynamics model's equations. Starting by CEV is a comprehensive, and dependent variable. Figure 5 demonstrates the relationship between CEV and its independent components (CLV, CRV, CIV, and CKV). CEV is a function of all these four components based on Equation. (6).

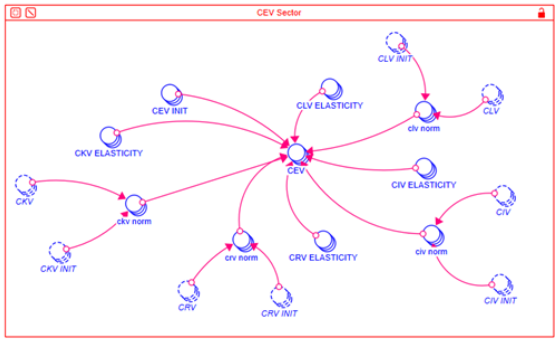


**Figure 5.** CEV's system dynamics model.

CLV depends on many factors including Churn probability, Recency, Frequency, Monetary (RFM) values, cross-selling and up-selling, and many more. These variables are collected together in (Customer characteristics, exchange characteristics, and Firm Specific characteristics) as demonstrated in Figure 3. These factors are formulated in Equation (8) and presented in Figure 6.

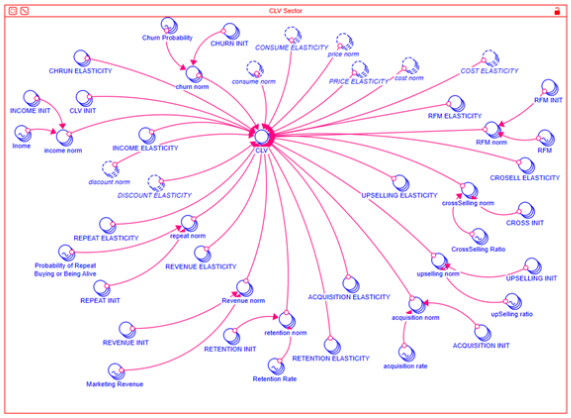


**Figure 6.** CLV proposed system dynamics model.

CRV is a function of many independent variables either related to the customer or his referred friend. Equation 17 formulated CRV as a function of all these factors (Figure 7).

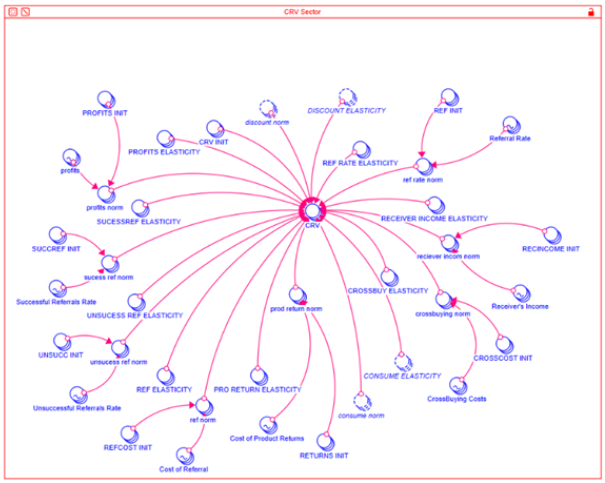


**Figure 7.** CRV proposed system dynamics model.

CIV depends on a set of factors that are related to spreading the Word of Mouth (WOM) from a customer within a network. It focuses on not only existing customers but also potential ones. WOM can be positive, negative or neutral. Hence accordingly, CIV can take positive, negative or zero values respectively (Figure 8).

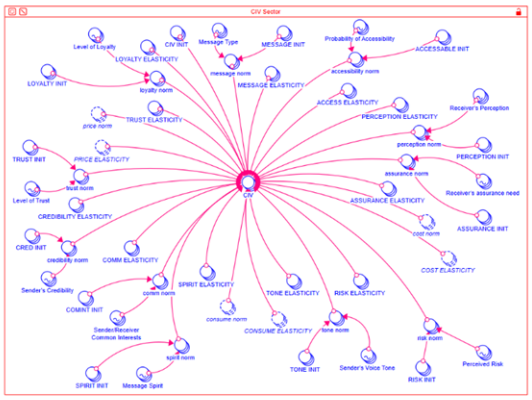


**Figure 8.** CIV proposed system dynamics model.

CKV focuses mainly on determining customers' possibility to give feedback to the firm that represents ideas for innovations and development. Figure 9 shows the relationship between CKV and its independent variables. All these parameters are dimensionless.

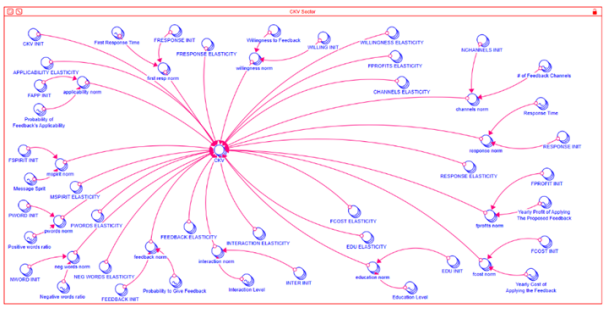

**Figure 9.** CKV proposed system dynamics model.

## Results and Discussion

This section introduces the experimental results of the proposed CEV's framework. It starts with presenting the online survey that is used to determine the elasticity values of CEV's non-linear model (subsection-4.1.). Then presenting system dyanmics model based on this non-linear model that drive the dynamics within CEV's system dynamics model (subsection-4.2.).

### Online survey

This single round survey consists of 73 questions that are formulated in two languages (*i.e.,* Arabic, and English). There are 1000 respondents filled this survey over around 14 days. The settings of this survey are presented in Table 3. This survey is created in Survey.com website. Figure 10 shows an example of first question of the survey in Both English (Figure 10a), Arabic (Figure 10b) languages. The Arabic version of the survey was filled by 84 respondents, while the English version was filled by only 16 respondents [23].

| Study's purpose | Determining elasticity values that maximize CEV |
|---|---|
| Number of Questions | 73 |
| Number of respondents | 100 |
| Study's duration | 2 Weeks |
| Number of rounds | 1 |
| Respondents Locations | Egypt |
| Consensus approach | Frequency of Agreement |
| Bias management | Anonymity |
| Survey's Languages | Arabic, English |

**Table 3.** CEV's online survey.

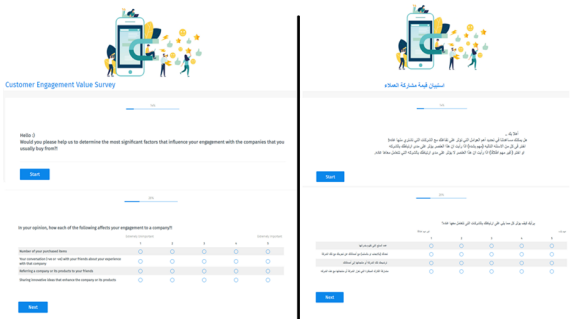


**Figure 10.** CEV's survey sample question.

As demonestrated in Figure 10, the choices of each question are discrete values range from 1 to 5, according to the importance of this factor in its corrresponding CEV's component. In case this factor is not importance, the expected selection is 1. While, if the factor has significant contribution in its corresponding CEV's component, the expected selection by the respondent is 5. The selected values are mapped to descritize elasticity fractions values. By this way, only finite values are stated to cover infinite possible elasticity values. This mapping is presented in Table 4. There are many benefits for this survey being online. The onling process makes it more automated, easy to apply, and efficient by saving time and cost [24].

| Survey Value | Elasticity Mapped Values |
|---|---|
| 1 | 0.01 |
| 2 | 0.3 |
| 3 | 0.5 |
| 4 | 0.7 |
| 5 | 1 |

**Table 4.** Elasticity values mapping.

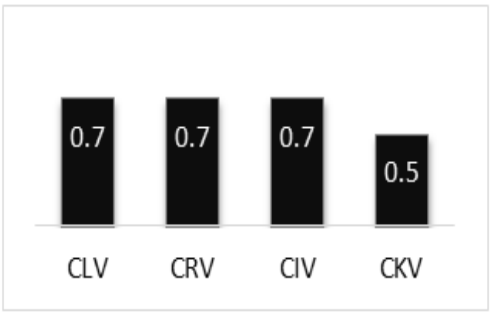


**Figure 11.** CEV's Related Indicators elasticity parameters values.

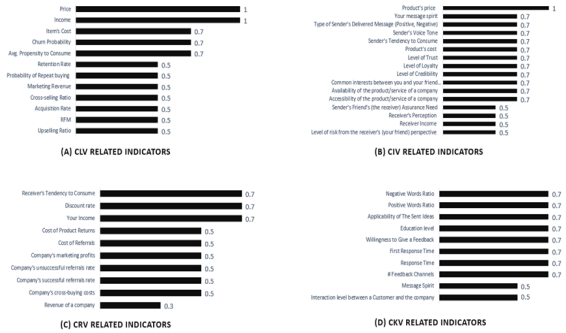


**Figure 12:** CEV's components' Elasticity Parameters.

## CEV's system dynamics model

The proposed system dynamics model is applied using Stella Profissional software program, version 2.2.1. The non-linear model drives its dynamics. The model runs over 1000 customers generated randomly follow normal distribution. Figure 13 presents the CEV's model [25]. While Figure 14 demonstrates the results of each CEV's component of running the model using Stella over those 1000 customers.

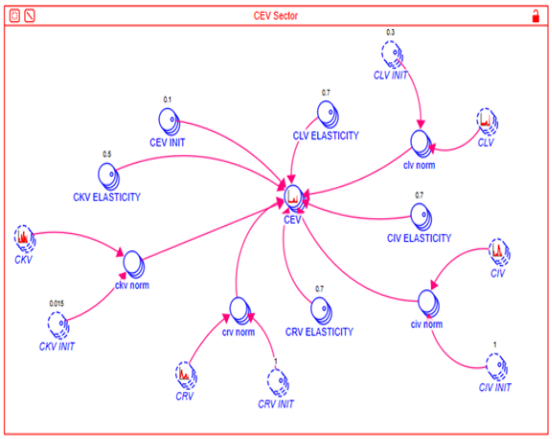


**Figure 13.** System dynamics model of each cev's component.

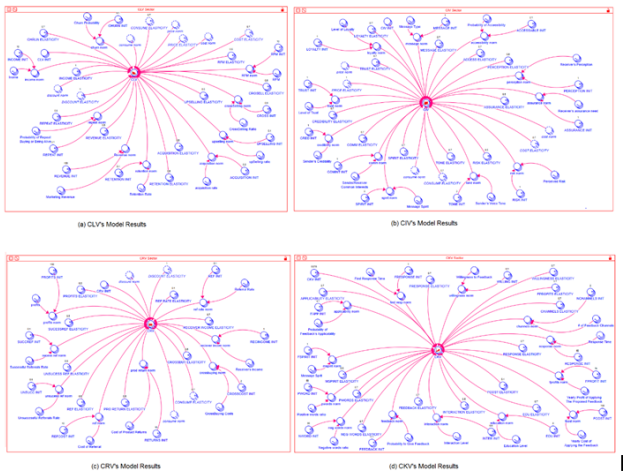


**Figure 14.** CEV's components SD results.

Figure 15 shows the results of the proposed CEV system dynamics model of two random customers over 24 months. Each month is respresented by a point on each trend. While, Figure 16 demonestrates the refliction of these components' values over CEV's value. The latter figure proves the significance of the non-purchaing components in CEV. The highest contribution is for CLV, yet the non-purchasing components still have remerkable effect in determining the value of CEV [26-29].

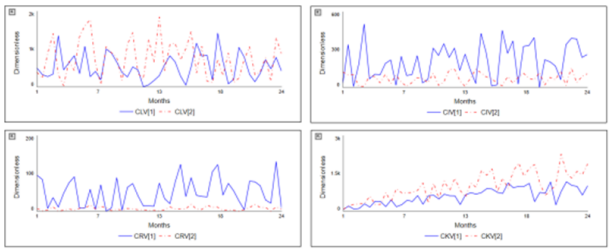


**Figure 15.** Purchasing and non-purchasing component's trends for a sample of two customers.

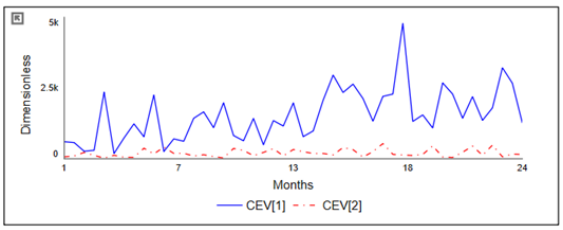


**Figure 16.** CEV's trend for two random customers.

# Managerial Implications

This section presents the managerial implications of the proposed framework. It is expected to have a set of advantages and benefits for managers and stakeholders. On top of these advantages is that it allows aboard and comprehensive view of the set of the most significant factors of CEV, and relate these factors in a cause and effect relationship. Consequently, empowers the decision-making process by a practical CEV's model. The second benefit of the proposed framework is simulating the complex and nonlinear

dynamic relationships of CEV's components. Third, this research helps in determining the effect of each factor in its corresponding purchasing and non-purchasing components. Fourth, it proves the significance of CLV in determining the level of engagement of each customer. Fifth, it highlights the significance of the non-purchasing components in CEV.

## Limitations and Future Work

The main limitation of the proposed framework is the restriction in the selected features. As it mainly focuses on the internal factors and excluded the external factors that may have a great effect on each of the CEV's components. Another limitation is that the proposed CEV system dynamics model is not applied to a real-life dataset to test its effectiveness. It was only applied to simulated data based on randomly generated data. As future work, other significant factors might be injected into this proposed framework. It also might be applied to real-life test cases to test its robustness in reality. Furthermore, an optimization algorithm might be used to determine the elasticity parameters. The values of these parameters might also be determined through a Delphi method.

## Conclusion

Customer engagement value is a crucial concept that measures the relationship between a firm and its customers. Consequently, the researchers competed in developing models that measured or simulated CEV. The previous models were either theoretical or depend on gamification concept. In this paper, a general-purpose system dynamics framework was developed to describe the relationship between CEV's components. It also listed the factors that each component depended upon. A non-linear model was formulated to describe the non-linear, and complex relationships between these components. This model was an input to the system dynamics model that also depended on a set of elasticity parameters that determined the effect of these factors. Those elasticity parameters were determined using an online survey. The proposed system dynamics model was implemented using randomly generated data for 1000 customers on Stella Professional software program. The proposed system dynamics model proved the significance of both purchasing and non-purchasing components of CEV for determining the level of engagement of each customer within a firm.

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