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Service design based on social simulation: An integrated experience mapping methodology considering customers and service providers

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Approaches using both real data and social simulations have been proposed to address economic and social problems. Understanding the structure of models and the results of simulations may be used by not only model developers and analysts but also by decision-makers in management and administration as well as on-site managers. Therefore, methodologies for extracting knowledge and insights from simulation log data and a framework for propagating the extracted knowledge and insights to stakeholders are important. In this study, we compare log analysis frameworks and create a formal description of social simulations for benefit-delay products and services to determine their merits, shortcomings, and limitations. Then, by extending an experience mapping method from a previous study, we propose a method for also describing a service provider's experience. We use this method to simulate pre- and post-retirement asset sustainability. The main findings are as follows: 1) an integrated experience description of the customer and provider sides of a benefit-delay service design is feasible, and 2) customer targeting based on this description is possible.

KEYWORDS

social simulation, simulation analysis, experience mapping methods, service design, life planning

1 Introduction

Approaches to designing products and services that use social simulation based on real-world data have recently been proposed. Yamada et al. used social simulation techniques to design services for introducing new equipment at airports [1, 2]. Kikuchi and Takahashi used social simulation based on large-scale questionnaire data to design financial services for life planning [3, 4]. These practical decision-making analyses are expected to contribute to efficient social and economic decision-making and product and service design. However, few studies have been conducted for products and services that require customers to wait a very long time to enjoy their benefits such as medical care, education, and asset formation (hereinafter, “benefit-delay services”) [5].

As product and service design using social simulation becomes more prevalent, understanding and interpreting its model structure and results will become more important for developers and analysts as well as decision-makers in management and administration and perhaps even for those in charge in the field of practice. Therefore, 1) methodologies for extracting knowledge and insights from simulation log data, and 2) a framework for propagating the extracted knowledge and insights among stakeholders are both necessary. To address this issue, an approach exists that attempts to analyze and formally describe simulation logs using the human-centered design concept [6–8] and the experience mapping method [9–11], both of which are used in design thinking [12–14]. Although this approach may facilitate communication between stakeholders, few studies have been conducted on “benefit-delay services.”

In this paper, we first compare frameworks for the log analysis and formal description of social simulations that contribute to product and service design to discuss their merits, shortcomings, and limitations. Then, by extending an experience mapping method previously proposed by the authors, we propose a new method for also describing a service provider’s experience. The proposed method enables an integrated experience description of both the customers and service providers of a benefit-delay service design and the development of a customer targeting strategy based on the resultant description. The main contributions of this paper are as follows: 1) The proposed method yields a description that may lead directly to the design of benefit-delayed services and products. 2) The proposed experience mapping methodology is capable of extracting knowledge that directly supports marketing measures and management decision-making. To demonstrate the proposed method, we use it to simulate pre- and post-retirement asset sustainability.

The proposed experience mapping method is based on the previous literature and satisfies the following requirements: 1) it expresses the customer’s perspective, 2) the content derived from the log analysis results is captured concisely in a single map without any need for special justification or explanation, 3) information that suggests the next design action is included, and 4) it also expresses the service provider’s perspective. Note that 1) through 3) were set according to [15], and 4) was added to contribute to benefit-delay product and service design. Our proposed methodology enables us to: (I) express the perspectives of both customers and service providers, (II) concisely represent simulation results on a single map, and (III) include information in the form of “solutions” and “boundaries” on the map to guide the next course of action.

The paper is organized as follows. [Section 2](#) introduces the previous literature, [Section 3](#) describes the methodology, [Section 4](#) describes the simulation model, [Section 5](#) provides a demonstration, and [Section 6](#) concludes.

2 Related work

2.1 Social simulation and results analysis

Social simulation is a social science that utilizes computer simulation to analyze social phenomena [16, 17]. There are many prior studies in the financial domain [18–22]. Many recent studies in the social simulation field have been grounded in real-world data [1–4]. The combination of retrospective data and computational modeling of future scenarios is expected to improve our understanding of ongoing social complexity [23].

Extensive research is being conducted to raise awareness and facilitate understanding among stakeholders regarding the results of social simulation runs and the structure of models. Depending on the granularity of the analysis, three types of knowledge can be extracted from simulation results: micro-level analysis [24], macro-level analysis [25], and meso-level analysis [26, 27]. In addition, a linguistic model has been proposed to formally describe the results of simulations targeting business organizations [28]. Examples of its application to the results of agent simulation runs also exist [29, 30].

However, few studies have been conducted on log analysis frameworks or formal descriptions of social simulations that relate directly to the design of benefit-delay services and products.

2.2 Experience mapping techniques

“Design thinking” has been attracting attention in the design of products and services [6–8]. As an observational method, experience mapping techniques such as the persona–scenario technique [9], the customer journey map [10], and the empathy map [11] are used to discover users’ latent needs.

The use of experience mapping may enable us to standardize the perceptions of stakeholders such as the developers and marketers of products and services. This method may also be a more effective means of facilitating communication among stakeholders, which is a problem encountered in the analysis of social simulation results as discussed in [Section 1](#) [12–14].

1) Persona–Scenario Method

The concept of “personas” is widely used in the fields of marketing and human-computer interaction [9, 31]. Personas are believed to promote the design of customer-oriented products and services. In the marketing field, personas create an image of a person based on clear and specific real-world data. This can improve the quality of decisions regarding product and service design for specific customer attributes.

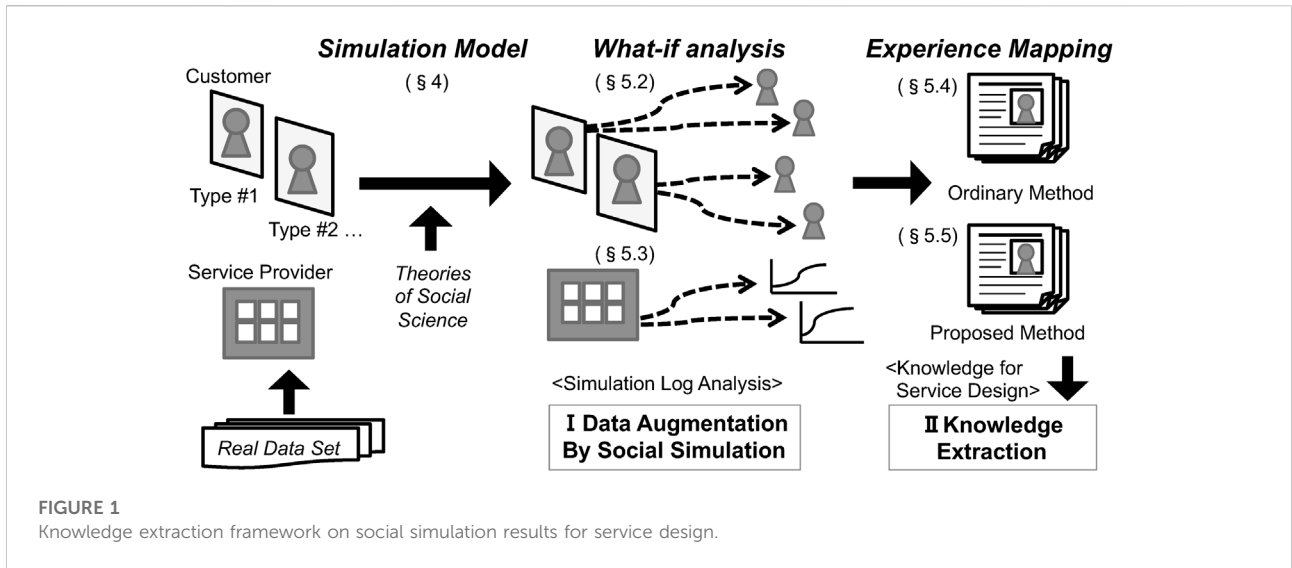


FIGURE 1 Knowledge extraction framework on social simulation results for service design.

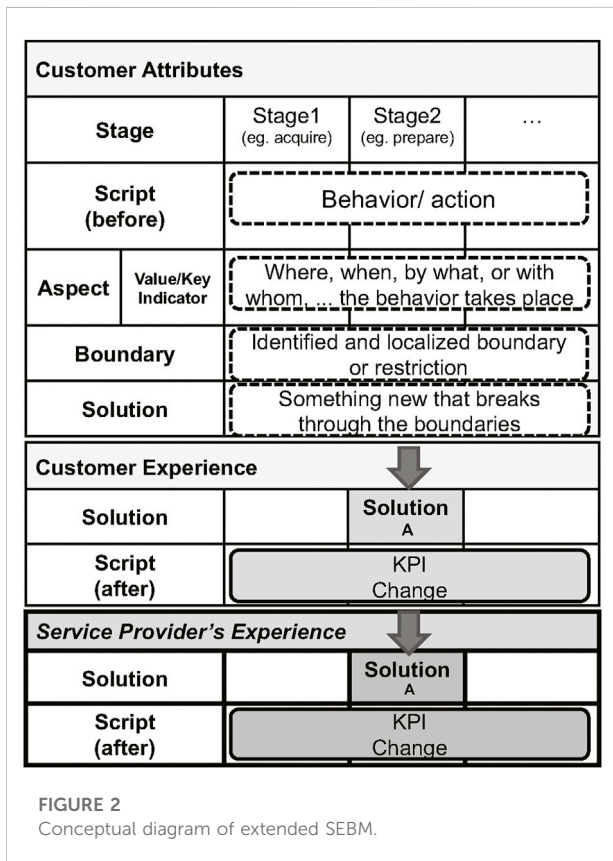


FIGURE 2 Conceptual diagram of extended SEBM.

2) Customer Journey Map

The customer journey map [10] is a visualization of customers' emotions, thoughts, and issues they may have by arranging actions related to products and services in

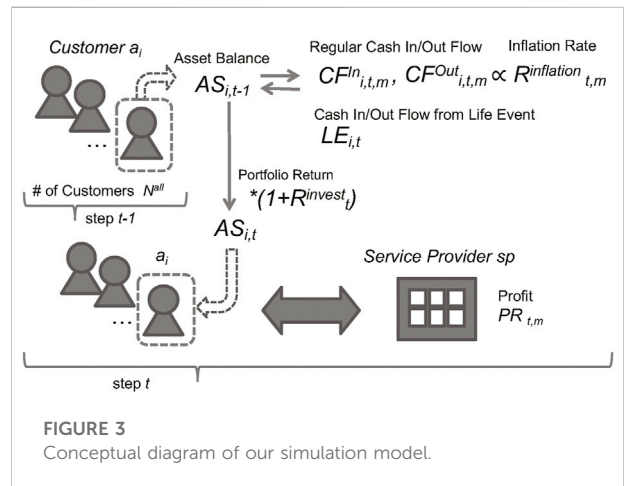


FIGURE 3 Conceptual diagram of our simulation model.

chronological order. This method is the most basic and widely used visual description method in service design.

3) System Experience Boundary Map (SEBM)

SEBM is an experience mapping model that formally describes the changes in a customer's experience prompted by new products and services resulting from business innovation [11]. An SEBM focuses more on user interface changes than user experience mapping methods such as the user experience map, mental model diagram, and customer journey map [11].

An SEBM describes changes in a customer's experience of an existing good or service due to the emergence of novel goods and services through the following three-step procedure [11]. 1) The stage–aspect decomposition of the

TABLE 1 Parameter settings and Customer's characteristics.

(1) Model parameter					
Attributes			Value		
Portfolio Return	Mean (μ), SD (σ)		6.37%, 18.0%		
Inflation Rate	Mean ($\mu^{inflation}$), SD ($\sigma^{inflation}$)		0.53%, 1.26%		
Number of Trials	K		10,000		
(2) Customer's Parameters and Characteristics					
Type	Attributes				Measures to Reduce the Depletion Rate
	Age	FA^{now}	FA^{future}	R^{risk}	
#1	57	40 m yen	25 m yen	25%	Asset succession
#2	72	40 m yen	None	0%	Curbing expenditure, Risk-taking
#3	67	40 m yen	None	0%	Curbing expenditure, Risk-taking
#4	57	40 m yen	None	5%	Risk-taking, Curbing expenditure, Postponement of retirement
#5	72	40 m yen	None	45%	Risk-taking
(3) Service Provider's Parameter					
Attributes			Value		
R^{trust}			0.1%		

characteristics of the experience into two axes: “Stage” and “Aspect”; 2) an extraction of the potential limits/constraints of the experience in each decomposed stage and aspect boundary; and 3) the description of the new behavior using the solution to the limits/constraints.

Through this three-step procedure, an SEBM describes customer experience changes in a table (i.e., an experience map) decomposed from certain perspectives. This experience map describes the constraints that exist for a customer in terms of when, where, and with whom it occurs, in addition to what kind of experience will be created by resolving these constraints [11].

2.3 Benefit-delay services

Customers receive benefits such as comfort and convenience as well as pleasure and enjoyment from using various services. Focusing on the benefits received by customers, Fujimura classified services according to *when* a customer enjoys their benefits [5]. Goods and services that allow customers to receive benefits while they use the service are called “benefit-immediate services.” Conversely, “benefit-delay services” are services for which the benefits are not necessarily enjoyed while they are being consumed because it takes time for a customer to receive the benefits.

Financial products and services for future life planning such as asset formation, insurance, and asset inheritance services are classified as benefit-delay services because the direct and essential

benefits may not be experienced by the customer for several decades.

In examining benefit-delay services, tracing the customer's experience until he or she receives the benefits is important. In addition, the sustainability of the product or service provider should be considered.

3 Methodology

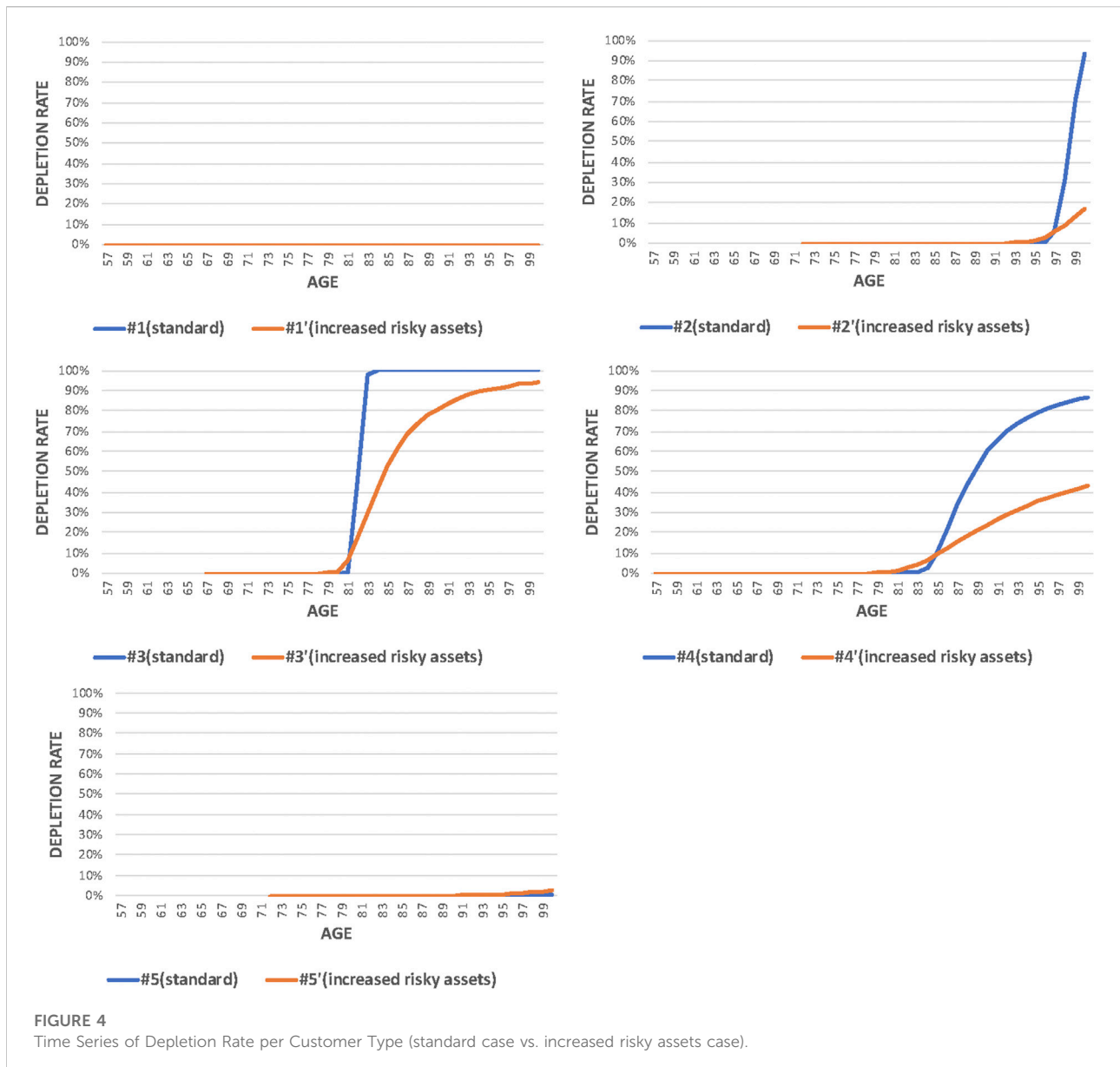
3.1 Knowledge extraction framework on social simulation results for service design

Our framework is designed to run simulations using real-world data on customer attributes to evaluate measures to increase the sustainability of customers' retirement assets using data and simulation results [12–14]. Figure 1 depicts an overview of the proposed framework. Our framework consists of the following two procedures:

I) Data augmentation using social simulation: Real-world data and simulation logs/paths are integrated and treated as augmented customer and service provider attribute data.

II) Knowledge extraction from augmented data: From the augmented data, knowledge about the sustainability of assets for each customer and about the business conditions of the service provider are extracted and described for service design by the experience mapping techniques.

Real-world data consist of large survey data that reflect various customer attributes (Section 5.1). We use cross-

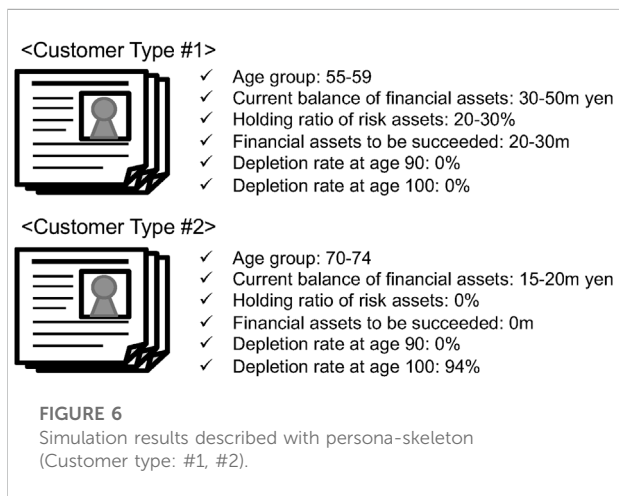
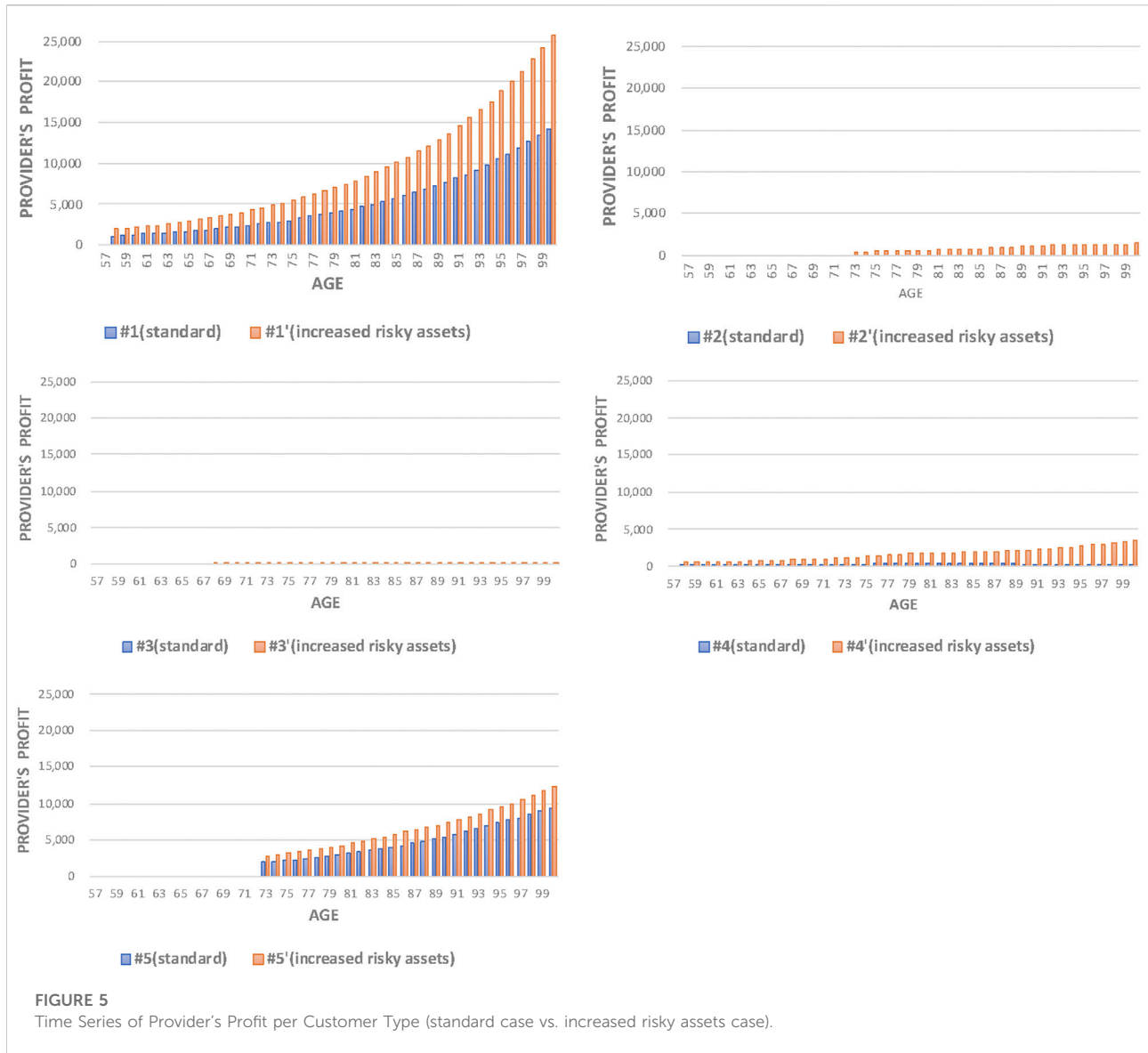


sectional data from individual questionnaires [3] and construct a social simulation model based on finance theory [32, 33] (Section 4) that addresses asset formation in retirement while considering asset succession and risky asset price fluctuations. Based on the model, simulations are run to conduct a “what-if” analysis of a customer’s asset and service provider’s sustainability (Sections 5.2, 5.3). The future asset depletion rates of customers and profits of service providers as obtained from the simulation results, are treated as augmented data for the original questionnaire data. Finally, the results are represented using ordinary and

the proposed experience mapping techniques [9–11] (Sections 5.4, 5.5).

3.2 Extended SEBM method

To represent an experience that integrates both the customer and service provider perspectives on benefit-delay services, we propose an experience mapping method that extends the SEBM model [11], as described in Section 2.2.



The extended version of the SEBM method consists of three main parts: the upper, middle, and lower parts (Figure 2). The upper part expresses customer attributes and corresponds to the “Stage” and “Solution” in an SEBM. The middle part represents the customer experience and illustrates the changes in the customer’s experience and script when a customer chooses one of the solutions indicated in the upper part. This can be interpreted as the result of the what-if analysis when one of several possible options is chosen. Then, the script (after) describes the changes in key performance indicators (KPIs) on the customer side. The lower part expresses the experience of the product or service provider. When a customer chooses a certain solution, it shows how the KPI of the entity that provides the solution changes in response to a change in the customer’s “Stage.”

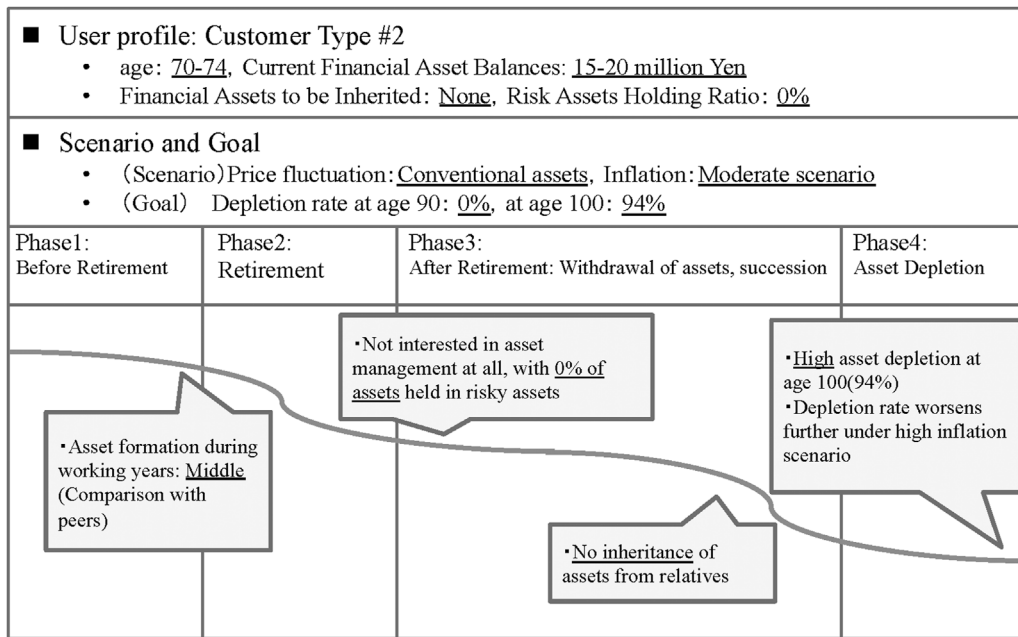


FIGURE 7 Simulation results described with Customer journey map (Customer type: #2).

	Stage		Script (before)	Aspect	Boundary	Solution	Script (after)
				Value/ Key Indicator			
Customer Experience	At Work	Asset Formation (age: 55-59)	Increase asset balances with employment income	Stock: 15-20 [mYen]	-	-	Same as before
	Retire	Retirement (age: 60)	Shift to asset withdrawal stage	-	-	-	Same as before
	Post-Retire	Asset Withdrawal (age: 60-)	Withdraw assets according to asset class	Flow: ▲0.615 [mYen/year]	Deterioration of Net income	Curbing spending	Reduce amount of withdrawal
		Investment (age: 60-)	Asset management according to the risk assets held	Holding Ratio: 0%	Loss of reproductive opportunities, Inflation tolerance: Low	Increase in the percentage of risk assets held	Asset management by increasing amount of risk assets held
		Asset Succession (age: 70)	Receiving succession of assets from relatives	Flow: +0 [mYen]	-	-	Same as before
	Asset Depletion (age:90/100)	Possibility that asset balance will become negative	Depletion Ratio: 0% / 94%	-	-	Reduces possibility of negative asset balances	

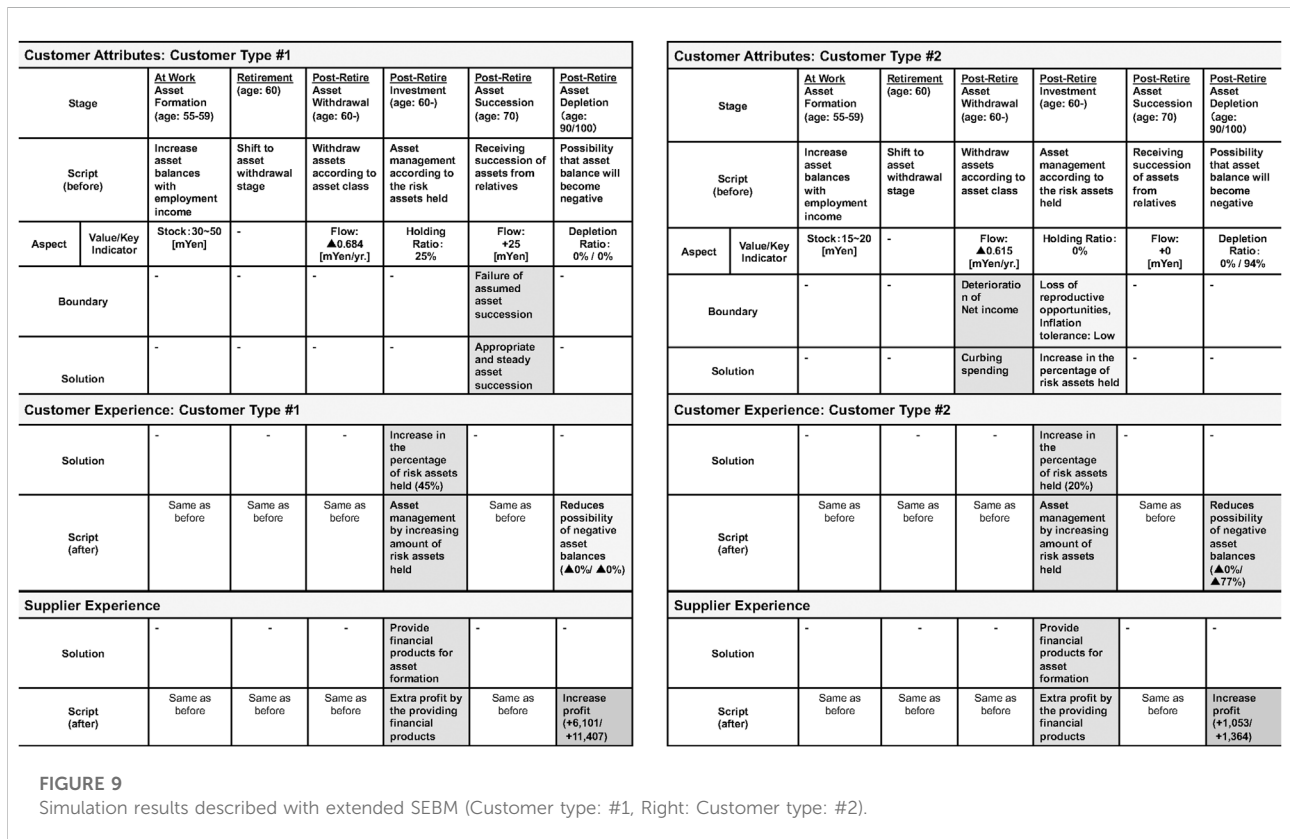
FIGURE 8 Simulation results described with SEBM (Customer type: #2).

The extended version of the SEBM model represents and integrates the experiences of both the customer and service provider. From the product or service provider perspective,

the SEBM framework facilitates decision-making when targeting customers by comparing and considering customer-side and service provider-side KPIs.

TABLE 2 Pros and cons of ordinary experience mapping methods.

	Persona-scenario method	Customer journey map	SEBM
Pros.	<ul style="list-style-type: none"> Leaves little room for interpreting the results Allows data expansion through simulation 	<ul style="list-style-type: none"> Expresses the thoughts and feelings of customers and handles customer experience holistically 	<ul style="list-style-type: none"> Able to depict changes in the customer experience in a single map
Cons.	<ul style="list-style-type: none"> Provides only static information for a certain cross-section Unable to express both customers' thoughts and feelings and service providers' perspectives 	<ul style="list-style-type: none"> Provides only static information for a certain cross-section Unable to express the service provider perspective 	<ul style="list-style-type: none"> Unable to express the thoughts and feelings of customers Limits the perspective of the service provider



4 Simulation model

In this section, we describe the social simulation model used in this study, which is extended on our previous studies [3, 4]. Section 4.1 provides an overview, and Sections 4.2, 4.3 introduce the model components: namely, the customer and the external environment. Sections 4.4, 4.5 describe customer cash flows and the rules for asset formation and withdrawal. Finally, we explain the model's macro indicators: namely, the rate of asset depletion (customer-side KPI, Section 4.6) and the service provider's revenue (provider-side KPI, Section 4.7).

4.1 Outline

We develop a computer simulation model that represents a customer's asset formation and withdrawal before and after retirement as well as the earnings of financial service providers (Figure 3).

To illustrate the proposed model, we simulate a customer's asset situation at a future point in time, accounting for asset succession and price fluctuations of risky assets. Each customer in the model exhibits a specific asset balance at a certain age. According to the customer's status, he or she exhibits both regular income and expenditures (i.e., cash inflow and

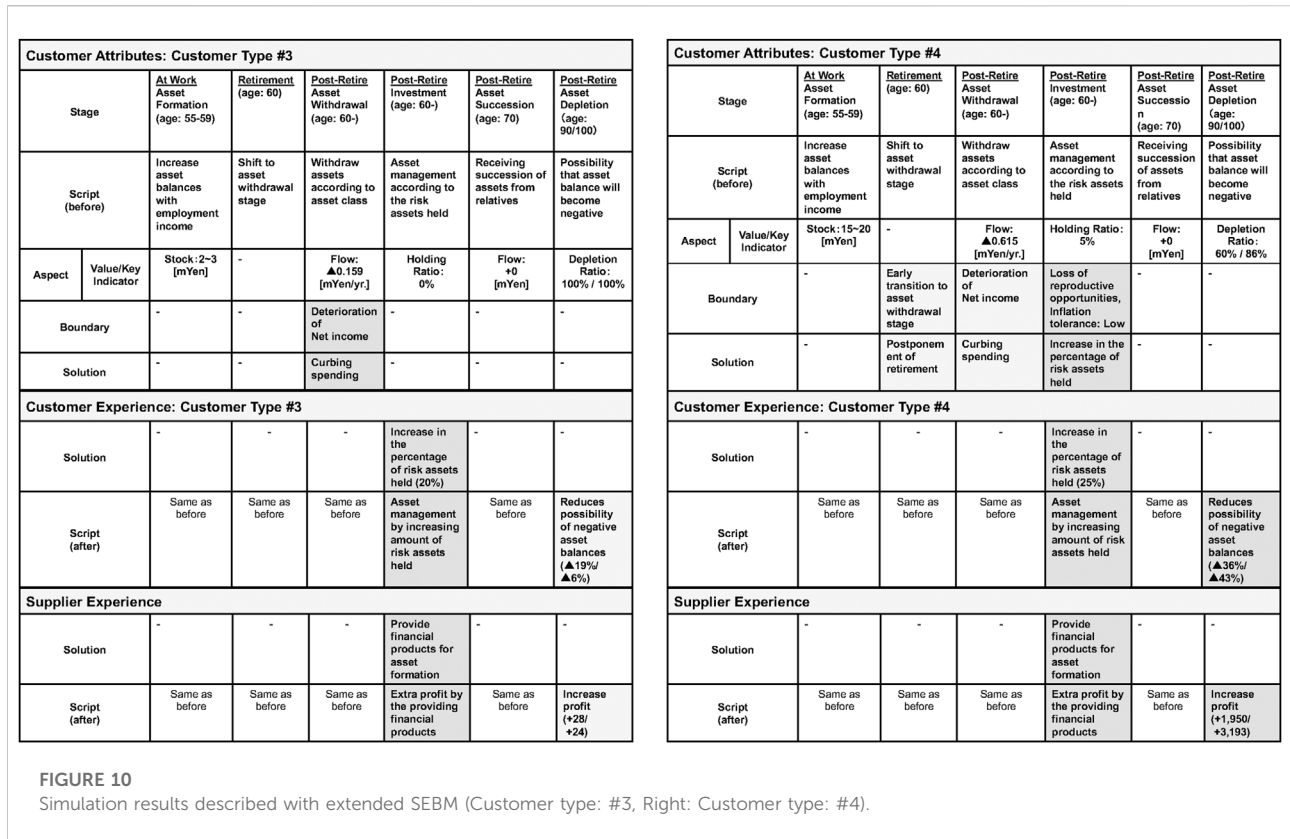


FIGURE 10 Simulation results described with extended SEBM (Customer type: #3, Right: Customer type: #4).

outflow) and unexpected income and expenditure, depending on his or her life events like asset succession, before and after retirement. Each customer’s characteristics are expressed statistically. We perform what-if analysis by manipulating the customer attributes to examine their decision-making in response to the implementation of a particular policy. The service provider, which is an asset management company, provides financial products to its customers and earns income from the fees that it charges.

Each customer’s assets include cash, deposits, and risky assets. Risky assets are fully invested in a portfolio of traditional assets and provide returns that are proportional to the portfolio’s risks. Regular income and expenditures are adjusted to account for inflation. The external environment comprises the inflation rate and the portfolio’s risk–return profile of each customer, as further described below. The service provider earns fee income proportional to the customer’s risk asset balance.

4.2 Customer

Let A be the set of customers, and $\#A = N^{all}$. Customer a_i exhibits the following attributes at step t of the simulation: age ($age_{i,t}$), retirement age ($age_i^{retired}$), cash and deposit balance ($CA_{i,t}$), risk asset balance ($RA_{i,t}$), cash inflow ($CF_{i,t}^{In}$), cash

outflow ($CF_{i,t}^{Out}$), cash flow from life events ($LE_{i,t}$), and total asset balance ($AS_{i,t} = CA_{i,t} + RA_{i,t}$).

$$A = \{a_i = (i, age_{i,t}, age_i^{retired}, CA_{i,t}, RA_{i,t}, CF_{i,t}^{In}, CF_{i,t}^{Out}, AS_{i,t}, LE_{i,t})\}$$

Age is expressed as follows:

$$age_i \in \{age_{i,0}, age_{i,0} + 1, \dots, age_i^{retired}, \dots\}$$

In the simulation time step, a single step represents 1 year in real time.

4.3 External environment

The return of portfolio j and the inflation rate are generated in a time series using a Monte Carlo simulation as follows, where K denotes the number of trials.

Annual portfolio return is expressed as follows:

$$R_t^{invest} = X_{1,t} \sigma + \mu.$$

The annual inflation rate is given as follows:

$$R_t^{inflation} = \left(\rho X_{1,t} + \sqrt{(1 - \rho^2)} X_{2,t} \right) \sigma^{inflation} + \mu^{inflation},$$

where σ represents the risk of a portfolio, μ represents a portfolio's expected return rate, $\sigma^{inflation}$ denotes the standard deviation of the inflation rate, $\mu^{inflation}$ denotes the expected inflation rate, and ρ represents the correlation coefficient between the portfolio and inflation rate. $X_1, X_2 \sim N(0, 1)$, and $cov[X_1, X_2] = 0$.

The cumulative value, IRC , of the inflation rate, referred to as the cumulative inflation rate, is expressed as follows:

$$IRC_t = IRC_{t-1}(1 + R_t^{inflation}), IRC_0 = 1.$$

4.4 Cash inflow/outflow

Retirement cash inflows and outflows, CF , at step t are determined by considering the asset class to which customer i belongs and the cumulative inflation rate as follows:

$$CF_{i,t}^{In} = CF_{i,0}^{In}(1 + IRC_t)$$

and

$$CF_{i,t}^{Out} = CF_{i,0}^{Out}(1 + IRC_t).$$

To keep the estimated possibility of withdrawals conservative, the net cash flow before retirement is set to zero.

4.5 Asset formation and withdrawal rules

The cash and deposit balance and risk asset balance at each simulation step are varied according to the following rules. This expresses the preferential withdrawal of highly liquid cash and deposits in the asset withdrawal stage.

If

$$CA_{i,t} + CF_{i,t}^{In} - CF_{i,t}^{Out} \geq 0$$

then

$$CA_{i,t+1} = CA_{i,t} + CF_{i,t}^{In} - CF_{i,t}^{Out} + LE_{i,t}$$

$$RA_{i,t+1} = RA_{i,t}(1 + R_t^{invest})$$

else

$$CA_{i,t+1} = CA_{i,t} + LE_{i,t}$$

$$RA_{i,t+1} = RA_{i,t}(1 + R_t^{invest}) + CF_{i,t}^{In} - CF_{i,t}^{Out}$$

4.6 Asset depletion rate

For K trials, the number of times that the asset balance becomes negative at age τ is denoted by $K^{shortage}$, and the asset depletion rate (hereafter, the depletion rate) is expressed as follows:

$$R_{i,\tau}^{shortage} = K_{i,\tau}^{shortage} / K.$$

4.7 Service Provider's profit

The service provider, sp , exhibits the following attribute at step t of the simulation: profit PR_t . The service provider's revenue is assumed to be equal to the fee income derived from the risky assets held by its customers. R^{trust} is assumed to be the asset manager's trust fee ratio.

$$PR_t = \sum RA_{i,t} R^{trust}$$

5 Demonstration

5.1 Simulation settings

In this section, we describe the model parameters, customer attributes, and service provider attributes for running the simulation.

First, the parameters for the external environment, such as portfolio risk-return and inflation rate, are empirically parameterized by referring to previous studies [3]. Next, we discuss the client attributes and parameters. Referring to previous studies [3], we use the results of clustering individual questionnaire data and classifying respondents into several types. The questionnaire is unique in that it comprehensively examines each individual's asset situation (current asset balance and expected income and expenditure in retirement) as well as asset balances inherited from relatives and investment pRef. [34]. Respondent attributes used are age, current financial asset balance (FA^{now}), financial asset balance to be inherited (FA^{future}), and percentage of risk assets held (R^{risk}). In addition, measures that could reduce the asset depletion rate for each client type are also analyzed [3]. Finally, with respect to the service provider parameter, the trust fee rate is set with reference to the prevailing value.

Table 1 summarizes the above discussion. The simulation will be performed with these settings from now on. Note that the other model parameters are as follows: $age_i^{retired} = 60$, the actor's age at which a life event occurs: $age_{i,t} = 70$, $LE_{i,t} = FA_i^{future}$. The correspondence with the model described in Section 4 is as follows: $N^{all} = 5$ (Customer Type #1-#5), $CA_{i,0} = FA_i^{now} * (1 - R_i^{risk})$, $RA_{i,0} = FA_i^{now} * R_i^{risk}$, $CF_{i,0}^{Out} - CF_{i,0}^{In} = CF_i^{net}$. Then, the value of CF_i^{net} is set with reference to macro-statistical data [35].

5.2 Simulation results (1): What-if analysis of asset depletion rate for each customer

Based on the simulation settings, we set the attributes of the customers and simulated the depletion rate in the future. Then, we performed what-if analysis, increasing the risk assets

Customer Attributes: Customer Type #5							
Stage		At Work Asset Formation (age: 55-59)	Retirement (age: 60)	Post-Retire Asset Withdrawal (age: 60-)	Post-Retire Investment (age: 60-)	Post-Retire Asset Succession (age: 70)	Post-Retire Asset Depletion (age: 90/100)
Script (before)		Increase asset balances with employment income	Shift to asset withdrawal stage	Withdraw assets according to asset class	Asset management according to the risk assets held	Receiving succession of assets from relatives	Possibility that asset balance will become negative
Aspect	Value/Key Indicator	Stock:30~50 [mYen]	-	Flow: ▲0.684 [mYen/yr.]	Holding Ratio: 45%	Flow: +0 [mYen]	Depletion Ratio: 0% / 1%
Boundary		-	-	Deterioration of Net income	Loss of reproductive opportunities, Inflation tolerance: Low	-	-
Solution		-	-	Curbing spending	Avoid excessive risk to prevent price fluctuations	-	-
Customer Experience: Customer Type #5							
Solution		-	-	-	Increase in the percentage of risk assets held (65%)	-	-
Script (after)		Same as before	Same as before	Same as before	Asset management by increasing amount of risk assets held	Same as before	Increase possibility of negative asset balances (+0%/ +2%)
Supplier Experience							
Solution		-	-	-	Provide financial products for asset formation	-	-
Script (after)		Same as before	Same as before	Same as before	Extra profit by the providing financial products	Same as before	Increase profit (+1,976/ +2,981)

FIGURE 11 Simulation results described with extended SEBM (Customer type: #5).

of the customers. The customer attributes in Table 1 are used, and R^{risk} is set to +20% for each customer type. Next, we simulated the depletion rate in the future (Figure 4). The time series of depletion rates for each customer type is shown as blue lines for the standard case and orange lines for the case of increased risky assets.

5.3 Simulation results (2): What-if analysis of asset depletion rate for service provider

In addition, we simulated the service provider’s profit in the future (Figure 5). Then, the time series of the service provider’s profit for each cluster is shown in blue bars for the standard case and orange bars for the case of increased risky assets.

5.4 Knowledge extraction using ordinary experience mapping methods

5.4.1 Formal description using a persona-scenario method [12, 13]

The following simulation results are formally described using ordinary experience mapping techniques. First, we used a persona–scenario method [12, 13].

Figure 6 illustrates the contents of Table 1 and Figure 4 in the form of a persona skeleton. From the original questionnaire, the attributes “Age group,” “Current balances of financial assets,” “Holding ratio of risk assets,” and “Financial assets to be succeeded” were selected and described as the attributes obtained by clustering method. The statuses “Depletion rate at age 90” and “Depletion rate at age 100” were selected and described from the simulation results.

The advantage of using the persona scenario method of formal description is that it allows us to observe and compare differences in attributes and conditions among customer types, including simulation results, with little room for interpretation. On the other hand, the limitation exists that only static values are entered for a given cross-section.

5.4.2 Formal description using a customer journey map [13]

Second, we used a customer journey map to formally describe the simulation results [13]. Figure 7 depicts the contents of Table 1 and Figure 4 in the form of a customer journey map, illustrating Customer Type # 4 as a sample.

The “User Profile” part describes the attributes obtained from the original questionnaire by the clustering method. The “Scenario and Goal” part displays the various assumptions made in the simulation and the results of the simulation. In the “Phase” part, the simulation period is divided into four phases according to the customer’s condition. After that, we summarized the changes in the balance of assets held as well as the customer’s status in each phase. Furthermore, in the balloon in the figure, we filled in the status of the customer based on the simulation results. Discussions between stakeholders can also be used to describe the thoughts and feelings of the target customers and users. In this way, a formal description of the simulation results using a customer journey map demonstrates the advantage of allowing the customer or user’s perspective to be expressed.

5.4.3 Formal description using an SEBM [14]

Third, we used an SEBM to formally describe the simulation results [14]. Figure 8 illustrates the contents of Table 1 and Figure 4 in the form of an SEBM. We illustrate Customer Type #2 case in this section as a sample.

First, the “Stage” part of Figure 8 represents the customer’s state changes in the simulation (At Work, Retire and Post-Retire). The “Aspect” part represents key indicators related to the simulation, corresponding to the behavioral variables of the simulation. These include simulation default settings, customer attributes, and macro variables obtained in the simulation results. By depicting the contents of Table 1 and Figure 4, it is possible to represent customer attributes at the start of the simulation (Asset Balance, Cash Flow, and Risky Assets Holding Ratio) and expected future attributes (“Depletion Ratio at age 90” and “Depletion Ratio at age 100” in Figure 8). However, the information obtained from this part is static (i.e., it is snapshot-like).

Next, the “Solution” part of Figure 8 corresponds to the measures to reduce the depletion rate for each customer type listed in Table 1. The “Script (after)” part then expresses how the simulation results change when depletion rate reduction measures are adopted. Thus, we can depict the dynamic transformations in user experience in a single map. An SEBM also enables us to compare “as-is” and “to be” scenarios by

capturing information that leads the next design actions, such as how to improve countermeasures for each customer type. Conversely, the inability to express the thoughts of customers and users indicates room for improvement in service and product design. Furthermore, there are limitations in expressing the perspective of the service provider side.

5.4.4 Pros and cons of ordinary experience mapping methods

Based on Sections 5.4.1, 5.4.2, 5.4.3, we discuss the pros and cons of ordinary experience mapping methods. The persona–scenario method features the following advantages: 1) it leaves little room for interpreting the results, and 2) it allows data expansion through simulation. However, it features the disadvantages of providing only static information for a certain cross-section and not being able to express both customers’ thoughts and feelings and service providers’ perspectives. The customer journey map expresses the thoughts and feelings of customers and handles customer experience holistically. However, like the persona–scenario method, the customer journey map features the disadvantages of providing only static information for a certain cross-section and not expressing the service provider perspective. An SEBM provides dynamic information by comparing before and after scripts from the viewpoint of the type of solution could solve each customer’s boundary. In other words, it is able to depict changes in the customer experience in a single map. However, it has the disadvantages of being unable to express the thoughts and feelings of customers and limiting the perspective of the service provider.

Ordinary experience mapping methods have both advantages and disadvantages (Table 2). We emphasize the main advantage of an SEBM—namely, that changes in user experience can be depicted in a single map—and propose an extended formal descriptive model based on the SEBM model. The extended SEBM model represents an experience that integrates both the customer and provider perspectives, as described in Section 3.2.

5.5 Knowledge extraction using the proposed experience mapping method: The extended SEBM method

In this section provides a formal description of the simulation results using the extended SEBM framework. Figures 9, 10, 11 describes the contents of Table 1 and Figures 4, 5.

Figure 10 (Right) maps the simulation results for Customer Type #4, which demonstrates a low percentage of risky assets (5%) (Table 1) and a low tolerance for inflation. Customer Type #4, as a “Solution,” should take appropriate risks to hedge inflation (Table 1). If the customer takes measures that are consistent with the “Solution” (risky assets +20%), the depletion rate at ages 90 and 100 will be reduced by 36% and 43%, respectively (Figure 4). At this time, the additional profit to the service provider is + 1,960 and +

3,193, respectively, thereby ensuring an increase in revenue (Figure 5). Figure 10 depicts a map of these results. In this case, the depletion rate is significantly improved for the customer, and the service provider increases its revenue correspondingly. Therefore, it is reasonable for the service provider to target Customer Type #4 as a marketing strategy.

Similarly, Figure 9 (Left) maps the simulation results for Customer Type #1. Here the “Solution” should be to provide appropriate asset succession; however, inconsistent measures are taken to improve the proportion of risky assets. Thus, the service provider’s revenue increases, but the customer depletion rate does not increase. Targeting Customer Type #1 is a measure that only improves the service provider’s experience.

Figure 10 (Left) maps the simulation results for Customer Type #3. Here, the “Solution” should reduce spending, but inconsistent measures are taken to increase the share of risky assets. Although the customer depletion rate increases slightly, the increase in the service provider’s revenue is limited. Targeting Customer Type #3 provides limited improvement in the experience of the customer and the service provider.

Figure 9 (Right) maps the simulation results for Customer Type #2. Here, as in Customer Type #4, the “Solution” and measures are consistent, and the customer depletion rate increases significantly, especially at age 100. In addition, the revenue of the service provider increases significantly. Targeting Customer Type #2 is a measure that improves the experience of both the customer and the service provider.

Figure 11 maps the simulation results for Customer Type #5. Here, the “Solution” should reduce the amount of risk required to decrease the price volatility of risky assets; however, the exact opposite measure is taken by increasing the proportion of risky assets. Although the service provider’s revenue increases, the client depletion rate decreases slightly, especially at age 100. Targeting Customer Type #5 is a measure that worsens the customer’s experience and should be avoided.

The extended version of the SEBM method integrates both the customer and provider experiences. From the viewpoint of a product/service provider, the SEBM framework facilitates decision-making regarding targeting customers by comparing and evaluating KPIs on the customer and provider side.

The extent of achievement of the requirements described in Section 1 is as follows. The extended SEBM model is able to 1) express the customer’s perspective, 2) depict simulation results concisely in a single map, 3) include information in the map that guides the next actions in the form of “solutions” and “boundaries,” and 4) express the perspective of the service provider.

6 Conclusion

This study compares frameworks for log analysis and formal description of social simulations that contribute to

product and service design and discusses their merits, shortcomings, and limitations. We propose an experience mapping method by extending an ordinary method that is also describes the service provider’s experience. We illustrate this method by using it to simulate pre- and post-retirement asset sustainability. The proposed method is capable of 1) describing the integrated experience of both the customers and providers of a “benefit-delay service” design and 2) enabling customer targeting based on this description.

The main contributions of this paper are as follows: 1) The proposed method yields a description that may lead directly to the design of benefit-delayed services and products. 2) The proposed experience mapping methodology is capable of extracting knowledge that directly supports marketing measures and management decision-making.

We plan to expand the scope of SEBM-related case studies and demonstrations in a future work.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

TK is employed by Mitsubishi UFJ Trust and Banking Corporation.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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