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Application of System Dynamic Approach for Family Takaful Product Analysis

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ABSTRACT

Takaful, the Islamic alternative to conventional insurance, is based on the concept of social solidarity, cooperation and mutual indemnification of losses of members. The 'transparency' offered in the Takaful system will eliminates the elements of gharar (uncertainty), maisir (gambling) and riba (usury). Due to the dynamicity and complexity of cash flows in the Takaful system, the application of system dynamic approach is used in order to discover any possible internal and external impacts in the assumptions used in determining contributions rate from the participants. The traditional approach, which is the deterministic approach, has limitations where changes of the actual experience may cause operators to stop issuing the contract or product. Using system dynamic, these possible effects from the actual experience can be determined in terms of the amounts transferred to shareholder's fund and results obtained can assist the management to decide which assumptions to be used so that the operators will continue solvent and making profit at the same time. The results of System Dynamic simulation analysis in this paper represent the impacts of component changes in the Takaful model. The results can be used as decision tools for the Takaful operators to determine the best assumptions and strategies in order to maximise their profits.

Keywords: Actuarial Science, System Dynamic, Insurance, Takaful

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INTRODUCTION

Takaful, the Islamic alternative to conventional insurance, is based on the concepts of social solidarity, cooperation and mutual indemnification of losses of members. It is a pact among a group of persons who agree to jointly indemnify the loss or damage that may inflict upon any of them, out of the fund they donate collectively.

This fund is being managed by the Takaful operator. It is widely understood that the participants consider each other as a "family member" and that each and every one pools together in times of loss. In the event of a loss, the operator will pay out the specified amount to the respective participants. Should there be any surplus, it will be distributed to all its participants. This proves that the Takaful operator only works as a fund manager, or a protection and profit sharing venture between the operator and participants.

At the moment, there are fifteen Takaful operators in Malaysia, consisting of two retakaful operators, five foreign Takaful operators, and eight local Takaful operators. Since the endorsement of the Takaful Act in 1984, the Takaful industry has increased significantly, with an annual growth of 27% in assets and a net contribution increase of 19%. All these were evident from the years 2003 to 2007. This rapid change in the Takaful industry has made the Takaful operators to re-evaluate and study the product features to make it more competitive in the market.

One of the tools available to re-evaluate and study the Takaful product features and assumptions is the system dynamic approach. System dynamics is a computer-based model that specially designed to solve looping cases. A dynamical system is a function with an attitude that tends to do the same thing over and over again and it can estimate the next steps well. This system dynamic model tells us how the behaviour of the system results from the interactions of its component parts. This model combines both qualitative and quantitative aspects and aims to enhance the understanding of the complex systems to gain insights into the system behaviour (Srijariya, Riewpaiboon, & Chaikledkaew, 2008).

The research focuses on the applicability of the system dynamic in order to discover the possible impact in the assumptions used in determining contributions rate from the contract holder. The operation of the cash flows from the participants within the Takaful model or system is a dynamic and complex system due to many inter-related factors such as management expenses, investment earns, death claims, withdrawal claims, economic factors and also competitions among other Takaful operators. By using the traditional pricing methods in the Family Takaful product (premium for life insurance), decision makers for Takaful product development who may be the appointed actuary or members from the top management of the Takaful operator need to do more study on each variable or factor to gain a better understanding of the impacts of the pricing and operational strategy.

The scenario now is that the components in the Takaful model have been changing due to the impacts of economic condition of the country, as well as the policy intervention of Malaysian central bank, Bank Negara Malaysia (BNM). As a result, more Takaful licenses are issued to the industry and with the entrance of new competitors into the industry, the level of industry competitiveness has increased as well. The consequences of those changes could hurt the Takaful operators where the possibility of a large-scale loss to the Takaful operators may occur when issuing a new Takaful product.

The traditional pricing method approved by the appointed actuary of the Takaful operators may be sufficient to help the Takaful operator to remain solvent. However, any other changes that arise in the industry would give an impact to the product, perhaps benefiting the customers but may not be beneficial to the Takaful operator. Since the word 'Takaful' represents the

Islamic insurance system, it is crucial for the Takaful operators to able to produce a product that is fair and profitable for both parties, namely the Takaful customers and Takaful operators.

The perspective of the Takaful system has never been viewed from a dynamic system perspective. The study provides an opportunity to explore and exploit the dynamicity in the Takaful system using the system dynamic approach. A system dynamic model can be used to visualise any possible impact arising from the changes in economic condition, policy, behaviour of the policy holders and other changes that could give significant impacts to the profitability of the products of the Takaful operators. However, the traditional methods are not able to view this dynamicity and thus limits the capability of the Takaful operator to gain a good understanding of the bigger picture of the opportunity to perform Takaful product pricing. It seems that system dynamics can be used as an alternative approach to visualise all impacts arising from the changes of each component in the Takaful system and will act as decision support information for the pricing of Takaful products.

Some examples of possible changes that may give impacts to the Takaful model are increases in death claims, increases in withdrawal claims when the participants switch to another Takaful operator, unfavourable economic condition that will result in lower investment earnings from the expected and also high management expenses due to inflation. It is difficult to get a clear picture of the combined effects of the components due to the complexity and dynamicity of the Takaful system. The detailed Takaful model will be presented in the subsequent section. Each component of the model has a complex interconnection and relationship with other external factors and it can be further enhanced by using the system dynamic approach. In this study, system dynamic is used to model the components, factors and units in the Takaful model.

This study focuses on applying the system dynamic model in the Takaful model as an extension of the traditional approach of pricing. In general, this study provides an extra step to re-evaluate the pricing of family Takaful product and ensure sustainability and profitability of the product in the market. On a more specific term, this study contributes towards offering the decision makers of Takaful operators the opportunity to explore new methods in making better decisions within their scope of work. These decisions made may be crucial in order to meet the objectives of the Takaful operators. The simulation model developed from system dynamic approach can provide insight or visualisation into the impacts of any changes in the component of the model, which can be the translated into decisions that should be done by the Takaful operators.

Introduction to System Dynamic

System Dynamics is a computer-based model especially to solve looping cases. A dynamical system is a function with an attitude that tends to do the same thing over and over again and can estimate the next steps well. This system dynamic model tells us how the behaviour of the system results from the interactions of its component parts. This model combines both qualitative and quantitative aspects and aims to enhance the understanding of complex systems to gain insights into system behaviour (Srijariya, Riewpaiboon, & Chaikledkaew, 2008).

System Dynamic is applicable because the methodology can be used in solving real world crisis, which is depending upon reaction structure (Grosser, 2005). This methodology is also capable of capturing the effect of hypothetical assumption. It includes concepts, variable interdependency and dynamic systems with powerful shifting effects which can be used to analyse large and complex real-world situations that cannot be solved through conventional quantitative analysis. Furthermore, System Dynamic can be used to determine important variables for both long-term and short-term effects. Rational and logical future behaviour also can be drawn but it is not used as forecasting method. Other than that, its simulation-based theory can helps us to evaluate simulation-based scenarios, in order to find the best assumptions to price the contributions of a Takaful product.

In this paper, the System Dynamic model was modelled based on two main scopes; which are the internal and external factors of the component in the Takaful system.

System Dynamic Advantages

Sterman (2006) mentioned that System Dynamics is a method to enhance learning in complex systems. The ability to model diverse relationships between elements of a particular system and how these relationships influence the behaviour of the system over time has made it a better model compared to the traditional statistic approach. System Dynamics model educates us by identifying the inconsistency and allows one to see how the identified complex interactions work when all are active at one time (Taylor & Lane, 1998; Sapiri, Kamil, Mat Tahar, & Tumin, 2010).

Systems Dynamics provides a general communication instrument connecting many academic disciplines (Martin, 1997). The perspective of System Dynamics, with its emphasis on feedback, changes over time and the role of information delays actually notify the policy makers the projected and unintended alternative consequences. In addition, System Dynamics was used to design and test policies intended at altering a corporation's arrangement so that its behaviour would develop and become more (Radzicki, 2011). One feature that is common to all systems is that a system's structure determines its behaviour.

System Dynamics also can be used to analyse how structural changes in one part of a system affects the behaviour of the system as a whole. System Dynamics was initially based on the feedback control theory which consists of both quantitative (hard) and qualitative (soft) approaches in examining the dynamic behaviours of the development and changes of a system (Maani & Cavana, 2000). This model also seeks to predict dynamic implications of policy, not forecasting the outcome at a given time in future.

This theory is supported by Hirsch (1979). Grosser (2005) and Sterman (2006) stated that System Dynamics models can be used to draw reasonable future behaviour, depending upon the structure of the system. This will help policymakers and planners to have a better understanding of the relative impacts of alternative interventions they might be taking into account and anticipate unintended by-products of new programmes and policies. These models are not intended to serve as forecasting method. The policymakers will make decision based on the historical data and performance goals as the baselines to determine whether a particular policy generates behaviour of the main variables that is better compared to the baseline or even other policies.

The strength of System Dynamics model is the ability to justify own assumption of the system faced (Olaya, 2011). The wonderful advantage of the System Dynamics model is that its parameters can be accustomed by policy makers based on the changing situation or to construct visualised alternatives in planning (Udompanich, 1997). Furthermore, System Dynamics acknowledges the critical role of an individual and organisational core model, which means, it does not plainly model them. In other words, it only utilises factual data. System Dynamics is not about point prediction, the behaviour characteristics can evaluate whether or not the model can meet the conditions and behaviour leading to the event (Grosser, 2005).

System Dynamics is more effective than others in changing the thinking and actions of the audience. This is because it consists of stock and flow diagram and also the ability to track movements of people and things in a clear and systematic way. This methodology is also useful in providing qualitative system behaviour, whereas discrete event simulation is superior in revealing detailed features related to discrete queue dynamics. In terms of data requirements, System Dynamics is typically very much less as System Dynamics models are usually of higher-level and more aggregated. More useful modelling can be done with less data. Some healthcare settings are rich in useful data. Other than that, System Dynamics approach can include macroeconomics variable, behavioural variables and application variable which are not applicable in the traditional approach.

In this paper, System Dynamics approach will be tested for its applicability in the Takaful System. For this purpose, a few macroeconomic variables or economic conditions (e.g., inflation rate, favourable economic condition and Takaful operator's competitors) are tested. These variables are proven to be significant based on the secondary sources. Thus, it was included in this research, along with the basic assumptions of contribution calculation by using the traditional approach.

DESIGN APPROACH

Takaful Model

For this paper, the hybrid model of Takaful, that combines the model of Wakalah and Mudharabah, was selected because it appeared to be more well-accepted and favourable than other models, apart from being widely adopted by many newly-established Takaful operators (Islamic Financial Services Act 2013, n.d).

The main reason for using the system dynamic approach is to visualise the set of assumptions used in order to find the optimum contribution rate, which is fair to the participants and profitable to the Takaful operators. The main problem with the traditional approach is that it will take longer time to test each set of the assumptions. Moreover, the traditional approach will not consider any changes in the components after the product is launched. Using the system dynamic, the set of assumptions will be used as the initial values and it will be tested by changing the components in the system to see whether it will give positive impact towards profitability, or vice versa.

The model is detailed out in Figure 1 below:

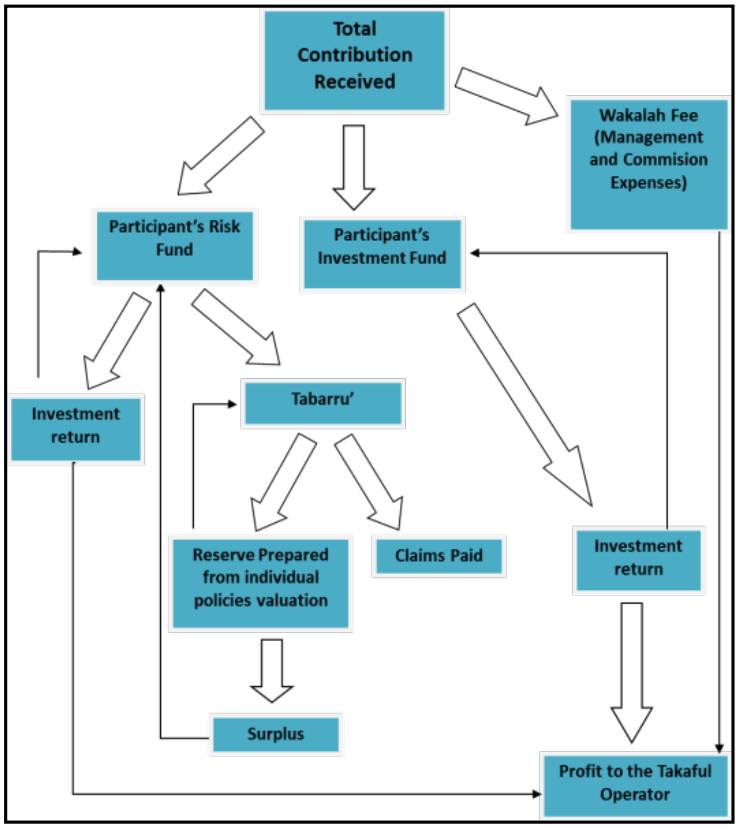

Figure 1. A detailed workflow of the Takaful System

All of these elements in the Takaful system must be properly determined in order for the Takaful operator to remain solvent and continue to make profit. Elements such as participants to Takaful operator's agreed ratio, contributions rate, commission and administration expenses, rate for investment return, reserve assumptions, as well as claims and withdrawal rate have to be properly assumed and calculated.

In this research, the system dynamic model is developed by first exploring the internal factors or components in the model, followed by combining them with the external components which involve uncertainties. The effects of each component on the others, including both internal and external, are examined separately.

Development of the Causal Loop Diagram

The involvement of investment activities, influence of the rapid growth of Takaful operators, and effects of inflation in the expenses may also cause significant effects on the Takaful operator's profitability. There is no use of issuing a contract or policy that will burden any parties involved, be it the operators or contract holders.

In this study, for the purpose of demonstrating the system dynamic approach, some of the economic variables and external components having relationship with internal components were used. Hypothetically, the relationship of the economic variables and the internal components can be best described as in Table 1 below:

Table 1
Hypothetical relationship between changes in economic variables and vhanges in internal components of the model

Changes in economic variables	Changes in internal components
Unfavourable market condition	Increase in actual expenses
(Increase in inflation rate)	Decrease in investment performance
(Decrease in overall national interest rates)	Decrease in number of participants
	Increase in number of withdrawals
Increase in number of claims and withdrawals	Increase in reserving assumptions
	Decrease in overall investment performance
Increase in competitiveness in the market	Increase in the number of participants
	Increase in total contribution received

The relationship of both external components (including economic variables) and internal components is best described in the causal loop diagram below. It is important to determine any real positive and negative relationships in order to have a system dynamic model that will represent the real situation in the simulation result.

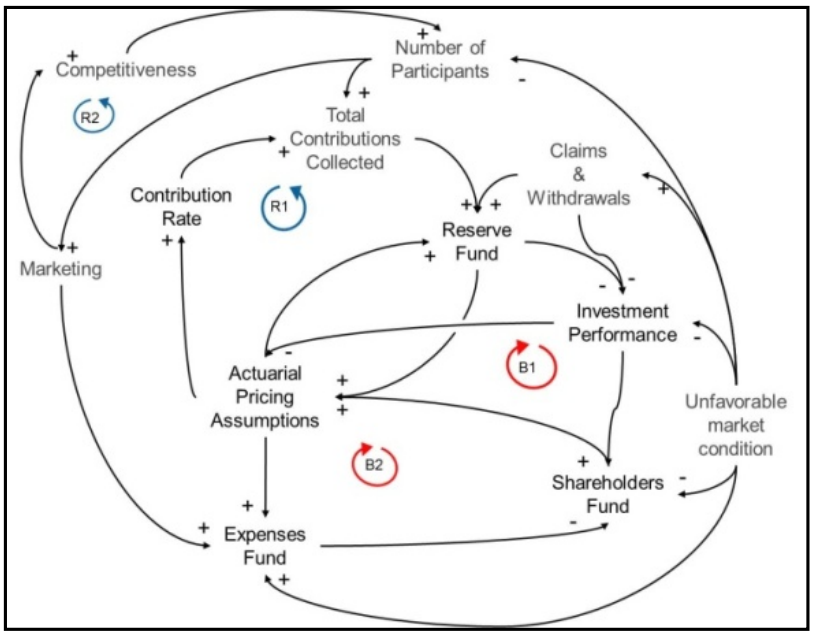

Figure 2. CLD for both the internal and external components

The system dynamic model proposed in this paper will assist the management to increase any factors that will lead to increases in cash inflow in terms of total contribution collected. The operators can make changes whether to have an improvement in marketing that also will lead to increases in the expenses by the operators. This improvement in marketing will also enhance the competitive element of the product compared to the other operators, and hence, will increase the number of participants for that particular product.

Figure 2 contains several balancing and reinforcement loops. The first balancing loop links between the actuarial pricing assumptions, reserve fund prepared, investment performance of the operators and shareholders' fund. Increase in Actuarial pricing assumptions will increase the reserve fund needs to be prepared by the operators. This will result in lesser fund provided for the investment where the investment for the reserve fund needs to be more prudent to meet the obligations towards the participants. Lesser fund for investment will lead to lesser amount to be transferred to the shareholders' fund as a profit sharing between the participants and the Takaful operators. The shareholders fund's income depends entirely on the investment performance of the operators, where higher provision required for the investment will result in the more amounts to be transferred to the shareholders' fund.

The second balancing loop links between the actuarial pricing assumptions, expenses fund prepared and shareholders' fund. Prudent assumptions in the actuarial pricing assumptions will lead the operators to prepare more funds in the expenses fund, and this will result in lesser amount to be transferred to the shareholders' fund. Motivated by maximising returns by the operators to continue operates, the shareholders of the operators will somehow force the management to reduce the pricing assumptions in order to provide more funds to be transferred to the shareholders' fund.

Proposed Stock and Flow Diagram for Takaful System

Two major characteristics, which are mainly provided by the system dynamic approach, are changes over time and feedback-transmission and receipt of information. In the system dynamic model, stock and flows are used to model the flow of work and resources through a project. Stocks represent the stored quantities and characterise the state of the system and generate the information upon which decisions are based. Flows are the rate of increase or decrease in stocks.

In this study, the unit used for time is in a yearly basis. This is because most of the components in the system happen on a yearly basis such as investment earned, total expenses for the year, total contribution received for the year, yearly claims rate and withdrawal rate, surplus, inflation rate, etc.

Based on the earlier causal loop diagram, the final simulation model was developed to enable more investigation on the changes of components by using simulation. Different decisions by the operators will be simulated by this model to evaluate the outcomes and visualise the impacts without having to conduct real experiments. The developed system dynamic model is shown in Figure 3.

In this model, reserve fund is prepared in the Participant Risk Fund (PRF) and the fund used for investment purposes is the Participant's Investment Fund (PIF), as suggested in the BNM Guidelines (2010) on Takaful Operator Framework. The investment portion (in terms

of percentage) from the Total contribution collected is a balance resulting from the deduction into Expenses Fund from the wakalah fee and also deduction into PRF from the tabarru rate.

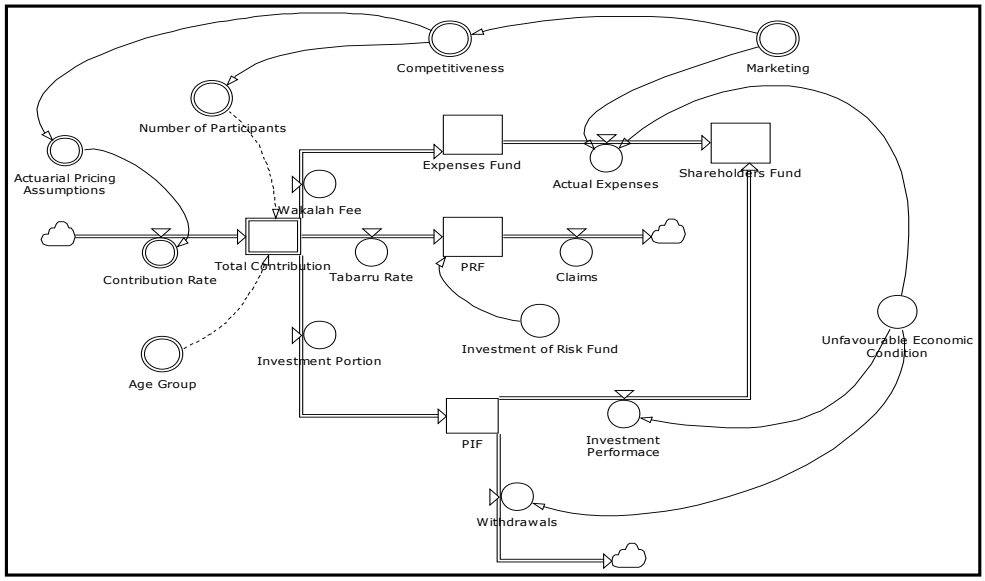

Figure 3. The proposed stock and flow diagram for the Takaful System

RESULTS AND DISCUSSION

Simulation Analysis of the Proposed System Dynamic Model

The simulation test combines two external variables which can lead to loss for the Takaful operator. These variables are the inflation rate and competition of the market. Increase in competition in the market, combined with the increase in inflation, will supposedly result in a major loss for the Takaful operator.

For example, through economic crisis, there would be increase in the inflation rate that would result in increases in the operational cost and expenses. Furthermore, during this time, there will be lesser participants who are willing to participate in buying the Takaful products. This analysis will test the point which will be the bench mark for the decision makers to be prepared on the worst case scenario.

Inflation rate, combined with the competitive market, are two variables that cannot be controlled by decision makers. However, this analysis can give a warning alarm at which point these combined variables would affect the profitability of the Takaful operator. Increase in the competitive market will result in fewer participants coming in to buy the product. On top of that, the inflation rate will increase the expenses occur each year.

The table below shows the input used in the simulation for this analysis:

Table 2
Input for the simulation model of unfavourable market condition

Changes in Component	Profit 1	Profit 2	Profit 3	Profit 4	Profit 5
Total Number of Policies	2500	2500	2500	2500	2500
% increase of number of policies every year	1%	-1%	-2%	-10%	-10%
Inflation rate	4%	4%	4%	0%	4%

The simulation result based on the inputs from Table 2 can be referred in Figure 4.

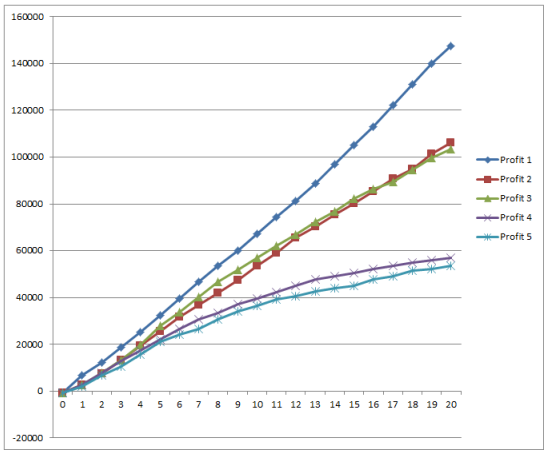

Figure 4. Inflation and competitive market vs. profit

The results above show that even when the number of policies dropped to 10% every year, and the inflation rate increased to 4% every year, the Takaful operator will still be making positive profit throughout the year. The expected outcome from this analysis was that the Takaful operator would result in loss when these two economic factors (inflation rate and competition) are combined in the market. This result of the analysis somewhat contradicts with the earlier expected outcome stated in the earlier chapter. However, it gives a very valuable insight into the current market situation which can lead to the Takaful operators' profitability. Based on this particular analysis, it is highly unlikely for a Takaful operator to result in loss or insolvency due to unfavourable market condition.

As stated earlier on, the Takaful operator will still be making profit throughout the year even though both the variables of the inflation rate and the competitive market are combined. Nonetheless, small changes to both the components will not give a big impact on profitability. However, the changes do lower any potential profit in the long run. In this Takaful system, it is clear that the decision maker can apply the system dynamic approach to help them make better decision to meet the objectives of the Takaful operator.

CONCLUSION

As a conclusion for the analysis, the results of profit differ for each variation in the Takaful model components. However, the Takaful operators will still continue to make a positive profit in the long run, regardless of the assumptions used in the pricing with the condition in Malaysia.

All of the visualisation results from the system dynamic simulation model can be used to help the Takaful operator plan for any future product to be launched and to be prepared for any changes that may happen around the industry. In this Takaful system, it is clear that the decision maker can apply the system dynamic approach to help them make better decision to meet the objectives of the Takaful operator.

This system dynamic model has also been proven to be used in visualising the impacts of changes to each component. Every small or big change can be tested using the system dynamic model so as to help determine the point at risk where this point can lead to insolvency, and also loss, from the product launched.

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