A STATISTICAL CASH FLOW MODEL FOR DEVELOPING PRICING STRATEGY IN THE CONSTRUCTION INDUSTRY

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ABSTRACT

A STATISTICAL CASH FLOW MODEL FOR DEVELOPING PRICING STRATEGY IN THE CONSTRUCTION INDUSTRY

This thesis presents a cash flow model to identify the risks and develop a strategy including pricing for build-and-sell real-estate development projects, in which a flat-for-land agreement is made. Discrete Event Simulation method is used for the uncertain variables and MATCH Uncertainty Elicitation Tool is used to transform expert judgments to probability distributions for variables. The model aims to simplify the complex uncertainties in land acquisition, construction, and selling of the constructed properties and estimate a cash flow to evaluate the risk for profit and negative cash balance during the project. The construction cost, property sales times and prices, advance and monthly payments for each sale are simulated to estimate the cash flow.

A real-life case study data was simulated to observe results and test the model. Results of the case study have shown that the risk of loss at the end of the project increases when Net Present Value is calculated as well as the profit decreases because the cash-out flow tends to be more at the early stages of construction while cash-in flow tends to be more near the end. Furthermore, the failure risk of the project was so high because of the months with negative cash balance which is with 77.6 % probability and at a range between 11 to 15 months.

Finally, actions such as increasing or decreasing property prices, working capital, loan amount and loan duration to improve the project’s performance are discussed together with their impact on profitability while avoiding negative cash balance.

Keywords: Eliciting Probability Distributions, Cash Flow Risk Management, Discrete Event Simulation, Flat-for-Land Investments, Pricing Strategy

ÖZET

İNŞAAT ENDÜSTRİSİNDE FİYATLANDIRMA STRATEJİSİ GELİŞTİRMEK İÇİN BİR İSTATİKSEL NAKİT AKIŞ MODELİ

Bu çalışma, arazinin satın alınmadığı, bunun yerine kat karşılığı anlaşmanın yapıldığı yap-sat gayrimenkul geliştirme projeleri için riskleri belirlemek ve fiyatlandırmayı da içeren bir strateji geliştirmek için bir nakit akış modeli sunmaktadır. Modeldeki değişken parametrelerin belirlenmesinde Kesikli Olay Simülasyonu yöntemi kullanılmıştır. MATCH Belirsizlik Çıkarsama Aracı kullanılarak uzman görüşlerinin olasılık dağılım eğrilerine dönüştürülmesi sağlanmıştır. Model, arsa edinimi, inşaat ve inşa edilen mülklerin satışındaki karmaşık belirsizlikleri mümkün olduğunca basitleştirmeyi ve karlılık ve proje sürecindeki negatif nakit akışı dengesi risklerini tahmin etmeyi amaçlamaktadır. İnşaat maliyeti, konut satış fiyatları ve zamanları, her satıştaki peşinat ve aylık ödemeler nakit akışını öngörmek için simule edilmiştir.

Ayrıca bir gerçek hayat örneğine ait veriler simülasyonda kulanılarak elde edilen sonuçlar gözlemlenmiş ve model test edilmiştir. Sonuçlar, zarar riskinin Net Değer Analizi ile beraber arttığını göstermiştir çünkü nakit girdileri projenin sonuna doğru daha fazla olma eğilimi gösterirken, nakit çıkışları projenin başlangıcına yakın olma eğilimi göstermektedir. Bununla beraber, negatif nakit akışı dengesi olan ayların sayısının %77.6 ihtimalle 11 ile 15 ay arasında olması nedeniyle projenin başarısız olma riskinin çok yüksek olduğu gözlemlenmiştir.

Son olarak projenin performansının arttırılması için yapılabilecek fiyat artışı veya indirimi, sermaye ve kredi arttırımı ve kredi süresi uzatılması gibi eylemler, karlılık ve negatif nakit dengesini azaltmaya yönelik etkileriyle birlikte tartışılmıştır.

Anahtar Kelimeler: Olasılık Dağılım Eğrilerini Çıkarsama, Nakit Akışı Risk Yönetimi, Kesikli Olay Simülasyonu, Kat karşılığı Yatırımları, Fiyatlama Stratejisi

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DES	: Discrete Event Simulation
FTIM	: Fixed Time Incrementing Method
FAR	: Floor Area Ratio
LGD	: Loss Given Default
MATCH	: MATCH Uncertainty Elicitation Tool
NPV	: Net Present Value
ODA	: Overdraft Deposit Account
RC	: Reinforced Concrete
SHELF	: The Sheffield Elicitation Framework
TRY	: Turkish Lira
VAT	: Value Added Tax
VTIM	: Variable Time Incrementing Method

CHAPTER 1

INTRODUCTION

Investment decisions in real-estate development projects, including a wide variety of projects (Başdoğan and Önel 2013); occasionally start with the decision on the land when aimed to construct a building on it. Depending on the goal of the development project and investment, the land can be rented for a certain period, bought partially or entirely. Leasing the land for construction purposes is expected for commercial projects, although it can also be for temporary residential facilities. Ownership for such projects is not possible for the properties constructed; therefore, such developments generally include building and then renting properties to generate income for the leasing period of the land. Acquiring the land provides other means of income than just building and renting out, selling the properties partially or as a whole and trading the land itself for a higher price to gain profit. However, for such build and sell investments, the cost of the land can cover a considerable part of the total investment expenditures spent at the beginning of the process.

Buying the land that the building will be constructed on is the first thing that comes to mind concerning the mid-scale and large-scale build-and-sell projects performed by mid-scale and large-scale investment and construction companies. However, in rural areas of Turkey, where there are relatively small-scale projects, and medium-sized projects, a different type of agreement between the investor and the landowner takes place. The investor and the landowner sign a contract to construct the building in exchange for ownership of a certain number of properties that will be built. This agreement can be perceived as a partnership between the two parties or trade of land and construction service. Keeping the working capital without paying anything for land acquisition increases the chance of completing the construction and reduces the risk for negative cash balance during construction; however, it also makes the price of the land depend on the construction cost and time-sensitive because of the inflation rates.

Furthermore, the total amount of profit from sales decreases as some properties are exchanged for the land. This type of agreement is quite common for projects where the working capital does not cover the entire investment cost due to the investor's preference or lack of funds for the whole project. Moreover, investors prefer to use the least amount of capital they own and expect the investment itself to provide funds during the process. On the other hand, the investor might want to use a minimum amount of funds for that project even though they can cover all of it in order to invest in more projects or simply the amount of capital might be insufficient to cover both land acquisition and construction phases. Therefore, due to underfunding, the investment relies on property sales during construction or other solutions like loans from banks which might still not be enough to cover the underfunded amount. Decreasing prices at early stages to increase sales and obtain cash to be spent for construction becomes vital for completing the project. The time of sales, increase of the construction cost, the amount and frequency of payments from clients, and payment terms to the suppliers are uncertainties that need to be considered at the very beginning of the investment decision.

Apart from funding, construction, as a time-consuming process, is the part of the investment that needs a much more extended period than land acquisition, making the investment related to a future period (Yulia and Per 2018). From the beginning of the investment process until the end, many uncertainties that will affect the estimations may occur, thus causing risks for the entire investment. Since the construction and sale of the properties will take a long time, assessing risks for this period is vital for the success of the investment. Simulating the process is one of the solutions as it is for many investment types. However, the insufficiency of data from real-life experiences to support the theoretical background about the investment decisions in real estate (Del Giudice, De Paola, and Cantisani 2017) shortens the list of simulation types that can be performed for analysis. Moreover, lack of such information leads to searching for methods to obtain data from experts using alternative ways, like eliciting probability distributions using expert knowledge. A web-based software named MATCH Uncertainty Elicitation Tool (Morris, Oakley, and Crowe 2014b) is used to determine the probability functions used for the variants in the simulation.

Unavailability of precise data in construction and the uncertainties that exist about the time of sales, construction cost, final agreed prices of sales, payment plans, etc., makes it challenging to decide on the type of simulation that best fits to represent the complex structure. For the tool that will be used at the decision stage for the investment, the details at every stage of the process are not necessary and also makes the process too complicated to assess which is not preferred at such early stage. For this reason, Discrete Event Simulation (DES) method is used to model the process so that important factors that affect the performance of the investment such as cost, pricing and funding can be observed and modified when necessary or required.

1.1. Problem Definition

Due to increasing competition in the market, even small-scale investments have started to contain more risks, lesser profits, and more expensive land prices. Furthermore, the number of firms that perform build and sell investments is increasing rapidly because the entry barrier for small-scale construction firms in Turkey is relatively low. Technical education that leads to a degree in engineering or architecture is not a condition for the lowest level of contractor classification regulated in March 2019 (2019); before that, it was not requested from any construction firm regardless of the company's scale. Therefore, data collection in the construction sector is quite challenging because of two main reasons. Firstly, especially small and medium scaled firms do not have any organized data at all, because they do not need one due to high profits and relatively less risks than when the competition was lesser in the past, so they did not need to record it. After all, the company's know-how generally relies on one- or two-people’s expertise and experience. Secondly, although they might possess the organized data they have collected through their own experience, they are unwilling to share details of their know-how with any parties due to competition in the market.

Construction is generally performed on-site in Turkey, especially for residential developments, for various scales, which makes it relatively harder to estimate and control. The process takes months, if not years, and the amount of funds spent is also so high that no investor would like to risk losing it. Considering the high fluctuation in currencies that directly or indirectly affect the raw material prices and the higher inflation compared to developed countries that affect construction costs, staying within the estimated budget is a challenge. Moreover, higher loan rates (especially mortgage) negatively affect property sales and make it hard to predict the time of sales from the beginning until the end of the investment.

On the other hand, the flat-for-land ratio for a particular plot is usually more predictable than the land price. First of the parameters affecting the ratio with a major impact is the property prices within the area, which is compared to the land price and construction cost, then the results are used by both parties of the agreement to have a consensus. Because it is a commonly used method in small-scale development projects, the ratios are generally determined for many plots in the region as mentioned earlier in the past contracts, thus leading to a specific understanding of the ratio range for that region. The second parameter is the specialty of the plot, such as being adjacent to streets where commercial activities are high or facing scenery, sea view, etc. The factors in the second parameter have a minor impact within the ratio range determined in the first parameter. All the parameters are subjected to negotiations depending on the leverage of the landowner or the investor.

The terms for the flat-for-land ratio contracts generally include the deadline for the completion of the properties (the ones that will belong to the landowner and the common areas at least) together with the specifications for the use of material as well as the distribution of the deliveries of the title deeds. Landowner grants a certain number of deeds after a phase of construction is complete. The phases are also determined during the contract phase such as the getting the construction permit, completion of moulding work, mounting of cabinets, fenestration, plastering, etc. However, the contractor may agree with buyers through contracts for future sells where the deeds are given after the payments are complete. Therefore, payments may start immediately after the flat-for-land contract is signed. The contract also contains the penalties for late deliveries, terms for excuses to be accepted for both parties' non-compliance to the terms of the contract.

When the number of total properties does not allow to obtain an integer number because of the sharing ratio, one of the properties might be shared between the parties involved. For this reason, that property might either be sold to a third party and the capital obtained can be shared, or one of the parties involved pay-out the other for the rest of the property share as an entry for cash-in or cash-out to the model. One other solution to this situation is to share total Floor Area Ratio (FAR) area and design different features especially in terms of size. In some cases, the landowner might request cash instead of the ownership of one or more properties or may want to buy some of the properties at the beginning. Finally, both the investor and landowner might agree to share the total sum obtained from property sales after every sale that happen or in total at the end of the project.

As construction, which is a time-consuming process, progresses, prices for the properties as well as prices for the cost of construction change continuously. For this reason, the prices determined at the beginning of the investment do not have to be constant, as well as the costs will not be fixed either. At any rate, the increase will be parallel to the inflation rate yet there will always be a range considering supply-demand ratio and the financial situation of the project. However, once the property is sold, the price of the property is fixed and cannot be changed afterwards unless agreed to.

1.2. Objectives of the Research

This thesis presents a cash flow model to identify the risks and develop a pricing strategy for build-and-sell real-estate development projects, in which the land is not acquired, but a flat-for-land agreement is made instead. The model aims to simplify the complex uncertainties in land acquisition, construction and selling of the constructed properties as much as possible. Moreover, the model is intended to be used as a tool by the investors for the flat-for-land build and sell real estate developments.

Significant actions followed while building the model are:

- Use of MATCH software for eliciting the probability distributions of variant parameters of the model.
- Creating a cash flow diagram to monitor the financial status of the investor in terms of avoiding negative cash balance.
- Use of Discrete Event Simulation (DES) Variable Time Incrementing Method (VTIM) to simulate the cash-in model.
    - Property Prices
    - Sales Times
    - Advance Payments
    - Monthly Payments
- Use of Discrete Event Simulation (DES) Fixed Time Incrementing Method (FTIM) to simulate cash-out model.
    - Total Construction Cost
- Combining cash-in and cash-out models to simulate the cash-flow balance and monitor the financial situation accordingly.
- Observing the final cash-flow model to assess the probability of:
    - Various ranges of cost
    - Various ranges of total income
    - Various ranges of profit
    - Various ranges of profit percentage

- o Various ranges of NPV
- o Number of months with negative cash-flow balance
- o Number of months with negative cash-flow balance less than the limit of the Overdraft Deposit Account (ODA)

The study also gives opportunity to observe the results for different pricing strategies (lower and higher) that will affect the time of property sales and the possibilities to observe the effect of the pricing on the profit and success of the investment. Furthermore, by modifying the financial data such as the duration of the loan, working capital, the effects are observed on especially profit and number of months with negative cash balance or number of months with negative cash balance less than the ODA limit.

1.3. Scope of the Research

The model created in this study focuses on small and middle-scale investors that sign a flat-for-land agreement with the landowner and then build and sell properties. The real estate developments subjected to the survey mainly consist of residential units; however, mixed-use development projects that contain commercial units on the ground floor can also be considered within the scope of the study. As a case study, a construction firm has shared financial data on their investment plan for a particular plot in Milas, Muğla, Turkey. The flat-for-land ratio is also pre-determined and agreed upon by the landowner and the firm which is 1/3 meaning the landowner gets one out of three properties and the investor gets the remaining two properties.

The property prices are determined according to the expectancy of the company considering the prices in the neighbourhood of the plot and are confirmed through dialogue with real estate agents and other investors that sell properties in the vicinity. The prices may vary between 300.000 TRY (Three hundred thousand) and 400.000 TRY (Four hundred thousand) concentrating around the mean value which is 350.000 TRY (Three hundred and fifty thousand) for the project phase.

The company has allocated 1.000.000 TRY (One million) for the investment and plans to take out a loan of 1.000.000 TRY (One million) from bank on the eighth month of the timeline. The amount of loan is confirmed with the bank at the investment decision stage. Moreover, it is also confirmed with the bank that the company can use an ODA during the investment phase with a maximum limit of 150.000 TRY (One hundred and fifty thousand). The overdraft deposit account is not used in the model as an entry because it can only be used as a tool to delay payments for a month, however it is taken into account to observe number of months with cash balance under the limit of the ODA which means for one or more time the cash balance over -150.000 TRY (One hundred and fifty thousand) can be tolerated for an expense of the interest of the ODA for that month.

The size of the building, the number of storeys above or under the ground, total height of the building that can be constructed onto a plot is determined in city plans, laws and regulations. For this reason, it can be calculated using the given coefficients, the size of the land, and the size of the constructable are after the spaces between buildings are left. Moreover, the trends in the area together with the know-how of the investor or consultants (real-estate agents, architects, etc) allows the investor to calculate the number of blocks and properties that can be built on the plot considering various property types like one bedroom, two bedrooms, three bedrooms etc. These calculated data are accepted as known data because they also drive the design process of the project as criteria that need to be fulfilled.

After all the calculations are complete the known data are used to estimate the construction cost and total revenue from the sales to determine if the investment is feasible or not. However, the possibility of different scenarios that may occur and what actions can be taken then, cannot be calculated easily using simple math as it was used above. The number of variants makes it quite difficult to anticipate what will happen after every single action. Simulation, on the other hand, is a technique to establish a model to observe the results of the current situation and the results of the actions that can be taken in the future to improve the performance of the investment which are as follows.

- Changing the amount of working capital,
- Changing the duration of the construction,
- Changing the amount of the bank loan,
- Changing the duration of the bank loan payback period,
- Changing the prices of the properties,
- Changing specifications of the construction to;
  - Increase property prices,
  - Decrease the construction cost.
- Payment times and methods to suppliers and contractors

Finally, after using the data calculated for simulation, evaluating the results for different scenarios after modifications, the investor will have sufficient data to decide on the strategy for the investment if the probability for success is within the accepted range of the investor's criteria. If the criteria for success determined by the expectations of the investor are not met or the risks are higher than the tolerance limit, the investor may choose not to progress and decide not to invest in the project.

1.4. Structure of the Thesis

This thesis comprises of five chapters. The first chapter explains background information about the situation in the real-estate business, describes flat for-land real-estate development model, dependence on sales during construction, and risks of underfunded investments. The second chapter gives a broad perspective about eliciting probability distribution using expert judgments, the use of discrete event simulation in different areas, both FTIM and VTIM methods and informs about the use of cash flow concept in construction. The third chapter explains the methodology behind the model and how the simulation is built using Excel software built-in Microsoft Office Suite. Furthermore, it shows how expert opinions are transferred to data using MATCH online tool. The fourth chapter reports the simulation results using the data from the case study and discusses the outcomes of the simulation process and results. Finally, the sixth chapter summarizes the research and the simulation and discusses the actions that can be performed to improve project's performance.

CHAPTER 2

DISCRETE EVENT SIMULATION FOR CASH FLOW ANALYSIS

2.1. Eliciting Probability Distribution

Due to the unavailability of relevant data to model a system with uncertainties such as environmental systems, expert opinions and judgements can be used to determine the type of probability distributions to be used for the models to simulate the system's behaviour (Morris, Oakley, and Crowe 2014b). For example, expression of expert judgments as a subjective probability distribution was used for a case of pollution of sulphur from coal-fired power plants by Morgan et al. in 1984 (Morgan et al. 1984). Furthermore, Cooke (Cooke 1991) highlighted the importance of eliciting in his book about uncertainty. Together with the technological advances, representing experts' experiences in models and performing complex computations could be done using software and computers. Meyer and Booker define elicitation techniques as a means where aspects of the knowledge of the experts are described, especially for systems with sparse data in their guidebook about eliciting (Meyer and Booker 1991).

An obscure quantity in a model can be defined as a random variable; it can be continuous, taking a value from a range of quantities, or discrete as taking a distinct value only (O'Hagan et al. 2006), emphasizing the importance of Bayes’ Theorem as a recipe for learning from experience

$$\boldsymbol{P(E|F)} = \frac{\boldsymbol{P(E)P(F|E)}}{\mathbf{P(F)}}$$

Equation 1. Bayes’ Theorem
(Source: O'Hagan et al. 2006)

Where;

E stands for an uncertain event of interest,

F stands for a piece of new information that is obtained (what is we learn is that event F occurs),

P (E) stands for prior probability: knowledge before event F,

P (E | F) stands for posterior probability: knowledge after event F,

The theorem explains the conversion of prior probability of E, P (E), to posterior, P (E | F) after event F occurs.

One of the various ways of applying this formula into practice is elicitation. For this reason, in 2008, O'Hagan and Oakley have published SHELF: the Sheffield Elicitation Framework, a package that contains documentation, software, and templates to be used as a tool for elicitation (O'Hagan and Oakley 2008).

This study focuses on eliciting probability distributions for variable parameters in the simulation. However, transforming expert opinions and judgments into information and finally having quantitative probability distributions is a challenge, especially if the technical or mathematical knowledge of the expert is not sufficient to express it as a mathematical equation. As an interface containing various techniques to transform experts' judgments into distribution models, Morris, Oakley and Crowe have published another web-based tool based on the SHELF package in 2014 called MATCH Uncertainty Elicitation Tool (Morris, Oakley, and Crowe 2014b). The tool contains five input modes: roulette, quartile, tertile, probability, hybrid (Morris, Oakley, and Crowe 2014a). Unlike the other four modes, the roulette mode (Johnson et al. 2010) does not require any specification from the expert as a median number or probability, which requires technical knowledge of probability. On the contrary, the basic principle is to distribute the chips in the grid chart prepared and provided by the researcher, like betting on a roulette game in a casino.

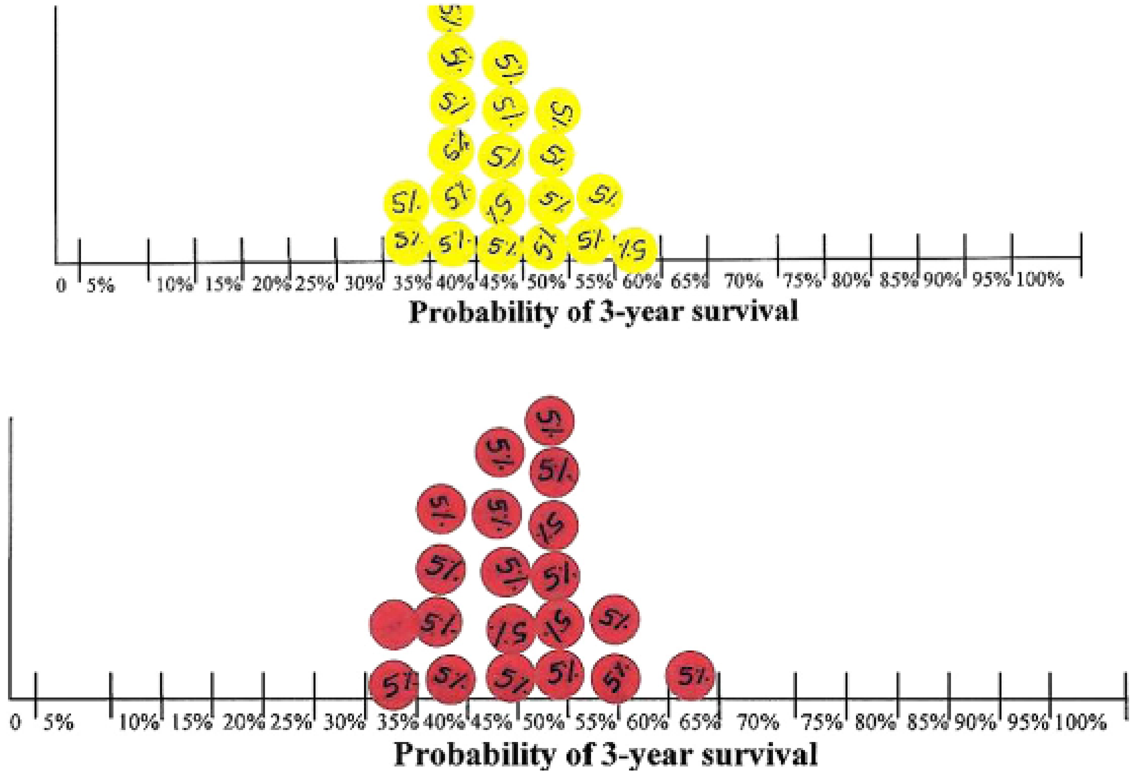

Figure 1. An example for the use of chips (stickers) representing 5% probabilities each and 100% in total (Source: Johnson et al. 2010)

The first step of using the tool is to design the grids so that the diagram can represent the uncertainty of a variant parameter to see all the probabilities. After it is complete, researchers can send the empty charts to the experts to get their opinion. The type of distribution for the output can be chosen manually, or the program can automatically select the one that best represents the distribution if the auto-select option is checked. The tool also provides instant data on the distribution model output as per the probability at a certain point at the Fitting & Feedback tab.

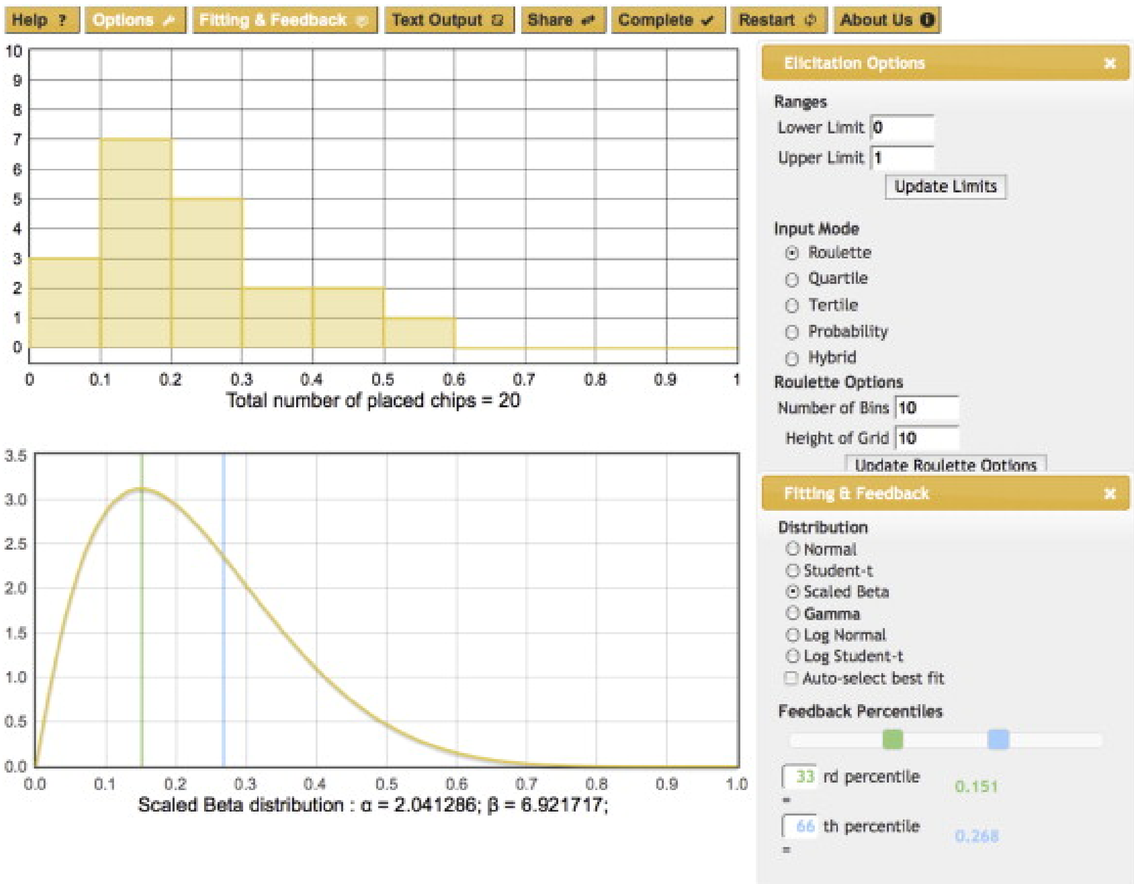

Figure 2. A screenshot from MATCH Uncertainty Elicitation
(Source: Morris, Oakley, and Crowe 2014b)

Figure 2 shows a screenshot of the MATCH Uncertainty Elicitation tool, where a chip is represented with a painted rectangle bounded by the grid. The grid is obtained by entering the necessary numbers to the Elicitation Options tab by the researcher. The fitting and feedback tab allows the researcher to choose between distribution types and auto-select options (which is also included) to select the best fit available. After the chip distribution is complete, the tool presents the graphic for the probability distribution.

2.2. Discrete Event Simulation Approach

Construction is a complex task with many uncertainties, and it is costly due to high resource usage such as time, money, materials, equipment, labour, etc. For this reason, a decision on a real estate investment involving construction cannot be made based on guesswork or intuition because a poor decision might lead to severe consequences that cost a lot to the investor (Sharma 2016). In order to avoid that, quantitative methods are widely used in decision-making processes that involve such complex operations. Operations research is used (as a method) to analyse and solve complex problems using scientific methods (Sharma 2016) to decide to achieve the best result using these resources. One of those scientific methods is simulation, which is, by definition, imitating random behaviour of a system so that the system performance could be estimated (Taha 2011).

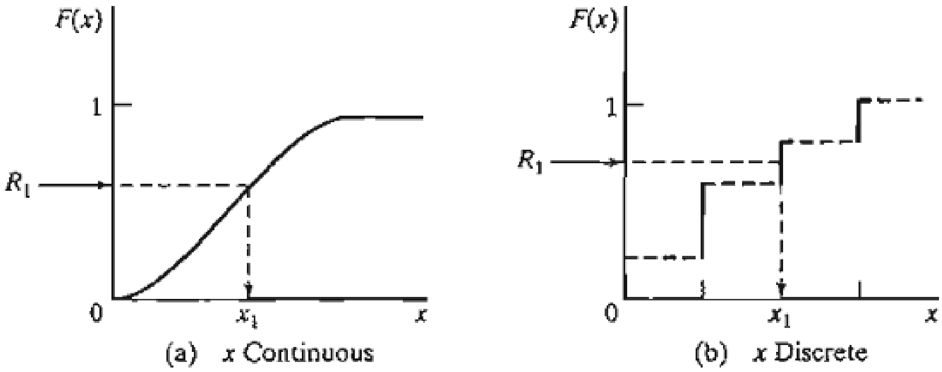

Figure 3. An illustration for comparison of samplings from a probability distribution
(Source: Taha 2011)

Figure 4. Occurrence of simulation on a time basis
(SourceTaha 2011)

With the help of discrete event simulation, Christy and Kleindorfer (1990) demonstrate cash flow scenarios of various samples to help decision-makers about their future investments. This simulation combines short-term production processes and long-run financial processes within a single model simultaneously.

Lee and Ghosh (1994) provide a simulation of banking payments in the U.S. using discrete event simulation. They claim that this new transparent real-time network helps the banking system perform better and reduce the risk.

Hlupic and Robinson (1998) employ a discrete event model to determine how simulation models perform in the business processes. The authors state that this kind of simulation is helpful for decision-makers who would like to know how a new choice will affect their business. Thus, this model prevents the company from high-cost wrong decisions in real life.

Lee, Cho, and Kim (2002) introduce a new methodology that combines discrete event simulation (DES) and other continuous aspects which DES does not have. They employ this new model named discrete-continuous to simulate a supply chain system that contains both discrete and continuous nature equally.

Similarly, Tong, Mues, and Thomas (2013) propose a discrete-continuous model to simulate Loss Given Default (LGD) in mortgage loans. The authors state that this combined model outperforms the well-known existing models in dealing with zero losses.

Montevechi et al. (2009) seek to demonstrate financial risks that administrators face in different scenarios within the industry with the help of discrete event simulation techniques. These scenarios allow administrators to re-design the whole process to enrich the best financial option for their industry.

Taylor et al. (2018) employ discrete event simulation for performance determination of business strategies affecting economic and assembly aspects of the system. The authors introduce the model as a real-time simulation that helps decision-makers predict the system's future state with existing data.

Allen et al. (2018) create a model taking operative and economic aspects of a supply chain system for capacity management in aerospace with the help of discrete event simulation. This mixed model is helpful for decision-makers to forecast cash flow scenarios according to investment options and future demands.

Murphy et al. (2020) employ discrete event simulation to combine financial and production data to predict the upcoming scenarios within a system and choose the most profitable option.

2.2.1.1 Fixed Time Incrementing Method and Variable Time Incrementing Method

As mentioned earlier discrete event systems focus on the behaviour at the state of time at which the event occurs unlike continuous systems. The event might be repeating at a certain time interval on a regular basis like monthly payments or salaries which makes the time a fixed input not a variable. What events occur between two timelines are simulated and given as an output at the simulation. So, the event on a specific time node represents the total of the events that occurred between itself and the previous node. In some cases, the time interval between two events is not a variable but a fixed time and is not simulated. Such systems with a pre-determined time interval between events, where the system state is checked on a regular basis are called Fixed Time Incrementing Methods (FTIM) because the event that the system clock is based on is regular such as monthly payments, maintenance times etc. Especially cash-out flows for construction are suited for such cases because while constructing a building the investor has to deal with lots of minor and major payments depending on the stage and progress of the construction which requires to be well planned in terms of time and funds. For this reason, instead of planning the many variant payment times, investors prefer to obey pre-planned payment times so that they can pay at certain time intervals and that all the payments can be done without error. Furthermore, the progress of the construction is also planned according to the balanced payment schedule which is also an input for supplier and contractor selection. It also makes it easy to communicate with the suppliers and contractors, who already know when the payments are going to happen. Stahl indicates it is generally the small and mid-size firms in the area of construction and mechanical engineering, with number of payments between 200 and 250 that corresponds to more than half of the total payments (Stahl 1993).

On the other hand, there are situations where the system state is not checked regularly because the occurrence of events that the system clock is based on are not regular but variant. Such systems with undetermined time intervals between events are called Variable Time Incrementing Methods (VTIM) because the event that the system clock is based on are irregular and variant making it a variable in the simulation such as sales times, order times, incoming customers etc. As for construction, which is also a type of manufacturing, all cash-in variables are simulated using VTIM such as sales times, prepayments, monthly payments etc.

Banks and Carson uses the discrete event system for event-scheduling to show the use of discrete event systems, defining an activity as a duration of time that can either be constant as in FTIM or random (determined by a probability distribution) as in VTIM (Banks and Carson 1986).

Lidberg et. al. uses variable time incrementing method (defines as variant based setup times) to simulate a production line of a factory for decision making and optimization purposes (Lidberg et al. 2020).

DES is also used effectively to model and analyse complex operations in construction such as earthmoving operations for planning and design purposes (Rekapalli and Martinez 2011). Furthermore, the study also shows the possibility of visualisation of the simulation using software.

2.3. Cash Flow Concept

Due to the increasing competition in the market and decreasing profits the risks of the investments have increased. Besides, construction is a time-spread production process that requires resources; therefore, frequent transactions for buying and selling occur during the process, which means the flow of cash in both ways, as in cash-in and cash-out. Kenley describes cash-in as the movement of funds from client to the contractor and cash-out as the movement of funds from contractor to subcontractors, suppliers and direct costs (Kenley 2003). In the case of this study, payments from property sales, advance payments, progress payments and others are accepted as cash-in and all the expenses for construction, fees, direct costs, interests, etc. For this reason, the accuracy of cash-flow forecasting is crucial for the construction stages (Hwee and Tiong 2002) and it must be considered when the investment decision is made during the contract phase for land acquisition. However, it is vital to differentiate the construction expenses from the cash-out flows (Cui, Hastak, and Halpin 2010) because of the difference in time due to the deferred payments. Simultaneously, the same time-lags might occur in cash-in flows, and there might be delays for payments from the customers. Golden et al. emphasize that due to increasing inflation and increasing interest rates caused by that, cash-flow management becomes an increasingly important problem. (Golden, Liberatore, and Lieberman 1979)

Navon proposed (Navon 1995) a cash-flow management system with a deterministic approach after Reinschmidt and Frank proposed a stochastic approach to analyse the interaction between different schedules and cash flow system (Reinschmidt Kenneth and Frank Walter 1976).

Kaka and Price, discuss if modelling a net cash-flow system be reliable for the contractor at the bidding stages of tenders (Kaka and Price 1991). Kaka also states that conventional cash-flow forecasting methods fail to present variations in the cash-flow model and suggests by increasing variables and taking risks into account, a more flexible system can be obtained using probabilistic simulation techniques (Kaka 1996). Furthermore, Odeyinka et al. showed the need for further study as the risk of occurrence and its impacts on cash-flow forecast (Odeyinka, Lowe, and Kaka 2008).

Al-Joburi Khalil et al. mention that cash flow has previously been studied within the scope of forecasting, project delay, failures in businesses and scheduling while highlighting the negative cash flow trends and patterns have not been studied closely enough even though their impacts on construction performance (Al-Joburi Khalil, Al-Aomar, and Bahri Mohammed 2012). They also emphasize that the shortages in cash might lead to failures in businesses as well as bankruptcy.

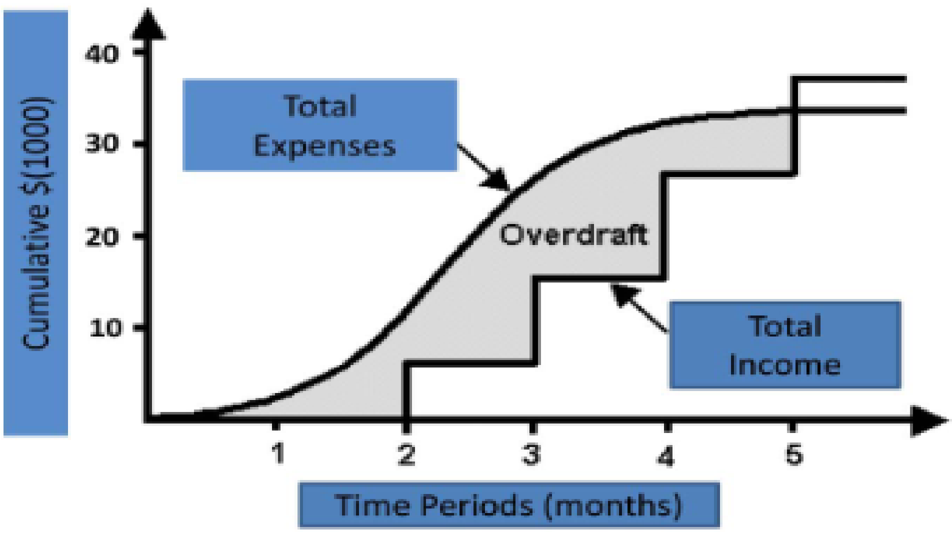

Figure 5. Typical expense versus income profile
(Source: Al-Joburi Khalil, Al-Aomar, and Bahri Mohammed 2012)

Chen et al. on the other hand discuss the effect of payment conditions on the cash flow forecasts which is not only essential for the assessment of the conditions but also for accurate forecasting. (Chen, O’Brien William, and Herbsman Zohar 2005)

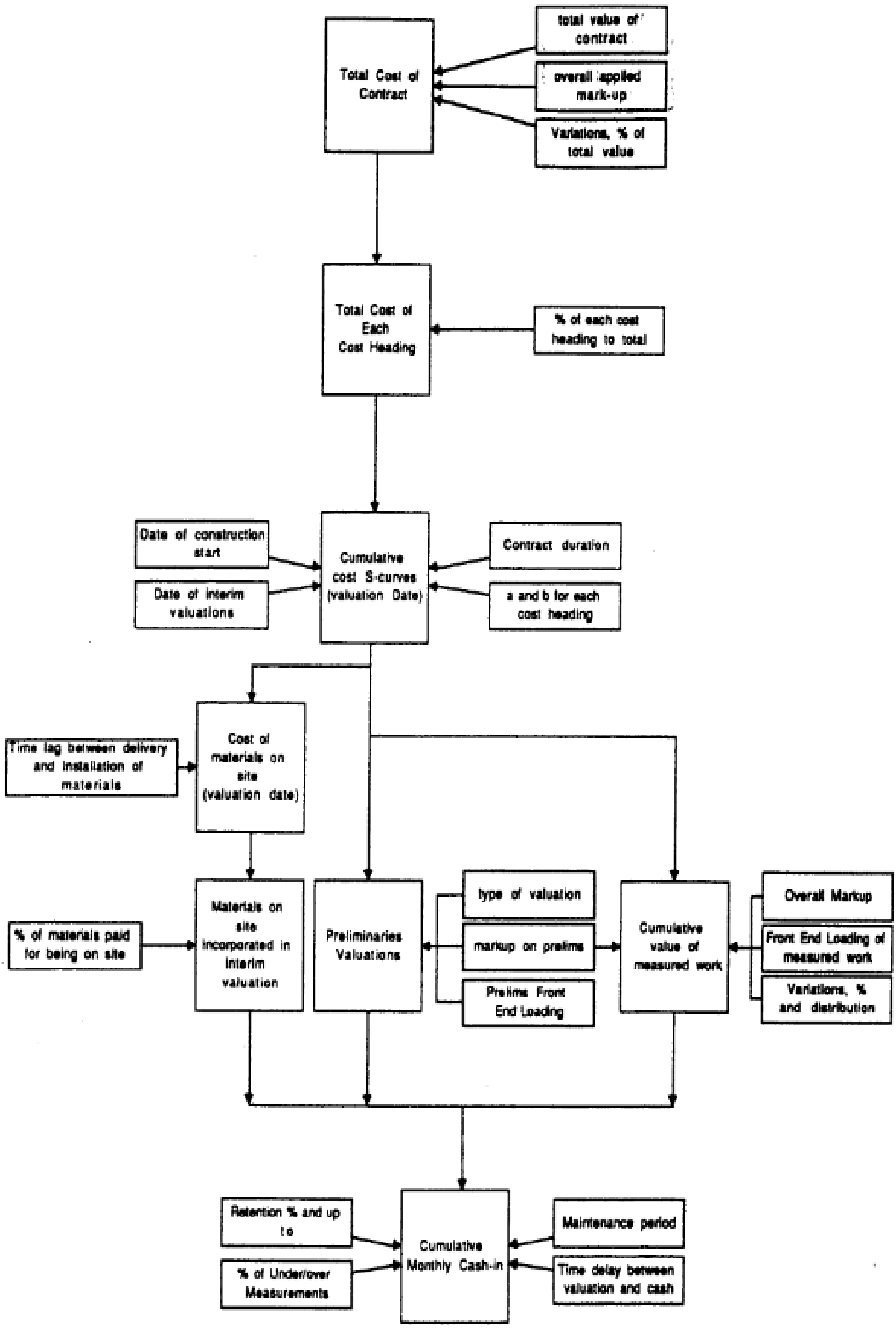

Figure 6. The Mechanism of the Flexible and Accurate Cash-Flow Mechanism proposed by (Source: Kaka 1996)

Karshenas and Haber indicate the necessity of keeping the monthly cash flow under a particular limit while they also emphasize that time is also a resource that must be optimized during project cost optimization (Karshenas and Haber 1990).

Moreover, Cui et al. indicate use of different strategies synergically for cash flow management (Cui, Hastak, and Halpin 2010). Highlighting that cash flows are not same as revenues and expenses they classify payments into three categories which are operating, investing and financing.

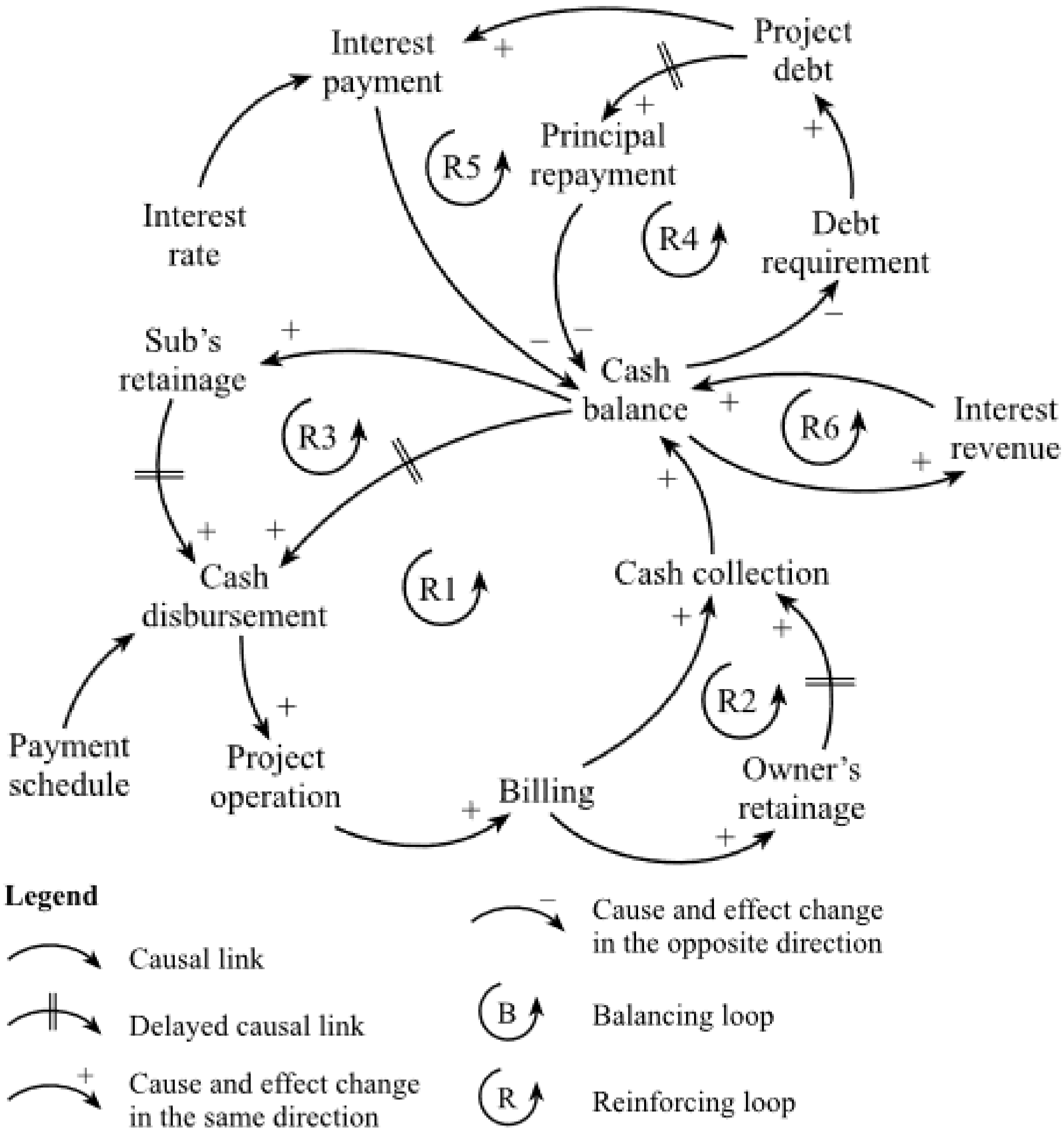

Figure 7 Feedback loops in project cash flow
(Source: Cui, Hastak, and Halpin 2010)

CHAPTER 3

A DISCRETE EVENT SIMULATION MODEL FOR CASH-FLOW OF A BUILD-SELL REAL-ESTATE INVESTMENT WITH A FLAT-FOR-LAND CONTRACT

A flat-for-land contract between investor and landowner covers the terms of exchange where the landowner sells the plot in exchange for an agreed number of properties. The terms of the agreement also define specifications decided upon, such as the deadline for delivery of the properties, the deadline for construction permits, construction materials used, etc. Generally, the properties that are handed over to the landowner are among the ones that will be built on that parcel. However, there may be various other types of agreements in which the landowner takes:

- a specific share from the total sales,
- an agreed number of properties plus a certain amount of cash,
- properties that will be built on other plots of land,
- properties that are already constructed and owned by the investor in other areas.

There are other cases in which the landowner might pay the investor when the agreed share does not allow an integer outcome so that the option is one party pays out the other one for that shared property.

A discrete event simulation model has been developed for a real-estate development project for the following conditions in this study.

- The land is acquired with a flat for land contract.
- Investor constructs the building or has it constructed.
- There is a deadline limiting the duration of construction because of the flat for land agreement.
- The investor aims to sell all the properties except for the ones to be delivered to the landowner.

Figure 8 illustrates the structure of the developed model where the inputs are defined. Working capital is data determined by the investor.

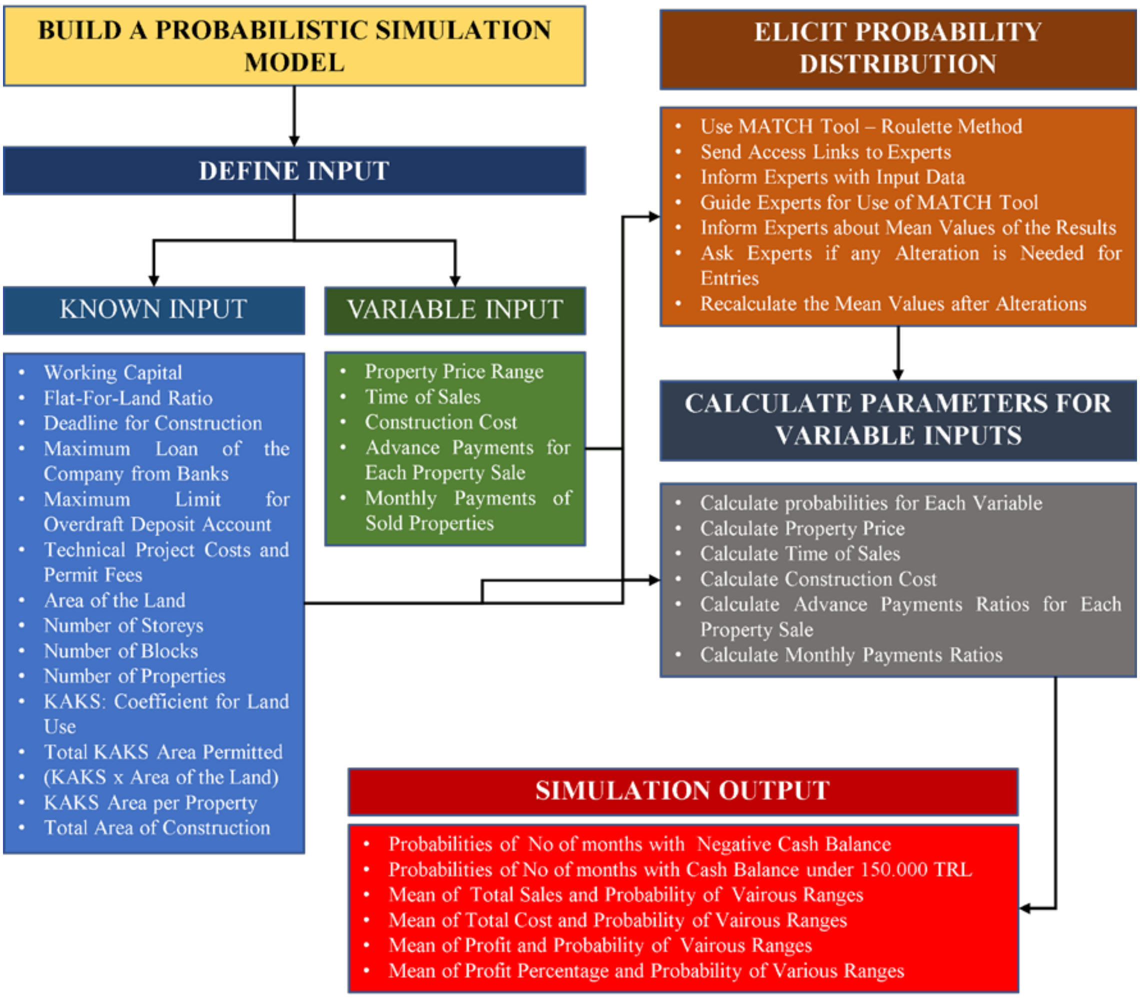

Figure 8 Structure of the Model

The Flat-for-land ratio is usually pre-determined for regions. Although there are minor variances in these pre-determined values, the investment calculations are done at the beginning of the investment according to the pre-determined value. Inequalities between properties in terms of function, orientation, scenery, etc., may cause minor changes in the flat-for-land ratio in terms of the total sales price. Still, these ratios are used when sharing the properties at the negotiations before the contract phase. Another term added to the contract is the deadline for the construction, depending on the size of the building. The design phase of the building, delivering projects and documents to local authorities to apply for the building permit and getting it must also be considered while determining the project's total duration. The investor's credit rating in the eyes of banks and credit institutions is also among the knowledge an investor always possesses and updates regularly. The investor either holds a specific amount of cash or blocks some possessions such as real estate as a loan guarantee. The investigations after credit applications happen very quickly and the institution or bank responds rapidly, even in a day. Banks also provide overdraft deposit accounts to their customers on-demand, given the guarantees mentioned above, which can be seen as a credit paid at the end of the month. The limit is also calculated according to the customer's request. It must be within the boundaries of the total credit limit of the investor or under the limits determined by the institution's policy.

Project design and documentation services in Turkey are contracted with a fixed price instead of price per person-hours, making it easy to collect such data in a deterministic way. Knowing the details of the project that will be built, it is also possible to calculate the permit fees for the project. The area of the land is written on the title deed. The landowner can learn from the local authorities the allowed number of storeys to be built on the plot. By the simplest definition, this total FAR is basically the ratio of the total area of the enclosed spaces to the land area under some specifications defined by regulations. The FAR for the plot is calculated by multiplying the FAR by the land area. The investor knows from experience what the range of FAR per property should be. So, by dividing the FAR by this value, the number of properties to be built can be calculated for that plot. The regulations also limit the areas of the spaces which are not added to FAR. Knowing this knowledge and the minimum requirements for these spaces, the investor can calculate and determine the total area of the construction.

Aside from the data known or obtained through deterministic approach, some uncertainties can cause the investor's profit to drop dramatically or even cause loss. In addition, due to increasing competition in the market, the overall profit ratios are decreasing, leading investors to take more risks to increase total income. One of these risks is to allocate relatively lower amount of funds to the development project or invest in projects that exceed the total amount of capital. In such cases, the feasibility of the investment, even survival, depends on importing capital transfer either through loans or advance payments from early sales. However, sales cannot be anticipated, although selling trends in the market give a broad perspective about the probabilities, including the selling time and property price range, the advance payments at sales from customers and monthly payments afterward. For this reason, these uncertainties are accepted as variable inputs for the model.

A cash flow analysis is prepared for the model where the investor can determine the cash-out flow even though the variance at the total cost. The investor can use a turnkey contractor with a fixed price for craftsmanship to minimize the risk of cost increase or use deferred payments to obtain a balanced payment schedule for the cash-out flow. The construction process usually progresses ahead of payments because of the deferred payment system, which is typical in the construction sector in Turkey. However, especially payments for materials such as iron reinforcement, bars and concrete, cannot be deferred, although there are exceptions that involve high interest rates for the delay. Iron rebars and concrete are used for building the load-bearing system of the building (a vast majority of residential buildings in Turkey are reinforced concrete) during the initial stage of construction that contains moulding and ironworks. Besides, these processes generally are not paused because of the extra mobility cost for the moulding material which cannot be easily carried from one construction site to another. Therefore, the cash-out plan of the investor can only be balanced after the reinforced concrete load-bearing system is built until the end of construction, even beyond completion, except for the last month of the building phase when the final fees and taxes are paid.

After all specific data known or calculated are collected, the probability distributions for the variable inputs for the simulation are obtained using MATCH tool. Then, a local expert is given detailed information about the plot of land, properties to be built and price range using the roulette method. The roulette method is used because of the ease of use instead of giving numbers about probabilities or lead them uncomfortable to answer, which could be misleading.

The expert was asked to illustrate the probability of:

- Sales time in terms of month,
- The price of the properties sold,
- The advance payment at sales,
- Regular payments during construction after sales,
- Construction over or under cost.

Figure 9 demonstrates the screenshot of the webpage that the experts visit after clicking the web address sent by the researcher. The horizontal axis represents the time from Month zero to Month twenty-seven. On the other hand, the vertical axis represents the number of properties sold for a particular month.

The simulation stage contained two different types of discrete-event simulations in terms of time incrementation. Since the payments are made every month by the investor to the contractors, the cash-out flow was simulated using the Fixed Time Incrementing

Method (FTIM) because the system clock must be advanced every month for the payments. On the other hand, times of property sales may not happen every month, so the system clock has to advance from event to event, making it suitable to use the Variable Time Incrementing Method (VTIM). So, a mixed-use of the two discrete-event time incrementing methods were used to build the model and running the simulation. The number of scenarios where the cash-flow balance is negative for at least one month and the number of scenarios where cash-flow balance is under -150.000 TRY which is the limit of deposit Overdraft Deposit Account (ODA) the company are also evaluated to calculate the probability of the project's success. Alternative means other than advance and monthly payments are called to play such as bank loans, delaying payments, and overdraft deposit account to keep the balance over zero because lack of funding at such state can cause profit decrease or loss. Once the balance is negative, if other forms of funding cannot be provided, then the construction will eventually stop, leading to late delivery. Otherwise, more monthly payments in the cash-out model must be added to the following month to compensate for the month when the project was underfunded. The total delay time of deferred payments varies from investor to investor; however, repeating the delay too often will inevitably cause problems in the construction and selling processes.

The property prices, amount of advance payment after a property is sold and the monthly payments after the first payment are subject to negotiations between the buyer and the investor, however, other factors like as the financial situation of the buyer or investor, the phase of the construction, the situation at the market may affect the amount agreed at the end of the negotiations.

CHAPTER 4

MODEL IMPLEMENTATION, RESULTS AND CASE STUDY

4.1. Model Implementation

The investment is basically a manufacturing and selling process and the main elements are cost, sales price, profit and time. However, construction comprises of many elements and therefore is a quite complicated process to calculate the cost especially at the beginning of the investment process even when the designs are not yet complete. Building the model starts by collecting data about the parameters that will be used for assessing the performance of the investment.

First, collecting the data about the land which made it possible to calculate the number of properties with certain features leading to the number of properties and the sales prices for the given features. Furthermore, the same data leads to the calculation of the total area of the building as well as the number of storeys, number of blocks etc. The specifications for the properties to be built are taken into consideration by the expert while using the roulette method to elicit the probability distributions for the sales prices. The same data are also used to obtain the probabilities for the sale times and together with the cost data, profit can easily be calculated.

Secondly, the collected data, and calculated inputs are shared with the expert to consider when using the MATCH tool roulette method. From the data given by the expert and with the use of the MATCH tool the possibilities for different values of variant parameters such as cost, sales, sales times, are calculated and added to the model as reference.

Finally, the relations between the added parameters are linked to each other using mathematical equations into a cash-flow diagram and finally, the obtained data for the case study are applied to the model and the results from different scenarios are compared at the end.

The progress of the construction may not be reflected simultaneously in the model because it focuses on cash-flow and the various payment methods for different type of costs. While some type of works may be paid in advance, some costs may be deferred and paid days even months after the work is complete or during the work progresses such as paid in advance, during the work process and after the work is complete. In this type of investments, most of the contracts with the subcontractors are agreed upon fixed prices for the work concerned or fixed price per unit such as sqm or m giving a perspective about the construction cost.

The first phase of reinforced concrete construction, which is the construction of the load bearing system of the building, is a phase where the payments are mainly in advance (acquisition the iron reinforcement bars), after every phase is complete (poured concrete and part of labour payments) and after the work is complete (remaining payments of the labour). Therefore, it is a stage that consumes the working capital rapidly and that the investor would not wish to elongate because of the nature of the work and risk of increasing labour costs. Many of the rest of the works after that is flexible in payments. Usually, a portion of total payment is paid in advance followed by progress payments and the final payment after completion. This gives the investor the opportunity to arrange the payments because the main strategy for the investor is to balance the monthly payments at a level with minimum variation after the RC works are complete and before the end of construction when the final payments, fees and taxed are paid.

4.2. Case Study

The case has been studied using the model developed in this study, in which an investor plans to develop a build-and-sell project; the land located in Milas is acquired with a flat-for-land contract instead of buying. Milas is a town situated in Muğla province in Turkey.

An investor who is experienced in flat-for-land build and sell investments in the town is given information about the land, its location, the neighbourhood and specifications of the properties, and current financial situation of the investor. The expert used MATCH Eliciting Probability Distribution tool with the aid of the researcher explaining what chips represent for every single variable. After the roulette charts are collected, the probabilities of the results are calculated and shared with the expert and asked if any modification for the roulette charts is required.

If the cash-out model is analysed, the last month of the construction, month twenty-four, is the month with the most expenses. Because at this stage, to get the residential permit, all the fees and taxes are expected to be paid. Together with the ongoing costs of the construction, it might even decrease the balance under zero. The first three months of the construction phase are months seven, eight and nine when the reinforced concrete load bearing system is built. The cost in the mentioned three months covers almost 40% of the total cost, while the other months in between have a regularly balanced cash-out flow as desired by the investor. Besides, the month before the last month of construction, month twenty-three, is the month with the most revenue. At this stage, the properties are supposed to be more than 80% complete, which allows the buyers to take mortgage loans from the banks and pay for the remaining revenue.

The months between the payments that cannot be delayed or postponed are the months that allow flexibility in cash-out flow to balance payments because the materials can be bought with deferred payments. For this reason, the monthly payment ratios have been accepted as stable. On the other hand, the cost increases have been simulated using the discrete-event simulation fixed time incrementing method.

The sales times of properties are simulated using Variable Time Incrementing Method (VTIM). Although there are exceptions, buying a property even before the flat-for-land agreement contains a high risk; therefore, the simulation of purchasing a property from this particular project starts from month zero, which is the first month after the flat-for-land contract is signed. However, while assessing the probability distribution cases, the probability of some properties sold after the first 24 months is also considered. On the other hand, the investor is expected to deliver the projects to apply for a building permit and get the license less than six months after the contract is signed.

Table 1 was used to inform the expert and shows the known and variable data inputs.

Table 1. Inputs of the Case Study

Input	Value	Input Type
Working Capital	1.000.000 TRY	Known Input
Flat-For-Land Ratio	1/3 for the landowner	Known Input
Deadline for Construction	24 Months After Contract	Known Input
Maximum Loan of the Company from Banks	1.000.000 TRY	Known Input
Maximum Limit for Overdraft Deposit Account	150.000 TRY	Known Input
Technical Project Costs and Permit Fees	250.000 TRY	Known Input
Area of the Land	1750 sqm	Known Input
Number of Storeys	3	Known Input
Number of Blocks	3	Known Input
Number of Properties	21	Known Input
FAR : Floor Area Ration	1.2	Known Input
Total FAR Permitted (FAR x Area of the Land)	2100 sqm	Known Input
FAR per Property	100 sqm	Known Input
Total Area of Construction	2.700 sqm	Known Input
Construction Cost per sqm	1400 TRY	Variable Input
Construction Cost	3.780.000 TRY	Variable Input
Construction Cost Ratio to Estimation	0.70 – 1.3	Variable Input
Property Price Range	300.000 TRY - 400.000 TRY	Variable Input
Time of Sales	Month0 – Month 27	Variable Input
Advance Payments Ratio to Property Price	%25 - %75	Variable Input
Monthly Payments Ratio of Sold Properties to the Remaining Payments	0% - %20	Variable Input

Firstly, the expert is asked to distribute 100 chips among the months at the project timeline when it is most probable for the properties can be sold according to the knowhow of the expert. The progress of construction is also related to the sales; therefore, the expert is informed that the construction of the load-bearing system will be complete by the end of the Month 9 and the deadline for the construction is Month 24. However, the timeline is modelled as 27 months because there could still be sales after the construction is complete as well as some payments may be deferred so that they can exceed the deadline of the project.

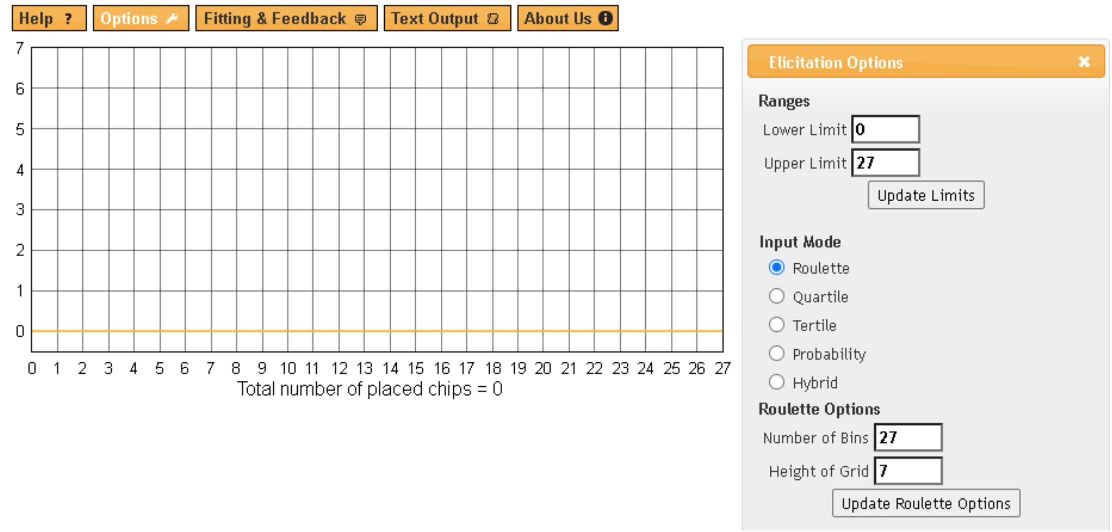

Figure 9. Screenshot from the MATCH tool for Property Sales Times

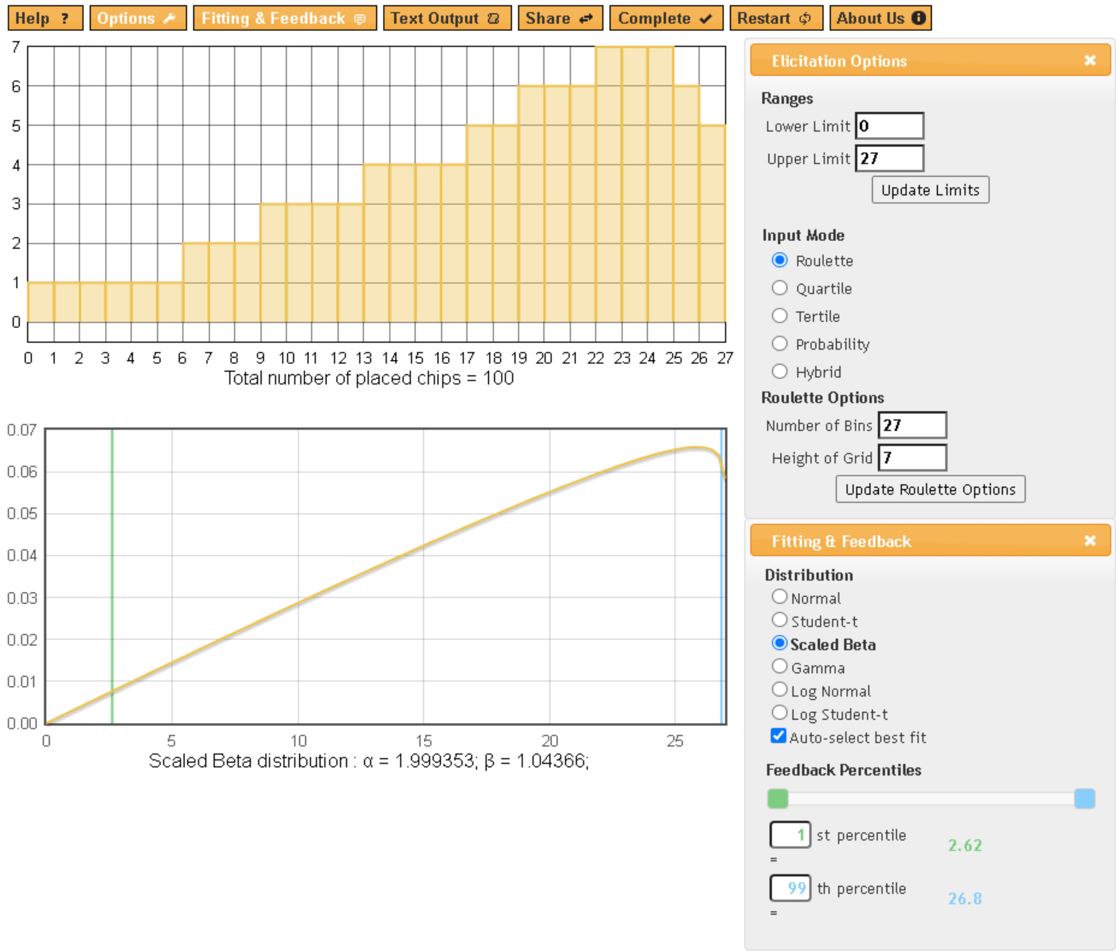

Figure 10. Screenshot chart from the MATCH tool for Property Sales Times by the expert

As seen in the screenshot the probability of sales increase as construction starts to be nearer to completion. The tool selects Scaled Beta Distribution with values below as the best fit for the input provided.

$$\alpha = 1.999353 \text{ and } \beta = 1.04366$$

The results of the probabilities for each month are as follows.

Table 2. Data used in the model for Property Sale Time

Property Sale Time					
Month	**Probability**	**Month**	**Probability**	**Month**	**Probability**
1	0.01	**10**	0.03	**19**	0.05
2	0.01	**11**	0.03	**20**	0.06
3	0.01	**12**	0.03	**21**	0.06
4	0.01	**13**	0.03	**22**	0.06
5	0.01	**14**	0.04	**23**	0.07
6	0.01	**15**	0.04	**24**	0.07
7	0.02	**16**	0.04	**25**	0.07
8	0.02	**17**	0.04	**26**	0.06
9	0.02	**18**	0.05	**27**	0.05

Secondly, the expert is also asked to distribute 50 chips for the property price range between 300.000 TRY and 400.000 TRY considering the construction progress, the financial data such as working capital allocated for this project and the number of properties for sale.

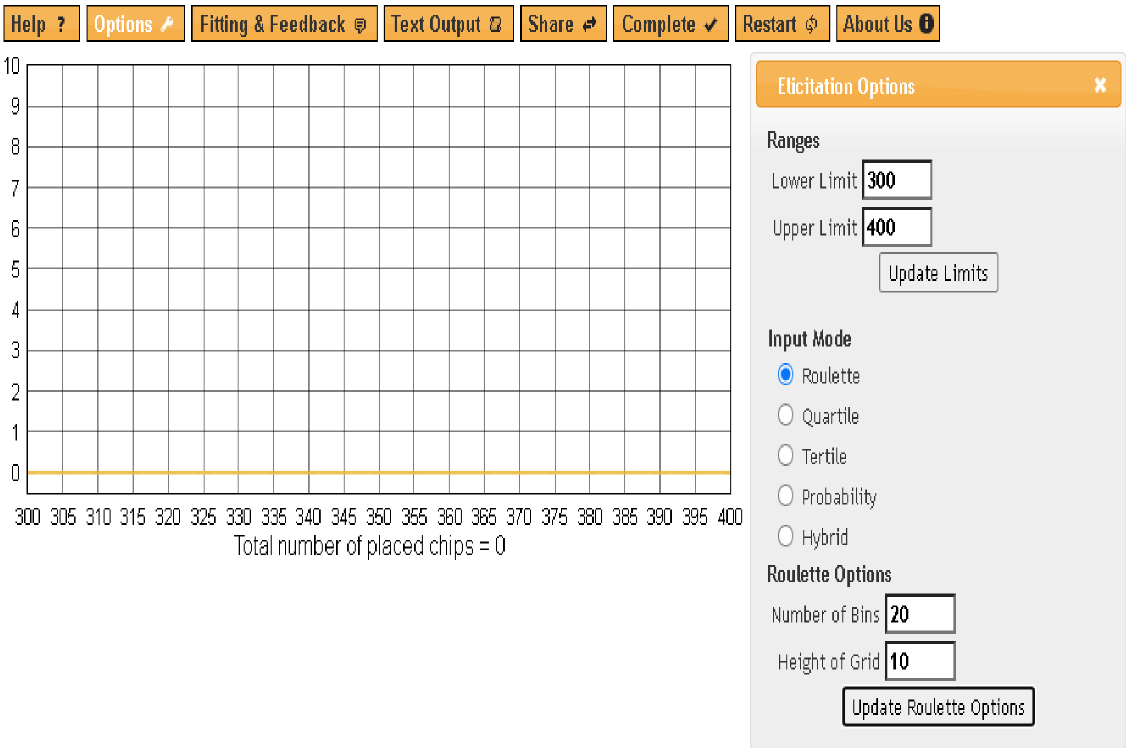

Figure 11. Screenshot from the MATCH tool for Property Prices

Normally, the property prices would increase as the construction progresses however, it is not accepted that way because of the risk of negative cash balance that can lead to a pause in construction process. If the working capital together with the loan was higher and the risk for completion of the project was much lower, investor would normally intend to sell the properties within the high range and the buyers would intend to buy near completion because of the high prices. Furthermore, the need for liquidity may be a disadvantage for the investor during the negotiations or vice versa. If the process pauses or stops for lack of capital, then the costs for the following months may have to be higher to compensate for the lost time, or the construction may be delayed, which may lead to penalties. For this reason, the property prices may vary regardless the progress of the construction.

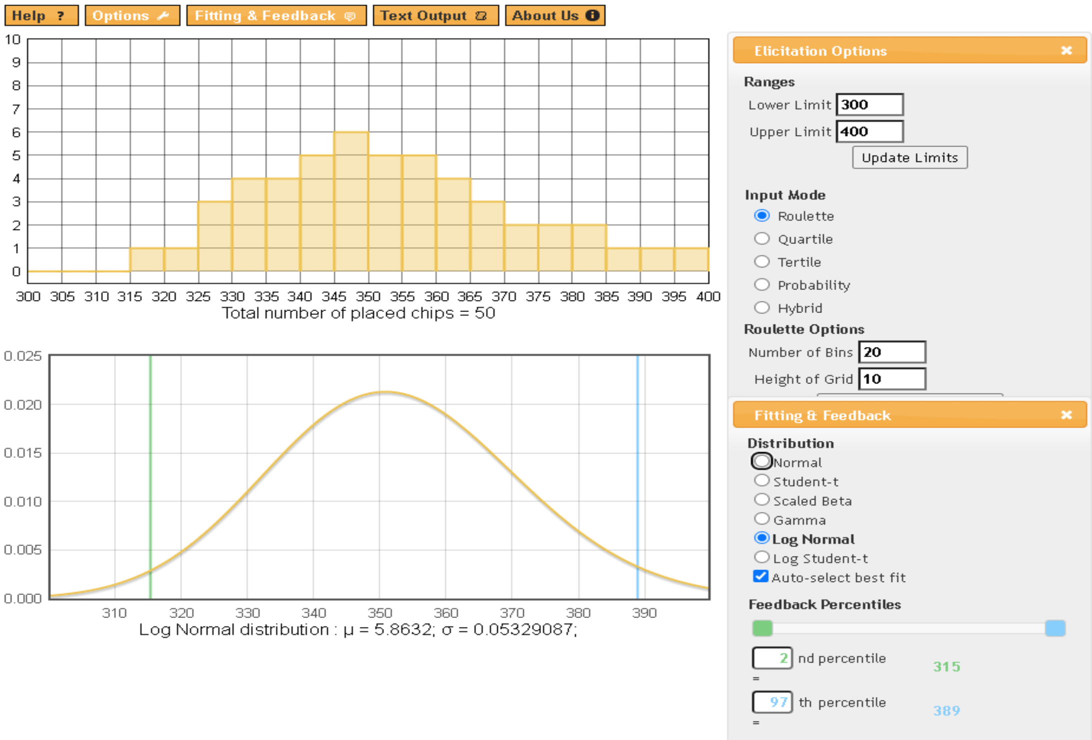

Figure 12. Screenshot from the MATCH tool for Property Prices by the expert

As seen in the screenshot at Figure 12, the probability of sales price is near to the mean value of the price range. The tool selects Log Normal Distribution with values below as the best fit for the input provided.

$$\mu = 5.8632 \text{ and } \sigma = 0.05329087$$

The results of the probabilities for each month are as follows.

Table 3. Data used in the model for Property Prices.

Property Price					
Price	**Probability**	**Price**	**Probability**	**Price**	**Probability**
311,000.00 ₺	0.01	**350,000.00 ₺**	0.12	**384,000.00 ₺**	0.03
321,000.00 ₺	0.03	**355,000.00 ₺**	0.10	**389,000.00 ₺**	0.02
325,000.00 ₺	0.03	**360,000.00 ₺**	0.09	**393,000.00 ₺**	0.01
330,000.00 ₺	0.05	**365,000.00 ₺**	0.09	**398,000.00 ₺**	0.01
335,000.00 ₺	0.06	**370,000.00 ₺**	0.08	**400,000.00 ₺**	0.01
340,000.00 ₺	0.08	**375,000.00 ₺**	0.05		
345,000.00 ₺	0.09	**379,000.00 ₺**	0.04		

Thirdly, the expert is asked about the expectations for ranges for the construction cost estimate which is simply calculated by multiplying the total area of the building with the unit construction cost. 50 chips were asked to be distributed between the coefficients ranging between 0.7 – 1.3.

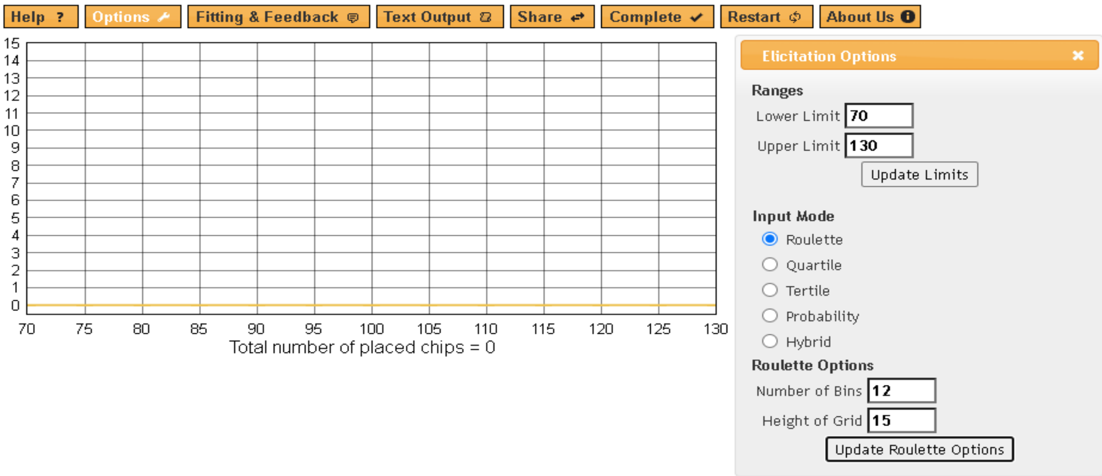

Figure 13 Screenshot from the MATCH tool for Construction Cost Coefficients

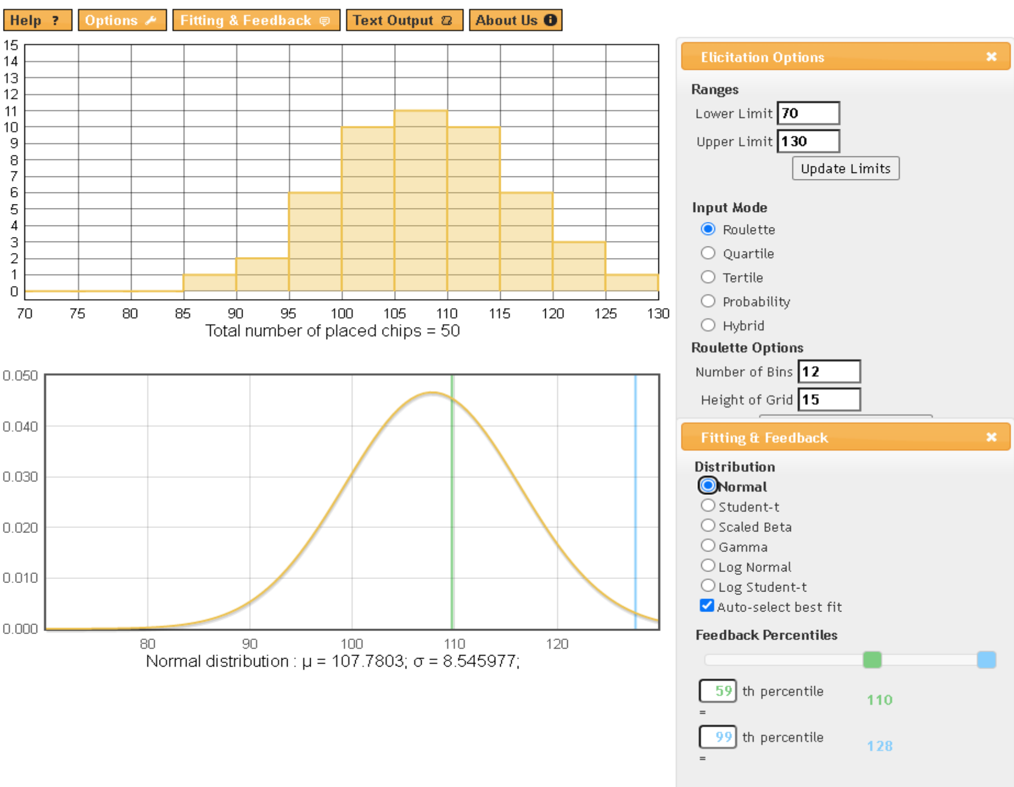

Figure 14.Screenshot from the MATCH tool for Construction Cost Coefficients by the expert

As seen in the screenshot the probability of cost tends to be more than estimated at first. The tool selects Normal Distribution with values below as the best fit for the input provided.

$$\mu = 107.7803 \text{ and } \sigma = 8.545977$$

The results of the probabilities for each coefficient are as follows.

Table 4. Data used in the model for Construction Cost Coefficient

Total Construction Cost			
Coefficient	**Probability**	**Coefficient**	**Probability**
0.9020	0.02	**1.1500**	0.22
0.9520	0.05	**1.2000**	0.12
1.0000	0.11	**1.2500**	0.05
1.0500	0.21	**1.3000**	0.02
1.1000	0.20		

Fourthly, the expert is asked about the advance payment for property sale during the construction process considering the timeline and the sale price of the properties. The range might vary from 25 % to 75% depending on the negotiations, the financial state of the buyer and the investor. Distribution of 50 chips was done between a range of ratios to the property sale price which are 25%-75%

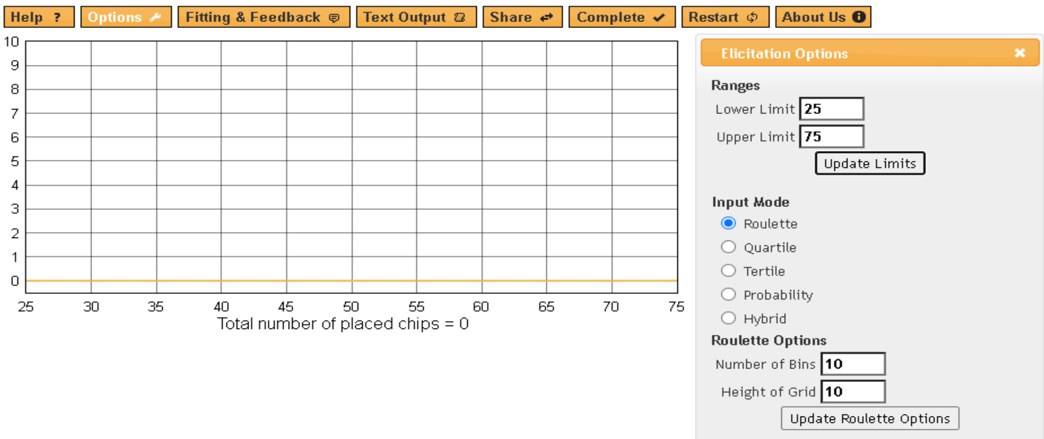

Figure 15.Screenshot from the MATCH tool for Advance Payment Ratio to the Property Price

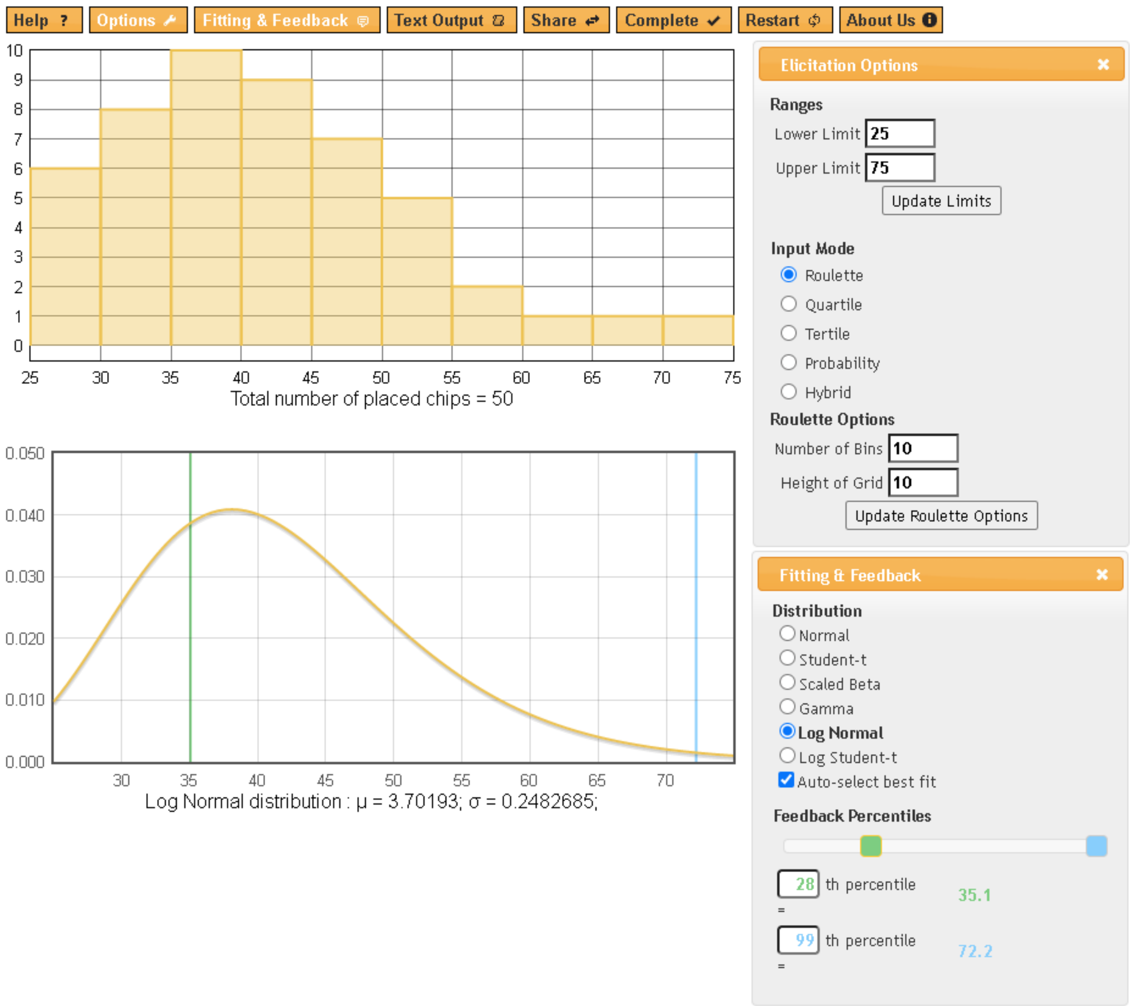

Figure 16. Screenshot from the MATCH tool for Advance Payment Ratio to the Property Price by the expert

As seen in the screenshot at the Figure 16 above, the probability of advance payment ratio tends to be under 50 percent of the agreed price during the negotiations. The tool selects Log Normal Distribution with values below as the best fit for the input provided.

$$\mu = 3.70193 \text{ and } \sigma = 0.2482685$$

The results of the probabilities for each ratio are as follows.

Table 5. Data used in the model for Advance Payment Ratio to the Property Price

Advance Payments					
Ratio to Sales Price	**Probability**	**Ratio to Sales Price**	**Probability**	**Ratio to Sales Price**	**Probability**
0.2540	0.03	**0.4490**	0.18	**0.6460**	0.03
0.2990	0.08	**0.4990**	0.14	**0.6750**	0.01
0.3510	0.17	**0.5500**	0.09	**0.7220**	0.01
0.4000	0.20	**0.5960**	0.05	**0.7500**	0.01

Finally, the expert is asked to distribute chips between a range of monthly progress payments from the customers that have bought a property. The chips are distributed between a range of ratios to the remaining payment after advance payment. After the total amount of monthly payments is determined, the amount is distributed to the months after the advance payment until one month before the construction is completed which is Month 23 for the case study. On Month 24, the building is completed and ready to be delivered and use of mortgages is possible for the clients so that the final payments for the sold properties can be done together with the delivery of the title deeds.

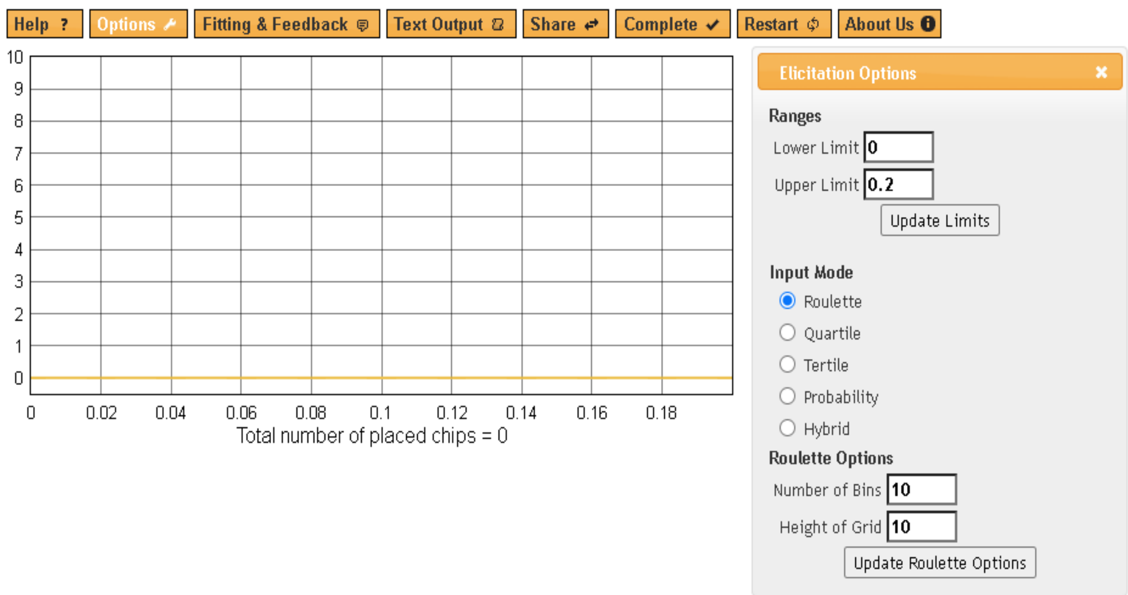

Figure 17. Screenshot from the MATCH tool for Monthly Payment Ratio to the Remaining Payments

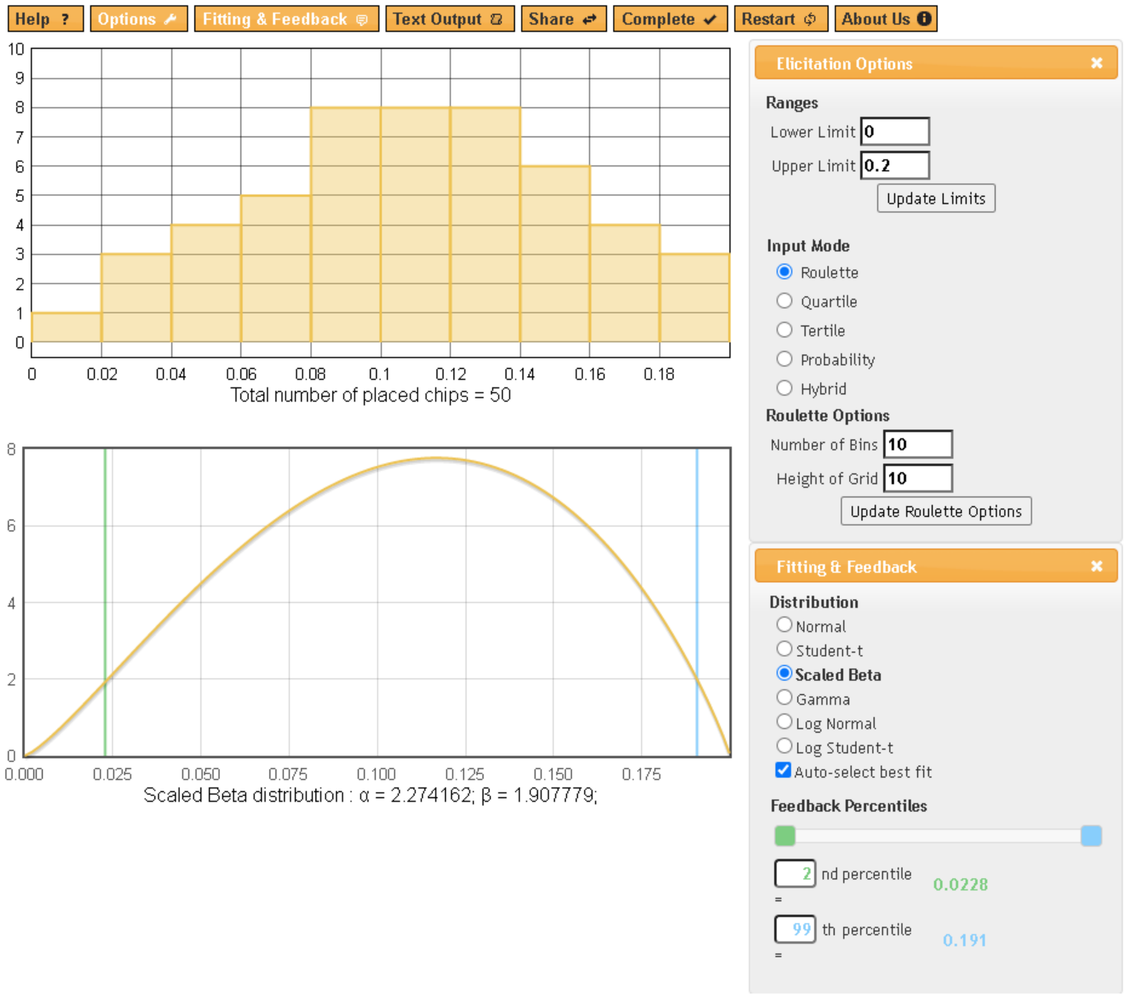

Figure 18. Screenshot from the MATCH tool for Monthly Payment Ratio by the expert

As seen in the screenshot the ratio of the probability of ratios of the total of monthly payments to the remaining payments vary between 0% to %20 percent. The tool selects Scaled Beta Distribution with values below as the best fit for the input provided.

$$\alpha = 2.274162 \text{ and } \beta = 1.907779$$

The results of the probabilities for each month are as follows.

Table 6. Data used in the Model for Monthly Payments Ratio to the Remaining Payment

Total Monthly Payments from Buyers					
Ratio to Sales Price	**Probability**	**Ratio to Sales Price**	**Probability**	**Ratio to Sales Price**	**Probability**
0.0000	0.01	**0.0803**	0.12	**0.1600**	0.13
0.0228	0.01	**0.0998**	0.14	**0.1830**	0.11
0.0407	0.05	**0.1210**	0.16	**0.2000**	0.03
0.0605	0.09	**0.1400**	0.15		

CHAPTER 5

RESEARCH FINDINGS AND DISCUSSIONS

A real-life case data was used to simulate the proposed model. The data obtained together with the probabilities is added to the simulation which was run for 1000 trials. Discrete Event Simulation method is used for both cash-in and cash-out models using months as the unit for time. For the cash-in model, Variable Time Incrementing Method VTIM was used so that the system clock advances after every sale when it happens and the incomes along with it are distributed to the cash-flow diagram accordingly. The costs are, however, planned as monthly event where the system clock advances for every single month. For this reason, Fixed Time Incrementing Method was used to simulate the cash-out model. Finally, after combining the cash-in and cash-out models together with the financial data available, such as amount, time and duration of loan and the amount of working capital as well the incomes and expenses thorough interest the cash-flow diagram is obtained. Microsoft Office Suit Excel program is used for building the model, for calculations and simulation. Random number generator add-in was used to obtain the simulated numbers by introducing the possibility data derived from MATCH online tool.

The obtained results for the simulation are the mean of total sales, total cost profit, profit percentage and Net Present Value together with the possibilities of values within various ranges for each output. These values obtained aim to address the possibility of the financial gains from the project. Moreover, the mean of the number of months with negative cash balance for every trial and the mean of the number of months where the cash balance is under the ODA limit which is -150,000.00 TRY are also counted. The use of ODA allows the investor to tolerate the negative cash balance up to 150,000.00 TRY which might allow the investor to gain one or more months of tolerance until a property is sold, and income is obtained.

The results of the simulation showed that for the given data, total sales vary from 4,866,313.51 TRY up to 5,354,049 TRY with a mean value of 4,866,313.51 TRY. The standard deviation calculated is 82,441.94 TRY. However, the most likely ranges of sales observed are from 5,000,000.00 TRY to 5,200,000.00 TRY with a total probability of 76.7 % where the probabilities for the range between the amounts 5,000,000.00 TRY and

5,100,000.00 TRY is 36.6 %, and 5,100,000.01 TRY and 5,200,000.00 TRY is 40.4 %. It is also observed that the total sales will be between 4,900,000.01 TRY and 5,300,000.00 TRY with a total probability of 99%.

Table 7. The Results for the Total Sales Ranges and Probabilities

TOTAL SALES		**Min**	**Max**	**Std. Dev.**	**Mean**
		4,866,313.51 ₺	5,354,049.02 ₺	82,441.94 ₺	5,103,507.41 ₺
Range	**Probability**	**Range**	**Probability**	**Range**	**Probability**
4,866,313.50 ₺	0.40%	5,000,000.01 ₺	36.30%	5,200,000.01 ₺	11.60%
4,900,000.00 ₺		5,100,000.00 ₺		5,300,000.00 ₺	
4,900,000.01 ₺	10.70%	5,100,000.01 ₺	40.40%	5,300,000.01 ₺	0.60%
5,000,000.00 ₺		5,200,000.00 ₺		5,354,049.02 ₺	

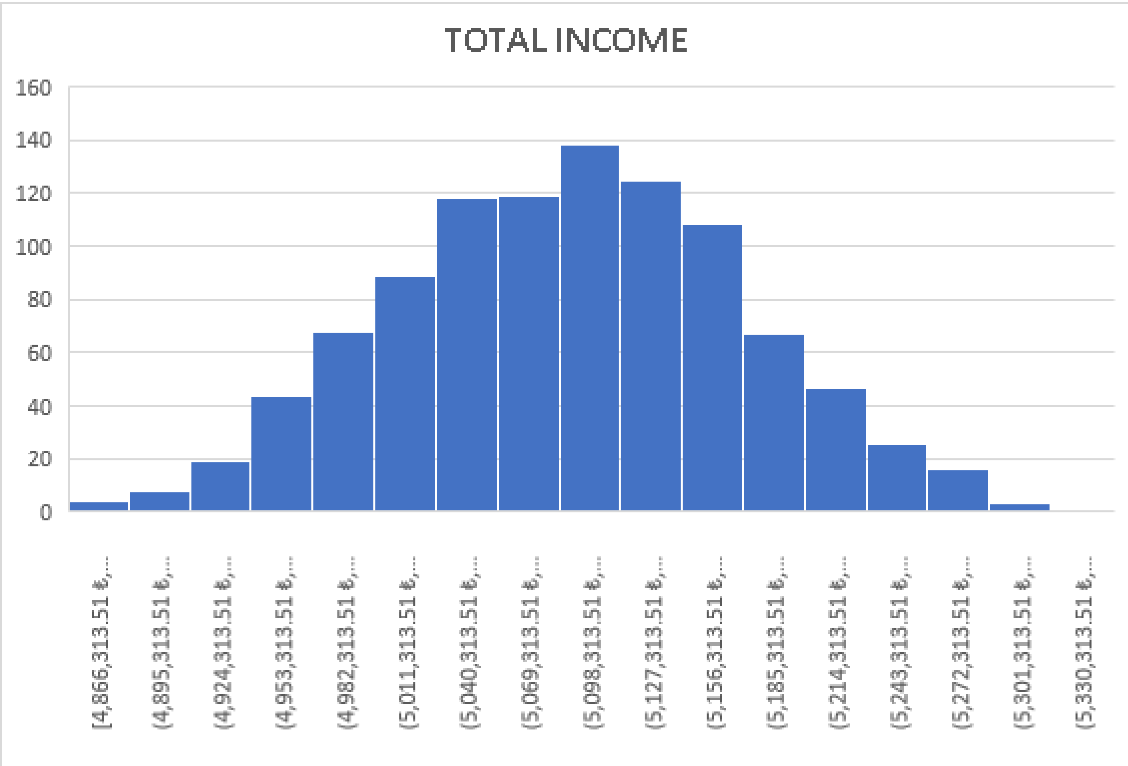

Figure 19. Histogram for the Results for Total Income

The results for the construction cost, however, vary between 3,550,090.44 TRY and 5,054,530.44 TRY with a mean value of 4,306,990.08 TRY and the standard deviation is 320,330.16 TRY. With a 63.4% probability the cost will be between

4,000,000.00 TRY and 4,499,999.99 TRY, and the probabilities for the range between 3,550,090.44 TRY and 3,999,999.99 TRY is 17.4% same as the probability for the range between 4,500,000.00 TRY and 4,999,999.99 TRY which is also 17.4%. As a combination of the abovementioned ranges, the cost range between 3,550,090.44 TRY and 4,999,999.99 TRY is 98.2%.

Table 8. The Results for the Total Cost Ranges and Probabilities

TOTAL COST		**Min**	**Max**	**Std. Dev.**	**Mean**
		-5054530.439	-3550090.439	320330.1626	-4306990.079
Range	**Probability**	**Range**	**Probability**	**Range**	**Probability**
-5,054,530.45 ₺	1.80%	-4,499,999.99 ₺	63.40%		
-5,000,000.00 ₺		-4,000,000.00 ₺			
-4,999,999.99 ₺	17.40%	-3,999,999.99 ₺	17.40%		
-4,500,000.00 ₺		-3,550,090.44 ₺			

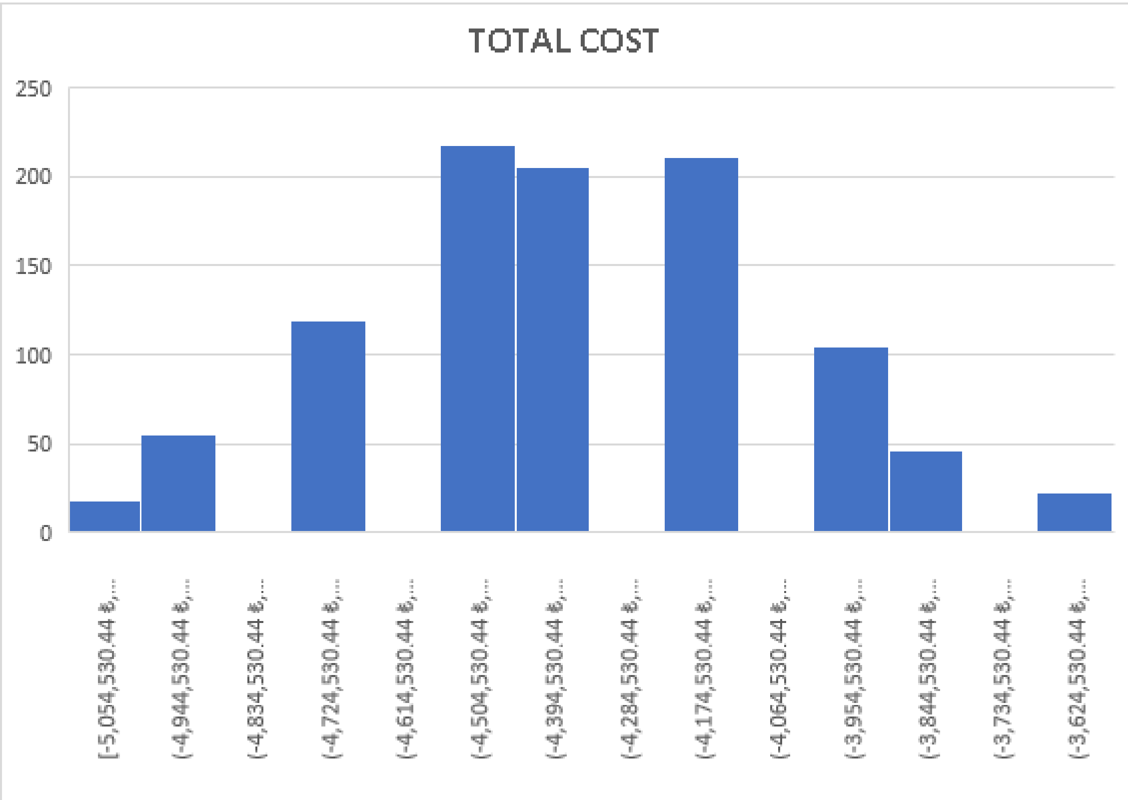

Figure 20. Histogram for the Results for Total Cost

The mean value for the profit is 796,517.33 TRY with a minimum value of (minus) -105,776.22 TRY, a maximum value of 1,751,095.10 TRY and the standard deviation is 349,798.87 TRY. The risks for no profit and loss are only 1% and the probability of the profit range from 0.01 TRY to 500,000.00 TRY is 18.5%. Almost half of the trials indicate the profit range between 500,000.01 TRY to 1,000,000.00 TRY with a possibility of 50.3% and the range between 1,000,000.01 TRY and 1,500,000.00 TRY with 27.8%. The profit range between 0.01 and 1,500,000.00 TRY is 96.6% in total.

Table 9. The Results for the Profit Ranges and Probabilities

PROFIT		**Min**	**Max**	**Std. Dev.**	**Mean**
		-105,776.22 ₺	1,751,095.10 ₺	349,798.87 ₺	796,517.33 ₺
Range	**Probability**	**Range**	**Probability**	**Range**	**Probability**
-105,776.23 ₺	1.00%	500,000.01 ₺	50.30%	1,500,000.01 ₺	2.40%
0.00 ₺		1,000,000.00 ₺		1,751,095.10 ₺	
0.01 ₺	18.50%	1,000,000.01 ₺	27.80%		
500,000.00 ₺		1,500,000.00 ₺			

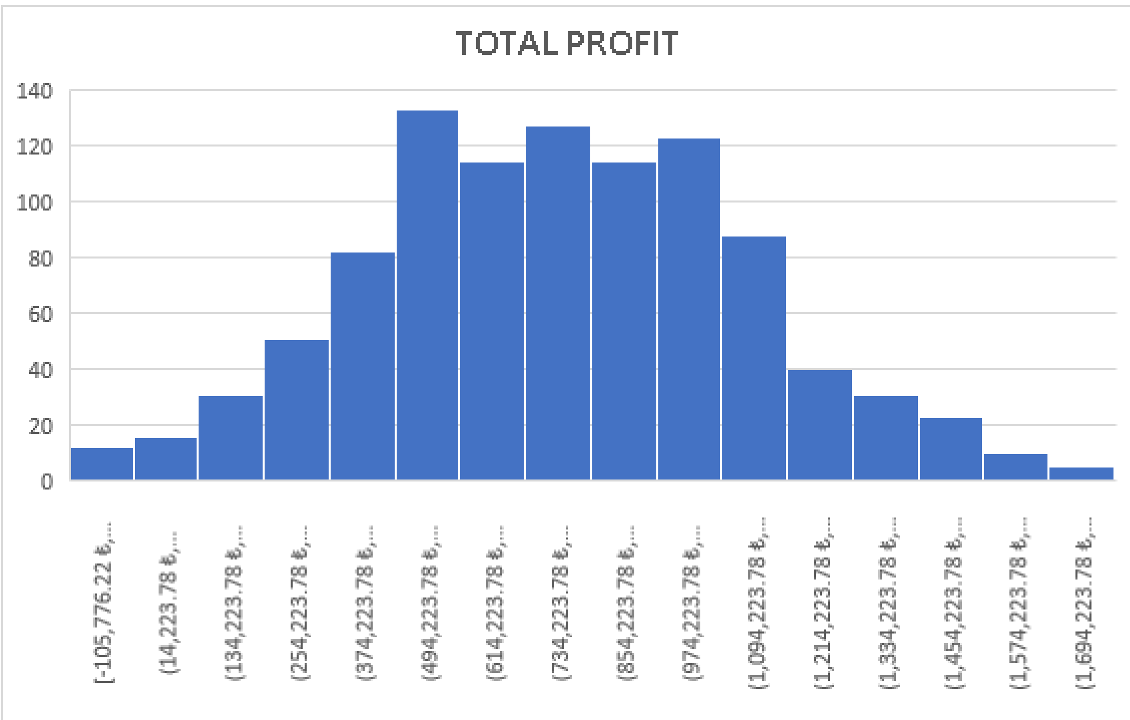

Figure 21 Histogram for the Results for Total Profit

On the other hand, the percentage of the profit varies from -2.09 % to 49.33 %, the mean value for profit percentage is 19.2% with a standard deviation of 9.969 %. The model shows that that the range of profit between 10.01 % and 20% is 39.3% probable and the range between 20.01 % up to 30 % is 30.3 % probable. The range between 0.01% and 40% covers 96.3 % of the results.

Table 10 .The Results for the Profit Percentage Ranges and Probabilities

PROFIT %		**Min**	**Max**	**Std. Dev.**	**Mean**
		-2.092701%	49.325366%	9.695572%	19.196720%
Range	**Probability**	**Range**	**Probability**	**Range**	**Probability**
-2.09%	1.00%	10.01%	39.30%	30.01%	10.60%
0.00%		20.00%		40.00%	
0.01%	16.10%	20.01%	30.30%	40.01%	2.70%
10.00%		30.00%		49.33%	

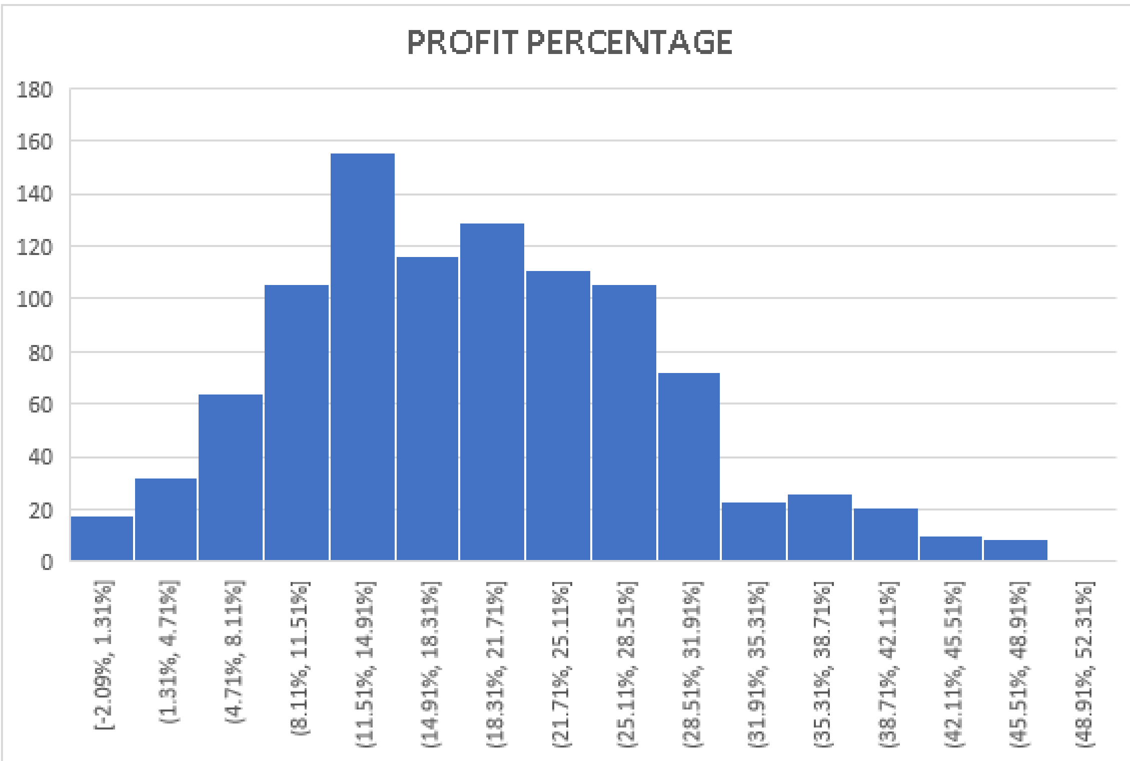

Figure 22 Histogram for the Results for Profit Percentage

NPV for each scenario is calculated by subtracting the NPV of the cash-out flows including the known inputs and loan payments, from the NPV of the cash-in flow including monthly interest gains from the bank when the cash balance is positive. The working capital is also subtracted from the NPV so that the positive results show the success of the investment and negative results indicate failure. The results vary from -520,224.41 TRY to 1,036,253.59 TRY with a mean value of 260,965.57 TRY and standard deviation is calculated as 280,865 TRY. The possibility of negative results is 18.5% in total and majority of the possibilities range between 0.01 TRY and 500,000.00 TRY covering 61.5 % probability. The NPV range between 500,000.01 TRY to 1,000,000.00 TRY is 19.9 % probable. The NPV is expected to be between -499,999.99 TRY and 1,000,000.000 TRY with a total probability of 99.8%.

Table 11. The Results for the NPV Ranges and Probabilities

NPV		**Min**	**Max**	**Std. Dev.**	**Mean**
		-520,224.41 ₺	1,036,253.59 ₺	280,865.64 ₺	260,965.57 ₺
Range	**Probability**	**Range**	**Probability**	**Range**	**Probability**
-520,224.42 ₺	0.10%	0.01 ₺	61.50%	1,000,000.01 ₺	0.10%
-500,000.00 ₺		500,000.00 ₺		1,036,253.59 ₺	
-499,999.99 ₺	18.40%	500,000.01 ₺	19.90%		
0.00 ₺		1,000,000.00 ₺			

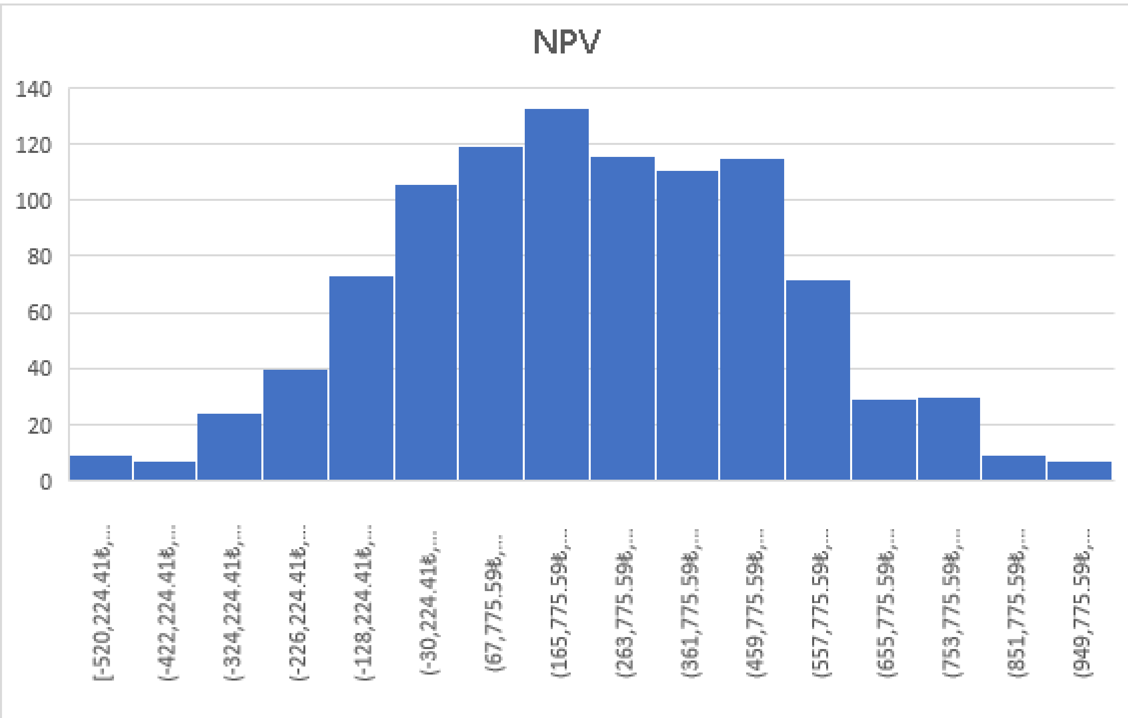

Figure 23. Histogram for the Results for NPV

Even though the end results are important in terms of financial gains, the process is much more decisive for the success of the project because the end results can only be achieved only if the project can continue until the end, in our case, construction. For this reason, the cash balance has to be over zero for most of the time, especially for projects where the sum of loans and working capital does not cover the whole expenses from beginning until the end. Results of the simulation for the case study demonstrates that the cash balance will be negative for maximum 17 months. The mean value for the trials is 12.23 months and the standard deviation is 2.79 months. The possibility of having negative cash balance between 11 to 15 months is 77.6 % in total. 14 months is the most likely among others with the probability of 21.4%. Table 12 below demonstrated the results for number of months with negative cash balance.

Table 12. The results for the Number of Months with Negative Cash Balance and Probabilities

PROBABILITY OF NEGATIVE CASH BALANCE		**Mean**	**Min**	**Max**	**Std. Dev.**
		12.23	**0.00**	**17.00**	**2.79**
0 Month(s)	**1 Month(s)**	**2 Month(s)**	**3 Month(s)**	**4 Month(s)**	**5 Month(s)**
0.006	**0.001**	**0.007**	**0.005**	**0.005**	**0.007**
6 Month(s)	**7 Month(s)**	**8 Month(s)**	**9 Month(s)**	**10 Month(s)**	**11 Month(s)**
0.012	**0.024**	**0.025**	**0.048**	**0.061**	**0.102**
12 Month(s)	**13 Month(s)**	**14 Month(s)**	**15 Month(s)**	**16 Month(s)**	**17 Month(s)**
0.127	**0.175**	**0.214**	**0.158**	**0.018**	**0.005**

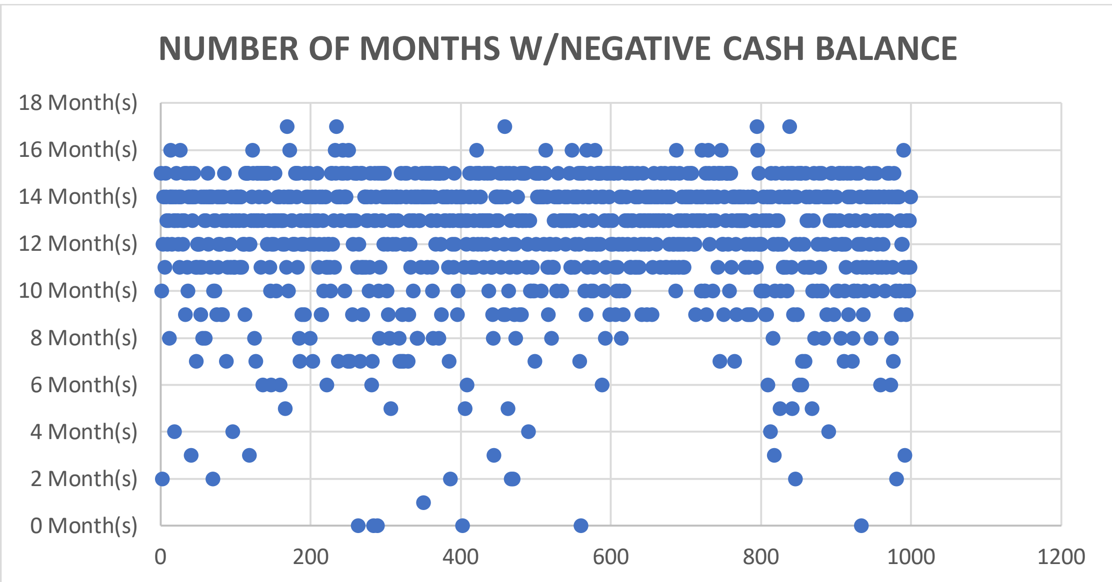

Figure 24 Point chart showing the Trials with the Negative Cash Balance

The Overdraft Deposit Account (ODA) acts as a short-term borrowing tool for cash so that the payments can be delayed for a certain period for the expense of interest until there is a change in the cash-in situation. As the construction and payments continue thorough process, and considering the size of payments, the tolerance may not be more than one or two months. For this reason, the number of months with cash balance less than ODA limit is also calculated using the simulation. The results from the simulation of the case study shown in Table 13 shows that the project will have a cash balance less than the limit of the ODA from 10 to 14 months with a probability of 70.8%. 12 months is the most likely among others with the probability of 17.0%. The maximum number of months is 17 months with a mean value of 10.89 months and the standard deviation is 3.25 months.

Table 13. Results for the Number of Months with Cash Balance less than the limit of the ODA (-150,000.00 TRY)

PROBABILITY OF CASH BALANCE UNDER 150.000 ₺		Mean	Min	Max	Std. Dev.
		10.89	0.00	17.00	3.25
0 Month(s)	1 Month(s)	2 Month(s)	3 Month(s)	4 Month(s)	5 Month(s)
0.019	0.007	0.009	0.011	0.009	0.019
6 Month(s)	7 Month(s)	8 Month(s)	9 Month(s)	10 Month(s)	11 Month(s)
0.032	0.023	0.048	0.067	0.105	0.119
12 Month(s)	13 Month(s)	14 Month(s)	15 Month(s)	16 Month(s)	17 Month(s)
0.170	0.165	0.149	0.043	0.003	0.002

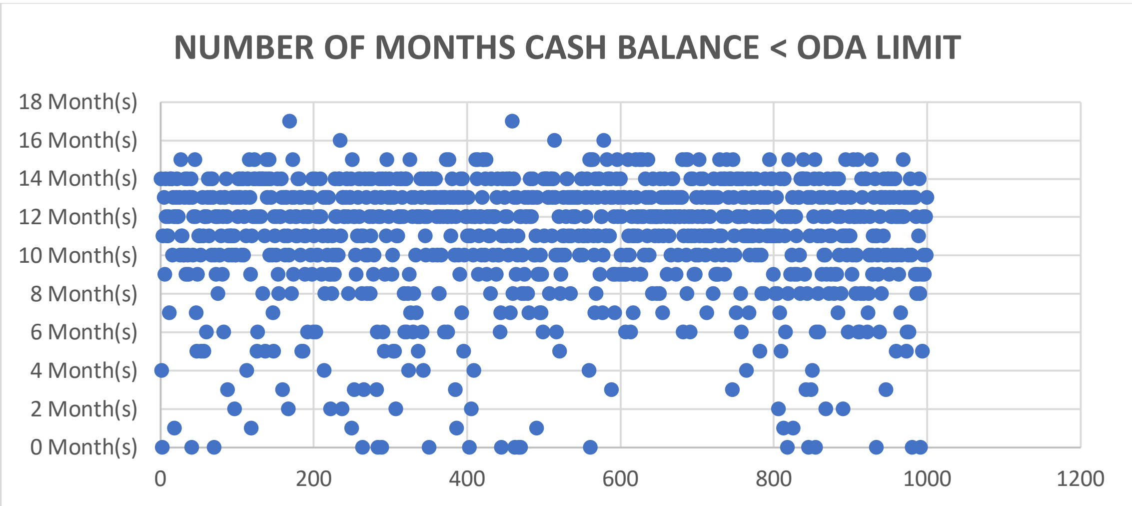

Figure 25. Point chart showing the Trials with the Cash Balance less than Overdraft Deposit Account Limit

CHAPTER 6

CONCLUSION

Increasing competition in the real estate market causes decreases in profits, forcing investors to take more risks to increase production and total gain. Managing higher financial risks requires a better assessment of the current situation and a reasonable estimation of the scenarios that might occur in the future. Besides, investors seek ways to decrease financial risks or share some of them with other parties involved in the investments. The flat-for-land method, for this reason, is a commonly used method in Turkey where the landowner accepts properties instead of cash in exchange for the land. The reason is usually that, the total cost of the properties is higher than the land price and the construction cost of the properties that will be delivered to the landowner is either lower or close to the land price and the total amount of capital invested in the project is lower as much as the amount of the land price.

Another risk for the investor is to allocate less capital than the total cost and rely-on the property sales during construction leading to advance and monthly payments afterwards. The investor might distribute the capital into two or more projects to gain twice or more profit than a single project which can also bring more profit than the loss of profit due to underfunding of the projects. Distribution of risks into multiple projects instead of one can also be an advantage. Other than the advantages, the investor may simply not have sufficient funds to complete the entire project.

Construction is a long-term process making the investment long-term as well, thus more risks are involved than short-term investments. The change in costs, prices, and uncertainties that may arise through time, may affect the success of the investment and the investor. Since the construction process contains many uncertainties and lack of organized data, the discrete event simulation approach is chosen to analyse the situation for such investments. Unlike continuous simulations, the discrete-event simulation approach deals with the system's state only when the event occurs, making it an advantage while dealing with situations with insufficient data and lots of uncertainties.

The stochastic approach requires information about the distribution types of variable inputs such as time of property sales, property prices, advance payments, and monthly payments during construction. However, due to insufficient data, eliciting method using the MATCH Uncertainty Elicitation tool made it possible to transfer the expert opinion, knowledge and judgments into quantitative data that can be used in the simulation.

Use of Variable Time Incrementing Method for cash-in model and Fixed Time Incrementing Method for cash-out model and combination of the two with a cashflow simulation helped to observe the system behaviour in the Discrete Event Simulation Approach.

The model aims to evaluate the performance of a real estate development project, which is not fully funded at the beginning, in terms of profit and the possibility of completion.

First of all, the results indicate that total range of income gained from the project at the end, with a total possibility of 76.70%, corresponds to an average property price between 357,142.86 TRY and 371,428.57 TRY per property which is above the average sales price in the vicinity (350,000.00 TRY) for the current time. Considering the incomes will be obtained most lately two years later, the increase in price is obviously less than the inflation rate making the average property sales less than the current prices. However, the fact that only 1,000,000.00 TRY working capital is allocated for the project, makes it acceptable because the sales are on-project sales, and the risk is lesser.

Moreover, the results demonstrate that the cost estimated at the beginning, by simply multiplying the total area with the unit cost, will most likely be between 4,000,000.00 TRY and 4,500,000.00 TRY, which is 19.05% more than the estimated cost, with a possibility of 63.40 %. Considering that almost half of the total cost will be spent at the initial periods of the process and the inflation rate in the country, it remains under the inflation rate which makes it acceptable.

Primarily, the aim for investment is to gain profit therefore, the system is built to decrease costs and increase revenues by any means possible. The results indicate that there is only 1% possibility for the project to have loss instead of profit gain. The amount of profit between 500,000.00 TRY and 1,000,000.00 TRY has 50.3% probability. If the profit amounts are compared to the working capital allocated for the project at the beginning, the profit gain seems more than half of the capital risked for the investment. However, if it is compared to the total amount risked for the investment, the profit gain is under the inflation rate and the general expectancy for profit from such a project which is at least 20%. On the other hand, the possibility for the profit to be within the range between 1,000,000.00 TRY and 1,500,000.00 TRY is 27.8% so that the investor may be satisfied with the outcome.

After the outputs about percentage of the profit to the total cost, it is naturally observed that the ratio of profit is 99% over zero, 33.9% between 10% to 20% profit, 30.3% between 20% to 30% profit. The profit percentage is calculated separately to observe the relation between cost and profit. The probability of profit between 500,000.00 TRY and 1,000,000.00 TRY is 50.3% (approximately between 10% to 20% of the cost 4,000,000.00 TRY and 4,500,000.00 TRY with a probability of 63.4 %). However, the probability of achieving profit percentages between 10% to 20% drops to 30.9%. A 20% profit percentage range shifts to the upper range between 20% to 30% meaning possibility of obtaining more profit with less risk involved.

Net Present Value of the project, however, indicates that there is a higher risk of loss with 18.5% probability unlike the other results. Majority of the NPV results, 61.5%, is located between 0.00TRY and 500,000.00TRY and only 19.9% is located between 500,000.00 TRY and 1,000,000.00 TRY. The main reason for this contradiction is that the costs tend to be more at the beginning and decrease as construction progresses (except for the last month of construction when the fees and remaining payments are done), however, the sales tend to happen more likely close to the end of the process. Besides majority of the payments also must happen at the end after delivery. Considering the construction to take 18 months to be complete and the inflation rate NPV performance is expected to be less than that of the amount of profits.

Another major criterion for the project performance is the sustainability of the cash-flow and progress of the construction. Regardless of the profit level, if the continuity of construction and cash-flow cannot be sustained, the process will eventually pause or end causing losses in both situations. Therefore, it is vital to observe the system performance in terms of the sustainability of the continuous progress meaning the process and the payments must be planned in a way that the cash-balance does not decrease to negative or intolerable negative values.

As mentioned earlier, the tolerance to the delays in deferred payments varies between the investors and contractors and suppliers. Therefore, cash balance being under zero for several months, will affect the construction process and property sales during construction. Suppose payments to suppliers are delayed for too long, even beyond the agreed time of deferred payment, in that case, the supplier might stop sending materials or unpaid workers might quit and may not be replaced because of the unwanted reputation. If the construction slows down or stops because of such delay, new customers will not have the confidence in the investor to complete the project, which will avoid sales.

Moreover, customers who have already bought a property might stop paying the monthly payments because the construction is not progressing. They might even give up on the purchase and request a refund of total revenues. The building may even be complete but late. Then penalties will be charged to the investor for late delivery to the customers and landowner too. For this reason, the number of months where the balance is below zero is counted to calculate the probability of completing the project. Moreover, even though some scenarios demonstrate high percentages of profit gains, the number of months where the total balance is negative, the project might be considered as failing.

According to the simulation data, the cash balance will most likely be negative for 11 to 15 months with 77.6% possibility. Moreover, the probability of negative cash balance for 6 months or less is only 4.3%. If the overdraft deposit account is considered, the results still show that the cash balance will be under the limit of the ODA for 10 to 14 months with a 70.8% probability. As the numbers demonstrate, the ODA is only effective for one month to tolerate the lack of funding which emphasizes it as a tool for borrowing money for a short period.

Given the circumstances, even though the financial results obtained through simulation looks promising, the project tends to have a low performance in terms of sustaining positive cash-flow balances. Using the data and the results derived from it, the investor has to bring financial solutions.

First of all, the investor may give up on the investment. Secondly, the investor may choose to increase the allocated working capital, if it is possible, which will increase the capital at risk and decrease the NPV results. Investor might also try to lower prices for the properties to achieve earlier sales with lesser profit margins. Apart from that, the investor might increase the amount of loan and/or increase the loan term which means increased interest costs and lesser profits. However, thanks to the tolerability gained through the loan, the investor can compensate the increased cost by simply increasing the property prices. Finally, investor might choose to work with financially strong contractors (generally with higher prices) and pay them simply using properties as payment method (barter).

Table 14. Actions and Effects List for the Investor

ACTION	**EFFECT**
Give up on Investment	
Increase Working Capital	Decreases the NPV
Lower the Property Prices Bring Sale Times Earlier	Decreases the total profit
Increase the loan or loan term	Increase the interest paid to the bank. Decrease Profit
Pay contractors by barter. (Property or properties in exchange for contractors’ service)	Might affect the profit both positively and negatively depending on the negotiations

A case was used to observe the implementation of the model. The Value Added Tax (VAT) returns are not involved in the model.

The method used for simulating the cash flow model is done intuitively by investors who do not have a technical background. Further studies using eliciting and availability of better data sets, will make it possible to understand how to deal with cases in such conditions better.

“All models are wrong, but some are useful.”
George E. P. Box

The study presented in this paper can also be used as a tool when deciding on real-estate investment in terms of managing financial risks for not only flat-for-land build and sell project but also when the land is bought. The amount paid for land acquisition can be added as a negative value to the cash-flow analysis.

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