Probability Of Actions

First the rules of the game were such that to attack (which includes robbing, sabotaging, destroying) a particular structure and to sell a particular kind of goods, a person must roll the dice twice for neighbouring markets or players and three times for opposite neighbouring markets or players.

In this way, the probabilities of being successful in the attack or selling was as follows:

For attacking or selling on adjacent sides: 1/ (6+6) = 1/12
For attacking or selling on the opposite sides 1/ (6+6+6+6) = 1/24

As can be seen, the probabilities for making a successful attack or a successful selling was too low which would lead to a large number of failed attacks and hence boredom.

So, we decided to increase the probability by adding an element of chance of success (in percentage) and combining a second 10-sided dice throw in the following way: There chance of success will decrease 10% each space which is further from the structure space and then a person must get more than the first digit of the chance of failure(100% - chance of success) on the 10-sided dice which would result in varied probabilities but definitely greater than the once we got in the simple game. Also, by changing the number of throws for attacking the adjacent player's structures to one and opposite structure to three we decreased the probabilities for some of the events to balance the previous increase in probabilities.

The resulting probabilities for attacking a particular structure would be the following:

The probability of getting a particular percentage is dependent on how far the structure is from the player's territory's edge. It increases as the structure is nearer to the edge and decreases as it gets farther from the edge, and the probability for being successful also increases as the percentage of success increases as given in the table below.

Chance of success	Probability of being successful in the act
10	1/10
20	2/10
30	3/10
40	2/5
50	½
60	3/5
70	7/10
80	4/5
90	9/10
100	1

The range for chance of success for selling the goods to the adjacent market is from 30% to 80%, and the maximum chance of success for selling to the opposite market can be 50%. Hence the range for probabilities of being successful in selling the goods to adjacent markets is from 3/10 to 4/5 depending on the 6-sided dice throw and the maximum probability for selling to the opposite market can be ½, but how much depends on the initial throw.

The initial planned probability difference between attacking/selling to the adjacent side and attacking/selling to the opposite side remains.

Probability of getting hit by any weapon:

For calculating the probability of getting hit by a weapon in any attacking or selling process, we need to calculate the spaces in the way of that player that are in the range of any weapon.

Let it be the variable numRange.

Then while attacking or selling on adjacent sides, the probability of getting hit by any weapon, becoming injured and failing the attack or selling goods process is:

numRange / 6

And while attacking or selling on the opposite side, the probability of getting hit by any weapon and injured and failing the attack or selling goods process is:

numRange / 18

Clearly, while attacking on the opposite side, numRange will be higher as the probability of spaces in any weapon's range in a longer way will be more.

So, the probability will be almost the same in both cases.

The addition of weapons decreases the probability of successful attacking or selling and balances that process by decreasing the spaces where the player can land with the first single or triple dice throw.

The weapons cannot be levelled up with money because that will result in increased protection and too many spaces occupied with weapons

The limit of number of each kind of weapon has been set in accordance with limiting the number of spaces that can be affected by weapons.

Probabilities involved in trading tables for deciding prices:

For determining prices while selling, the player throws 6-sided dice twice and use the trading table which has the following probabilities:

- Probability that the price will increase from the market price while selling is : 5/11
- Probability that the price will decrease from the market price while selling is : 5/11
- Probability that the price will be the market price while selling is : 1/11

  So, while using a trading table during selling, prices are equally probable to go up and equally probable to go down. The probability of having no change in price is small. So, the player selling can be lucky or unlucky equally likely.

For determining prices while trading between two players, both players throw a 6-sided dice once each and use 2-trading tables which has the following probabilities:

- Probability that the price will increase from the market price is : 15/36
- Probability that the price will decrease from the market price is : 15/36
- Probability that the price will remain same as the market price is : ⅙

  So, while trading in-between the players, the probability that the price will be more than the market price will be the same as the probability that the price will be lower than the market price. So, neither of the players is favoured while doing this action.

Game Duration

- The total game lasts for a varied time between 1 hr to 2 hrs. It is dependent on the experience level of the players. The first-time players take more time in taking turns as compared to the experienced players.
- Each turn takes 30 seconds to 60 seconds depending upon the progress of the game. In the beginning players take less time to decide as a smaller number of options are available to them but as the game progresses the number of options starts increasing in the game which is as follows:
  - Deciding which goods to produce as the production structures increase in number.
  - Deciding which goods to loot as the safehouse structures of opponents increase in number and variety.
- First, we chose the number of rounds to be 40, but it was taking much time, so we reduced them to 30, by changing some aspects which fastened a game a bit.

Prices

Prices for buying the production and safehouse structures:

We chose to fix the same prices of production and safehouse structures for each kind of good, so that all goods can be equally appealing and every player having one of the markets has equal opportunities.

- The prices for production structures are: $100
- The prices for safehouse structures are: $200

Prices for leveling up the production and safehouse structures:

The price for leveling up the structure will be double the price of the original price bought or double the price for which it was previously leveled up. This will ensure the balance between the benefit caused by increased production capacity and the amount required to pay for the increased production capacity.

Prices of Goods:

- Initially we had set the price for the goods around the range of 1-10 percent of the cost of producing structure, but then we found out that the game was too slow as to get the money for buying second structure or upgrading a structure to next level, it would cost around 10-100 turns of producing the goods from a single level 1 structure. So, then we adjusted the prices of the goods to be around 50-200% of the production structure. So that the game could become faster. Now the turns required for buying a second structure from one structure needs only 1 to 4 turns of producing the goods from the first structure.
- The price for selling the goods to the market in their own territory will be 50% of the production structure cost which is the lowest price possible as there is no risk involved.
- The price for selling the good to the market in the player's opposite side will be double the market price of that good to award higher for higher risk.

Prices of Weapons:

- Tommy gun nest: 500 dollars
- Sniper's perch: 300 dollars
- Dynamite crates: 200 dollars

- Tripwire bomb: 200 dollars
    - The prices of weapons have been fixed such that greater the probability of making other players hit by that player's particular weapon, the greater the price needed to buy that weapon.

Market-Price Card Analysis

Each batch of the four goods – guns, booze, artifacts and drugs can only have one of the four prices – $200, $150, $100 or $50 in each round. For determining prices of the goods in each round, a market card containing prices for all the goods needs to be drawn from a pile of 96 cards in which a specific card has four instances. In a particular card, two goods cannot have the same price.

Probabilities of Prices	$200	$150	$100	$50
Booze	24/96 = ¼	24/96 = ¼	24/96 = ¼	24/96 = ¼
Artifacts	24/96 = ¼	24/96 = ¼	24/96 = ¼	24/96 = ¼
Drugs	24/96 = ¼	24/96 = ¼	24/96 = ¼	24/96 = ¼
Guns	24/96 = ¼	24/96 = ¼	24/96 = ¼	24/96 = ¼

So, in each round the price for each good is equally likely to be any of the four prices.

Scores

The player with the highest scores in the end wins. The scores are calculated as follows:

Points to which Structures evaluate to:

More the number or level of structures, the more fun the game is.

To incentivize the buying or leveling up of structures, each of the structures evaluates to twice the money spent on the latest upgrade (if levelled up) or twice the money spent on buying the structure (if not levelled up).

Points to which Currency evaluates to:

Money must evaluate to the least scores to favour buying or upgrading structures, so the exchange is kept in the following way:

1$ evaluates to 1 point

Fame Token Analysis

The concept of fame tokens is introduced to incentivize players to attack other players rather than just focus on producing and selling goods for money. It also incentivizes buying weapons. This results in increased player interactions and makes the game fun. In the final calculation of scores for winning, to give successful attacking more weightage, fame points will evaluate to greater scores than structures or money will evaluate to.

- Each type of successful attack leads to gain of one fame token for the attacker and lose of one fame token for the player who gets attacked, except sabotaging in which the exchange of fame tokens is double

    This incentivizes players to attack other players.

- Each type of unsuccessful attack or selling leads to loss of one fame token for the attacker or seller except sabotaging, in which the higher reward is balanced by higher risk which is loss of 3 fame tokens.

- The player who injures other players with weapons, gains one Fame token without risking anything. Whenever the player gets injured, they lose 2 fame tokens.

    These things incentivize players to buy expensive weapons to gain fame tokens without any risk, to make other players lose fame tokens and increase one's winning chances. Weapons make the gameplay fun, hence they must be incentivized to buy.

- Each fame token evaluates to 1000 points which is equivalent to two level-3 production structures and one level-1 production structure.

    This is far more weighted than just focusing on production.