EVALUATING MEAN TIME TO OPERATION (MTTO) AND OTHER RELIABILITIES METHODS FOR COMPUTING CRITERION RELIABLE RISK OF RETURN (RRR) IN TEHRAN STOCK EXCHANGE

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Introduction. Devising the rating model and using it in Tehran Stock Exchange makes it possible for investors to distinguish more effective companies from other ones better. Therefore, they would do more rational investments and, on the other hand, the efficient portfolios can access their needed financial resources more easily and cheaply. It helps the capital market to move toward efficiency (Jafari, 2015). A Portfolio manager as a decision-maker needs a decision matrix that is a list of values in rows and columns that allow an analyst to systematically identify, analyze, and rate the performance of relationships between sets of values and information. The matrix is useful for looking at large masses of decision factors and assessing each factor's relative significance. The nice thing about the decision matrix is that it can apply to many different types of decisions.

A decision matrix is a list of values in rows and columns that allow an analyst to systematically identify, analyze, and rate the performance of relationships between sets of values and information. Elements of a decision matrix show decisions based on certain decision criteria (Lucid Content Team). The suitable criteria for DM are important. Defining RRR as the efficient and suitable criterion for the decision matrix is the aim of this research. For this purpose, RRR is calculated with reliability engineering. These techniques are a sub-discipline of systems engineering that emphasizes the ability of equipment to function without failure. Reliability describes the ability of a system or component to function under stated conditions for a specified period. Reliability is typically described as the ability of a component or system to function at a specified moment or interval of time (IEEE, 1990).

Scientific Novelty. This study evaluates a new criterion with high efficiency in the decision matrix as a criterion with good quality in Multi-Criteria Decision Making (MCDM) methods. This paper proposes a criterion Reliable Risk of Return (RRR) that it can show how an investor can trust to return of a company that their return more than a specific amount that investor defines it also proposes Mean time to operation (MTTO) technique for calculating criterion RRR. The MTBF, MTTF, FIT are famous reliability techniques in engineering for computing reliability of a system, these techniques were

[1] Multi Criteria Decision Making
[2] Decision matrix

used in this research for calculating RRR in Stock Market to construct portfolios and find a profitable company.

Structure. We propose a new criterion RRR for a decision matrix in the stock market as an efficient criterion for DM in MCDM methods (Rew, 1988) and can use it for computing the weight of alternatives (companies) and rank to them independently. The remainder of this paper is organized as follows. Section two reviews some concepts for this research. The third part presents the steps of research and use the RRR criterion to a real-world problem. Section five illustrates the result of the real-world problem and comprehensively compared it to the Bank deposit and Market Index. The conclusions and suggestions for future research are represented in the sixth section.

Literature review. A suitable criterion for DM in each research is important. This paper tried to propose to use new techniques for calculating criterion Reliable Risk of Return (RRR) for the stock market. For calculating the RRR criterion needs to compute the real price of the company's share for each trading day, to obtain the real price need to have DPS, capital increment and trading commissions. After collecting data need to show their effects on the stock price. The real price works like the main material for calculating the RRR that it calculates with reliability techniques.

Real price. The first thing as a base material of this research is the real price of each trading day. To compute real price we need price of stock for each trading day, capital increment, DPS and trading commission. After collecting these data we must add these data to stock price for this purpose, using the below formula:

$$Real\ price = \big(coeficient\ of\ capital\ increment \times (stock\ price \times trading\ commission)\big) + DPS \quad (1)$$

The RRR criterion needs methods for calculating reliability like MTBF, MTTF and FIT that they used in engineering and much science as a reliable technique.

Used reliability techniques. Reliability is the ability of a system or component to perform its required functions under stated conditions for a specified period. Availability, on the other hand, is the degree to which a system or component is operational and accessible when required for use [IEEE, 1990]. Most of the methods used to calculate reliability criteria these methods are used in many sciences. This research tried to use them as a reliable criterion in the stock market. MTBF, MTTF and FIT are reliability terms based on methods and procedures for product lifecycle predictions. Customers must often in-clude reliability data when specifying what product to buy for their application. MTBF (Mean Time Between Failure), MTTF (Mean Time To Failure) and FIT (Failure In Time) are ways of providing a numeric value based on a compilation of data to quantify a failure rate and the resulting time of expected performance. The numeric value can be expressed using any measure of time, but hours is the most common unit in practice. In this research measure of time is the day [Advantech, 2018].

In this study lifespan is trading days that stock of a company is traded and the failure rate is the number of times that stock price is less than specific amount and operation days are the days that stock price is over than specific amount. This probability is estimated from detailed analysis, previous data sets or through reliability testing and reliability modelling. Availability, Testability, maintainability and maintenance are often defined as a part of reliability engineering in reliability programs. Reliability often plays a key role in the cost-effectiveness of systems. Most of the methods used to calculate reliability criteria these methods are used in many sciences [RCM II, 2008]. Tracking and managing equipment and device failures are essential for any organization that relies on physical assets to deliver its product or service. It is the only way to keep operational disruptions down to a minimum. Measuring failure metrics is an integral part of asset management. MTBF points to the reliability of our equipment, and MTTF tries to estimate the average lifespan of non-repairable assets. These are by no means the only maintenance-related metrics. However, they are very popular, so we are giving them extra attention to MTBF, MTTF, FIT and MTTO as a technique that will propose in this study. For each of the stated methods, this research will: Explain what it measures and why it is helpful, provide a graphical representation, use an example to show how it is calculated and discuss what you can do to improve it.

MTBF. Mean time between failures (MTBF) is the sum of the lengths of the operational periods divided by the number of observed failures (Lienig & Bruemmer, 2017):

$$MTBF = \frac{\sum(start\ of\ downtime - start\ of\ uptime)}{number\ of\ failures} \quad 2)$$

Product purchasing decisions should not be based on feature sets alone. You should also consider the product's life expectancy. Understanding the methods used to predict a product life cycle will help you make informed decisions. Mean Time Between Failure (MTBF) is the number of failures per million hours for a product. This is the most common parameter used to predict a product's life span. Industries and integrators tend to pay close attention to MTBF, but consumers are often price-driven. They may not realize that a product with a short lifespan is not much of a bargain.

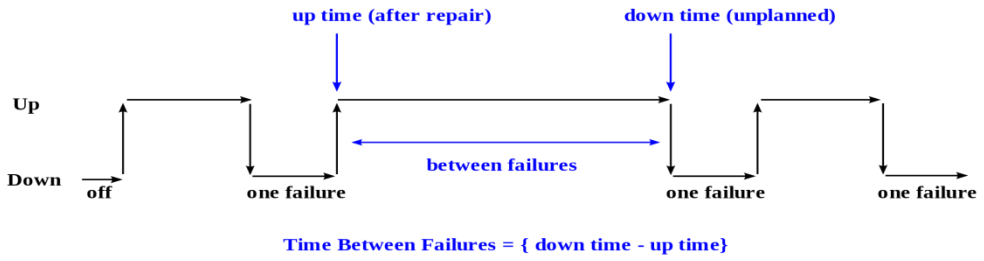

Figure 1. Lifecycle of a system

For example, an asset may have been operational for 1,000 hours in a year. Over the course of that year, that asset broke down eight times. Therefore, the MTBF for that piece of equipment is 125 hours [Hilt, Bakos & Jaro, 2016, 74-75].

MTTF. Mean time to failure (MTTF) is a maintenance metric that measures the average amount of time a non-repairable asset operates before it fails. Because MTTF is relevant only for assets and equipment that cannot or should not be repaired, MTTF can also be thought of as the average lifespan of an asset. To calculate MTTF, divide the total number of hours of operation by the total number of assets in use.

$$MTTF = \frac{\text{Total time of operation}}{\text{Total assets in use}} \quad 3)$$

Calculating MTTF with a larger number of assets will lead to a more result as MTTF represents the average time to failure. Example of MTTF calculation:

For example, we want to calculate the MTTF of the conveyor belt rollers at your facility. There are 125 identical rollers, which operated a total of 60,000 hours in the last year. Your MTTF calculation would look like this:

MTTF = Total hours of operation ÷ Total assets in use = 60,000 hours ÷ 125 assets = 480 hours

We can conclude that the average lifespan of a roller at your facility is 480 hours.

MTTF applies to assets that are non-repairable—when they fail, they are replaced (Fiix, n.d.).

MTTO. Mean time to operation (MTTO) is a maintenance metric that measures the average amount of time a repairable asset fails after its operations. Because MTTO is relevant only for assets and equipment that can or should be repaired, MTTO can also be thought of as the average duration of failure of an asset. To calculate MTTO, divide the total number of hours of failures by the total number of assets in use.

$$MTTO = \frac{\text{Total time of failures}}{\text{Total assets in use}} \quad 4)$$

FIT. By definition Failure Rate is the total number of failures within an item population divided by the total number of life units expended by that population during a particular measurement interval under stated conditions. It is usually denoted by the symbol λ. The dimension of the failure rate is the reciprocal of time and the unit used is 10^9/hr = 1 FIT (Failure in Time). In other words, 1 FIT mean 1 fail in 1,000,000,000 hours [Lienig & Bruemmer, 2017].

$$FIT(MTBF) = \frac{1}{MTBF} \times 10^9 \quad 5)$$

Failure rate is the frequency with which an engineered system or component fails, expressed in failures per unit of time. It is usually denoted by the Greek letter λ (lambda) and is often used in reliability engineering. The failure rate of a system usually depends on time, with the rate varying over the life cycle of the system. For example, an automo-

bile's failure rate in its fifth year of service may be many times greater than its failure rate during its first year of service. One does not expect to replace an exhaust pipe, overhaul the brakes, or have major transmission problems in a new vehicle.

Suppose it is desired to estimate the failure rate of a certain component. A test can be performed to estimate its failure rate. Ten identical components are each tested until they either fail or reach 1000 hours, at which time the test is terminated for that component. (The level of statistical confidence is not considered in this example.)

Estimated failure rate is:

$\frac{6\ failures}{7502\ hours} = 0.0007998 \frac{failures}{hour} = 799 \times 10^{-6} \frac{failures}{hour}$, Or 799.8 failures for every million hours of operation (Li et al. 2010).

Failure In Time (FIT) is another way of reporting MTBF. FIT reports the number of expected failures per one billion hours of operation for a device. This term is very important in the semiconductor industry, but is also used by component manufacturers. FIT can be quantified in a number of ways. Examples include: 1000 devices for 1 million hours, 1 million devices for 1000 hours each, and other similar combinations. FIT and Confidence Limits (CL) are often provided together. In common usage, a claim to 95% confidence in something is normally taken as indicating virtual certainty. In statistics, a claim to 95% confidence simply means that the researcher has seen something occur that only happens one time in twenty, or less. For example, component manufacturers will take a small sampling of a component, test for x number of hours, and then determine if there were any failures in the test bed. The CL will be based on the number of failures that occurred [Khavaninzadeh, 2021].

Tip2. In this research instead of 109 used 365 as a year and total days of a company's share traded.

Example of real-world. This section explains the process of calculating the RRR criterion with an example. For this purpose, are selected ten companies from different industries listed on the Tehran Stock Exchange.

Population and sample. The process of selecting alternatives in choosing companies from the listed companies in Tehran stock exchange with some rules likes they have worked more than six years, different industries, their shares are traded in the market every year and their data be available like trading days, capital increment and DPS. In this research, ten companies were selected from this list.

Data collection method. Collecting information has been done based on the return of companies. The important things are closing price for each day of the year, capital increase and DPS. This information was obtained from reliable sites that belong to the Tehran Stock Exchange itself. The data are used in this research include closing prices, capital increment and DPS from 1393 to 1398 of ten companies of Tehran Stock Exchange. All this information can change the closing price but there are other things that to make data more accurately are trading commission. The commission calculated at the

end of each trading day; can help investors to find the accurate return of the company. After collecting data, the process on them begins to convert them to useful data for this research. For this purpose must change closing price after increment capital, DPS and buy and sales commission.

Data analysis. For analyzing data that collected must use them in reliability methods and find results. For this purpose define these methods for the stock market. Failure system happens when the days that the price of a share is less than the specific price that the investor determined as a minimum gain of investing and the number of failures is several periods of failure in a specific period that investor determined it. Operation system happens when the days that stock returns more than investor determined profit. The role of real price is important to calculate the operation system and failure system.

Step by step of process with example of real world. Now it is time to explain steps of calculation of RRR criterion and show them with an example of Tehran Stock Exchange, for this purpose is chosen "Bekab" company of listed company in TSE[1].

Frist step: Investors must determine the amount of profit that they expect in a year then must determine a parameter that can satisfy investors' expectations of the investment. This parameter is mandatory Materiel Reliability (RM) it defines the amount of stock that can be supposed expected profit for one year. In this research, RM is twenty percent.

Table 1. Calculated RM for a company

Bekab	1395	1396	1397	1398	1399
RM	13856	13637	14713	11596	92694

Second step: calculating total days that stock traded.

Table 2. Calculated Trading days for a company

Bekab	1395	1396	1397	1398	1399
Trading days	234	235	224	229	227

Third step: Compute the number of system failures, fail days and operation days.

Table 3. Calculated Fail number, Fail days and Operation days for a company

Bekab	1395	1396	1397	1398	1399
Fail Number	1	5	2	1	3
Fail Days	234	74	210	17	52
Operation Days	0	161	14	212	175

[1] Tehran Stock Exchange

Fourth step: Use reliability methods MTBF, MTTF, MTTO and FIT in four modes. These methods are explained in the previous section with formulas (2-5).
After computing the amount of MTBF, MTTF and FIT for each company annually then calculate the average of each year with previous years.

Tip2. For calculating the MTTF needs to know the weight of assets. For this purpose, as a rule, suppose the assets have the same weight for the first year in the portfolio.

Table 4. Calculated reliability methods for a company

METHODS	1395	1396	1397	1398	1399
MTFB	0.00	32.20	7.00	212.00	58.33
MTTO	2340.00	1303.06	3277.17	564.25	838.25
MTTF	0.00	2835.03	218.48	7036.55	2821.05
FIT(MTBF, trading days)	234.00	7.30	32.00	1.08	3.89

Fifth step: Compare results of recommended companies and portfolios by each method in two types. This step compared the return of each company and portfolio that is recommended by reliability methods in two modes annual and average for ten companies that selected from the list of companies in Tehran Stock Exchange.

Sixth step: To make a decision. Now it is time to find the best portfolio and company that is recommended by reliability methods. Absolutely if the investors choose only one company that system recommended has more risk than a portfolio that the system recommended.

Table 5. Calculated MTTF for a company

MTTF											
Company	Faravar	Behbahan	DPI	Shefan	Hafari	Hekasht	Lebtan	GheShe	Bekab	PeShand	MAX
1397	545	3948	237	3337	5356	1674	4900	683	218	1238	5356

The recommended company by system is “Hafari” for 1398 and recommended portfolio with MTTF for 1398 is:

Table 6. The Calculated weight of companies and return of the portfolio

1398	Company	Faravar	Behbahan	DPI	Shefan	Hafari	Hekasht	Lebtan	GheShe	Bekab	SUM
Weight	0.025	0.178	0.011	0.151	0.242	0.076	0.221	0.031	0.010	0.06	1.00
Return	62.99	4.02	16.66	44.44	16.79	83.57	14.17	6.97	28.94	283.83	283.83

Analysis. This section shows the return of each portfolio constructed with only the RRR criterion according to each reliability technique. The MTBF, MTTF, MTTO and FIT are methods used for calculating the RRR criterion proposed in this research. To understand ability of this criterion needed to use it in the real example of the Tehran Stock Market. Assumed we have ten alternatives and only one criterion and RRR calculated by different reliability methods. Compare return of each method can be a good criterion for obtaining RRR performance. The below charts show their return.

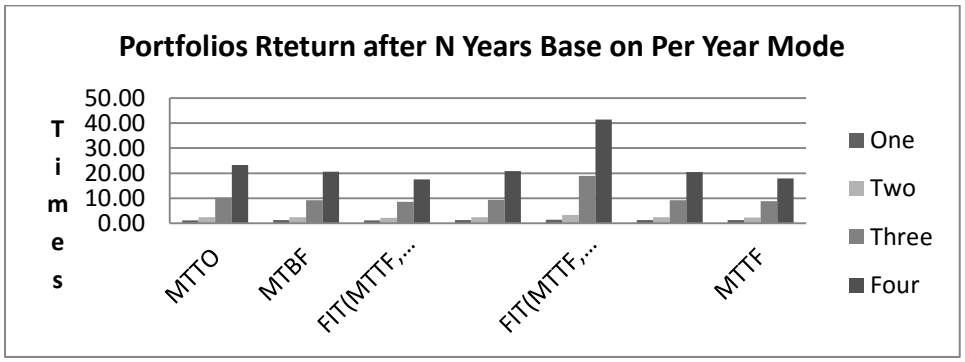

Figure 2. Returns of each portfolio that constructed with RRR after N years with reliability techniques based on Per Year mode

This chart shows the return of each portfolio that was calculated with reliability methods based on per year mode from 1396 to 1399 that the system recommended. The FIT [MTTF, 365] has performed better than other methods. The FIT [MTTF, 365] make an investor's capital 41.42 times more than the beginning of investing after four years.

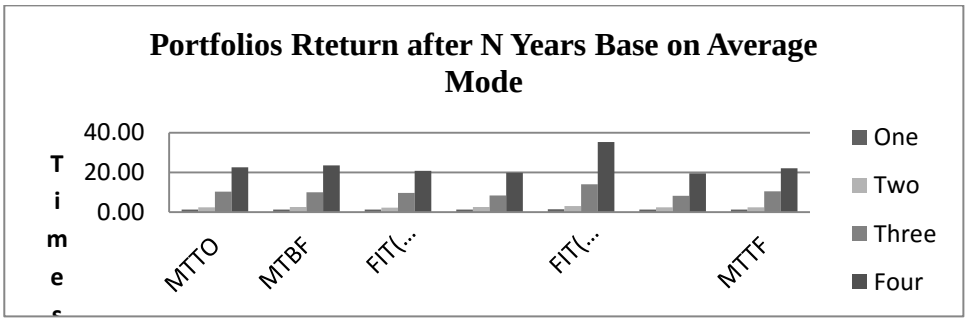

Figure 3. Returns of each portfolio that constructed with RRR after N years with reliability techniques base on Average mode

This chart shows the return of each portfolio calculated with reliability methods based on the Average mode from 1396 to 1399 that the system recommended. The FIT [MTTF, 365] has performed better than other methods again. The FIT [MTTF, 365] make an investor's capital 35.23 times more than the start of investing after four years.

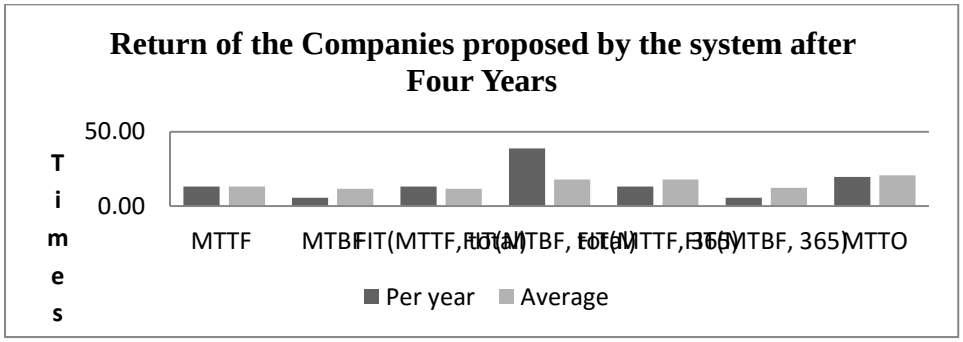

Figure 4 Return of each portfolio base on Per Year and Average

Figure 4 shows the return of portfolios with only one company that is recommended by the system for each year. The return of FIT (MTBF, Total) based on per year is more than others methods. The FIT (MTBF, total) make an investor's capital 38.79 times more than the beginning of investing after four years.

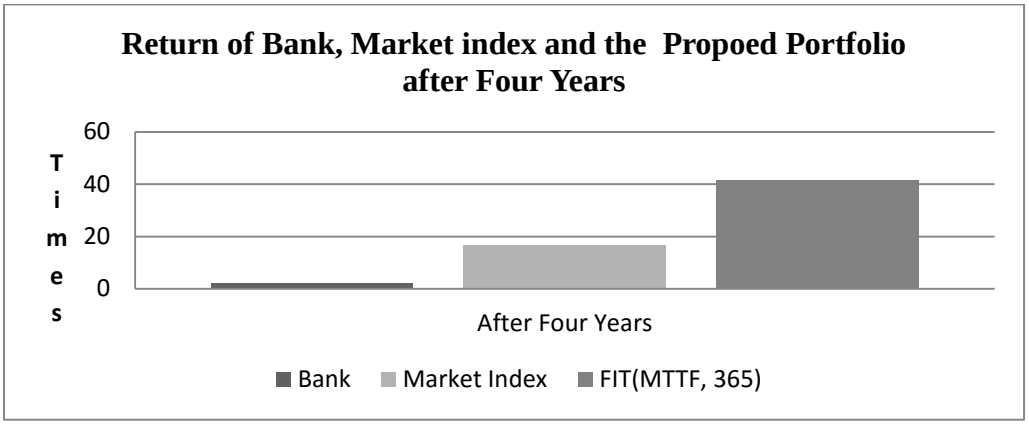

Figure 5 Returns of Bank, Market and portfolios constructed with FIT (MTTF, 365) based on per year after four years.

This chart shows the return of BANK, Stock Market Index, and FIT (MTTF, 365) as the best method for constructing a portfolio. The FIT [MTTF, 365] constructed the best portfolio. The portfolio is recommended with FIT [MTTF, 365] base per year mode for constructing the portfolio for 1400 is in the below table:

Table 7. Recommend a portfolio for 1400

1400	Faravar	Behbahan	DPI	Shefan	Hafari	Hekashti	Lebutan	GheShekar	Bekab	PeShand
Weight	0.02	0.02	0.03	0.04	0.03	0.73	0.06	0.01	0.04	0.03

Conclusions. This paper has used famous reliability techniques MTBF, MTTT, FIT and MTTO in the stock market. The companies are from different industries listed on the Tehran Stock Exchange. All methods that used to calculate the RRR criterion were succeeded to decrease their risks and increasing their return but investing in the bank and stock market could not do such work. The results are determined in Figures 5 and 6.

FIT [MTBF, Total] method is suitable more than other methods for recommending a company with a high return. On the other hand, if investors want to make a portfolio, FIT [MTTF, 365] has a stronger performance to construct a portfolio with only criterion RRR than other techniques. In the end, the article recommends a company and a portfolio for next year. This paper can be useful to research in future studies and different types of investors like funds, brokers, risky and risk-avert and beginner investors.

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Evaluating Mean Time to Operation (MTTO) and Other Reliabilities Methods for Computing Criterion Reliable Risk of Return (RRR) in Tehran Stock Exchange

Keywords: Portfolio, MCDM[1], DM[2], Criteria, MTBF, MTTF and FIT

This study evaluates a new criterion with high efficiency in the decision matrix as a criterion with quality in Multi-Criteria Decision Making (MCDM) methods. This research discusses some concepts such as reliability techniques, MCDM, decision matrix (DM) and real return also proposes a criterion Reliable Risk of Return that is called RRR. This criterion can show how an investor can trust to the return of a company that their return is more than the specific amount that the investor defines it. For this purpose, by applying a creative to use reliability techniques that are usually used in other science, especially engineering. This research proposes a new technique MTTO and uses other reliability techniques creatively. Results of this research can be helpful for investors to choose the best company from the list of companies also recommend profitable portfolios. The MTBF, MTTF, FIT and MTTO are famous techniques that are used to calculate the reliability of a system.

[1] Multi Criteria Decision Making
[2] Decision matrix