**Ph.D. Research Proposal**

Doctoral Program in …..

<Ph.D. in … >

Force Ratios and Relative Combat Power

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**Chapter 1: Introduction**

1. In the beginning combat power and force ratio was a subject of skilled soldiers like Sun Tzu, Clausewitz and others. In the 1900s, the subject attracted the attention of engineers like Lancaster. At this stage, mathematical explanations were used to explain the importance of the subject. With the rapid development of technology, the subject has become the subject of operational research. Researchers like Depuy and Briddle have examined the subject with the help of well-designed mathematical models.
2. I think this **subject is worth to attention because**; the abilities of **modern programming languages** like Python have potential to exploit the already in place information to the level hard to imagine even at the end of the century. Calculation and analysis capability of this discipline that framed in the field **Data Science** provides useful tool for explaining the variables once more with different dimensions.
3. **Primary issues** in this research will be to find **the explanatory power of force ratios** along with other relative combat power factors (leadership, morale, maneuver, firepower and protection) for the outcome of the battle. Moreover, my intention is to **develop a mathematical model** which will also attempt to explain the nonmaterial factors of war of **morale and leadership** with quantitative analysis.
4. I have studied this topic in my Turkish War College education between 2007-2009. I did operation analysis and force comparisons at the brigade and corps levels. In this master thesis I also had the opportunity to examine this subject with examples of war history. Doctrine in that time advises some sort of action according to force ratios. One general acceptance was if you have 3:1 force ratio you may plan to attack.
5. It is my initial judgement that force ratios are too deterministic, and needs to be analyzed. Because there are armies in history fight and win the war although they have less manpower or means to fight.
6. I will determine the variables of the combat power through two cases selected from the battles of periods of different characters. Then, using these variables, I will try to develop a mathematical model by using the battles fought in the same periods as data.
7. These periods will be; Napoleonic time battles, where military art was systematically used in battles. The time period will cover between 18th and 19th century. And the battles who fought at the second world war and after, where technology was used extensively. My focus will be on morale and leadership factors.

**Chapter 2: Literature Review**

1. Theory about this topic starts with ***Sun Tzu***. He emphasizes “capturing enemy’s army intact rather than destroying”. According to him; “acme of the skill” is not winning 100 victories in 100 battle but to subdue the enemy without fighting.By this way the troops are not worn out. He terms this as the “art of offensive strategy”. From this point Sun Tzu advises force ratios as such; when 10:1 surround, 5:1 attack, 2:1 divide, 1:1 engage or elude, if force ratio is less then enemy, capable of withdraw**[[1]](#footnote-1)**.
2. ***Clausewitz*[[2]](#footnote-2)**’s approach to force ratio as “superiority of numbers” and he says this is most common element in victory. He specifies that it is not force ratio but strategy with deciding; time, place, and the forces of the engagement has considerable influence on engagement’s outcome. However, *if purpose, circumstances, and the fighting value of the troops is disregarded*, then distinguishing factor will be the “number of troops”. And he asserts that *if superiority reach the point where it is overwhelming*, superiority of numbers will be the most important factor in the outcome of an engagement, so long as it is great enough to counterbalance all other contributing circumstances. Hİs methodology on building this theory is “historical examples”. He concludes that even the most talented general will find it very difficult to defeat an opponent twice his strength. He says that “when we observe that the skill of the greatest commanders may be counterbalanced by a two-to-one ratio, in ordinary cases, a significant superiority in numbers will suffice to assure victory, however adverse the other circumstances”.
3. ***Lanchester***[[3]](#footnote-3)arguesthatnumerical comparison of the forces is universal and “counting the pieces as of value, and denying the extended theory, is illogical.” He asserts that “*the number of men knocked out per unit time will be directly proportional to the numerical strength of the opposing force, efficiency of weapons and unit value (training, morale)”.* And he defines **N-square law** as “*the fighting strength of a force is proportional to the square of its numerical strength (for red forces r²) multiplied by the fighting value of individual units (N)*.[[4]](#footnote-4)
4. **Lanchester** specifies if two armies are successively brought into action their aggregate fighting strength of will be hypotenuse of a right-angle triangle. The **n-square law** explains the penalty that must be paid if such division happened. If battle fleet separated into 2 equal parts, increase would require to be fixed at approximately %40 percent – that is to say, in relation of 1 to √2; more generally the solution is given by a right-angled triangle[[5]](#footnote-5). He gives **Nelson’s Tactical Scheme at Battle of Trafalgar** as an example of this case.Nelson planned to envelop the half of -23 ships- combined fleet with 32 ships. This, according to n-square law would give him superiority of fighting strength of almost exactly 2:1[[6]](#footnote-6). He forced combined fleet to fight in two groups thus, inflicted √2 times their force in the beginning of fight. Thus, we are led to appreciate the commanding importance of a correct tactical scheme.
5. By the early 1960's, **Soviet** applied operations research theory to the problems of operational and tactical decision-making. One such application was the **Correlation of Forces and Means** (COFM) [[7]](#footnote-7). The Soviet Dictionary of Military Terms defines this as “an objective indicator of combat power which makes it possible to determine the degree of superiority of one side over another. This is determined by means of comparing the quantitative and qualitative characteristics of subunits, units, and formations and the armaments of one's own forces and those of the enemy.
6. Later **Dupuy**[[8]](#footnote-8), US Army Colonel and military historian developed **Quantified Judgment Method** (QJM), where the outcome of a battle is predicted using a multiplicative-additive formula in which various factors relating to the strength and firepower of the fighting parties as well as the circumstances are taken into account. Dupuy and his associates adjusted the parameters of model by using known statistical facts of several recorded battles. He assesses combat power with an equation. In this equation Combat Power is defined as multiplication of Force Strength (number and types of weapons plus personnel), Operational Environmental Factor and Quality of Troops (P = S x OE x Q).
7. **Biddle**[[9]](#footnote-9) treat the subject with systematic manner and used material and nonmaterial variables, backed up with a combination of empirical evidence and careful deductive reasoning. His research methodology combines recent historiography with formal doctrinal theory, case method, statistical analysis, and simulation experimentation. He argued that, material factors alone cannot explain capability. He advanced analysis of this with one key nonmaterial variable: **force employment**, or the doctrine and tactics by which armies use their materiel in the field.
8. In 2018 a Rand Report provided a detailed explanation of “will to fight” and a model designed to support assessment of partner forces and analysis of adversary forces[[10]](#footnote-10). They accept that morale, cohesion and discipline is associated with the “will to fight” but they argue “morale” especially is ill-defined. Their model provides US army military planners to assess the “will to fight” dimension of the units rather than a mathematical model that tries to explain the factors affecting the war results.
9. There are some researches which focus on use of **quantitative decision aids**[[11]](#footnote-11). Smith points out that there are two schools of thought—moral (man is the decisive power on the battlefield) and quantitative (many battlefield phenomena are quantifiable either with deterministic, probabilistic or heuristic models)—and these are not competitors rather complimentary. The main requirement for the decision maker is to keep them in balance. His final advice is the maximum use of quantitative methods together with intuition and experience.
10. Another research is made by Yigit and he argues that even though it is more probabilistic than other battle outcome predictors, the force ratio is a valid estimator of battle outcome, after analyzing 660 battles of CDB90FT data set which covers the period of Netherlands War of Independence in 1600 and Israel-Lebanon War in 1982. His final conclusion is like that: “despite some slight differences among probability of winning values corresponding to specific force ratio values of the data set, the general trend remains applicable for the overall analysis of the campaigns, emphasizing that the P (attacker wins given force ratio) value increases as the force ratio value increases[[12]](#footnote-12).
11. Same research is made with different methodology by Coban**[[13]](#footnote-13)**. He analyzed the same but updated data set of CDB90G with **classification trees**. He pre-selected three variables namely Objective, Relative and terrain and weather variables. Force ratio together with, tank, artillery, cavalry ratio is analyzed in Objective Variables. He concludes that the descriptive statistics reveal that the objective variables are not highly correlated with victory. Prediction with only Objective variables yielded high misclassification rates. So, he states that “Objective variables alone are not sufficient to classify battle outcomes”. However, he finds that some of the relative variables, such as leadership, have a strong relationship with the battle outcome. He tried second model with both Objective and Relative variables. The result classification models have relatively low misclassification rates.
12. Christian argues that force ratios are invalid and their continued use may develop unwanted mental constraints**[[14]](#footnote-14)**. Christian refers to Force Ratio as “heuristics” and he argues that force ratios are a derivative of Lanchester’s early work on concentration and attrition but do not account for technological developments and the multiple domains of warfare that make up the modern battlefield. He advises that US Army must differentiate force ratios from correlation of forces models. Force ratios should be abandoned as invalid heuristics. Correlation of forces models, with some effort, may provide utility to planners if they can be separated from force ratios and altered to present the results of its comparison in terms of anticipated effects and expenditures.

**Chapter 3: Research Objectives and Methodology**

**1. Identified gaps:**

1. Although the concept of force ratio is well explained theoretically and its explanatory power within the relative combat power factors is analyzed systematically (especially by Biddle), morale and leadership factors are not analyzed thoroughly due to its qualitative nature.
2. Judgements up to now relies limited data set, max battles analyzed to make deduction was 660 battles of CDB90G dataset, which has real data flaws.

**2. Research questions:**

1. What is the degree of explanatory power of force ratios and other relative combat power factors on the outcome of the battles fought between state actors within the time periods of Napoleonic time battles (years between 1750-1850) and 2nd world war and afterwards?
2. What is the leverage of morale and leadership on the outcome of these battles?

**3. Research methodology:** Literature on this topic reflects about the degree of force ratio’s reliability. While some researchers state that it explains certain degree of result while others state that more sophisticated models need to be used. So, my intention is to develop a model with dependent variable as the outcome of the battle. I will define independent and intervening variables in the research although I have initial propositions. And with regression model I will try to find explanatory power of these variables, in which force ratio will be the one that is to be analyzed.

1. **Research steps:** 
   * 1st step: I will do a **case study** to comprehensively determine the variables. In this study, I will reveal all the variables that may affect the outcome of the battle over the two battles from the designated time periods.
   * 2nd step: I will **create a database of battles** with the use of current ones but with concatenating all the available databases with the help of Python Pandas Data Analysis techniques. Because all databases currently available has its own flaws. But if they are to be concatenated all together, it will be more efficient to make deductions.
   * 3rd step: I will **apply my variables to the database** to **produce a mathematical model** with regression analysis. All other statistical analysis will be conducted here to test the hypothesis.
2. **Unit of analysis:** My unit of analysis will be **battles**. Because battles are better suited for analysis with compare of operations and campaigns.
3. **Data’s to be used:** I will create new comprehensive database with using below databases.
   * U.S. Concepts Analysis Agency’s updated version of the historical combat data set[[15]](#footnote-15): 660 battles from Netherlands War of Independence in 1600 and Israel-Lebanon War in 1982.
   * Conflict Catalog and A Guide to Intra-State Wars[[16]](#footnote-16): 3708 conflicts from 1400 A.D. to the Present in Different Regions of the World.
   * A Guide to Intra-state Wars[[17]](#footnote-17): 300 civil wars waged from 1816 to 2014.
   * University of Michigan’s Correlates of War Dataset[[18]](#footnote-18): Covers all interstate wars involving at least 1000 battle deaths between 1816-1992.
4. **Initial Variables:** It is my initial conceptualization that personnel morale and leadership have different and exponential effect than other factors that’s why I thought that they need to be analyzed as intervening variables.

* Dependent variable: outcome of the battle.
* Independent variables: Relative combat power factors except morale and leadership.
* Intervening variables: Morale and Leadership

1. **Models to be used:**

|  |  |
| --- | --- |
| Name of Model | Reason |
| Linear regression | This model will yield the percentages of independent and intervening variables effects on variation in the outcome of the battle. |
| Predictions (not intended, up to potential Advisor’s recommendations) | Applying machine learning algorithms (Logistic regression, decision trees, K Means Clustering and others) to data set to make predictions for future battle scenarios. |

1. **Initial null hypothesis** to be tested (significance level of 0.05):
   * No relationship between relative combat powers and outcome of the battle exists
   * Morale has no effect on the outcome of the battle.
   * Leadership and its byproduct maneuver have no effect on the outcome of the battle.
2. This methodology is the most appropriate for the proposed topic because; well defined variables together with llinear regression model is best to reach R² values. These values will tell us how much of variation in battle outcomes can be explained by taking relative combat power factors into account.

**Chapter 4: Conclusion**

In this research I will try to find the explanatory power of force ratios along with other relative combat power factors (leadership, morale, maneuver, firepower and protection) for the outcome of the battle.

My aim is to **develop a mathematical model** which will also attempt to explain the nonmaterial factors of war of **morale**and leadership with quantitative analysis.

**With the current search level,** I may say that **what will make my research unique is**that;

* I will work on**morale factor**with a similar methodology just as Steven Biddle did on "force employment". Of course there is so much work in this issue like Rand Report' "Will to Fight" but they did not attempt to show explanatory power of this on the historical fights. In this report they advise how to increase the morale factor of the troops with noting that it is difficult to catch the effects of it.
* I will use **Python Pandas Data Analysis** techniques and **machine learning**tools to make my deductions. I think this **computing power** which I already acquainted with a 9 month Data Science course, will give us much more perspectives than previous studies.

My intention is to conduct this search and continue to search on this issue in this period of my second career. So **I will give my full time on this issue**.

And I think that study will find a place in literature.

1. TZU, Sun. The Art of War, Translated and with an Introduction by Samuel B.Griffith, Oxford University Press, p.77-80. [↑](#footnote-ref-1)
2. CLAUSEWITZ, Carl Von. On War, Edited and Translated by Michael Howard and Peter Paret, Princeton University Press, Princeton, New Jersey, 1984, p. 194-195. [↑](#footnote-ref-2)
3. LANCHESTER, F.W. Aircraft in Warfare, London, 1916, p.39-66. [↑](#footnote-ref-3)
4. He gives an example of this law: with the assumption of “machine-gun is 16 times effective than rifle”, 250 men armed with machine-gun necessary to replace a battalion (1000 men strong) in the field (16\*r²=1\*1000²). [↑](#footnote-ref-4)
5. Example of this is an army of 50K giving battle in turn to two armies of 40K and 30K respectively, equally well armed; then the strengths are equal, since 50K²=40K²+30K². But if divided force fight in one part then the army of 50K will be overwhelmed. [↑](#footnote-ref-5)
6. Though explanation is given like this: 23\*√2=32.5, means since combined fleet is divided, they need √2 plus force to make equation with the UK fleet. I make this deduction to reach 2/1 force equation: 32²=23²+23², thus in the first battle would be fight with 32²=23² this portion. Equals to 1024 vs 529. [↑](#footnote-ref-6)
7. WOMACK, James K., “Soviet Correlation of Forces and Means: Quantifying Modern Operations”, Master’s Thesis, US Army Command and General Staff College, Fort Leavenworth, KS, 1990. [↑](#footnote-ref-7)
8. DUPUY, T.N., Numbers, Predictions & War: The Use of History to Evaluate and Predict the Outcome of Armed Conflict, Hero Books, 1985. [↑](#footnote-ref-8)
9. BIDDLE, Stephen. Military Power, Princeton University Press, 2004, p.2. [↑](#footnote-ref-9)
10. CONNABLE and others. “Will toFight”; Analyzing, modelling, and simulating the will to fight of military units, 2018, RAND. [↑](#footnote-ref-10)
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12. YIGIT, Faruk. “Finding the Important Factors in Battle Outcomes: A Statistical Exploration of Data From Major Battles”, Master’s Thesis, Monterey, California. Naval Postgraduate School, 2000, p.xii-xv. [↑](#footnote-ref-12)
13. COBAN, Muzaffer. “Predicting battle outcomes with classification trees”, Master’s Thesis, Monterey, California. Naval Postgraduate School, 2001, xvii. [↑](#footnote-ref-13)
14. CHRISTIAN Jashua T., “An Examination of Force Ratios”, Master’s Thesis, US Army, School of Advanced Military Studies, US Army Command and General Staff College, Fort Leavenworth, KS, 2019. [↑](#footnote-ref-14)
15. CDB90FT data set. Requirements and Resources Directorate, “Combat History Analysis Study Effort (CHASE): Progress Report for the Period August 1984-June 1985,” U.S. Army Concepts Analysis Agency, 1986. [↑](#footnote-ref-15)
16. BRECKE, Peter. “Conflict Catalog (Violent Conflicts 1400 A.D. to the Present in Different Regions of the World”. [↑](#footnote-ref-16)
17. DIXON, Jeffrey S. And SARKEES, Meredith R. “An Examination of Civil, Regional, and Intercommunal Wars 1816‐2014”. [↑](#footnote-ref-17)
18. SINGER, J.David. and SMALL, Melvin. Correlates of War Project: International and Civil War Data, 1816-1992, computer file, 1994. [↑](#footnote-ref-18)