CRANFIELD UNIVERSITY

GURKAN YESILYURT

EFFECTS OF LEADERSHIP AND MORALE ON THE OUTCOME OF THE BATTLE ALONGSIDE OTHER COMBAT POWER ELEMENTS INCLUDING FORCE RATIOS

CRANFIELD DEFENCE AND SECURITY

LEADERSHIP AND MANAGEMENT

PhD

Academic Year: 2021 - 2024

Supervisor: Dr. Iftikhar Zaidi

Associate Supervisor: Dr.Irfan Ansari

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Supervisor:  Dr. Iftikhar Zaidi

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This thesis is submitted in partial fulfilment of the requirements for the degree of Enter degree

***(NB. This section can be removed if the award of the degree is based solely on examination of the thesis)***

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ABSTRACT

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ACKNOWLEDGEMENTS

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LIST OF ABBREVIATIONS

|  |  |
| --- | --- |
| IT | Information Technology |
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# INTRODUCTION

This research will try to find the explanatory power of combat power elements including force ratios under the intermediating effects of Strategy, Leadership and Morale (intervening variables) for the outcome of the battle (dependent variable). I will try to determine the proportions of the variance estimated from the intervening variables.

## Area of Research

## Research Objectives

I hope to develop a mathematical model which will identify explanatory powers of material and nonmaterial elements as predictors of victory or defeat at the battlefield. With this research, I will try to prove the magnitude of the impact of the two most fundamental non-material components of combat, namely leadership and morale, on other elements of combat power and outcome of the battle.

## Background

• 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 formulas 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.

• Especially Briddle added very important dimension to the subject with inserting a non-material variable to the research model, which is force employment.

• I think this issue, which has been examined in many aspects so far, should be examined in terms of Leadership and Moral factors.

• I think this subject is also 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.

## Study Value

The results of this research would be utilized in wargaming.

The resulting model can be used to predict future conflicts in the next stage (with adding machine learning algorithms).

This research can take its place in the literature as it examines the effects of strategic management, leadership and morale on the results of combat quantitatively.

## Fields of Research

Figure ‑ Field of Research

## Theoretical / Conceptual Framework

Diagram

Description automatically generated

Figure ‑ Theoretical Framework

## New Knowledge

Strategic Management which may be considered as a by product of Leadership and Morale never have been analyzed in quantitative manner in a comprehensive model.

There is only one example in literature where Stephen Biddle put Force Employment to a model and analyzed its influence on the variance of the outcome of the battle.

It is my understanding that force employment is doctrinal part that every army should somehow incorporate to their training programmes. I think the way leaders use their force changes according to the features of the leaders and the mood of the soldiers. That’s why I be analyzing leadership and morale factors.

So, this research will find its place in literature with expanding already in place knowledge of the subject.

## Initial Literature Review

1. Strategic Management on Clausewitz’s terms is to use engagements for the purpose of the war . The strategist must therefore define an aim for the entire operational side of the war that will be in accordance with its purpose. In other words, he will draf the plan of the war, and the aim will determine the series of actions intended to achieve it: he will, in fact, shape the individual campaigns and, within these, decide on the individual engagements.

2. This approach is not contradictory with the principles of Strategic Management Process where mission, vision, values ands goals is tied to SWOT analysis and formulating strategies fed with external and internal analysis. And all this processes reaches out to strategy implementation and progress review. Adaptive leaders who executes this process according to changing circumstances is becoming successful while others fail. In military art the process is the same while the circumstances differs. Although they have same means and capabilities some armies fails while others are successful. Force ratio and other combat power elements have been analyzed throughout the history to find mysterious reasons on explaining the real reasons of victory.

3. 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 .

4. Clausewitz ’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”.

5. Lanchester argues that numerical 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).

6. 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 . 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 . 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.

7. 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) . 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.

8. Later Dupuy , 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). He uses also second formula to identify Actual Battle Results. With manipulating these two formulas he tried to gain the quality of the troops . Although Dupuy made comprehensive contributions to the subject especially in predicting future conflicts, his attempt to formulize the non materiel factors of the battle is criticized even after one year his famous book is published . His formula of assessing the quality of the troops lacks clarity.

9. Biddle 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.

10. 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 . 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.

11. There are researches which focus on use of quantitative decision aids . 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.

12. 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 .

13. Same research is made with different methodology by Coban . 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.

14. Christian argues that force ratios are invalid and their continued use may develop unwanted mental constraints . 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.

## Methodological Considerations and Research Design

### Identified Gaps

a. 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.

b. 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.

### Research Questions

#### Initial Research Question or Hypothesis

Research Question-1: What is the degree of explanatory power of combat power elements including force ratios on the outcome of the battles fought between state actors?

Research Question-2: What is the leverage of leadership and morale on the outcome of these battles?

#### Initial Null Hypothesis to be tested:

Hₒ: Material elements of combat power elements are correlated with the outcome of the battle.

Hₒ: Material elements of combat power elements are correlated with Leadership and Morale.

Hₒ: Leadership and morale factors are strongly correlated with the outcome of the battle.

Hₒ: When effects of Leadership and Morale are removed, material elements of combat power are no longer related with the outcome of the battle.

### 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.

### 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 multiple regression analysis. All other statistical analysis will be conducted here to test the hypothesis.

### Unit of Analysis

My unit of analysis will be battles. Because battles are better suited for analysis with compare of operations and campaigns which has bigger dimensions.

### Theoretical Framework

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: Combat power factors except morale and leadership.

• Intervening variables: Morale and Leadership

### Models to be Use

• Multiple regression: This model will yield the percentages of independent and intervening variables effects on variation in the outcome of the battle.

• Predictions: Applying machine learning algorithms (Logistic regression, decision trees, K Means Clustering and others) to data set to make predictions for future battle scenarios.

## Data Sources & Ethical Considerations

I will create new comprehensive database with using below databases.

• U.S. Concepts Analysis Agency’s updated version of the historical combat data set : 660 battles from Netherlands War of Independence in 1600 and Israel-Lebanon War in 1982.

• Conflict Catalog and A Guide to Intra-State Wars : 3708 conflicts from 1400 A.D. to the Present in Different Regions of the World.

• A Guide to Intra-state Wars : 300 civil wars waged from 1816 to 2014.

• University of Michigan’s Correlates of War Dataset : Covers all interstate wars involving at least 1000 battle deaths between 1816-1992.

## Ethical Considerations

I will use already available datasets with referencing them. So my intention is not to organize tthe dataset from scratch. But I will use all available datasets in a concatanated manner with referencing and exploit as much as I can with the computer programmin language of Python and its data analysis libraries such as Pandas, Numpy, Stats and etc.

There also available model on this subject especially of Stephen Biddle. I will use it with referencing and I will expand his work with adding two important quantitave variables namely Leadership and Morale.

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REFERENCES

Insert list of references here

APPENDICES

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Appendix Title (Use Heading 7)

Appendix Section (Use Heading 8)

Appendix Subsection (Use Heading 9)

Creating captions in Appendices

If you have chosen to include chapter numbers in your captions then follow the instructions given here to apply the same format to the captions in your appendices. This section explains how to caption the figures and tables in your Appendices, assuming that Heading 7 is numbered “Appendix A” and that the Figures and Tables are going to be labelled ‘Figure A-1’, ‘Figure A-2’, ‘Table B-1’ etc.

You will have to create new, separate labels that look like the ‘Figure’ and ‘Table’ labels you used in the main body of your thesis.

1. Select the **References** tab on the Ribbon then click on **Insert Caption**
2. Click **New Label**. Type **Figure\_Apx** then click **OK**
3. You now have two labels for figures, called **Figure** and **Figure\_Apx**  
   Repeat for table captions.
4. In the **Caption** box, type your caption text
5. Click **Numbering**. Tick **Include chapter numbering** and choose **Heading 7** from the drop-down list of styles and click **OK** twice
6. Your caption should look something like this:

**Figure\_Apx A‑1 This is the caption text for a Figure in the Appendix**

1. Delete the extraneous ‘\_Apx’ from the caption label so it reads:  
   **Figure A‑1 This is the caption text for a Figure in the Appendix**  
   **TIP:** Instead of deleting each ‘\_Apx’ individually use **Find & Replace** to modify all the labels at once.

Creating Lists of Figures and Tables for Appendices

This template already includes a List of Figures and a List of Tables, however you will have to create two new lists for the ‘Figure\_Apx’ and the ‘Table\_Apx’ labels.

1. Place the insertion point on a blank row after the existing List of Figures
2. Select the **Insert Table of Figures** command on the **References** tab of the Ribbon
3. Set the **Caption Label** box to ‘**Figure\_Apx**’ and click **OK**  
   **Note:** Word will put a single blank line between the original and new lists preventing it from appearing as one seamless list. However if you select the blank paragraph between the tables you can hide it by opening the Font dialog box from the Home tab and selecting **Hidden**.
4. Click after the List of Tables and repeat for the Caption Label ‘Table\_Apx’