Spatial Decision Support Systems Use in Peacekeeping and Stability Operations Analysis:

Spatial Analysis for U.S. Army Civil Affairs Civil Information Management

By

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DEDICATION

There is an old (and now overused) African proverb stating, “It takes a village to raise and child”. In the spirit of both that proverb, and the University of Texas at Arlington’s College of Architecture, Planning and Public Affairs (CAPPA), I formally state that it took a municipality for completing of this dissertation. This lengthy dedication is to my municipality.

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ABSTRACT

SPATIAL DECISION SUPPORT SYSTEMS USE IN PEACEKEEPING AND STABILITY OPERATIONS ANALYSIS: SPATIAL ANALYSIS FOR U.S. ARMY CIVIL AFFAIRS CIVIL INFORMATION MANAGEMENT

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Becoming a core U.S. military mission in 2005, Stability Operations deals with the political, economic, social and structural resiliency of a county or region. It is conducted to support and develop a host nation’s government, or to initiate governmental services in a non-governed area until the host nation can do so itself. Inherent in this is the provision of public goods, whether the military is the principal provider or to understand the relative public good provision levels within a given area. This understanding is known as situational awareness of the operational environment (OE), a significant issue for any military commander and staff. An integrated geographical representation of key socio-economic factors within the OE is required. Known as the Stability common operational picture (Stability COP), creating it is problematic. The general characteristics of socio-economic data are not readily practical for meaningful presentation and integration through layers in a geographic information system (GIS). Many of the inputs for a Stability COP are recorded in a qualitative format, creating additional sets of analysis problems.

The purpose is to develop a procedure for collating, processing and analyzing/evaluating quantitative and qualitative socio-economic data for a Stability COP. This study integrates the techniques of context analysis, spatial statistical analysis, and spatial decision support systems (SDSS) within a geographic information system (GIS) platform. Since the study centers around the theoretical foundations from the fields of economics and public administration/urban planning, the result is a hybrid joint Content Analysis – Conglomeration - Multicriteria Decision Analysis SDSS method. Because of the cross-disciplinary nature of the research, the literature review references documents ranging from military strategy texts, manuals and articles and journals/texts discussing content analysis, spatial analysis, and SDSS. The study is a mixed methods development case study of the Iraqi operational environment after the 2007-2008 'Surge' and the decision of where the U.S. Army's main effort of Stability Operations would be located. Finally, implementation of such a CIM procedure creates policy implications for military force development to realize the Stability COP capability. This study adds to the body of knowledge in the areas of military analysis, Peacekeeping/Stability Operations and Spatial Decision Support Systems. Overall, this research is a synthesis of many earlier unconnected techniques to achieve the goal of a geographically integrated Stability Operations analysis.

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ACRONYMS AND ABBREVIATIONS USED

AD	Armored Division
ADRP	Army Doctrine Reference Publication
AHP	Analytic hierarchy process
AO	Area of operations
API	application programming interface
ARIES	Army Reserve installation evaluation system
ARU-DM	Army Reserve unit decision model
ASI	Additional skill identifier
ATP	Army Techniques Publication
BCa	Bias-corrected accelerated
C2C	Command and Control
C2C	Concept-to-Code
CA	Civil Affairs
CACOM	Civil Affairs Command
CAD	Computer-aided drawing
CAF	Conflict assessment framework
CAKMS	Civil Affairs Knowledge Management System
CAMEO	Conflict and Mediation Event Observations
CAO	Civil Affairs operations
CAPOC	Civil Affairs and Psychological Operations Command (aka., USACAPOC)
CARVER	Criticality, accessibility, recuperability, vulnerability, effect, and recognizability
CEMPS	Configurable emergency management and planning simulator
CI	Consistency index
CIFC	Civil information fusion concept
CIM	Civil information management
CISA	Communication/interaction with the system and sensitivity analysis
COA	Course of action
COO	Combined obstacle overlay
COP	Common operational picture/common operating picture
CR	Consistency ratio
DBMC	Database management component
DBMS	Database management system
DIME	Diplomacy, Information, Military, and Economics (Elements of national power)
DMC	Dialog management component
DoD	Department of Defense
DoS	Department of State
DOTMLPF	Doctrine, organization, training, material, leadership and education, personnel, and facilities.
EDA	Exploratory data analysis
ESDA	Exploratory spatial data analysis
FAO	Foreign Area Officer
FM	Field Manual
FOB	Forward Operating Base
FOUO	For official use only
GDELT	Global Database of Events, Language, and Tone
GEOINT	Geospatial intelligence
GIS	Geospatial Information Systems/Geographic Information Systems
HA/DR	Humanitarian Assistance and Disaster Relief
HTS	Human Terrain System
IDC	Information Dominance Center
IED	Improvised explosive device
IKD	Intelligence and Knowledge Development
ILE	Intermediate-Level Education

IOCS	Investment option comparison and selection
IOE	Investment option evaluation
IPB	Intelligence preparation of the battlefield
IQR	Interquartile range
ISAF	International Security Assistance Force
IT	Information technology
JC	Joint Command
JCIDS	Joint Capabilities Integration and Development System
J-CIM	Joint CIM
JP	Joint Publication
KDE	Kernel density estimation
KM	Knowledge management
K–S	Kolmogorov–Smirnov process
LAN	Local area network
LISA	Local indicators of spatial autocorrelation
MACBETH	Measuring attractiveness by categorical-based evaluation technique
MAP-HT	Mapping the Human Terrain
MAUT	Multi-attribute utility theory
MCDA	Multi-criteria decision analysis
MCDM	Multi-criteria decision-making
MCOO	Modified combined obstacle overlay
MCPUIS	Multi-criteria Planning of Urban Infrastructure Systems
MDMP	Military Decision-Making Process
MMC	Model management component
MND	Multi-National Division
MNF	Multi-National Force
MOE	Measure of effectiveness
MOP	Measure of performance
MOS	Military occupational specialty
MPICE	Measuring progress in conflict environments
MPK	Mission planning kit
NCO	Non-commissioned Officer
NCOIC	Non-commissioned Officer in Charge
NGO	Non-governmental organization
NONO	NOn-significant, NOt rejected
NPS	Naval Postgraduate School
NSPD	National Security Presidential Directive
OE	Operational environment
OIF	Operation Iraqi Freedom
ORSA	Operations research and systems analysis
PCA	Principal component analysis
PKSOI	Peacekeeping and Stability Operations Institute
PME	Professional Military Education
PMESII	Political, military, economic, social, information, and infrastructure
PMESII-PT	Political, military, economic, social, information, and infrastructure – physical environment, time
POI	Plan of instruction
PRT	Provincial Reconstruction Team
PSYOP	Psychological Operations
RDBMS	Relational database management system
RI	Random index
SC	Stakeholder component
SDSS	Spatial decision support systems
SITREP	Situation report
SOIC	Stability Operations Information Center
SOP	Standard Operating Procedure

SQL	Structured query language
SRDD	Storage, retrieval, and display of data
SSDCO	Security, Stability and Development in Complex Operations
SSTR	Stability, Security, Transition, and Reconstruction (Operations)
SWCS	Special Warfare Center and School
TCAPF	Tactical conflict assessment and planning framework
TRADOC	Training and Doctrine Command
TTP	Tactics, Techniques and Procedures
USACAPOC	United States Army Civil Affairs and Psychological Operations Command
USAFRICOM	United States Africa Command
USAID	United States Agency for International Development
USARC	United States Army Reserve
USASOC	United State Army Special Operations Command
USCENTCOM	United States Central Command
USPACOM	United States Pacific Command
USSOCOM	United States Special Operations Command
USSOUTHCOM	United States Southern Command
VUCA	Volatile, uncertain, complex, and ambiguous (environments)

1. INTRODUCTION

In 2005, Stability Operations were designated as a core U.S. military mission with priority comparable to Combat (Offensive and Defensive) Operations. National Security Presidential Directive 44 (NSPD-44) forwarded U.S. security promotion through coordination improvements, planning, and reconstruction and stabilization foreign aid implementation. While the directive assigns the U.S. Department of State (DoS) as the lead agency, the emphasis is given to the coordination of integrated activities and efforts by multiple departments of the U.S. government to include the Department of Defense (DoD).[1] Stability can be described as "the measure of regional resistance to political, economic, social and structural degradation or deterioration".[2] Stability Operations are conducted by the U.S. Military to support and develop a host nation's government or to initiate governmental services in a non-governed area until the host nation can do so itself. Inherent in Stability Operations is the provision of public goods. Whether the military is the principal provider of public goods or simply needs to understand the relative level of good provision within a given area, understanding how public good allocation occurs is key for Stability Operations. This understanding is known as situational awareness of the operational environment (OE), a significant issue for any military commander and staff. The OE is defined as "…a composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander".[3] An integrated geographical representation of key socio-economic factors within the OE is a requirement. This is known as the civil common operational picture (Stability COP). For the U.S. Army, the Civil Affairs (CA) branch is charged with helping to bring clarity on the civil OE through the use of Civil

Information Management (CIM); however, CIM is a component of CA that suffers from a lack of analytical capability. That is what this research attempts to rectify.

The CIM implementation arm of a CA unit (CIM cells) supports maneuver (combat) commanders at the tactical, operational, and theater strategic echelons. Their mission is to collect data on the civilian aspects of the OE, collate and process the various data sets, analyze and evaluate the combined data into a knowledge product, and distribute both raw data and analyzed/evaluated civil information to military and nonmilitary partners. Creating this integrated geographical representation is problematic. The general characteristics of socio-economic data make it relatively impractical for meaningful presentation and integration through most vector layers in a geographic information system (GIS). Many of the inputs for a Stability COP are recorded in a qualitative format, creating additional sets of analysis problems.

The purpose of this study is to develop a procedure for collating, processing, analyzing, and evaluating qualitative and quantitative socio-economic data for the creation of a Stability COP. This procedure involves combination of tools used in the field of urban planning utilizing data synthesis and analysis. The study integrates the techniques of context analysis, spatial statistical analysis, and spatial decision support systems (SDSS) within a GIS platform. Since this research centers on the issues of amalgamation, analysis, and use of information for Stability Operations, an examination of the underlying problems with information when conducting socio-economic analysis are discussed. Essentially, the theoretical foundations define the problems that are to be mitigated by investigation of the research question. The research question is, ‘How can urban spatial analysis techniques be used to implement an integrated Stability

COP?' Because of the cross-disciplinary nature of the research question, the literature review references documents ranging from military strategy text, manuals and articles on Stability Operations and CIM, and journals/texts discussing content analysis, spatial analysis, and SDSS. The methodology used is a development case study, outlining the procedure and demonstrating its use. This type of research method is prevalent in social science studies intended to produce a new curriculum, instructional method or technique. Thus, the intended result of this study is a new CIM spatial analysis methodology created by integrating existing social science techniques that mitigates the current problems inherent in producing the Stability COP.

2. STATEMENT OF PROBLEM

Because Stability Operation activities are fundamentally different from those involved in offensive and defensive operations, the informational requirements are also fundamentally different.[4] While offense and defense are kinetic (combat driven), enemy-centric operations and Stability Operations are activities that "maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief".[5] Stability Operations are inherently population-centric operations. Joint Publication (JP) 3-07 (Stability Operations) emphasizes this point, "[t]he primary military contribution to stabilization is to protect and defend the population, facilitating the personal security of the people and, thus, creating a platform for political, economic, and human security".[6] The focus is on the non-kinetic fight.

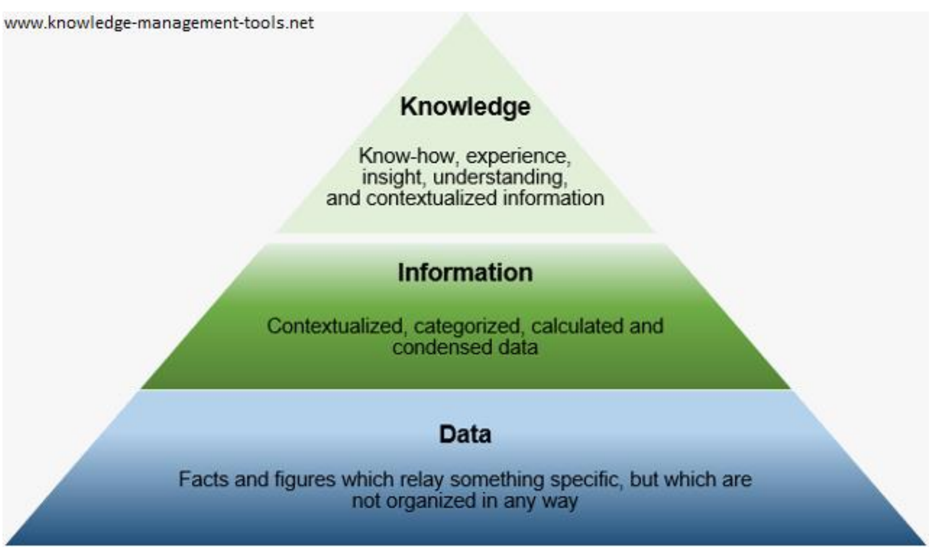
One point that highlights the differences is the comparative requirements for information. COL(R) William Flavin of the United States Army Peacekeeping and

Stability Operations Institute (PKSOI) identifies the differences when addressing Intelligence Preparation of the Battlefield (IPB). He notes that the emphasis and foundations for a post-conflict IPB are different from those for warfare.[7] Normally, the IPB procedure creates enemy-focused products that include event templates and matrices, a high-value target (HVT) list, and a modified combined obstacle overlay (MCOO).[8] Both products necessarily reflect the enemy-centric focus of the IPB procedures. Flavin state that Stability Operations “IPBs” should address political, economic, demographic, ethnic, religious, linguistic, psychological, and legal factors. Nontraditional and open source information such as travel agencies international organizations, commercial ventures, clergy, and nongovernmental organizations (NGO) become the new engagement targets for the area.[9] This split in information requirement highlights the combat/stability difference.

The dichotomy between combat and stability information issues extends to the operational assessments. Jonathon Schroden, research team leader with the Center for Naval Analyses Strategic Studies, noted that during conventional conflicts, well-established theories of war provide excellent identification of objectives and a comprehension of how to pursue them. These theories also enable the development of well demarcated progress metrics (terrain held, captured or killed enemy counts, or enemy equipment and material destroyed totals). Yet, the theories are more complex, the objectives and methods necessary to implement them are more complicated, and success and victory are more elusive to define for unconventional conflicts. The result is an environment where progress is more difficult to gauge and demonstrate.[10] While any exercise of the military instrument of power is a human endeavor subject to less objective scrutiny than other actions, both Flavin and Schroden note that nonstandard operations such as stability are exceedingly so. Stability Operations are dependent upon the more complex theories associated with social science. Given this fact, stability information processing and evaluation need an alternative method to the IPB.

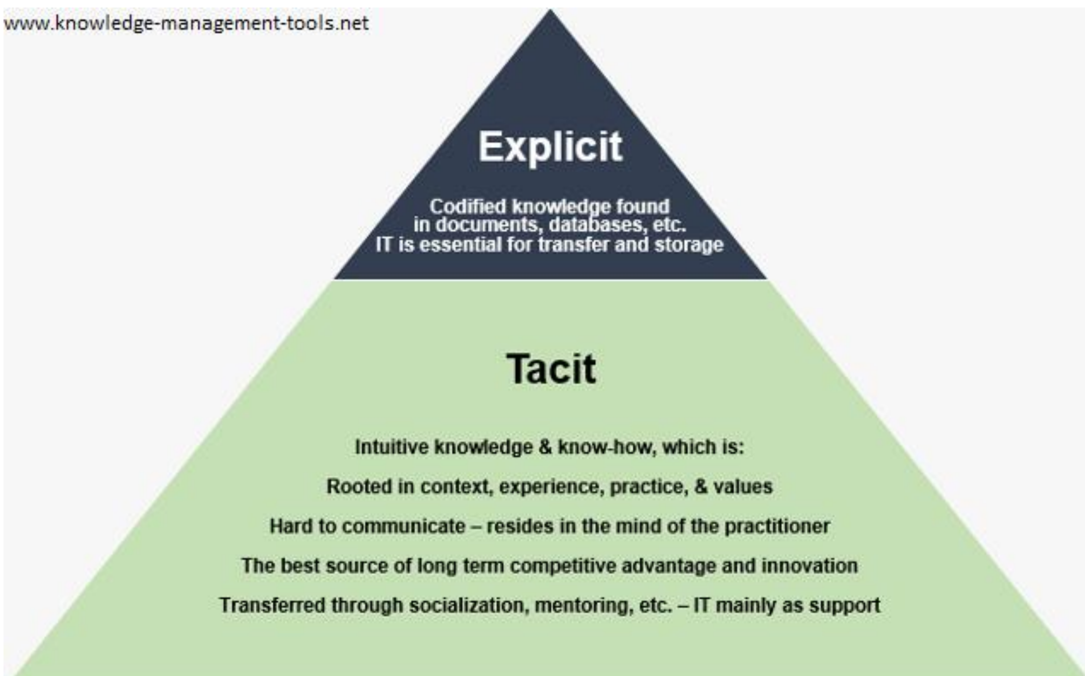
Stability information development is different from combat IPBs and is difficult due to the procedures that turn raw data into information, and information into knowledge. Despite the three terms' interchangeable usage, there is a hierarchy of terms among data, information, and knowledge (Figure 1):

> Data are individual facts, measurements, or observations, which may or may not be sufficient to make a particular decision. Information is obtained when elements of data are assembled, reconciled, fused [merged], and placed in an operational context. Knowledge is derived from being able to use information to construct and use an explanatory model based upon an understanding of the situation or phenomenon.[11]



Data-Information-Knowledge Transformation Diagram[12]
Figure 1

An additional differentiation of note occurs between the types of military information, Explicit and Tacit (Figure 2). Explicit information (e.g., the position of forces, weather, physical geography) needs minimal interpretation and can usually be communicated quickly and easily. The vast majority of combat information is explicit. The struggle comes in placing the information in a greater context and interpreting its implications.[13] Conversely, battle space knowledge is derived from tacit information, and tacit information requires interpretation. Supporting facts are transferred, but "the underlying organizing logic can seldom be transferred quickly and easily".[14] Consequently, battle space knowledge is a people-centric capability. Those dealing with knowledge develop, process, and communicate tacit information.[15]



Tacit-to-Explicit Knowledge Diagram[16]
Figure 2

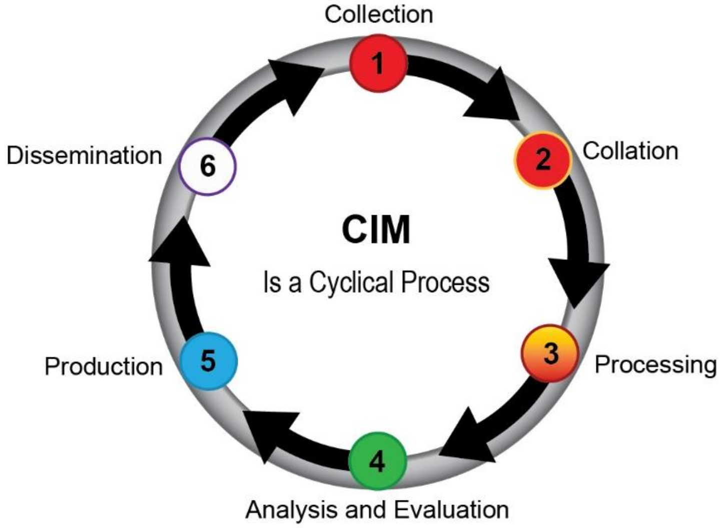
Stability Operations depend on understanding both tacit and explicit information in multiple contexts and with multiple implications.

NSPD-44 requires the DoD to provide specific support, including personnel, to "identify, develop and provide relevant information".[17] This requires the development of procedures and products providing comprehensive information management of noncombatant populace issues. CIM is a procedure designed to address the information needs of a maneuver command concerning the inhabitants of a specified area. Each branch of the military is developing some level of CIM capability. For the U. S. Army, CIM is defined as:

> [The process] whereby data relating to the civil component of the operational environment is collected, collated, processed, analyzed [and evaluated], produced into information products, and disseminated.[18]

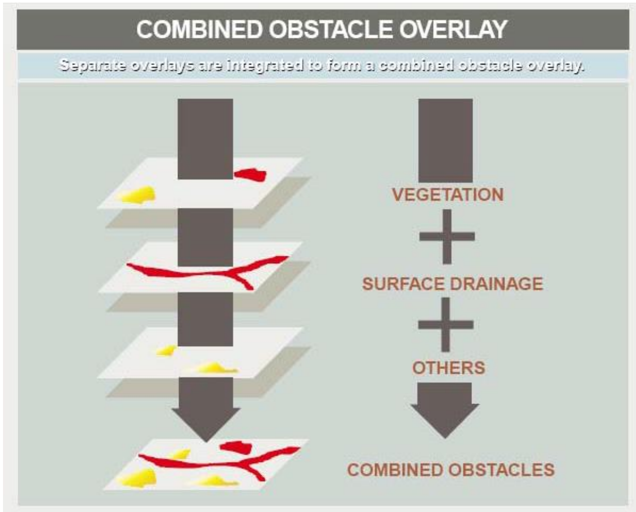
This collection – collation – processing – analysis and evaluation – production – dissemination methodology of civil information (Figure 3) is still in a nascent stage of development from the collation, processing and analysis/evaluation perspectives. Collation is the compilation of collected civil data based upon factors within the OE and the operations development.[19] It consists of compiling all collected civil data into one location, regardless of military source; it is the uniting of multiple sources of data from every level of operation. Processing is the physical and cognitive manipulation of separate pieces of data into information. It involves taking collated data and grouping it into cataloged categories.[20] This often requires the construct or use of an analysis framework or heuristic. Together, collation and process can be expressed as either "fusing" or "merging". Analysis and evaluation refers to the transformation of managed data into useful information and knowledge for the supported commander's decision making process.[21] Civil information analysis products include layered spatial information (GIS shapefiles), inputs for the Stability COP, CA Operations (CAO) estimate, maps, CAO running estimates, social network linkage diagrams, and other reports.[22] Yet, difficulties in developing methods for processing and analysis/evaluation severely limits the capability of CIM cells to produce the desired products. As a former Director of the

Defense Intelligence Agency stated, the failure in developing functional CIM results in "senior leaders not getting the right information to make decisions".[23,24] The COP and assessments are derived from the processing and analysis/evaluation steps of CIM and thus suffer from those steps' lack of development which are discussed. Of the many products that CIM contributes toward, the most important are the COP and assessments. These provide the foundation for the other products which are discussed below.



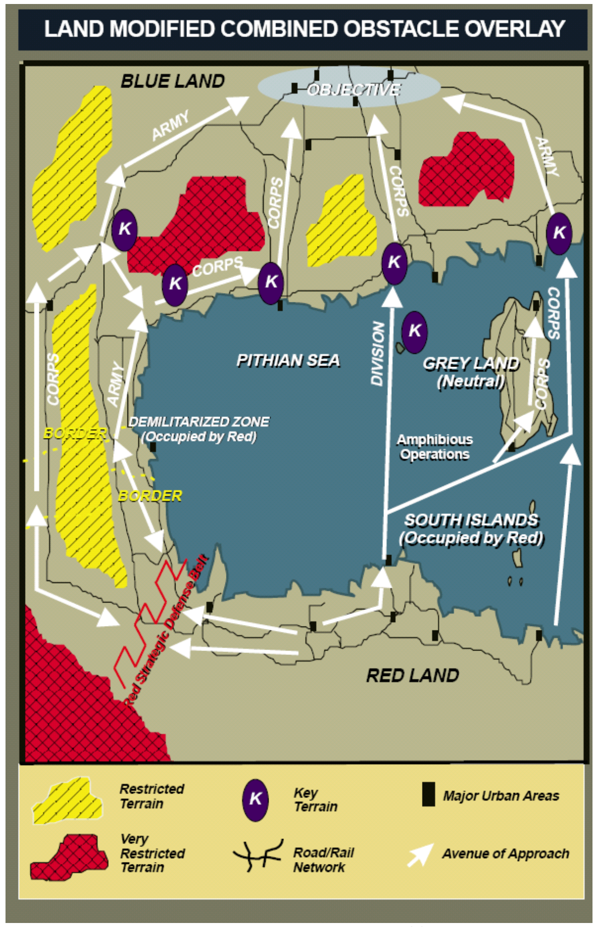
Civil Information Management Flow Diagram[25]
Figure 3

The COP is "a single identical display of relevant information shared by more than one command ... [It] facilitates collaborative planning and assists all echelons to achieve situational awareness".[26] Alternatively stated, it is the commander's shared, graphically-integrated display of relevant information.[27] While information is critical to each commander's decision making ability, the term "Common Operational Picture" is somewhat misleading. What is "common" is not the graphic but the underlying data.[28] A COP at any point in time is a stylized version of the entire OE, capable of presenting more than one view that represents a subset of the total information.[29] The MCOO spatially portrays how mobility is affected by restricting obstacles, key geography, engagement areas and defensible terrain.[30] It begins with the layering of various depictions of the physical terrain, both natural and man-made. This is the "Combined Obstacle Overlay" or CCO (Figure 4).



Initial MCOO Layers[31]
Figure 4

Then, areas of the OE where the geography principally favors one course of action (COA) as compared to others are identified and depicted spatially. The most effective spatial technique is to add the identified restricted and severely restricted areas to the CCO. From this military planners can develop and graphically depict critical items for Combat Operations to include avenues of approach, mobility corridors, counter-mobility obstacles, engagement areas, defensible terrain, and key terrain (Figure 5).[32]



Final MCOO Example[33]
Figure 5

This enemy-centric view of the OE is but one aspect and can be highly differentiated from a view focused on securing and influencing a given population.[34] The other key component of COP, "picture", is misinterpreted to mean that any portrayal of the COP (e.g., the slides shown in an Operations Center) is the COP in its entirety. While these pictures are COP outputs, they are not the entire COP. The entire COP is the combination of data, information and knowledge that is resident in the entire organization.[35] What is key to COP development is that information is aggregated and presented in a specific way to support decision making; it ensures that there is functional reliability among the different views.[36] The MCOO provides a method of merging the combat operations information in a straightforward application of layering the various physical variables and identifying the space that allows freedom of movement. Stability Operations currently lack a comparable method for conducting the contextual aggregation function.

Assessments are the other key product of CIM. JP 3-0 (Joint Operation) defines assessments as "[the procedure] that evaluates changes in the environment and measures progress of the joint force toward mission accomplishment".[37] Commanders at all levels continuously assess the OE and the progress of operations, comparing the current situation with an initial understanding, and adjusting operations based on this further analysis. Staff sections assist the commander through identifying and monitoring key indicators influencing operations, providing the commander information needed for decisions in a timely manner. The non-exclusive list of theoretical purposes and utilities of assessment include commanders’ decision making information provision (e.g., resource allocation), design cycle (plans) completion, OE condition change recognition, innovation and adaptation stimulation, operational uncertainty and risk reduction, actions to objective achievement causal linkage discovery, and subordinate unit performance evaluation.[38] Assessment tasks are different from the continuous situational monitoring of operational progress. They focus on the evaluation of mission, objective, and end state attainment.[39] Effective assessment entails evaluation criteria reflecting the degree of realization toward mission accomplishment. These are expressed as either measures of effectiveness (MOEs) or as measures of performance (MOPs).[40] MOEs "assess changes in system behavior, capability, or OE that [are] tied to measuring the attainment of an end state, an objective, or the creation of an effect".[41]

They are normally characterized by the question, “are we doing the right things (to achieve a desired end state)?” MOPs, or measures of performance, "assess friendly actions that are tied to measuring task accomplishment".[42] MOPs are normally characterized by the question, “are we doing things right (correctly)?” Generally, MOP aspects of operations are quantifiable, but not always easy to assess. Assessing the physical aspects of an operation is straightforward. Yet, the dynamic interface among friendly forces, adjustable adversaries, and malleable populations generally make assessing the MOE aspects even more difficult.[43] One source of difficulty is that none of the U.S. military manuals address how to conduct effective assessments. Publications JP 3-0 and JP 5-0 are notably vague regarding assessment.[44] The old U.S. Army Field Manual (FM) 5-0, The Operations Process, provided more detail on how to conduct assessments with much of its guidance coming from a practitioner’s viewpoint. But the guidance also contains contradictory instructions that detract from its overall utility.[45] Its replacement, Army Doctrine Reference Publication (ADRP) 5-0, The Operations Process, minimally attempts to clarify the contradictions in FM 5-0. The Counterinsurgency Manual, FM 3-24, provides a useful set of example indicators but fails to discuss how to develop an assessment framework/product, and how to collect, analyze, and evaluate data.[46] A second source of difficulty is derived from a lack of adequate training. Schroden identified two categories of service members tasked to implement operational assessments: staff officers who, irrespective of their skill sets, are placed in assessments billets, and operations research and systems analysis (ORSA) support officers.[47] The former often do not have the technical skill set to use the computer software tools required for assessment; the latter may have the software technical skills but lack the social science training required to accurately conduct assessment in a Stability Operations environment.

Fusing (collating/processing) and analyzing/evaluating necessary data into information and knowledge for stability purposes is more difficult because it is based upon social variables. Stability Operations function increasingly within volatile, uncertain, complex, and ambiguous (VUCA)[48] environments, characterized by a set of non-linear and interconnected variables. This environment is made of a system of interacting organizations, agencies, and governments in which complete knowledge about the factors governing strategy decisions is virtually impossible to obtain. Decisions must be made with incomplete understanding and all the associated risk incomplete understanding brings.[49] Spatial fusing complications arise due to these VUCA variables. Location of an entity must now share importance with other attributes. For instance, in Operation Iraqi Freedom, a tribe's Islamic school of thought and its relationship with U.S. forces, the insurgents, and other adjacent tribes were just as important as the tribe's location on a map. Evaluation of these variables not only requires identifying MOP and MOE, but also by examining how various factors interact. The elements of social stability interact with one another. Stability Operations need a methodology that accurately reflects "how well these elements are performed and the manner in which they interact, and the commitment of key members of that society to maintain or promote a standard acceptable to the populace".[50] Thus, the root problem is in development of a CIM methodology that effectively integrates the various stability factors. To resolve this deficiency, CA planners must understand why these political, economic, and social inputs are difficult to identify and integrate, especially in a spatial context.

3. THEORETICAL FOUNDATIONS AND RESULTING INFORMATION PROBLEMS

Urban planning is an applied social science with theoretical underpinnings applicable to stability informational difficulties. Specifically, there are three key theoretical ideas common to urban planning and Stability Operations.[51] The combination of the three theories creates a convergence between planning and stability, allowing the use of various planning analytical tools toward Stability Operations. Specific to this study, these theoretical frameworks indicate the possibility of urban planning methods' applicability to use in CIM analysis during Stability Operations.

The first theoretical foundation, Wicked Problems, argues that a "scientific" basis for social policy formation is problematic due to the nature of social issues.[52] Yet it is often not best suited for socially structured policy analysis. Policy planning problems are “ill-defined” and highly dependent on political choice for determination (not problem solution).[53] Wicked Problems authors Rittel and Webber listed a minimum of ten distinguishing properties of planning-type problems (those requiring identifying and choosing amongst a selection of policy options - hence wicked). They are:

- There is no definitive formulation of a wicked problem
- Wicked problems have no stopping rule
- Solutions to wicked problems are not true-or-false, but good-or-bad
- There is no immediate and no ultimate test of a solution to a wicked problem
- Every solution to a wicked problem is a “one-shot operation”; because there is no opportunity to learn by trial-and-error, every attempt counts significantly

- Wicked problems do not have an enumerable set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan
- Every wicked problem is essentially unique
- Every wicked problem can be considered to be a symptom of another problem
- The existence of a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution
- The strategist/planner has no right to be wrong.[54]

Yet, these ten properties do not operate independently. The interactive complexity of Wicked Problems makes social issues problematic.[55] Once mainly applicable to the Western world, the overarching point of wicked problems theory is increasing applicable to developing countries and ungoverned spaces; the plurality of populace (if not governance) has become the trend instead of the exception. Yet in a plurality, entities pursuing politically diverse goals make policy development and choice extremely difficult.[56] There is no theory that identifies what is thought to be societally best state; no theory that states what distribution of the social product is best; or what is not universally perceived as objective and non-partisan.[57] It is the social context in which the analysis is conducted that makes these conditions truly wicked. This theoretical framework serves as the contextual setting in which Stability Operations and the civil-COP are conducted. It is also he reason why the Stability COP are encumbered with VUCA characteristics.

The second foundation is the economic theory of club goods - a variation of public goods - those normally provided by the government due to the market's inability to do so. Club goods are public goods that become excludable but not rival.[58] Excludability is the capability of preventing people from using a good while rivalry is the diminishment of one person's goods consumption due to another person's consumption of them. Excludability is normally done through a pricing mechanism.[59] However, other societal factors can cause exclusion from a good or service. The club goods theoretical framework serves as the operational setting in which Stability COPs are conducted. It is the reason why Stability COPs are encumbered with VUCA characteristics creating the difficulties implementing support to a host nation's government or initiating governmental services in a non-governed area.

The final foundation - information asymmetry - is also an economic theory. It is defined as unequal knowledge possessed by the parties involved in a transaction.[60] This situation causes difficulty in distinguishing trustworthy transaction participants. This subsequently results in the inefficient use of scarce resources and requires government intervention.[61] A specific form of information asymmetry, adverse selection, arises from buyers having inadequate information about sellers' products.[62] This theory can be extended beyond the buyer-seller dynamic. In the case of goods provision, the dynamic is between distributor and recipient. Information asymmetry/adverse selection problems from inadequate distributor information about recipients can result in persons or selected populations being excluded from vital goods and services. In this case the distributor is the "buyer" of inadequate information of who needs the goods. The information asymmetry theoretical framework serves as the knowledge setting in which Stability Operations are conducted. It is the reason why the Stability COP are encumbered with VUCA characteristics when attempting to understand "what is needed where" in an operational area.

The intersection of the three theories creates a triad applicable to both urban planning and Stability Operations' information and knowledge difficulties. Examine first the intersection of club goods and information asymmetry. As stated, club goods are based upon excludability and non-rivalry. These "clubs" are based upon two basic premises: club membership sizes are restricted, and both goods provision and club membership size are interdependent.[63] Excludability is based on information within the distributor-recipient transaction, where the distributor suffers from adverse selection. Information asymmetry can present itself through various characteristics. A characteristic is the limitation of the human mind ability to collate, process, analyze, and evaluate large amounts of information. Another is the improper processing of information due to bureaucratic dysfunction. And yet another is the withholding information or the presentation of disinformation by an elite group operating from perceived privilege or political inequality.[64] The resulting information deficit creates the potential for one recipient's denial of goods and services and another recipient's gain of an inordinate portion of the same.[65] Merging this informational asymmetric induced club goods model into a situation in which solutions are not achieved through either resource optimization or process efficiency causes a scenario that is difficult to visualize and comprehend, and harder still to take action to remedy (i.e., wicked).

Urban planning fits the theory triad of wicked problems, public (club) goods provision, and information asymmetry. Methodologies from multiple paradigms justify urban planning's usefulness. Economics identify the requirement for governmental action to correct market failures. There are multiple resulting implications. First, governments must develop urban [spatial] information systems. Second, governments must develop methods of analyzing population migration, economic growth, and land use. Third, governments must provide for public goods and compensate for inequities in the distribution of basic social goods and services.[66] While economic paradigms justify government planning, they are not sufficient reasons for taking action. Public policy formation theories present that government action is also guided by the political bargaining process.[67] Pluralists models provide for the interaction between formal and informal groups pursuing a divergent range of goals where government's role is limited to the establishment and enforcement of the rules of the game, which ratifies the political modifications produced by the various groups. Yet pluralism is limited due to the political arena's domination by entities using governmental access for status, wealth, and privilege. Attainment of such status, wealth, and privilege indicates the possibility, if not the probability, of information asymmetry capabilities of these power gaining entities. These observations on the ability to conduct information asymmetry correspond to political aspects of Wicked Problems theory. The justifications of community interest promotion, decisional information improvement, and analysis of distributional actions effects segues and combines with Wicked Problems to meet the theory triad.

The characteristics of Stability Operations also meet the established theory triad. First, aspects of Stability Operations can be viewed as public good provision. JP 3-07's Stability Operations definition lists a number of public good missions, for example: "to maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief".[68] The context of goods provision is what is important. Because conflict and war impede daily life functions, providing fundamental public goods and services are urgent tasks confronting Stability Operations.[69] Such conditions lead to the establishment of a club goods condition because societies differ on what is considered a public sector service provision obligation and what is an individual, family, tribe/clan, or other social grouping obligation. The group that controls the assignment of responsibility controls choices about public services delivery and the provision of basic services. Generally, governments existing in fragile and post-conflict situations are usually centralized in form and are more susceptible to elite group capture. The dominant group or coalition controling the center also controls access to services universally. Central systems suffer from a ‘one size fits all’ mentality, capital city biases which that services to outlying areas, and depreciated responsiveness to local demands.[70] This situation is similar to the plurality problem in urban planning.

Second, the situation discussed above presents the potential for information asymmetries by those in power. Remembering that Stability (in this context) is a military operation, military strategist Clausewitz’s ‘fog of war’ theory (the initial unreliability of any information) still applies.[71] Yet, in contrast to Combat Operations where information may become enlarged and distorted, Stability Operations’ information issues are more likely to be hidden or misunderstood due to a lack of understanding them in a local area and cultural context. Groups gaining power under such conditions tend to increase control of information through the ‘mobilization of bias’. This is a devised constraint over human interaction (either formal or informal rules of the game) that empowers some groups and disenfranchises others. Groups in such conditions also gain power through latent conflict (the denial of attention to potential issues often realized by averting observable conflict).[72] Both mobilization bias and latent conflict are rooted in the exercise of information asymmetry, and that power can be extended to cover the distribution of public goods.

Finally, Stability Operations are inherently wicked problems. Military strategists Greenwood and Hammes in 2009 systematically and successfully applied the ten characteristics of wicked problems to Stability Operations at the theater strategic, and operational level of military planning. Specifically, these operations require a host of civil society and public administration experts in order to adequately conduct planning.[73] These experts provide assistance on the issues of social science required for situational understanding during Stability Operations.

Urban planning and Stability Operations are united by a triad of theoretical foundations. Public goods provision equates planning and stability as the underlying purpose for both. Information asymmetry impacts both urban planning and Stability Operations, creating adverse selection exclusion conditions upon the provision and distribution of public goods. The similarity of urban planning and Stability Operations as 'wicked problems' are based upon socio-economic and political factors causing problem 'resolution' rather than 'optimal solutions'.[74] In other words, it is easier to temporarily fix a symptom through optimization or efficiency than find and solve the root problem. These difficulties are compounded due to the expectation that information should be presented spatially (i.e., on a map through either – paper or computer graphics). Given the nascent stage of development of the CIM process and analysis portions and the triad of theoretical foundations similar to both urban planning and Stability Operations, it is worth examining the applicability of urban planning analysis methods to Stability Operations analysis within CIM.

4. RESEARCH QUESTION

Because Stability Operation informational problems are similar to those found in urban planning, it is reasonable to assume that a potential solution can be found in the analysis methods of applied social sciences such as urban planning. The initial research question was 'How can urban planning analysis techniques be used to implement an integrated Stability COP?' Because of the multiple issues involved with an integrated Stability COP development, a multi-component approach is needed. This study uses Spatial Decision Support Systems (SDSS) as that multi-component approach that creates an integrated Stability COP. While SDSS has multiple definitions, a capabilities oriented characterization defines SDSS as an "integrated environment which utilize[s]… both spatial and non-spatial models, decision support tools, … statistical packages … and enhanced graphics to offer the decision makers a new paradigm for analysis and problem solving".[75] An effects oriented characterization defines it as "an interactive, computer-based system designed to support a user or group of users in achieving a higher effectiveness of decision making while solving a semi-structured spatial decision problem".[76] In summary, SDSS has provided a methodology to address ill-structured and ill-defined spatial problems in an interactive and iterative procedure.[77] Generally, SDSS has been used for urban planning related purposes ranging from land use planning and impact analysis, housing accessibility analysis, nature habitat site improvement and woodland regeneration, potential city development, and watershed management.[78] Since SDSS' definitions and characteristics address the major current weaknesses of CIM analysis, it is useful to examine the components of SDSS.

Thus, the revision needed for procedure development in CIM's collation – processing – analysis components leads to three questions on establishing spatial analysis for Stability Operations:

- How can SDSS integrate qualitative political and socioeconomic factors into a singular visualization of the Stability Operational Environment (OE)?
- How can SDSS help provide a holistically spatial approach and systematic analysis adaptable to multiple situations and socioeconomic settings?
- How does SDSS facilitate cooperative planning and support all echelons in achieving situational awareness and decision making?

In summary, the research question is " 'How can a SDSS elevate the problems of spatially fusing and analyzing/evaluating necessary socially based data for stability analysis'."

4.1 Research Method Overview

This study presents a case study using a mixed-methods approach. Case studies involve in-depth explorations of a specific program, event, or process bounded by time and/or location.[79] The case study method proves useful in distinguishing the effectiveness of the proposed SDSS analysis technique. The specific case presented is the development of the Stability COP just after the Iraqi War 'Surge'. The Surge is the military operation intended to help the Iraqi Government to secure neighborhoods, protect the local population, and provide security within the Baghdad and Al Anbar provinces through the use of an increased American presence. The case study examines how the Stability COP for this period was developed and used to determine where a Operation Iraqi Freedom (OIF) post-Surge Stability Operations main effort was located in comparison to the results developed by the SDSS approach.

This mixed-method follows a sequential exploratory strategy whereby the collection and analysis of qualitative data leads the process and analysis of quantitative data. This strategy is useful for developing and testing a new instrument. It allows the development of analysis instruments by using a small group to create the instrument and then assembling quantitative data based on the instrument.[80] The qualitative portion is the Delphi technique. Developed at the Rand Corporation by Dalkey and Helmer in the 1950s, this is a method widely utilized and acknowledged for attaining opinion convergence regarding real-world knowledge from experts concerning specific topic areas.[81] During the interaction sequences, participants identities are unknown to each other. The questionnaires are conducted in an anonymous means in order to mitigate identifying a specific opinion to a specific person, so that ideas can be considered on its merits, regardless of the professional or social status of opinion originator by the other members of the group. U.S. Army Civil Affairs commanders of field grade rank (Lieutenant Colonel and Colonel) during or just post the Surge were selected to participate in the Delphi survey. They are identified as experts on the subjects of Stability Operations, Stability COP, and the situational conditions due to their service in the Civil Affairs branch in general and their presence in the Iraqi OE during the time when the decision of the post-Surge main effort location place was made.

The quantitative portion is the SDSS. As discussed above, SDSS is a multi-component approach used to address ill-structured and ill-defined spatial problems in an interactive manner. Component identification varies throughout the SDSS literature. The component list used for this study is from Sugumaran and DeGroote's 2011 text, which is essentially an amalgam of literature reviews. Four components are identified as core to SDSS. They consist of a database management component (DBMC), a dialog management component (DMC), a model management component (MMC), and a stakeholder component (SC).[82] While the emphasis of this study is the MMC component, an explanation of how these components function is needed for SDSS' application for Stability COPs.

4.2 Delphi

The experts were surveyed using the Delphi technique. This method is very helpful in certain applications because of its general characteristics, such as anonymity and iteration with feedback. The Delphi technique is a procedure whereby experts' opinions are polled regarding a given subject. It differs from other surveys in that it is repeated two or more times. The responses given by the participants on the first polling are evaluated and reported back to the participants to get their reactions to the differences between their individual answers and the 'median' response of the entire group. The results are used as weights to apply to scores within each criterion for the decision methodology.

As stated, members of the group were selected to participate in the Delphi survey based on their deployment in the Iraqi War during and just after the Surge. They were identified as experts due to their leadership position as U.S. Army Civil Affairs commanders during that time. Serving in these positions, those selected have in-depth knowledge of the OE and the COP. As stated earlier, the OE is a composite analysis of various conditions, circumstances, and influences affecting the employment of capabilities bearing on the commanders' decisions. The geographical representation of the OE is known as a COP and is difficult to achieve during Stability Operations due to general characteristics of socio-economic data not being readily practical for meaningful graphical presentation. Both the OE and resulting COP presentation can and should aid in the analysis of where Stability Operations should be conducted.

The first round of questions are open-ended ones designed to establish why and how the main effort location was selected. The post-Surge Stability Operations theater main effort was located in the city of Mosul, Nineveh province (northern Iraq), with actions taking place approximately September-October 2008. This provides a historical situational awareness from which a comparative case study is conducted. The questions are meant to describe the procedure(s) used to identify and describe the post-Surge composite civil OE and how this OE was used in the designation of the main effort area.

The second round of questions gatherers input toward the establishment of an analytic approach for a solution to the problem of where the main effort for post-Surge Stability Operations should be designated (i.e. which Iraqi province). This involves the ranking of criteria. The Delphi participants were a proxy for the military staff within MDMP. Each Delphi panel participant was asked to rank-order the eight interrelated operational variables U.S. military planners use to analyze and evaluate an OE: political, military, economic, social, information, and infrastructure (PMESII).[83] They were transformed into an analysis framework (heuristic) and served as the criterion for operational analysis. The full acronym is PMESII-PT with the PT standing for ‘Physical Environment’ (terrain) and ‘Time’ respectively. Neither time nor terrain are operational variables themselves, but are characteristics affecting the variables.[84] The action of mapping the PMESII variables places assigns the PT characteristics. The PMESII criteria were selected due to its pervasive use by the American military for analyze and evaluation aspects of the OE describing, not only the military aspects, but also the population's influence on it. The populace's influence is a central factor in the effectiveness of Stability Operations. The collective ranking is established using the median of the individual ranks.

The third round of questions finalizes the establishment of an analytic approach. This was a continuation of the analytic approach solution to where the main effort for post- Surge Stability Operations should be designated (i.e., in which Iraqi province). This involved the construction of a set of pairwise comparison matrices. Each of the PMESII operational criterion, in the established rank order, are compared to the PMESII criteria in the level directly beneath it with respect to its rank. These pairwise comparisons result in weights for application to each PMESII value within each Iraqi province. The median of each individual pairwise comparison was calculated in order to establish the collective matrix. The combination rank and pairwise comparison values are used to develop weights for the evaluation process.

4.3 Spatial Decision Support Systems (SDSS) Fundamentals

As stated above, there are four components to a SDSS: a database management component (DBMC), a dialog management component (DMC), a model management component (MMC), and a stakeholder component (SC). GIS is the base software; it functions both as the first two components, DBMC and DMC.[85] GIS can generally be defined as a software package "designed to store, manipulate, analyze, and output map-based, or spatial, information".[86] Described as the marriage between a relational database and computer-aided drawing (CAD) and often only thought of as a map making device, GIS' true power is its ability to jointly manage spatial and non-spatial data. The DBMC portion of the definition refers to relational databases with the ability to join or relate information by both attribute and spatial means. Attribute data describes quantitative and/or qualitative characteristics of the spatial data.[87] Spatial data digitally represents the physical world and is categorized by two data types, which are discussed below.

The first, vector data, divides the real world into clearly defined features by geometry based on point, lines or polygons.[88] Points are the simplest vector feature with spatial representations of longitude, latitude, and possibly elevation (x, y, and z coordinates). Lines are one dimensional features vector data defined by x and y coordinates only. Polygons are two-dimensional features defined by a series of points and line segments with the start and end coordinates being identical.[89] Because these polygons attempt to match physical terrain, they are often non-uniform-irregular in shape and size. Vector data are suited to analysis requiring connectivity of topological characteristics including proximity, overlay, network, and geocoding.[90] Physical issues concerning distance, shared space, routing or traffic flow, and location placement are best served by this form of spatial analysis.

The second data type is raster data. Rasters are two-dimensional grids with regular (equally-sized) individual cells; each grid cell contains a single characteristic representing a real world phenomena.[91] Natural phenomena that vary continuously across space (elevation, climate, etc.) and social phenomena of either discrete or continuous measure are better represented using raster data.[92] These structures can be layered and analyzed jointly per each cell . This is of great potential importance for CIM analysis. Raster structures facilitate models concentrating on the information within each gridded structure. In general, values for social, economic, political, and cultural Stability Operations data enable raster map algebra functions to develop an integrated and holistic CIM analysis.

The DMC portion of GIS refers to the development of effective user interface whereby the data are entered into the system and information is readily retrieved.[93] While early GIS systems were operated primarily by command-line programing, most of today's systems can be operated via graphical user interface (GUI), allowing for a more intuitive usage approach.

The third SDSS component (and the core component of this research) is model management component (MMC). Consider this as the 'decision support system' (DSS) part of the SDSS acronym. MMC helps in the management, execution and integration of various data sets and models.[94] There is a multitude of modeling techniques available for use as a MMC. One set of techniques is known as spatial analysis. It is generally defined as "the process of examining the locations, attributes, and relationships of features in spatial data through overlay and other analytical techniques in order to address a question or gain useful knowledge … [it] extracts or creates new information from spatial data".[95] An initial form of spatial analysis is the layering of vector data to find areas of intersection. This technique of simple map overlay in GIS is a version of 'sieve mapping' used to identify land use suitability by land use planners.[96] Basically, overlays depicting a single analysis criterion are created with areas deemed unsatisfactory (or satisfactory depending on the analysis) in each criterion darkened. The overlays are then placed over one another. Area disqualification is based upon multiple unsatisfactory criteria rankings. Those areas remaining are deemed susceptible to the desired aspects of all criteria.[97] Championed by Ian McHarg, the developer of how to breakdown a region into its appropriate uses for habitation, this form of spatial analysis was used to conduct a land use identification process based on community social values.[98] The U.S. Army currently uses a stylized version of this technique when conducting the discussed MCOO. Note that this is an extremely basic form of modeling and often fails to capture the intricacies of human interaction. Yet, it often provides a good initial reference point for further inquiry.

More advanced spatial analysis methods include a collection of techniques called exploratory spatial data analysis (ESDA). These techniques are used for spatial distribution description and visualization; identification of atypical locations or spatial outliers; and spatial association pattern identification (clusters or hot-spots). ESDA is a subset of exploratory data analysis (EDA) methods originally developed by John Tukey (1977) that focus on the distinguishing underlying characteristics of data.[99] Central to ESDA is the determination of a variable values' interdependence pattern over space. This identification of geographic clustering is measured by spatial autocorrelation.[100] Initially this is done using the Moran's ***I*** global index.[101] The purpose is to identify existence of the same pattern or process occurring over an entire geographic area. The 'Global Moran's' measures the correlation of a variable with itself through space.[102] As with other statistical tests, a null hypothesis is established for the purpose of falsification or disproving. The null hypothesis in this case is that there is no (or zero) autocorrelation of the variable values. Mathematically, the z-score for the expected value of a random Moran's ***I*** [E(I) = -1/(n-1)] is less than zero.[103] Because ArcGIS'

Global Moran's algorithm assumes a normally distributed dataset, analysis of this dataset is conducted using GeoDa. The procedure in GeoDa utilizes a Monte Carlo simulation process. Just as Bootstrapping enables accuracy assessment measures (e.g. variance, confidence intervals) for an unknown non-spatial population size through random sampling with replacement, Monte Carlo simulations conduct multiple random samples to obtain the distribution on populations (non-spatial and spatial) that are neither random nor normal.[104] Using the Moran's scatterplot developed by Anselin, the spatial agglomerations are identified as either zero (the null hypothesis), positive (similar high or low values spatial clustered together), or negative (dissimilar values in close location).[105] It classifies the autocorrelation as either spatial agglomerations or spatial outliers. Using a quadrant diagram, the different types of spatial autocorrelation are classified by location within the quadrant.[106] As stated above, the Global Moran's index provides a comprehensive examination of spatial autocorrelation within a geographic population. Spatial identification of where significant activities are needed to fulfill CIM's geographic display requirements. A LISA (Local Indicators of Spatial Autocorrelation) measure provides both information on the statistical significance of cases within the spatial agglomerations/spatial outliers and identifies non-statistically significant cases. Simply put, local high values can exist by virtue of being greater than others in their adjacent area and yet not be globally large. This 'Local Moran's index' (***Ii***) tests the statistical significance of ***I*** and ***Ii*** against an absence of spatial autocorrelation (i.e. a spatially randomly distributed variable) null hypothesis (H_0). The H_0 is rejected under the NONO principle (NOn-significant, NOt rejected).[107] LISA provides a capability to examine individual entities against the whole to develop a more nuanced picture of the OE.

A third spatial analysis technique is Boolean overlay. While sieve mapping is considered a basic form of Boolean analysis (binary or yes/no comparison), vector layer sets are limited to sieve mapping analysis. Advanced Boolean analysis uses raster layer sets and either mathematical or logical operations conducted between raster cells using a process known as raster algebra or map algebra. Conducting raster algebra on two or more data set layers is a useful analysis tool. The separate layers represent real-world phenomenon or human constructs. Boolean combinations create a new dataset having its own distinct meaning. Such analysis is common for urban and regional planners, transportation planners, and municipal engineers when conducting land suitability analysis. By setting multiple criteria and using separate land use and property parcel data, a planning analyst can identify specific parcels that fit criteria defined through the use of multiple Boolean operators.[108] These Boolean operators (AND, OR, & NOT) allow the combination of attributes (database fields/columns) across multiple datasets/databases for individual observations. Similar to Boolean operations within raster data, raster algebra is the mathematical cell-by-cell calculations of numeric values within the raster data.[109] The concept is based upon stored values in raster grids that allows function application to a single layer or multiple layers.

Another family of models for MMC use is called multi-criteria decision analysis (MCDA – also known as multi-criteria decision making or MCDM). These models are systematic approaches ln support of multiple alternative analysis during complex problems concerning multiple criteria (also making use of raster data mathematical capabilities). There are three major approaches of MCDA models, Full Aggregation, Outranking and Goal Programming (Aspiration/Reference Level).[110] Full Aggregation deals with development of a score of each selected judgment criterion and then synthesizing these into a global score for each alternative. Constructed as a tree-like criteria and alternatives hierarchy, the alternatives are evaluated with respect to each criterion and each criterion is weighted according to a collective stakeholders' or decision makers' importance assessment.[111] The scoring system allows the ranking of alternatives from best to worst to include equal ranking of alternatives. The most prevalently known Full Aggregation model is Analytic Hierarchy Process (AHP). The Outranking approach deals solely on the degree that one alternative is preferred to another.[112] A pairwise comparison is conducted on one alternative's set of criteria to another alternative's set of criteria. Each alternative's criteria set can differ. This method makes it possible for incomparability between alternatives due to a differentiation in the profiles. Thus, a complete ranking is not always possible.[113] The Goal Programming approach selects a target for each criterion, then identifies the alternative most closely reaching the target level. It is essentially based upon linear programing and, while the target may be selected subjectively, the actual criteria inputs cannot be subjective.[114]

One of the more sophisticated MCDA models are those using Fuzzy Logic. It involves the incorporation of data uncertainty due to situational vagueness rather than due to randomness alone. Unlike Boolean operations where the choice of an operation's use on data are binary, Fuzzy Logic uses a range of operations used on a conditional basis,[115] The logic is essentially based upon an intricate set of 'if-then' conditions applied to select the appropriate operation across a range of operations instead of depending on binary choices. This is analogous to a ‘nested if-then’ construct found in Microsoft Excel formula usage. For the purposes of spatial analysis, Fuzzy Logic can be considered a hybrid of Boolean and multi-criteria analysis techniques due to the functionality of ‘fuzzy sets’ as hierarchy of criteria used with methods like AHP.[116] These nested if-then sets serve as the knowledge-base options. It is a block stores of all of the prior knowledge (options) needed for the system to draw conclusions on an identified issue. A store prior knowledge system normally consists of two parts: a set of linguistic variables and terms with their membership functions and a fuzzy rules set in the form of if-then statements. Of the many types of MCDA models, those using Fuzzy Logic tend to be the most intricate to program and model because of the potential permutations of options. Because of Outranking’s incomparability, Goal Programming’s lack of subjective input use, and the overly intricate programing required for Fuzzy Logic, this study will select from the family of Full Aggregation MCDA models for use.

It is important to note that the use of these techniques are not mutually exclusive in conduct within the MMC. Combining techniques is useful when the initial or raw data does not readily allow transformation into information products that serve as the analytical base for knowledge and understanding. The socioeconomic, political, and cultural data set used during Stability Operations are examples of such raw data.

The final core SDSS component is the stakeholder component (SC). Stakeholders in this setting refer to the collective of individuals directly linked to the analysis product. This includes decision-makers/information end users, analysts, and system developers. SDSS successful application is dependent on the effective engagement of multiple and diverse potential participants.[117] It is a given that decision-makers are the key stakeholders at the process' culmination, needing meaningful information regarding the spatial problem. The analyst selects the appropriate models, conducts simulations, evaluates data, and interprets output products used in the decision making process. Note that there may be more than one analyst involved (e.g. separate modeling and GIS analysts). Developers design computer system architectures, create operator interfaces, and programs the system functionality. Designing the system is a crucial part of SDSS development and necessitates contribution from the entire continuum of system stakeholders and operators.[118] The CIM cell manning structure (containing soldiers specializing in GIS and computer information processing systems and officers trained in socio-economic, security and Stability Operations analysis) is similar in functional duties to those of the system developers and analysts. The decision-makers/information end-user function is represented by the military command. These stakeholder (SC) individuals jointly use the combined DBMC and DMC capabilities of today's GIS programs in conjunction with the various models and techniques of the MMC in order to transform the integrated spatial data into information. For the purposes of this research, parts of the Delphi survey were utilized to fulfill the SC portion of the SDSS.

4.4 Model Management Component (MMC) Specifics

Specifically for this study, and using the results of a geo-referenced analyzed text database as the source data, SDSS was used to develop this MMC integrated environment through EDA and ESDA on variables in the database, identification of spatial hierarchies of absolute and relative data for selected socio-economic and infrastructure variables, merger of individual selected variables through a geographical overlay procedure, and then a joint analysis of the variables using a decision making technique that allows subjective judgment and human interaction within the process. The details of various methodology components follow.

The methodology of Conglomeration as presented by Jesus Treviño. It is used to jointly conduct EDA and ESDA in identification of spatial hierarchies.[119] Conglomeration is the analysis of spatially grouped values developing from the combination of local high values and adjacent global high values.[120] The title ‘Conglomeration’ is meant to reflect the combination of statistical concentration (from EDA) and spatial agglomeration (from ESDA). It begins with EDA in order to identify concentration. Concentration in this context is defined as the presence of relatively high or relatively low values compared to other values in the population regardless of their geographic location.[121] This process will include calculations of descriptive statistics, normality tests, and development of threshold limit values to identify global high and low values for analysis. If the dataset is not normally distributed, it is still possible to obtain good performance statistics through the use of robust statistical analysis.[122] The process continues with an examination of agglomeration within the data set. Agglomeration is the concentration of adjacent spatially high local values. It involves calculation to Morans' ***I*** and LISA statistics. It concludes with a modified use of Treviño's conglomeration method for merging agglomeration and concentration analysis via a mapping overlay (sieve mapping) procedure.[123] This creates individual spatial conglomeration data sets based on identified socio-economic and industrial variables.

In Treviño's model, spatial conglomeration is conducted using vector data analysis on polygon geography. In order to conduct the individual variable overlay merge and joint variable decision making procedures, the vector data are transformed into raster data. Once done, the MCDA modeling technique used to jointly analyze separate layers is AHP. This permits consideration of both subjective and objective factors in alternatives ranking. For this analysis, the geography used is a point data set. While still in vector format, the specificity of the point locations allows use the statistical and algebraic functions conducted in a raster environment. Additionally, the use of point data for Morans' ***I*** and LISA statistics mitigates a concern in spatial data analysis. The concern is known as the 'Modifiable Areal Unit Problem' or MAUP. Spatial point data is often aggregated to various administrative boundaries (cadastrals, districts, census block groups and tracts, counties, etc.). While many configurations are official government geographies, there is still some level of arbitrariness in any of these geographies and the geographies are subject to change. Changes with these geographies affect how data points are aggregated by location.[124] This could potentially affect the values used in the AHP. The use of point data for this research helps to mitigate MAUP in the fact locational aggregations are conducted by matching longitude and latitude coordinates. It is recognized that many of the longitude/latitude coordinates are centroid locations for city geographies. Despite this fact, the research is not time-series based and there are no changes in geography during the month of the research.

Used in many fields including urban planning, AHP's primary usefulness comes from permitting decision makers to arrange the criteria and alternative solutions of a problem into a tiered and ordered decision model.[125] There are three general hierarchical steps in conducting AHP: goal identification, criteria (variable) selection, and alternative sets determination (courses of action). While the stages of the hierarchy may be expanded as necessary, the alternative solutions sets are determined at the lowest level of the hierarchy. Comparisons of the existing alternatives are determined by a pair-wise basis at each level of the hierarchy. These determine the weighted relative importance of each criterion. This weighing is normally conducted utilizing a nine-point scale. Then, a measurement of the criteria values for each of the alternatives is conducted. The AHP procedure synthesizes the alternatives' priorities with the criteria measurement into an overall ranked set of values indicating the comparative importance of each alternative.[126] This essentially equates to steps three through five of the Military Decision Making Process (MDMP), used throughout the U.S. Army for operational planning.

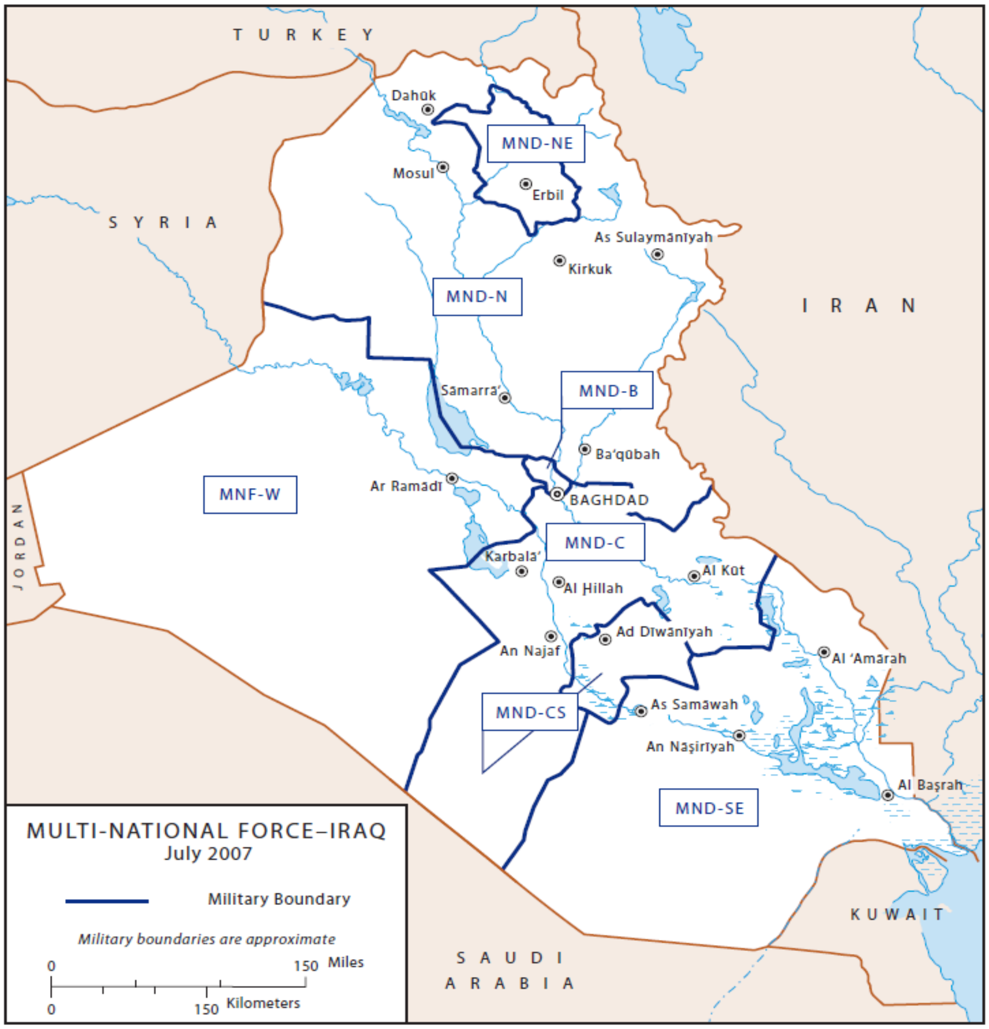
4.5 Case History

As outlined above, the case study subject was the OIF post-Surge decision to make the municipality of Mosul in the province of Nineveh the main effort. To understand this one must first understand the geographic and situational context of the Surge itself. The Republic of Iraq was composed of eighteen provinces or governorates at the time of the data collection in 2008 (an eastern section of the Sulaymaniyah province was separated in 2014 to create a 19th province, Halabja, in March 2014). Figure 6 shows a map of the Republic of Iraq with provincial boundaries.

Provincial Boundary Map of Iraq
(pre March 2014)
Figure 6

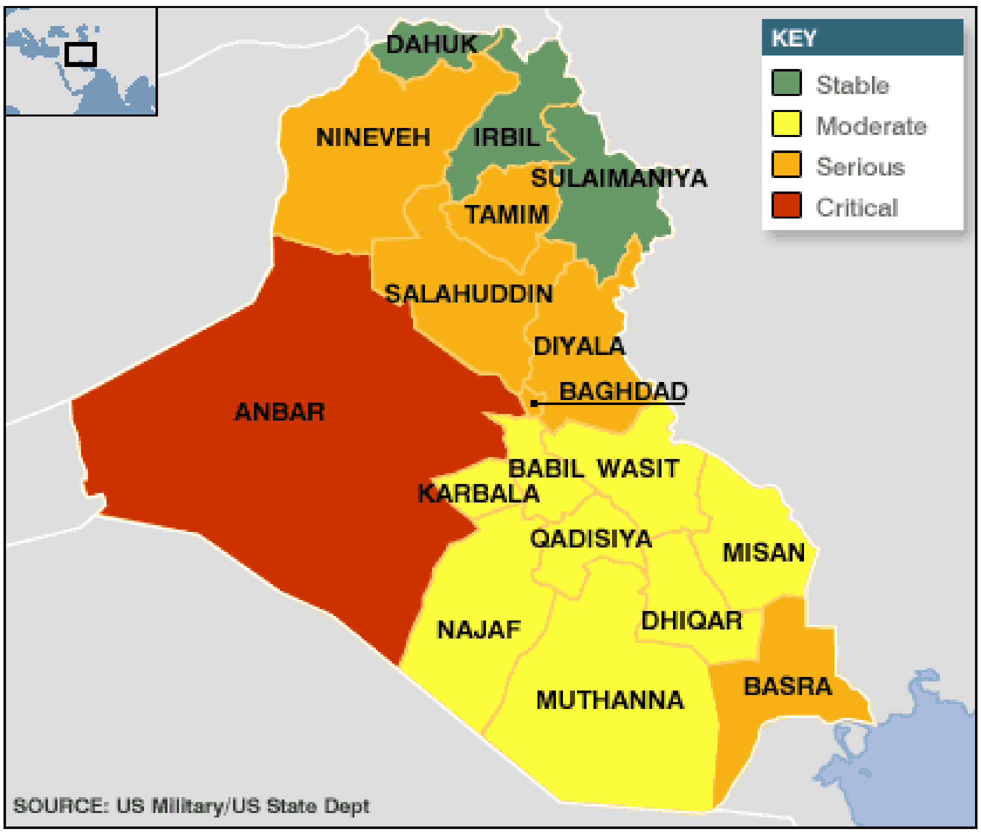
The senior OIF Coalition commander in 2006, General George W. Casey Jr., concluded that coalition forces were failing to achieve the lines of effort objectives of Economic Development, Governance, Communicating, and Security within the end state timeframe of 2009 planned.[127] From 2003 to 2006, the OIF Coalition focused on establishing Iraq forces to transfer the preponderance of the security obligation to Iraqi forces. Yet, an insurgency developed the wake of the 2003 American occupation, and it proceeded to prevent U.S. efforts in redeveloping Iraq into a self-sufficient and democratic state. Sectarian violence amid the Sunni (minority) insurgent groups and the Shi'ite (majority) militias had a stranglehold on progress. Despite the dismal situation, General Casey remained committed to the transition approach of using a limited sized American contingent.[128] Conversely, President George W. Bush decided to fundamentally alter the strategy. The 'Surge' was an increase of American troops in Iraq designed to regain security in Baghdad and Anbar Province while changing military strategy focus toward providing the conditions favorable to political and ethnic faction reconciliation.[129] Believing that more U.S. forces was the final opportunity to regain security, he ordered the placement of five additional Army brigades in reinforcement to Iraqi coalition forces and selected General David H. Petraeus as the new coalition commander. His 'marching orders' were to provide the bourgeoning Iraqi government with the necessary functioning opportunity to secure itself.[130]

Under General Petraeus, as the Multi-National Force–Iraq (MNF-I) commander, Iraq was divided into seven different areas of operations. As shown in Figure 7, each area was under the responsibility of brigade to division sized forces (2,000 to 15,000 personnel sized units respectively). Operations in Bagdad were under the control of the Multi-National Division–Baghdad (MND-B).[131] While the smallest of Iraq's 18 provinces, Baghdad accounted for twenty-five percent of the country's population. Most of the city's residents were Shi'ite, but the city also included several Sunni neighborhoods. Multi-National Division–North (MND-N) occupied the planes of northwest Mesopotamia, including the cities of cities of Mosul and Tikrit.[132] In the west, Anbar Province was designated as Multi-National Force–West (MNF-W), under control of an U.S. Marine Corps Expeditionary division sized unit. U.S. coalition partners' areas of responsibility were in southern Iraq, Multi-National Division–Center South (MND-CS).[133] The area covered the region south of Baghdad, was commanded by the Polish Army with troops from Armenia, Bosnia, Denmark, Georgia, Lithuania, Mongolia, Romania, El Salvador, Slovakia, and the Ukraine falling under the MND-CS command. Finally, the British commanded Multi-National Division–South East (MND-SE), centered in the province of Basrah.[134]



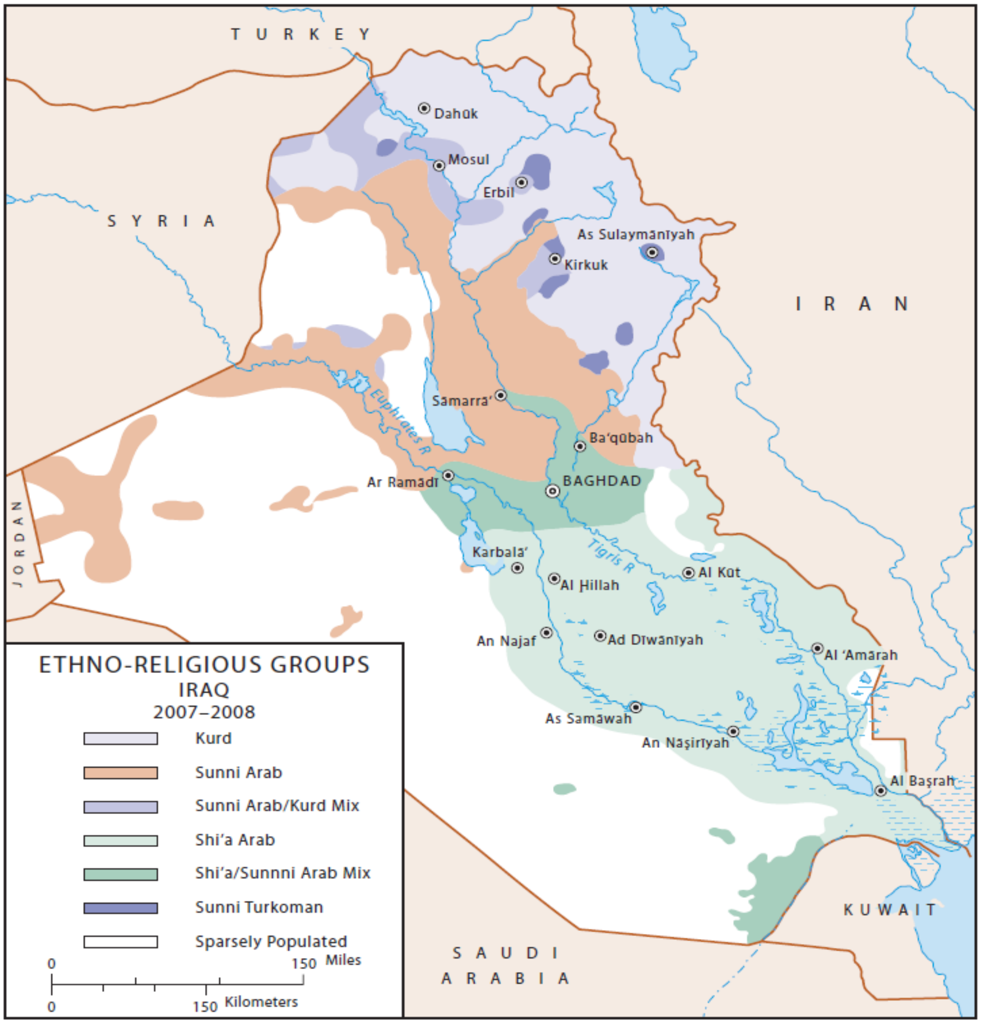
Pre-Surge Military Boundaries 2007[135]
Figure 7

The areas where U.S. forces predominated were also the areas of greater insecurity. Based on governance, security and economic situations, the main areas considered to be either critical or serious corresponded with MNF-W, MND-B, and MND-N. The evaluations made just before the Surge defined a critical rating as those areas with a non-functioning government or only a single strong leader, with no infrastructure for economics to develop, and with high levels of anti-Iraq forces activity prevalent with assassinations and extremism prevalent. A serious rating is defined as an area where the government is not fully formed, the economy is stagnant (i.e. high unemployment), and with routine anti-Iraq forces activity, again with prevalent assassinations and extremism (Figure 8).[136]



Provincial Stability Ratings as of 2006
Figure 8

Within MNF-W, MND-N, and MND-B, these sectors of greater insecurity were located within areas of highly concentrated Sunni populations (Figure 9). MNF-W was predominately populated by Sunni Arabs. Great swaths of MND-N were also controlled by Sunnis, and the areas that were not majority Sunni had a Sunni/Kurd plurality municipalities (northern parts of the sector) or a Sunni/Shi'a plurality (southern parts of the sector). MND-B had a Sunni/Shi'a plurality similarly to MND-N, since it was southernly adjacent.



Iraqi Ethic and Religious Distribution[137]
Figure 9

The liberation/invasion of Iraqi was based upon the use of speed instead of mass. But initial tactical success could not long hide the fact that 'Shock and Awe' did not equal control. The concept of rapid decisive operations – speed – restricted U.S. commanders from dealing with all aspects of operations (offense, defense, and stability) because it divorced the political, human and psychological dimensions of military conflict from the war. Situational control was lost, if ever gained, lacking the mass to deal with the above-mentioned dimensions.[138] Into this void the sectarian violence between Sunni insurgent and Shi'a militia arose. By 2007 the 'Iraq War' turned into a series of overlapping and interconnected conflicts including anti-coalition insurgencies, a sectarian Sunnis - Shi'a civil war, and community in-fighting within both the Sunni and Shi'a sects.[139] This was the situational status in which General Petraeus introduced his Counterinsurgency strategy.

The underlying theme of Petraeus' way forward was basically, "You can't kill your way out of this kind of war".[140] The goal changed from transforming Iraq into a Jeffersonian democracy (and the entire Middle East for that matter) to achieving a modicum of stability that would keep the country united and prevent the situation from morphing into a regional atrocity. This required change in overall tactics were soldiers would conduct more non-kinetic (aka.: non-shooting) engagements with the populace. In some ways, the new tactics were akin to 'Community Policing' undertaken in major U.S. cities. Conducting operations in proximity to local residents resulted in a number of tactical gains. Relations built with local Iraqis gained American forces critical intelligence, enabling the targeting of insurgents, and locating improvised explosive devices (IEDs). Incoming surge brigades were dispersed across the capital and the adjacent area. Two surge brigades were attached to the MND-B. Another three were deployed to the sections in MND-N and MND-C. While MND-C was considered to be 'moderate' (functional but fragile government, slowly developing economy, and steady but potentially unstable security situation), occupying the area to the south of Baghdad was critical to controlling MND-B's flank. Also, one of the more radical schemes was already being implemented by U.S. Marine forces in MNF-W, albite in a small fashion. An U.S. Army Brigade (1st Brigade Combat Team, 1st Armored Division – 1/1AD) was assigned to the city of Ramadi within the Ambar Province (MNF-W). The unit developed alliances with the local tribes in the region. 1/1AD was able to persuade the tribal elders that the Americans planned to stay and were intent on working with them to clear Ramadi of al-Qaeda insurgents. By the end 2006, the 'Anbar Awakening', brigade and Iraqi police jointy achieved extraordinary success prior to the start of the Surge. Mortar and small rocket attacks fell 67 percent, IED attacks declined 57 percent, and daily attack averages were down 38 percent. With the brigade now inside the city, coalition forces initiated humanitarian and civic reconstruction projects.[141] Despite the skepticism of the Marine commanders at the time, General Petraeus made the Awakening an integral part of his Counterinsurgency plan.

Without going into details of various battles, the Surge was a mixed success. A fitting description is "confusing starting to win with having won".[142] The Surge had regained the strategic initiate, gaining the needed breathing space for the Iraqi government to move forward; however, questions on the long-term direction of the nation remained unclear. The country's political tension seemed held in stasis by the Surge. While the country experienced less sectarian violence, the national government still suffered from dysfunctional sectarian divisions. There were *de facto* partitions between the Shi'a, Sunni, and Kurds. Additionally, it appeared that the country was becoming extremely influenced by its Shi'a majority neighbor Iran, and hostilities were rising between Arabs in general and the Kurds over control of oil and the municipality and province of Kirkuk.[143] Of all the areas in which the Surge took place, Kirkuk in MND-

N experienced the lest declines in sectarian and insurgent violence. Additionally in MND-N, Mosul (Nineveh Province) began to experience political strife as much of the Iraqi Army at location was Kurdish but largest portion of the population plurality was Arabic. Al Qaeda, while diminished, had not been successfully driven from the area and continued to exacerbate the Arab-Kurd division.[144] This is consistent with the findings of this research's first Delphi survey iteration.

As described above, the first round of Delphi questions consisted of open-ended, designed to establish why and how Mosul was selected as the Stability main effort. The first question was, "What were the factors leading to the designation of Nineveh province as the theater main effort?" The comments generally focused on the political strife between various factions:

> While Baghdad had the largest population, there were multiple fracture lines (Sunni/Shia/Kurd) with the added issues of the northern provinces bordering Syria and Turkey. ... In 2006 the al-Askari Mosque (Shi'a Shrine - City of Samarra) was bombed with lingering accusations between the Shai and Sunni factions and the al-Qaeda insurgents being blamed. Problems between the ethnic/religious factions became paramount in the post-Surge OE.

> [While the] 'bad guys' were in Anbar, Surge projects like the 'Sons of Iraq' helped to mollify the situation there. Insurgent activity increased in Talifar and Mosul, and also along the Iranian border. The less hazardous option was to conduct operations in Mosul and Talifar and not risk some type of confrontation along the border.

> … [T]he Surge stabilized Baghdad, Anbar and other areas. Mosul was deemed the least secure. But the overriding issue was political. It was an opportunity for the national government to prove that they could provide for their own security and that the national government could properly deal with minority populations (i.e., Kurd). Key to this was trying to establish if the national government-controlled resources or if sectional areas controlled them.

Another participant noted that the main effort was in MND-N, a sector totally under U.S. operational control. This enabled the focusing of U.S. assets more easily. MND-C, MND-CS, and MND-SE were reconfigured just after the Surge into a new MND-C and MND-S. Both new sectors became coalition partner operating areas. Applying post-Surge assets primary became an issue of controlling resources. There were dissenting viewpoints stating: “[While designated as such,] it was not readily apparent to this participant that Mosul was the post-Surge main effort”.

With the overall political uncertainty within the OE being confirmed, the rational developed from the Delphi initial iteration for choosing Mosul, Nineveh focused on some degree of security. Responses include:

> The focus was mainly on political issues with efforts toward security. It was all about proving a functional national government could be operated.
>
> Security became the most important issue.
>
> Security was primary but used the political, economic threads to hep to support and maintain security. There was a PRT [Provincial Reconstruction Team – a joint DoS/DoD Stability Operation] Mosul and the regional U.S. embassy which would provide good support to Stability efforts.
>
> It was approximately equal between security and other socio-economic issues. The OE still needed security, but stability began to emerge as an equal piece. As the security increased it gave greater possibility for stability operations.

When asked what procedures were used in the analysis of the post-Surge OE, the general consensus was that there was not a specific analysis procedure. Opinions ranged from:

> While both PMESII and DIME were used, the most important thing was the decentralization of effort; getting off the large FOB into the communities. Greater integration among the population countering the enemies influence.
>
> The analysis was more focused on troop to task. There was little analysis on the root causes of the violence.

to, a very un-definitive:

> [I am unsure] if an actual analysis process was used beyond security and the ability to leverage the U.S. Regional Embassy [in Mosul].

The final open-ended questions of the first Delphi survey asked whether any of the factors bearing on a commander's decision making ability displayed in a geographically integrated fashion and, if so, was it any help in designating Nineveh province as the theater's main Stability effort. On this there was a consensus that there was not an integrated geographically displayed of key factors existent. There was not a 'Stability COP' that assisted in the decision to designate Mosul as the Stability main effort.

It is at this point in time and location that this case study examined the decision to designate the municipality of Mosul as the Stability main effort. the end of the Iraqi Surge. Civil Affairs units were scheduled to deploy into Iraq in October of 2008 and an analysis of post-Surge activities was required. The following applies a retroactive Stability COP analysis to the decision.

5. DATA

The data used for the quantitative portion of this study is based on content analysis. While not a formal part of the methodology underpinning this study, it is important to understand why content analysis is important to the CIM function, what makes a properly developed content analysis data set appropriate for use, and why the specific dataset used within the analysis was selected. This explanation includes how the selected data set variables are applicable to Treviño's conglomeration method and ultimately Saaty's AHP method.

5.1 Content Analysis

The main form of event communication in the military is the daily situation report, commonly known as a SITREP. These reports are generally written qualitative documents. To conduct the processing and analysis/evaluation CIM functions, the qualitative data must be converted into a different form. The principal data form for analysis is based upon content analysis. One well-known definition of content analysis states that it is "a research technique for objective, systematic, and quantitative description of the manifest content of communication".[145] A second popular and similar definition describes a technique geared toward "making inferences by objectively and systematically identifying specified characteristics of messages".[146] Both of these, as noted by Neuendof, emphasize "the scientific method (including attention to objectivity, … reliability, validity, generalizability, … and hypothesis testing)".[147] Researchers consider content analysis at the crossroads of the qualitative and quantitative methodologies, and the analysis method provides a rigorous exploration of many issues of interest in areas ranging from business policy and business strategy to managerial thought and organizational reasoning, and from social-issues management to organizational theory.[148] As the initial part of the sequential exploratory mixed-method strategy, where collection and analysis of qualitative data leads the process, content analysis provides the ability for qualitative data, such as written reports, to be converted into quantitative data. An explanation of why content analysis is appropriate begins with an explanation of how it meets scientific rigor followed by the general procedure of conducting content analysis. The examination of its scientific rigor involves examining its emphasis on 'the scientific method' components of objectivity, reliability, validity, generalizability, and hypothesis testing.

Objectivity in content analysis is the development of procedures for the systematic categorization of raw text in a transparent manner. Transparency is key to the mitigation of an analyst's personal bias.[149] Additionally, the term 'systematic' also concerns the issue of bias in categorization application. It is the consistent application of categorization rules so that bias is suppressed. While the rules may reflect a researcher's interest and concerns, they can, or should, be applied without bias.[150] It is these actions, when conducted during the summarization of analyzed messages, that allows a scientific method (or methods) to be applied in the examination of the text involved.[151] Noting that objectivity is positivist, it is still desirable in the conduct of research. While there is no true objectivity, knowledge and reality are constructs agreed upon socially.[152] From this perspective, human inquiry is inherently subjective. Yet, as stated in the second definition above, a systematic or consistent method of inquiry is desired. By relaxing the overarching the standard from 'Is this true?' to 'Is this agreed to be true?' researchers can maintain a scholarly standard called intersubjectivity.[153] This substitution of constraining questions allows the use of the scientific method with allowances for the lack of pure objectivity. An *a-priori*, or previously theoretically deduced, design is necessary for adherence to the scientific guidelines. This design is reflected through the development of a coding scheme. While exploratory research can be conducted in the development of coding schemes, the *a-priori* design process can be viewed as a combination of induction and deduction.[154] Deductive in the fact that choices on variables' measuring and coding procedures must be decided upon prior to conducting observations. Inductive in the fact that exploratory work can take place before finalization of the coding scheme. Coding is the process of interpreting text or visual data in formal terms according to explicit and detailed rules.[155] The rules developed minimize idiosyncratic judgments that could create unreliability.

Reliability is the extent to which a process yields the same results in repeated trials.[156] It is a paramount necessity for the implementation of content analysis. For coding conducted by content analysis, this translates as intercoder reliability (also known as replicability). Intercoder reliability is defined as "the amount of agreement or correspondence among two or more coders." [157] It is a measure of the degree to which a process can be reproduced by different analysts under varying conditions and in various locations.[158] Having intercoder reliability is important for two reasons. First, it provides confirmation that the coding scheme was not used by only one individual. Doing so is more akin to expert analysis and not consistent with content analysis. Second, the use of multiple codes, when their efforts are calibrated against each other, allows for the processing of more messages; this increases the scale of the analysis.[159] Much effort and attention must be given to conducting human-based content analysis.

While human-based approaches have been the norm for content analysis, the computer-based analysis is becoming more applicable and offers advantages with regard to the two issues of intercoder reliability. The need for coding scheme standardization is mitigated. Computer-based techniques do not suffer from any subconscious standards change during the coding process. Nor will the coding process suffer potential differentiations in text interpretation during the process. Additionally, the scale at which computer-based coding takes place dwarfs the capability of hundreds of human coders.[160] Yet, computer-based analysis is limited to a quantitative method of analysis.[161] Known as ‘manifest content’ analysis, analysis drawn via this method is concerned with the apparent content of the observed text.[162] This is in comparison to latent content analysis that deals with normally unobserved concepts that are not measured directly but can be ‘represented’ by one or more indicators.[163] The difference between the two content types is roughly categorized as ‘surface’ and ‘deep’ language structures, with the latent content in issues of context, tone, and word/phrase usage.[164] Yet the differentiation between the two is subtle. Manifest (quantitative) content analysis is heavily dependent on the counting of coded textual data, but the act of coding requires qualitative identification procedures. Contrasted with the latent (qualitative), which places emphasis on themes and certain key ideas within the text.[165] Thus, reliability can be summarized by an archery target metaphor in which all the arrows fired are closely clustered. Note, there is no mention of where on the target the arrows are clustered, it is just important that they are closely clustered.

In contrast to where the target is consistently struck is the specification that the correct part of the target (i.e. the center or bullseye) is struck. Validity refers to the range that a measuring procedure represents the actual concept.[166] This concept is tantamount to discussed MOEs. The key question of validity is if one is measuring what truly needs to be measured. This links to the MOE characterization question, ‘are we doing the right things?' due to the concentration on the true and correct issue (mission or scenario) at hand. In the theme of hitting the center of the target, three types of validity are presented: face, social, and empirical.[167] While other forms of validity assessment exist, these carry greater emphasis within content analysis than other areas of study such as psychology due to the concern of content analysis with the text's meaningful relationship to a designated context.

Face validity is the stipulation that the measure reflects the content of the concept in question.[168] It is important in context analysis due to the attention toward how text, symbols, and images are interpreted in the shared culture at a given point in time.[169] This tends to be difficult to measure but is always present. Determining face validity is basically an intuitive process.

Social validity addresses whether the research result's quality gains acceptance due to its reflection of public discourse on significant social concerns.[170] This type of validity is concerned with the social desirability and usefulness of changes in behavior. It is an examination of whose behavior is being changed.[171] There are three key aspects of social validity: goals, procedures, and effects.[172] The term 'social validity' is most commonly used in the field of behavior analysts with a focus on the ethics of treatment. In terms of content analysis, social validity is the degree that researcher created content analysis categories are relevant and meaningful beyond academia.

Empirical validity serves as an umbrella category for several types assessments that support the stages of research, supports the finding of additional data, or defends against criticism of observation, experiment, and measurement.[173] While it does not deny or separate itself from either face or social validity, empirical validity serves as the scientifically grounded measure based upon rational arguments, research processes, and research conditions under which the data were obtained. For empirical validity, content analysis draws heavily from the field of psychology for its assessment methods. Specifically, assessments of content validity, construct validity, criterion-related validity, and predictive validity were defined as an important test of individual characteristics or abilities.[174] Content validity examines the extent a measure represents all features of a given construct. Construct validity, acknowledging that measured concepts are often abstract and not directly observable, examines how well a concept's measure relates to other concepts' measures in respects that are consistent with established theory.[175] Criterion-related validity, also known as instrumental or concurrent validity, examines the extent to which a measure is related to an established outcome. This assessment is based on a measure that are both known to differ from, and that are relevant to, the research concept.[176] Predictive validity, as noted by Bryman, is a similar concept, which examines the extent to which a measure is related to an outcome with the difference being that the measure is an outcome assessed at a later time. All the above mentioned forms of validity (face, social, empirical – et al.) are categorized as internal validity, are concerned with causal relationships of the measured variables.[177] External validity, also known as generalizability, is concerned about determining whether research findings are applicable beyond the conducted study.[178] Details on generalizability follows.

For issues of generalizability in content analysis, addressing how well a study's findings are applicable to other people, settings, and times is problematic for two reasons. First, care must be given to geographic issues when attempting to apply observations of one location to another location that is situationally similar but are not spatially related (i.e., in close proximity). Cultural, political, economic and even environmental differences between the two geographies could make any application of findings from one to the other invalid. Second, if the topic of a study for a geography is applied to a different situation in another geography, again any application of the findings from one to the other could be invalid.[179] However, these comparisons are made at a 'micro' scale for quantitative analysis purposes. If two different scenarios share key characteristics, then a larger scale theoretical inference is possible.[180] In terms of qualitative research, the vast amount of 'thick and deep' descriptive observations are comparable when the contextual characteristics are similar at a larger or more holistic scale. The ability of researchers to draw an overall perspective makes the development of theoretical inference possible, but only on a case-by-case basis.[181] This is key for developing the foundation for the final scientific method component, hypothesis testing.

Traditional presentations of research methods place emphasis on testing hypothesis for specific pattern evidence in designated datasets. Content analysis has a different concern for hypothesis testing focused on origination, intended and unintended audience, meaning to audience, mediation between antecedent and consequent conditions, and the dataset's ability to enable analysts to select valid answers concerning contextual questions.[182] Essentially, the counting of words, phases, or themes is not the lone objective. The 'analysis' requires abductively inferring contextual phenomena from texts based upon outside data. This develops a bridge between descriptive accounts of texts and what the text holistically means and attempts to provoke. Unlike deductive or inductive inferences, these abductive inferences are based upon warrants (analytical constructs) that operationalize relationships between what the text states explicitly and what the text implies.[183] The abductive inferences develop the theories which, in turn, develop the hypothesis for testing. Thus, in comparison to what is normally seen as hypothesis testing, the generalization of observed phenomena applied as a criterion, now the generalized test criterion becomes the extratextual meanings and themes which the individual texts may conform within.

5.2 Global Database of Events, Language, and Tone

Since most of these SITREPs have an intelligence security designation of either 'Classified' or 'For Official Use Only' (FOUO), their use in an academic setting is prohibited. Yet, a 'pre-content analyzed' set based upon periodical articles is available as a proxy. The specific database used for the analysis is the Global Database of Events, Language, and Tone (GDELT). It is a catalog of human societal scale behavior and beliefs across multiple countries ranging from 1979 to 2012.[184] The database events have been geo-referenced to both national and sub-national levels. For the purpose of this analysis, events at province/district level within Iraq for the month of September 2008 were used. Additionally, the data are formatted using the Conflict and Mediation Event Observations (CAMEO) event coding taxonomy. Originally intended to support a National Science Foundation (NSF) funded study of interstate conflict mediation, the CAMEO-automated coded data can also be used for studying other types of international interactions and natural disasters.[185] CAMEO was intended as an extension of Charles McClelland's WEIS, a coding framework for event data research developed during the Cold War and focused on a Clausewitzian global political view where sovereign states reacted to each other primarily through diplomatic and military pressure.[186] This coding system, while innovative in its time, was sufficient for dealing with contemporary issues of ethnic conflict, low-intensity violence, organized criminal activity, and multilateral intervention. As a consequence, the first stage of the development of CAMEO involved adding the cues and subcategories needed for the study of mediation and conflict upon the WEIS framework. The next stage involved searching for examples of the various category and defining them for the codebook, an action leading to the understanding that some of the desired distinctions were not possible given the quality of the news articles. The result was the consolidation of multiple categories into fewer cue categories.[187] Significant attention went into creating a theoretically intelligible and comprehensive coding scheme for CAMEO. This led to the development of 'opposing' cue categories (e.g., the creation of an 'Approve' category necessitated the addition of a 'Disapprove' category). While originally intended to code events on with international mediation, CAMEO has developed as an outstanding general coding scheme for examining political conflict as a result of a more comprehensive ontology from the WEIS base.[188]

This study's analysis used two event action attributes. NumArticles and AvgTone. NumArticles is the total number of source documents containing at least one incidences of this event. It assesses an event's importance; the more discussion of the event, the more significant it is.[189] It is a count/amount measurement and serves as an indication of magnitude. AvgTone is the average tone of documents containing at least one mentions of this event. With scores ranging from -100 (extremely negative) to +100 (extremely positive) and a value of zero being neutral, it assesses the importance of an event and serves as a proxy of event impact.[190] These values normally range between -10 and

+10. It functions as an indication of intensity. AvgTone is derived using a tonal algorithm.[191] This algorithm is analogous to relative risk in epidemiological studies where a ratio between the represent kernel density estimations (KDE - non-parametric method of estimating random variable probability density functions) of disease infection locations and case control locations is used to capture the disease risk for the case control population. Similarly, the tonal algorithm calculates the topic intensity (tone) as the ratio of the KDE of articles that mention a given topic compared to the KDE of articles that do not mention the topic for a given set of sample points.[192]

Within the GDELT database, variables describing the condition or situation of an OE are selected. The variables selected are based on the eight interrelated operational planning variables PMESII.[193] When a commander and staff know where their unit will deploy, analysis using the PMESII variables on that area begins. It then continues after receiving mission specifics and proceeds throughout the course of the operation. Not only does PMESII decompose the OE for combat operations, it also enables effects measurement for the range of operations considered under Stability Operations to include humanitarian aid, disaster relief, and noncombatant evacuation operations.[194] The military, information, and infrastructure operational variables are more readily identified and monitored spatially than the other PMESII variables. Thus, the action attributes of NumArticles and AvgTone derived by GDELT's CAMEO coding taxonomy for political, economic, and social events are especially useful for this analysis.

In terms of the content analysis' emphasis on objectivity, reliability, validity, generalizability, and hypothesis testing, only validity causes concern. Because of the automated design of the content analysis methodology, the GDELT creators do not allow for third-party verification. Neither the articles nor the article source list with dates are released. Despite using publicly available news report sources, GDELT representatives state that their licensing restrictions prohibit making the text available.[195] While the standard tenets of journalism require answering of six basic questions for a story (who, what, where, when, how, why), this information is sometimes lacking within the GDELT dataset. Specifically, the 'who' information is often missing about Actor 1 and/or Actor 2 variables. The implication is that an automated coding algorithm will fail to identify crucial information within the news reports; automation skimmed through the articles and will not have the ability to code for certain seemingly common situations. With no simple human verification to check for important missing data, the lack of transparency in the data collection process causes a significant barrier to independent validation of the constructs, affecting whether the content analyzed data is trustworthy. Yet, a post refuting the assertions that the GDELT dataset is faulty states that news reports of antagonistic political issues (e.g., government coercion, protest, insurgency, terror, etc.) often not successful in identification of a specific 'Actor' and/or specific 'Event Target' variable attributes of significant interest worthy of coding by those who investigate conflicts.[196] Additionally, a study conducted by Best, Carpino and Crezcenzi observed the differences between event data from full articles produced via human coding finding that, converse to expectations, hand coding full news stories did not lead to a significant improvement in the accuracy or depth of actor information compared to a machine coding method (TABARI)[197]. However, in his dissertation on political conflict, James Yonamine conducted analysis suggesting that the GDELT had a great amount of external validity. He first used the GDELT data to develop a time-series reflecting the amount of violent incidents that occurred weekly in Homs and Aleppo during 2011 and 2012. Specifically, he selected all conflict events that occurred in the vicinity of the latitude and longitude coordinates encompassing Homs and Aleppo, and then totaled these events by week. Then he plotted these time-series and visually compared the values with a Syrian NGO's ground-truthed database. The GDELT based time-series from Homs and Aleppo was nearly identical to that of the ground-truthed dataset. A second test reflecting Afghanistan located violence was conducted using the same GDELT methods and presented to U.S. government officials. The results were insignificantly indistinguishable to classified datasets maps (similar to the point that government officials inquired if the GDELT based maps were plagiarized versions of classified information).[198] Despite the content analysis issue within the GDELT dataset, it does not diminish its use as a SITREP proxy for demonstrating the use of SDSS for Stability COP development. The focus of this analysis is on how qualitative data can be spatially integrated, analyzed, evaluated, and displayed.

6. LITERATURE REVIEW

This literature review focuses on two major components: research within SDSS and the historical development of CIM. Specifically, the SDSS focus highlights the scope of its application to various domains and purposes. While based upon the research conducted by Sugumaran and DeGroote, additional examples leading toward the use of socio-economic data processing and analysis are presented. Next, the CIM focus highlights the efforts involved with geographically presenting a Stability COP. It is from the two reviews that the possibility of SDSS as a method of developing a collective Stability COP was identified.

6.1 Spatial Decision Support Systems (SDSS) Review

Sugumaran and DeGroote produced a literature compilation on a variety of peer reviewed articles, academic book chapters, and writings from conference proceedings. Only publications that implementing, reviewed, or created programs toward integrated model-based spatial software designed to support decision making procedures were included.[199] At the time of their publication, they discovered over 450 publications and categorized them into 11 stylized application domains based upon the major topic of the publication. These domains included the topics of public health, business, transportation, emergency planning, agriculture, urban studies, environmental planning, and natural resources management.[200] While many of the SDSS publications deal with policy issues, none specifically addressed SDSS use within U.S. military operations in general, nor Stability Operations specifically (such as foreign nation emergency services, infrastructure redevelopment and humanitarian relief). The largest number of articles (103) focused on natural resources management. In addition to those articles listed in the Sugumaran and DeGroote review, there have been other articles and dissertations addressing the uses of SDSS to socioeconomic situations. In 1994 Lee addresses the use of SDSS toward a specific ill-structured planning situation (a bus routing problem). To evaluate the effectiveness of decision-oriented support systems within an urban planning procedure (rather than just analysis-oriented planning), a DSS generator for multi-attribute judgment was developed. Four judgment methods were explored in constructing the judgment module. Scenario data for ill-structured judgment methods were developed by Monte Carlo simulation and implemented into the module. Evaluation of the system showed that the system satisfactorily functioned as designed, enabling users to explore problems in a constructive and iterative manner.[201] The system exemplified how procedural expertise could be brought to bear in an operational system.

SDSS application to land use decision making has been prevalent since McHarg used the traditional suitability analysis toward land use planning for Staten Island in 1969.[202] Anjomani, Sabri, and Shad dealt with land use/environmental planning problems by applying SDSS to develop alternative land use solutions.[203] Their study began by noting that many of the problems that these issues generated were both too complex for a purely speculative solution based on experience, imagination and intuition, and often lacked comprehensive data for a purely inductive analytical approach based solely on detailed study. They sought to use a more effectual approach, synthesizing elements of the inductive and intuitional approaches in a scientific process based on a combination of experimentation, observation, and explanation. Specifically, they sought spatial land use arrangements that would yield substantial improvements in energy conservation, ecological constancy, or agricultural production.[204] Key to the improvement was the search for an optimal solution. Anjomani, in previous studies (1984 and 1992), suggested implementing optimization models in the suitability analysis portion of the land use planning process instead of the traditional map overlay technique. This was done to consider demand for various types of land use in the analysis. In consideration of demand-side land use (i.e., how much of each land use type is needed), the authors applied linear and quadratic programming models as a part of a spatial analysis program (GIS). The map overlay technique previously used only dealt with the land use supply-side identification (i.e., what is the highest and best use for each land parcel).[205] This spatial supply-demand analysis not only allowed for the identification of locational equilibrium matches, but also a ‘what-if’ examination of various policy choices. Such policy choice issues included the establishment or change in zoning of an area. While zoning is technically a categorical variable, the combination of experience-based speculation of where zoning change can occur combined with spatial optimization enabled by SDSS methods measured the effects of the proposed changes in its entirety and identified the requirement for a more specific land-use plan.

An initial, but key, recognition in recent SDSS literature involves dealing with spatial planning’s numerous and contradictory objectives (e.g., minimizing air, water, and soil pollution; gaining acceptance of the projects; implementation cost reduction). There are requirements for societal values consideration in evaluations, human participation increase in decision processes, and better incorporation of the spatial dimension’s crucial role in such problems. Ferretti and Montibeller contend that there are key challenges confronting both designers in model development and practitioners in implementation toward decision making support.[206] The challenges impose important meta-choices to designers and practitioners. Different choices can lead to different content within the evaluation model and to distinctively different outcomes of the analysis. Meta-choices (also known as meta-decisions; Sousa and Yu, 2014) show that beyond needing to resolve the problem decision makers also need to decide how they will proceed to decide (i.e.: the ‘deciding how to decide’ problem).[207] Ferretti and Montibeller’s paper discussed the following key SDSS challenges:

- Who should participate
- How should they participate
- Selection of a [MMC] method to use
- Sources used to define objectives

- Compensating for limited spatial data for the criteria
- Attaining spatial standardization functions from experts
- Dealing with sustainability concerns in the evaluation
- Attaining criteria weights from experts
- Efficiently performing spatial sensitivity analysis [208]

They attempted to provide practitioners and scholars with an increased awareness about decision support systems design and implementation choices, a better understanding about the available choice alternatives, and a richer appraisal of the inherent advantages and disadvantages trade-offs between each alternative. Their conclusion was that the SDSS multi-criteria analysis incorporates methodologies that offer a sensible foundation for the assessment of dissimilar alternatives considering multiple, conflicting, and often disproportionate dimensions measured by well-specified criteria. A strength of the approach is that it can take into account qualitative criteria, as well as quantitative criteria. They state that a SDSS can overcome some of the shortcomings of traditional economic analysis (e.g., cost/benefit analysis) by allowing the overt inclusion of intangible and non-tradable goods and by modeling the priorities of decision makers and stakeholders.

Ferretti and Montibeller's point about deciding how to decide has been reinforced by Coutinho-Rodrigues, Simão, and Antunes.[209] Noting that urban infrastructure planning has important spatial implications, they stated that alternative courses of action evaluation requires explicit consideration of the important social, economic, and environmental effects encompassing multiple criteria. Their paper presented a DSS focused toward offering users, such as municipal and transportation agencies, a flexible and easy to use environment for providing decision aid in urban infrastructure planning. The spatial presentation of alternatives on maps provides a value added decision support processes of problems with support to urban infrastructure evaluation. It assists the user in locating the spatial elements in the actual environment. This system's development was motivated by an actual metropolitan case study analyzing the investment decision of an urban infrastructure in Coimbra, Portugal. Selection of the best investment option for a water supply system to satisfy the new demand created by urban development and expansion was the underlying decision. The multicriteria Spatial Decision Support System (MC-SDSS) developed for Coimbra was named MCPUIS (Multicriteria Planning of Urban Infrastructure Systems). MCPUIS integrated methodologies from three areas of research: geographical information systems (GIS), database management systems (DBMS), and multicriteria decision analysis (MCDA) producing a menu-driven SDSS. Its interface was designed to be user intuitive and friendly. The design allowed ease required parameter input and it allowed experimentation with the decision support methods. The integration of modules was designed to support the four basic functions: storage, retrieval, and display of data (SRDD); investment option evaluation (IOE); investment option comparison and selection (IOCS); and communication/interaction with the system and sensitivity analysis. Of particular concentration for this study were the IOE and IOCS modules. These modules most closely resembled the process and analysis perspectives of the CIM-SDSS desired. The IOE module conducted the process function through an assessment of investment options that accounts for performances on the various evaluation criteria. This required a cost/benefit determination for each of the various economic, social, and environmental alternatives. Because the data involved varies spatially, the criteria scores are often difficult to determine. The MCPUIS' IOE facilitates evaluations through ensuring the evaluations are built upon the same technical formula and data. Multiple criteria comparisons of the various alternatives for the urban investment decisions are performed by the IOCS function. It is commonly understood that no MCDA method is optimal for every problem and different methods will often produce different results for the same problem. The differences are more prevalent when there are greater alternatives with similar criteria values for those alternatives. Their work serves as an early guide for quantifying social data and implementing spatial comparative analysis.

While not specifically used in a military conflict specific domain, SDSS has been used for a variety of emergency planning, emergency response, public health, and hazard material mitigation situations. Such applications include Urban Search and Recuse by Heth et al. in 2006, Epidemic Disease Prevention by Yang et al. in 2006, and Guarnieri and Wybo's 1995 'Wildland Fire Prevention and Fighting' model implemented in a GRASS (an Arc-GIS precursor).[210] Researchers in England designed a SDSS for emergency evacuation contingency planning that combined simulation techniques with the spatial data management and display capabilities of a GIS.[211] It linked together the geo-topographical support and analysis capability provided by the GIS-ARC/INFO program, with a model simulation designed to approximate the detail dynamics of an evacuation process. The aim was to design a SDSS to provide an interactive evacuation simulator with dynamic graphics allowing for experimentation with policies by providing rapid feedback from the simulation. The purpose was to allow emergency planners to use the SDSS for experimentation with emergency evacuation plans for different contingencies. Key within this research was emergency evacuation that involves addressing both logistical and behavioral issues influencing evacuation operations. Two decision making streams occur in parallel during an evacuation. One stream concerns the actions of the authorities, those managing the evacuation operation. Another is the actions of individual evacuees. The behavioral issues encompass the difficulties that arise due to the discrepancy between the two action sets. The SDSS named the ‘configurable emergency management and planning simulator’ (CEMPS) was designed for planning evacuation contingencies rather than actual emergency management event execution. The simulation model is parameterized based upon data from the geographic database. While simulating the behavior of evacuees on the road network heading towards safety shelters outside the danger zone, it also provides tools for stakeholder progress querying during the simulation. The traffic load estimate on a road segment or the number of evacuees reaching a selected safety shelter are available during various phases of a simulation for policy and procedure evaluation. The approaches to traffic model design depends on the geography of their intended application and the details required in modelling the travelers’ behavior within the system. There are three basic categorization for network-based traffic simulation models - micro, macro, and meso, This is based on how they attempt to model the behavior of evacuating entities. Micro-simulators track the movement of individual vehicles within the simulation. Macro-simulators are directed by a fluid dynamic flow- like model. Meso-simulators attempt to combine the best of both micro- and macro-simulation by simulating ‘formations’ of vehicles within the network. The CEMPS traffic simulation model was designed as a micro-simulator of the evacuating entities simulating the behavior of each individual vehicle as it moves from the danger area to shelters outside the danger zone. Key to this research is the concentration on the design of a functioning integration interface between the GIS and the traffic replication model, or in other words, concentration on the DMC and MMC.

Related to emergency response uses, disaster relief and post-disaster activities such as debris removal, search-and-rescue, and relief transportation have benefitted from SDSS. Specifically, research on support to post-disaster debris operations presents a decision-support tool to aid disaster and waste management government officials with the collection, transport, reduction, recycling, and disposal.[212] Post-disaster debris hinders relief efforts and results in problems including economic, environmental and health issues. The post-disaster tool enabled optimization and balance of financial costs, environmental costs, removal operations duration, landfill usage, and recycled material volume generation. Designed to support post-disaster operational decisions as well as an aid in developing strategic disaster preparedness plans, the tool is presented as a DSS that utilizes Google Maps Image APIs to present maps for input and solution visualization. While not specifically using the spatial analysis capability of a GIS, the mathematical model developed includes consideration of spatial variables such as the usable area of landfills and locations of both debris and disposal sites used as inputs for transportation time calculations (in terms of days). The objective function is designed to minimize the weighted sum of financial costs, collection time, approximate disposal time, debris amount sent` to landfills, environmental impact penalty costs, and recycled debris revenue. The objective function is bounded by upper bounds for financial costs, collection duration, disposal time, space used in landfills by disposed debris, and environmental costs while the lower bound is represented by maximizing revenue obtained from recycled and reused debris. Despite the listing of this tool as just a DSS, it does contain all of the components of a SDSS despite only minimal focus on DBMC development and a greater preponderance of focus on the dialog management, stakeholder, and model management components (abbreviated DMC, SC, and MMC, respectively).

Use of SDSS for business applications are prevalent in issues of retail site selection, industrial location planning, tourism planning, consumer behavior analysis, and investment analysis. One example of a marketing decision making process in the selection of supermarket locations is the marketing exercise conducted in Sivas City, Turkey.[213] Sivas City was selected due to the ease of both participants access and data gathering from the Sivas' census bureau. The units of analysis were the city's districts. The study's purpose was to emphasize the importance of food, health, and education consumption expenditure maps that identifying significant factors important to investors and marketers in determining optimum sites. In this situation data integrating occurred within a GIS environment. Kotler presented use of a general marketing information systems model with sub-systems similar to the structure for SDSS.[214] The four sub-systems consist of a research system, an intelligence system, an internal records system, and a decision support system. A firm's research system is germane to the marketing research process. The intelligence system is the data gathering function associated to the exterior marketing environment. The internal records system is the data gathering function related to internal issues such as costs, revenue, and cash flow. Both datasets (information sets) are stored in a database. Together they approximate the SDSS' DBMC. The decision support system is, in turn, germane to the marketing manager’s analysis and decision making processes. The statistical and decision models are synchronized together within this system in order for the company increase effectiveness and efficiency in both the internal and external marketing environments tracking process. This serves as the SDSS’ MMC. The company utilizes the acquired information toward marketing strategy development and marketing planning processes developed through the marketing decision support system, thus approximating the SDSS’ SC.

The Sivas City supermarket location study focused on the marketing intelligence and marketing decision support sub-systems that analyze data and information related to the external marketing environment.[215] These sub-systems, as part of a process, can be likened to the collate-process-analysis/evaluate steps of the CIM process. Since the extent of a consumer market is measured in demographic, geographic and economic terms, the study focused on analyzing these factors as they exist within macro environments. The ‘fusion’ of the marketing strategy development and marketing planning process within the decision support system is a precursor to the type of social data integration desired for CIM and the Stability COP. Conducted in two rudimentary stages, the initial research stage was the data collection procedure using primary and secondary data. Primary data was collected through questionnaires. The secondary data was acquired from the Census Bureau of Sivas, Turkey. The two-part survey questionnaire began with questions gathering demographics (incomes, household residency count, etc.). The second survey portion inquired about consumption levels of items to include education, health, and clothing. The second stage consisted of data analysis using GIS to produce consumption and optimum location maps. The ‘Optimum

Location' was a user interface program developed to determine the best spatial location of market organizations, such as shopping centers, supermarkets, and clothing stores.[216] The optimum geographical location was determined by combining population, mean income, and the level of monthly mean average consumption in the districts. The program calculated the means of the related consumption types in all districts and then identified specific district(s) having the highest mean consumption level taking into account the mapped population and the district(s), and also displaying count of related districts in a message box.[217] Using an interface program, the 'Determining the Optimum Location' query is performed post the selection of the investment type (shopping center, supermarket etc.) and relays the circumstances related with population. The related districts are automatically determined and shown on the map and the number of related districts is then displayed in a message box.[218] The study delivered substantial analysis regarding Sivas City through the user interface programs created to perform certain given operations such as spatial analysis, queries, and documentation performed automatically. The entire process was structured off of Kotler's marketing information system model. The two marketing sub-systems (the research and the decision support systems) of this model were systematically conducted. The ability to receive precise and actionable information helps retail firms make marketing decision systems efficiently and effectively. The model can assist a firm to both easily and quickly make objective decisions without bias.

The United States Army Reserve (USARC) has used SDSS, not for tactical nor operational level analysis within a conflict OE, but for the desirability evaluations and comparisons of potential USARC unit sites.[219] The 'Army Reserve Installation

Evaluation System' (ARIES) SDSS was developed in 1996 in order to deal with operational readiness (trained and prepared manning) reserve units scheduled for rapid deployment. The ARIES application integrated a multiple criteria "Army Reserve unit-decision model" (ARU-DM), multiple Army Reserve data sources, and a GIS model into a SDSS. ARIES was based upon a module-based development heuristic, Concept-to-Code (C2C), and domain-explicit architectures. The design heuristic provided a organized means to support the end users in developing the desired system, facilitating creation of a data migration warehouse and integrating the SDSS application into the existing USARC Headquarters information technology infrastructure. The overall objective of site desirability was identified by twenty measurable decision parameters and collated into three major categories: places, people, and things. The reserve unit metrics had to be calculated directly from data sets accessible from the USARC local area network (LAN) and the proposed site location referred to a 50-mile region within the proposed site's zip code center (centroid). The relocation decision model (i.e., the MMC) was structured into a hierarchy of goals using Multi-Attribute Utility Theory (MAUT).[220] The MAUT model is a Full Aggregation model akin to AHP that utilizes economic utility functions to measure the preference of various alternatives.[221] ARIES represents one of the few attempts by the U.S. Army to use SDSS. In this attempt, however, the decision parameters under analysis did not include any socio-economic variable, which may have been germane to the unit location selection process.

Research demonstrating a spatially statistical oriented MMC was conducted by Sejwal, Jangra, and Sangwan.[222] This paper proposed a SDSS using spatial outliers for strategic industry foothold establishment analysis. More specifically, the analysis helped to eliminate locations less optimal for the needs of the industry. Spatial outliers are spatial objects with features statistically dissimilar from their surrounding neighbors.[223] Spatial outlier detection techniques aid site selection decision makers by evaluating locations from several variables. Using two different spatial outlier detection algorithms, sites deemed most unsuitable for industry establish are distinguished. The two spatial outlier detection algorithms used Mahalanobis distances - the measure of the distance between a point's value and the number of standard deviations of the mean of a distribution - to find most inappropriate sites from a multiple attribute spatial dataset.[224] One algorithm was based on neighborhood averages of the attribute values. The other was based on the median attribute values. As an important factor facing firms (national and international), industrial location establishment required managers to analyze large amounts of information regarding an available list of sites to include the critical factors of industrial location: rival markets, electricity, labor, raw material, transportation, tax structure, government policies, etc. Sites determined unsuitable (spatial outlier sites) were completely eliminated from the decision making process. Outlier identification algorithms were applied to find such unsuitable locations. The multivariate spatial outlier detection algorithms were used to establish how an information technology industry may be improved by analyzing large numbers of locations which are spatially arrayed. The proposed system is appropriate when large numbers of spatial items are distinguishable by non-spatial attributes. The critical factors affecting the successful operation of an IT industry were identified as availability of skilled labor, communication, transportation, access to latest technologies, availability of projects, electricity, medical facilities, and basic needs. Analysis conducted on a sample dataset of fifteen different sites located at different regions presented the outliers using mean and median algorithms in separate runs. Presented graphically, the identified sites are the ones where it is risky to establish an information technology firms. There are two conclusions by Sejwal et al. applicable to this study. The first is that the SDSS MMC can be improved by selecting more efficient spatial outlier identification methods. The second is that SDSS can be useful in other real-life applications including agricultural, financial, and demographic survey decisions.[225] It is from these two points that the use of Treviño's conglomeration, content analysis data, and demographics/socio-economic issues converge for the Stability COP and CIM.

6.2 Civil Information Management (CIM) History

The title of 'Civil Information Management' is actually a misnomer based upon its definition. The main basis for CIM is embedded in knowledge management (KM). As a business concept, KM is the process of maintaining and utilizing a firm's information by integrating its employees' professional experience and understanding.[226] The formal studies of KM and organizational design truly gained focus with the research by Drucker in 1988, with his study of firms' movement to information based organizations and employees specializing in knowledge development and management.[227] Embracing knowledge management as a discipline in 2003, the U.S. Army's perspective of KM is "process of enabling knowledge flow to enhance shared understanding, learning, and decisionmaking".[228] Army KM provides commanders with the knowledge and understanding to make decisions. Staffs, using various techniques, practices, and procedures piece together data and information and produce knowledge through analysis and evaluation. Staffs provide collective actionable knowledge to the commander, who in turn applies judgment to transform actionable knowledge into understanding to base a decision.[229] In other words, it enables action. As presented in the 'Statement of Problem' section of this study, knowledge is derived from information which, in turn, is derived from data. This process develops new knowledge, and combines, restructures, or repurposes existing knowledge in response to knowledge gaps. This is seen as 'knowledge creation'. Table 1 shows an example of military data becoming knowledge, giving note to the relationships occurring during the transformation. The act of processing (step three of the CIM methodology) transforms data into information. The act of cognition (analysis and evaluation, step four of the CIM methodology) transforms information into knowledge.

Term	*Example*	*Relationship*
Data	100 T72 tanks	Unrelated symbols out of context
Information	100 T72 tanks at grid location AB271683	*Processing* places the symbols in the context of the terrain and friendly forces
Knowledge	100 T72 tanks at grid location AB271683 indicates the enemy has committed its reserve	*Cognition* based on experience, analysis, or study provides meaning to the information

Example of Military Data Transformed into Information and Knowledge[230]
Table 1

This discussion on 'military knowledge management' is critical when compared to 'military information management': "the science of using procedures and information systems to collect, process, store, display, disseminate, and protect knowledge products, data, and information and knowledge products".[231] Information management is not focused on the transformation of data to knowledge, just the provision of a structure for commanders and their staffs to process and transfer information for decision making. While effective information management is necessary for knowledge creation, it is not sufficient to fulfill knowledge management.

Initial attempts were to place CIM as a subcategory of military intelligence, especially when dealing with irregular warfare (IW). Theorists and practitioners of IW realized the criticality of understanding the civilian population to the success of a campaign, but equated as part of traditional intelligence.[232] Yet, Lindenmayer notes that "[military] intelligence organizations frequently do not dedicate enough effort to support the process of integrating unclassified civil information (e.g., religion, values, economy, infrastructure, etc.) into the intelligence picture presented [to a military commander]".[233] While CA and special operations units focus on civil information requirements, these unit's tactics, techniques, and procedures (TTPs) have not historically been part of conventional forces doctrine, causing the development of 'one-off' non-doctrinal organizations in an effort to integrate social, economic, and cultural data and information into MDMP. The situation, caused partly by doctrinal and cultural resistance to socio-eco-culturally based analysis in the military intelligence branches and encompassing the entire the DoD, is the basis for 'big tent' approaches that incorporate the civil information gathering organizations and intelligence analysis agencies. This Civil Information Fusion Concept (CIFC) proposes a framework to merge Civil-Military information and intelligence.[234] The main goal of the CIFC was to change an otherwise stove-piped information sources environment so organizations and agencies can collaborate and consolidate; becoming a force-multiplier through flattening operational channels and developing a culture of sharing civil information. It is modeled from best practices and lessons learned from various military commands and missions to include the International Security Assistance Force (ISAF) Joint Command (IJC), Stability Operations Information Centers (SOICs), United States Africa Command

(USAFRICOM), and the United States Southern Command (USSOUTHCOM) Haiti Humanitarian Assistance and Disaster Relief (HA/DR) efforts. These organizations conducted missions focused on Stability Operations and needed to civilian population information requirements integration into the intelligence and operational planning cycles.[235] Listed criticisms to the CIFC concept included military intelligence's involvement in the collecting and managing of unclassified civil information (conventionally a CA domain) for Combat Operations purposes and not for Stability, the use of intelligence personnel to conduct reporter/sociologist style interviews, and the wide spread acceptance of a framework allowing intelligence personnel working in collaboration with all available colleagues (coalition, host nation, and NGO personnel).[236] The overarching theme in the list of criticisms is the involvement of intelligence agencies in the collection and analysis of civil information, a situation that presents negative perception issues with the available partners desired for creation of a collaborative environment and skewed the analysis focus away from Stability concerns. What Lindenmayer does not address is how the information is analyzed. The difficulty with the lack of analysis has been already addressed within this study in the referenced articles by Flavin and Schroden.

Within the U.S. Army Civil Affairs community, one of the earliest CIM execution and development systems was the Civil Affairs Knowledge Management System (CAKMS).[237] A prototype civil information management that combined GIS capability and decision support systems, it was developed to assist commanders in civil military operations planning, executing, and assessing. The project began in the winter of 2003 as preparation for the deployment of the 350 Civil Affairs Command (350 CACOM). The study of CAKMS by McQueen, Vialle, and Sullivan states that main concern of the 350 CACOM was the development of a civil COP methodology supporting military operations in Iraqi. The primary goals of CAKMS were the development of an interface for allowing users to geospatially view data and create map-embedded reports, and the enablement of soldiers and leaders to geospatially analyze the civil-military situation toward a more effective humanitarian aid response within an assigned area of responsibility in the work.[238] The intent of the database solution was to receive and format information from existing off-line data collection tools, analyze for trends using off-the-shelf GIS tools, and provide access through a web-based application. Key to this was the performance of the processing and display of the civil-military COP overlaid on a digital map or image and generation of standardized summary reports of collected civil-military data. The conceptual framework developed for CAKMS was focused on optimization of civil information flow, greater project data integration and de-confliction, and automation collection and management of critical spatially-related data toward leveraging for intelligence and civil military operations purposes.[239] An important factor was the idea of 'GIS Informed Operational Design'. This is based upon the concept of Operational Art – a cerebral approach by commanders and their staffs to: understand the OE; frame ill-structured and complex problems; and design broad operational approaches giving direction to planning.[240] The need to implement this cognitive approach requires understanding of Operational Design.

Operational design provides a creative methodology helping commanders comprehend the operation's context, develop an approach to surmount problem set issues and establish conditions for achieving objectives that develop the desired end state. It is essential toward creation of a common perspective and shared OE understanding. Design (in military context) is the product of the converging trends of complexity theory and new insights on social behavior on the military art.[241] Through leveraging the analysis capabilities of GIS, the traditional understanding of locational geography is supplemented with a synthesis of the social, cultural, and economic factors comprising human geography. Design based upon a COP enhanced by demographic, economic, social and political activity, geospatial information trends supports the requirements to develop a detailed understanding of the operational environment.[242] While championing the capability of a Stability COP, the CAKMS program provided very little discussion on the methodology for conducting an integrated analysis of designated Stability Operational factors for decision making purposes.

Additionally, Madera discussed in 2005 the role that CIM can play within counterinsurgency.[243] While recognizing that insurgency is a multidimensional phenomenon, his research focused on the interaction between the human and physical dimensions of geography. He states that while it was not an attempt to generalize this interaction as the main factor of insurgency, the spatial analysis did not probe profoundly into the greater geopolitical, macroeconomic, cultural, and psychological issues involved in counterinsurgency. Specifically, his study focused on framework provision development for understanding the interaction between the physical and human factors relevant to assessing the usefulness of counterinsurgency efforts by the Government of Colombia.[244] While discussing the linkage between application of GIS and increasing understanding concerning psychosocial, economic, and demographic factors in counterinsurgency analysis, he proposed further research be conducted. Yet, it was not specific on what methodological direction a GIS analysis based program should take.

The Human Terrain System (HTS) was one of the attempts to integrate social science and geographical analysis into the intelligence process. The concept was developed by Montgomery McFate and Andrea Jackson in 2005.[245] Initiated in 2007, the United States Army, Training and Doctrine Command (TRADOC) supported program hired personnel from the social science disciplines in order to provide military commanders and their staffs with an understanding of the local population (i.e. the 'human terrain') within an OE. The overall goals of the pilot program were to:

- Produce training products and courses
- Populate analytical frameworks
- Prove the importance of social science research methodologies to operations
- Establish a center of excellence
- Create a staff of social scientists to perform operationally relevant social science research
- Provide development advice for TTPs, SOPs, doctrine, and PME [246]

One of the key projects/products for development out of the HTT was a 'Cultural Preparation of the Environment' (CPE), a comprehensive and continuously updated database for use by maneuver commanders and their planning staffs. The database included map overlays of tribes, religions, and demographics points and areas of concern. The HTS connection to intelligence was primarily due as a response to the Iraqi improvised explosive device (IED). The thought by some tactical commanders was to get into the heads of tribal leaders and insurgent foot soldiers and deter them from planting IEDs. At the operational and strategic levels of the Army, the Marine Corps, and the DoD, there was a desire to find a way to insert cultural competence into training and education. Despite having CA components in the Army and Marine Corps as well as (not to mention Foreign Area Officers [FAO] and Psychological Operations soldiers [PSYOP]), cultural competence was seen as lacking within intelligence and operational capabilities.[247] Yet, this effort to ‘bring in outside help’ fell short of the goal.

In his 2018 *Military Review* article, Connable listed multiple parallel narratives describing the HTS initial emergence and ultimate demise. While the organic (CA/PSYOP/FAO) versus external (HTS) debate was the foremost narrative, one less publicized but equally important narrative was the difference between intelligence experts focused on threats and killing, and those focused on cultural understanding. While maintaining cultural competence, amassing and analyzing cultural information, and advising the commander on cultural issues were supposed to be part of the military intelligence community collective duty, the community did not have the capability to meet any of the requirements the during both the Afghanistan and Iraq wars. Intelligence was, and still is, designed and developed to warn of impending attacks and find enemy formations. In addition, irregular warfare requirements led to the development of high-value targeting capabilities. Intelligence was at the heart of the intensive, ongoing effort to find, fix, and finish insurgencies and terrorists. [248] While necessary for Combat Operations, this is not sufficient for Stability Operations.

Connable recognized that the two primary components of HTS (the teams and the reach-back knowledge [analysis] center) are needed. While the team component can be generated from the FAO, CA, PSYOP, human intelligence, and special operations communities in the military, Connable suggested analysis be supported by holistic, culture-inclusive military intelligence analysis; however, the various attempts to ‘integrate’ cultural analysis as a subset of intelligence repeatedly led to dismissal analysis at best, or total obliviousness of the cultural component at worse.

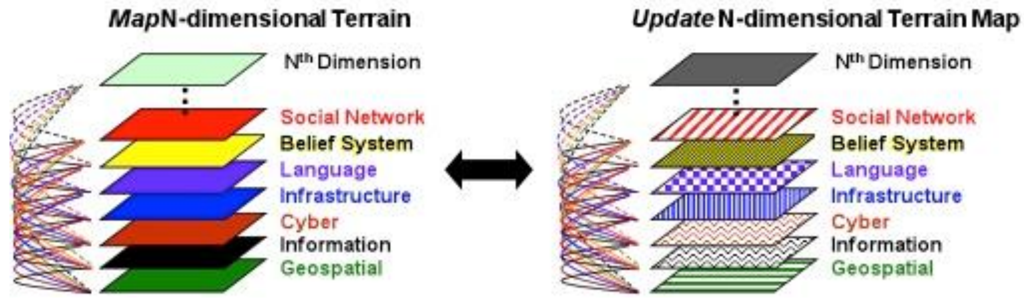
From November 2008 through June 2011, the Joint Civil Information Management (J-CIM) Joint Test program developed a guide designed to fill a doctrinal gap for CIM. It resulted from a requirement for effective civil information sharing in support of commanders and senior leadership decision making during Stability, Security, Transition, and Reconstruction (SSTR) operations and HA/DR operations conducted jointly by the DoS and the DoD. The lack of standardized CIM procedures for collecting, consolidating, and sharing civil information was identified as the major limits to operational planning capability.[249] The J-CIM program standardized and codified four of the six steps of the CIM process - collection, collation, production, and dissemination; but not process and not analysis. While highlighting several analytical methods for use in understanding the civil components of the operating environment, the training of analysts was beyond the scope of the J-CIM Tactical Handbook and discussed in generality within the J-CIM User Manual (the two main products of the J-CIM project).[250] Subjects referenced in include: MOEs and MOPs, Geospatial Analysis, Targeting Analysis (CARVER vulnerability analysis and MSHARPP forces protection assessment), and Time-Series Analysis. The proponents of the J-CIM test (United States Special Operations Command - USSOCOM) sought a follow-on joint test for the analysis step, but this did not receive enough support.

In May 2010 the ‘Mapping the Human Terrain’ (MAP-HT) system was sponsored by United States Central Command (USCENTCOM) as a limited Joint and Service integrated capability gap. Designed to provide tactical and operational commanders with improved capabilities to better integrate civil and socio-cultural information (stylized as human domain information) into the MDMP, it was an attempt to facilitate the CIM process within a commander's area of operations (AO).[251] This handbook served not as a technical manual for the MAP-HT computer system, but as guide for tactical and operational level CIM processes. Yet, the authors limit the scope of the document to four out of the six elements of CIM, with analysis as one of the 'specialty fields' outside the scope of the handbook.[252] While the handbook did not focus on how to conduct the analysis step of the CIM cycle, it did provide techniques and best practices for accomplishment of other portions of the cycle. The presentation of analysis technique concentrated on non-spatial analysis tools. Geospatial techniques consist of relatively elementary functions to the causal GIS users (emplacing point data, buffering, choropleth mapping). However, it does address the depiction of a Stability COP which illustrates civil considerations from a layered perspective. The model stated as the 'Dr. Griffin model' postulates a series of questions as a structured approach to developing a meaningful understanding of an AO for commanders.[253] Layer One asks, 'What are the meaningful social groups to which people belong?' This concentrates not only on the spatial identification of social, tribal and ethnic groups of influence, but also the dynamics of the social groups that have an impact on the motivations of the populations in which commanders operate. While the location is geo-referenced, under the Griffin model the dynamics are displayed via a Social Link Diagram, an analysis tool enabling determination of the relationships between various groups within an AO.[254] The two perspectives allow a joint depiction of the different groups that exist in the AO and location of spheres of influence (geographic), the size of the groups and common beliefs in the group (attributes of the geographic data), as well as the relationship they have to each other and group rivalries (link). Layer Two asks ‘Who leads these groups in the community; for what issues or domains do they have authority?’ Again, a social link diagram is used to display this layer. Layer Two is not referenced within a spatial context.[255] The key question for Layer Three is ‘What are the hierarchy of needs for the local populace overseen by that leadership?’. Beyond understanding what are the basic [public goods] needs of the people, and the local government‘s ability to handle them, this layer also attempts to identify outside organizations’ abilities to help with available resources to address the needs of the local communities and build capacity in local governance; gaps in local, international, and national resources to handle potential humanitarian crisis; and most vulnerable communities within the AO.[256] While the information for this layer is referenced within a spatial context, each public good element is mapped separately under the Griffin model. In fact, each of the ‘three layers’ is not a functioning layer in the GIS/spatial analysis sense. The developed information from the three was incapable of spatial integration. The methodology within the MAP-HT Handbook went the furthest in attempting a Stability COP, but still fell short of spatially integrating the various factors.

In 2012, Hanhauser advocated for a different use of existing capabilities toward the generation of a collaborative CIM and development of a Stability COP.[257] While the concentration of his Army War College paper is on how the Stability COP is different and need for collaborative civil information sharing, he presents points applicable to the discussion of CIM spatial analysis. First, the local level is both the greatest resource and consumer of civil information. This is due to the fact that needs, context, and effect are all locally derived.[258] Second, the various systems in use for CIM concentrate on data exchange and not content or analysis exchange; it is at best information without knowledge. He highlighted that the gathered information never serves a larger purpose.[259] His third applicable point is that even when the information is accessible, the lack of real context and useable [spatial] formatting makes a comprehensive civil common operating picture supporting appropriate decision making and action unobtainable.[260] Hanhauser's work does not directly address the issues of how to conduct analysis, spatial or otherwise. Yet, the emphasis on 'what products must be delivered and how' instead of 'what system should deliver information' serves as a guide toward the need of an effective spatial analysis for the Stability COP and Stability Operations in general.

A team of cadets and their instructors from the United States Military Academy (West Point) developed a tool to drive data collection methodology by U.S. Army Civil Affairs Teams and Security Force Assistance Teams, combine it with open source data, and conduct initial analysis and data visualization. Conducted in 2014, the intended audience were military commanders from Brigades up to and including Combatant Commands.[261] Using a risk framework developed by U.S. Pacific Command's (USPACOM) Socio-cultural Analysis Team, it views regional, national, and sub-national Stability environments through analysis the framework's five primary pillars: humanitarian crisis, outlier and recalcitrant states, regional power balancing, economic insecurity, and violent extremism. While stating all of five primary pillars, their research focused on creating a comparative index for the violent extremism pillar. They conducted two methods for creating a single index to measure violent extremism. The first method involved normalizing both a percentile rank and a ‘one-thru-five’ scale survey responses, and then summing them with a weighted additive value model. The second method used Principal Component Analysis (PCA) to generate a single index. The PCA transformed the original set of indicators into an orthogonal variable set (the principal components). By only using the first principal component (the first principal accounting for the greatest share of variable variance), a single index is created from multiple indicators. These methods used both human data collection and open source data assisted leaders in understanding stability in a designated OE. Both methods made use open source big data (GDELT) to meet information requirements. Additionally, the methods limited the information requirements of data collection teams, while also providing them with relevant national and regional data to assist in extrapolating information to the sub-national level where necessary.[262] While the West Point study did develop methods for incorporating content analysis data applicable for Stability Operations, it did not develop a way of integrating the USPACOM’s five pillar risk framework either spatially or any other manner.

One attempt to concentrate on an integrated view of the Stability OE is the “MANeuver in N-Dimensional Terrain” or MAN^N. This attempt involved mapping synchronized maneuver operations in a multi-dimensional terrain intended toward achieving a position of advantage in massing effects (i.e., aggregating and synchronizing overwhelming power at a location place and period). The MAN^N methodology generalizes spatial-temporal-centric maneuver concepts and identifies the forms of contact that extend across many domains including PMESII. MAN^N is designed to be complex, dynamic, adaptive, and distributed.[263]



MAN^N Spatial Analysis Conceptual Example[264]
Figure 10

The basic concept illustrated in Figure 10 is that various dimensions of an OE translate to the dashed lines joining the different dimensions representing interactions between the dimensions. Respective dimensions provide objectives conferring a position of advantage that allows commanders the capability to analyze how to combine effects across these dimensions. MAN^N, originally designed toward Counterinsurgency (COIN) analysis, was proposed as proactive slant incorporating all essentials elements of national power from the strategic through to the tactical level. This methodology did address issues of integrated analysis to include spatial and temporal issues, but the emphasis essentially ends on what inputs can be used and not how to conduct the integrated analysis.

The current Civil Affairs Civil Information Management Army Techniques Publication (ATP) was published in 2013 and delineates the collection – collation – process – analysis [and evaluation] – production – dissemination methodology. Both the 'Processing' and 'Analysis' sections of the ATP (chapters five and six respectively) reference the use of GIS to cognitively manipulate separate pieces of civil data into civil information[265] and to map the interrelationships of operational variables, current situation and their combined impact on the civil component.[266] In describing the use of spatial analysis, the ATP states that by breaking down the civil component by operational variables, each variable can be used separately of the others to establish specific indicators of instability and then these separate variables, in the form of spatial layers, can be stacked together to identify complex relationships and reveal how these components jointly impact the OE.[267] The ATP does not, however, discuss a methodology for achieving analysis and evaluation. At best, the publication concentrates on the spatial analysis of the "physical environment is referenced to form the COP".[268] Additionally, inputs such as key leader engagements (KLEs), civil geography mapping, and collecting of civil component reports [SITREPS] conducted by maneuver units, coalition and allied partners are raw CIM data that often are not inputted into a database for a proficient staff officer or NCO to collate, analyze, and produce recommendations for potential action.[269] While a revision of this ATP occurs at the time of publication of this study, the lack of spatial integration and analysis of socio-economic data/information prevents true Stability COP development and hence leads to an incomplete assessment for Stability Operations.

6.3 Review Results: Intersection of SDSS, CIM, and Stability COP

The review of the publications concerning SDSS, the history of the application of CIM, and the current methods of COP establishment was able to discover the extremely limited application of SDSS toward military analysis in general and none to the establishment of a Stability COP specifically. This identified knowledge gap highlights an established need for research in analysis methods for Stability Operations. Because of the needed ability to conduct judgments under ill-structured scenarios with both qualitative and quantitate data, methodological examination of SDSS implementation combining the use of content analysis of data, EDA and ESDA techniques, and MCDA is justified. While this study falls within the wider disciplinary discussion of SDSS' application, it is unique due to its domain application, military Stability Operations. The research question of how SDSS can establish a Stability COP and provide analysis for Stability Operations is an approach that differs from other that of scholars determining how to conduct a geographically integrated analysis of socio-economic factors.

7. METHODOLOGY

This research establishes how to develop an SDSS Model Management Component (MMC) for use in military Stability Operations. This requires interconnectivity between written reports from the field, coding of the qualitative data for quantitative use via a specified framework, statistical and spatial analysis of the quantitative data, then use statistically and spatially analyzed data within a decision matrix. The GDELT dataset provides a proxy for the field reports and, while initially converted from qualitative to quantitative data by use of content analysis during the GDELT process, requires additional coding for use in this study. Upon recoding using the PMESII operational structure, a collection of statistical and spatial analysis is conducted under a collective analysis method called Treviño's Conglomeration. The Conglomeration method is modified from Treviño's original technique in support of this research. Finally, the Conglomeration analyzed PMESII operational variables are used as decision criteria within an Analytic Hierarchy Process (AHP) to complete decision matrix. Due to the nature of data collected for decision analysis during Stability Operations, this SDSS MMC is the synergetic fusion of multiple analysis functions as opposed to a singular one. The organized parts of the gestalt are explained in the following sections of the methodology.

7.1 Re-coding of the GDELT Data

While the action attributes NumArticles and AvgTone are used for the PMESII variables, the current coding scheme used within GDELT is not PMESII. GDELT data entries are formatted using the Conflict and Mediation Event Observations (CAMEO) event coding taxonomy. Fortunately, the CAMEO coding taxonomy is readily ‘re-coded’ to conform for use in the PMESII analysis framework. This is done by identifying key words and phases of the PMESII variables with the event code description attributes of the GDELT database. The Political variable examines the formal and informal distribution of power and responsibility through the entire spectrum of governance, in addition to covert political powers. The Military variable examines the military (including paramilitary and security) capacities of relevant enemy, friendly, and neutral actors within a given OE. The Economic variable examines the individual and group activities of producing, distributing, and consuming means. Social describes the population’s cultural, religious, and ethnic composition and the beliefs, customs, and values within an OE. The first ‘I’, Information, examines the environment, span, and features, and effects of people, organizations, and systems collecting, processing, disseminating, or otherwise acting on media, public communications, and public perceptions. The second ‘I’, Infrastructure, examines the basic facilities, services, and installations needed for the functioning of a community or society. [270] Each of the eight operational variables also has associated sub-variables. Table 2 provides examples of sub-variables for consideration within each operational variable. Using these sub-variable lists as a guide, GDELT-to-PMESII ‘Crosswalk’ queries were established in Microsoft Access and used to implement the recoding procedure.

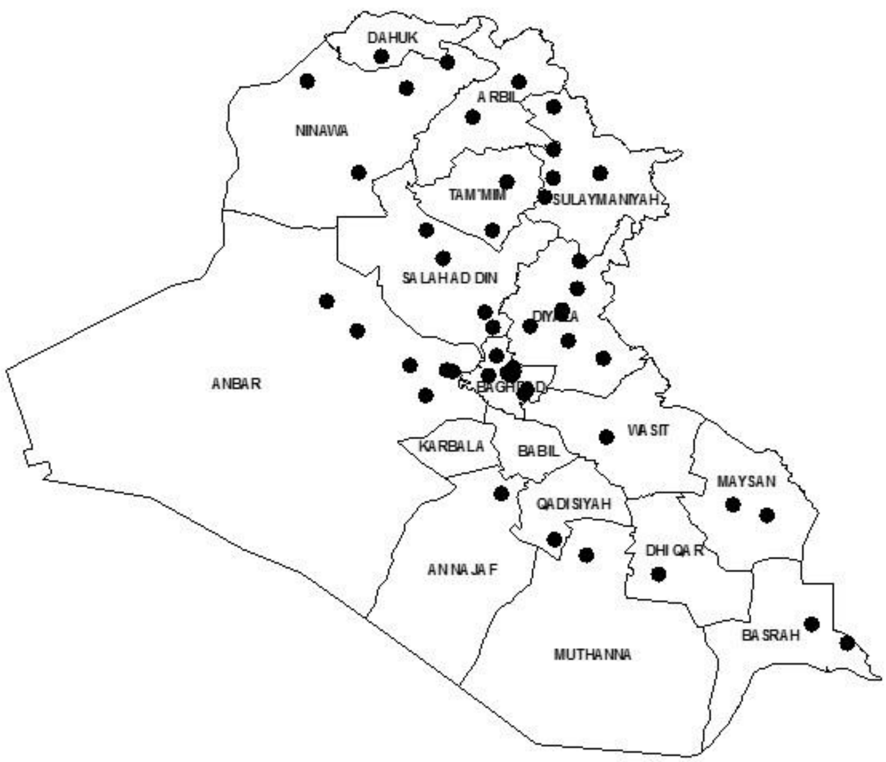
Political variable	Social variable
Attitude toward the United States Centers of political power Type of government Government effectiveness and legitimacy Influential political groups International relationships	Demographic mix Social volatility Education level Ethnic diversity Religious diversity Population movement Common languages Criminal activity Human rights Centers of social power Basic cultural norms and values
Military variable	**Information variable**
Military forces Government paramilitary forces Nonstate paramilitary forces Unarmed combatants Nonmilitary armed combatants Military functions • Command and control (mission command) • Maneuver • Information warfare • Reconnaissance, intelligence, surveillance, and target acquisition • Fire support • Protection • Logistics	Public communications media Information warfare • Electronic warfare • Computer warfare • Information attack • Deception • Physical destruction • Protection and security measures • Perception management Intelligence Information management
Economic variable	**Infrastructure variable**
Economic diversity Employment status Economic activity Illegal economic activity Banking and finance	Construction pattern Urban zones Urbanized building density Utilities present Utility level Transportation architecture

PMESII Sub-variables[271]
Table 2

The variables entitled 'EventCode', 'EventBaseCode', and 'EventRootCode' are aligned with the PMESII categories. This re-coding process does not affect the values of the NumArticles and AvgTone attributes. Not all for the entries from the September 2008 GDELT database are used. The GDELT-to-PMESII 'Crosswalk' Structured Query Language (SQL) database query program script for each operational variable are provided in the appendix.

7.2 Conglomeration in the MMC

The following is an example of how Treviño's Conglomeration is conducted in the initial part of the Model Management Component or MMC. For the purpose of this research, events at municipal/city/town level within the country of Iraq during the month of September 2008 are examined. For this example of Conglomeration, the event actions under analysis are those corresponding with the Economic operational variable. A spatial depiction of the Economic operational variable observations is presented in Figure 11.

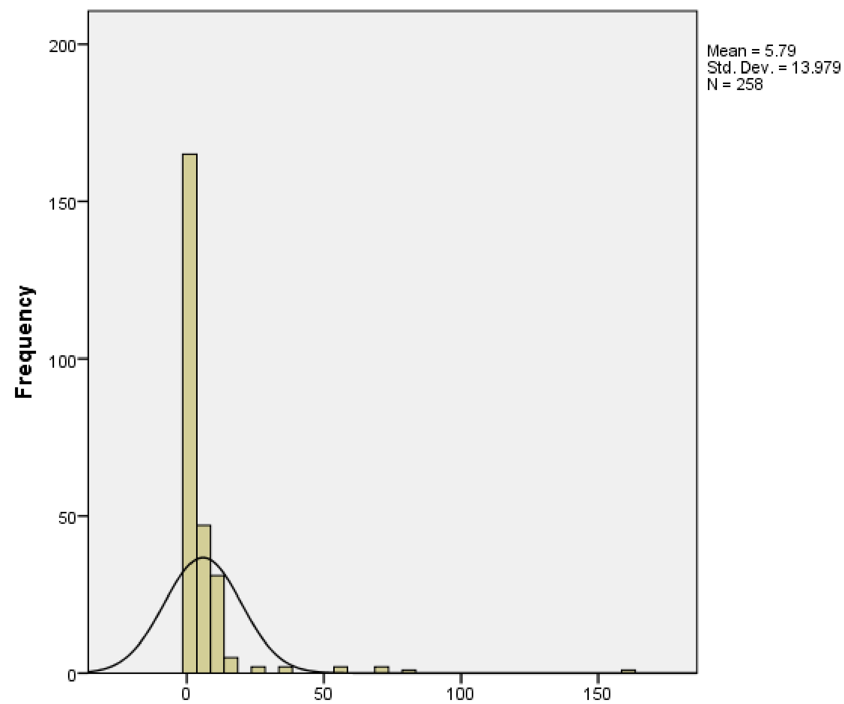


Map of Economic Operational Variables
Figure 11

Two event action attributes are used for this analysis, NumArticles and AvgTone. NumArticles, the total number of source documents with at least one mention of an event, assesses an event's importance. The count/amount serves as an indication of magnitude. AvgTone is the average tone of all documents containing at least one mention of this event. While the scores can potentially range from -100 (extremely negative) to +100 (extremely positive) with a value of zero denoting a neutral tone, the range for the Economic Iraqi subset is from 0 (neutral) to 12.14. Tone is an assessment of the importance of an event, serving as a proxy of event impact an indication of intensity.[272] The combination of geography, time frame, and variable selection results in 258 observations for analysis.

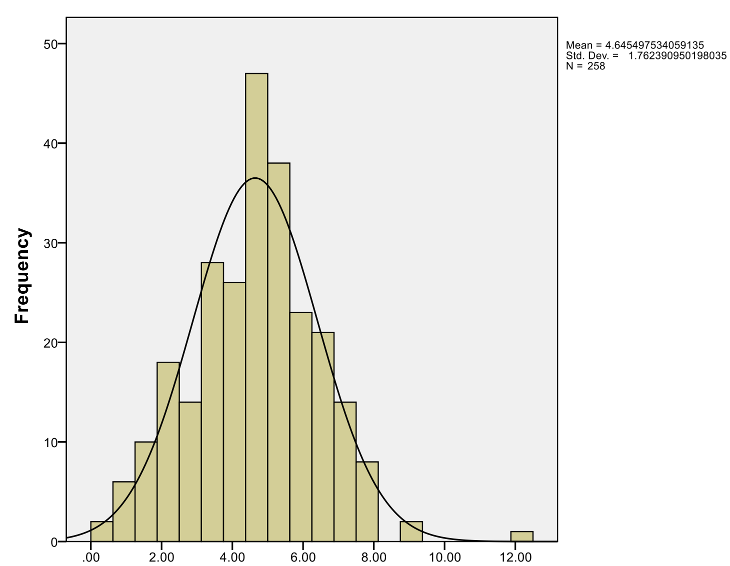
7.2.1 Descriptive Statistics and Normality Tests

The analysis begins with a calculation of mean, median, standard deviation, and skewness of the two variables. Treviño begins with exploratory data analysis (EDA) to verify that the data set is normal distributed. This analysis was calculated using SPSS 24 and Microsoft Excel 2013. NumArticles has a mean of 5.79, median of 2, standard deviation of 13.98, and skewness of 7.38. Since skewness describes the degree of asymmetry of a distribution about its mean, the relatively high positive value indicates an asymmetric distribution with a tail extending toward the right (i.e.: toward more positive values). The equation for skewness is defined as $\textbf{Skew} = \frac{n}{(n-1)(n-2)}\sum\left(\frac{x_j - \bar{x}}{s}\right)^3$. This skewness value is greater than 1, indicating positively skewed distribution. Figure 12, produced using SPSS 24, graphically shows the shape and degree of skewness.



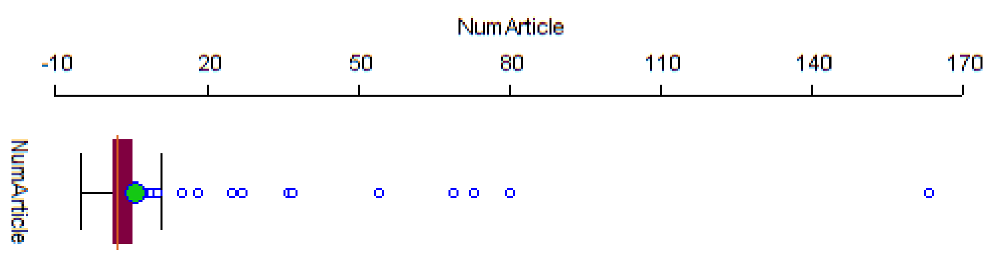
Economic NumArticle Histogram
Figure 12

AvgTone has a mean of 4.65, median of 4.75, standard deviation of 1.76, and skewness of .13. This skewness value is between -1 and 1, indicating a relatively normal distribution (Figure 13).



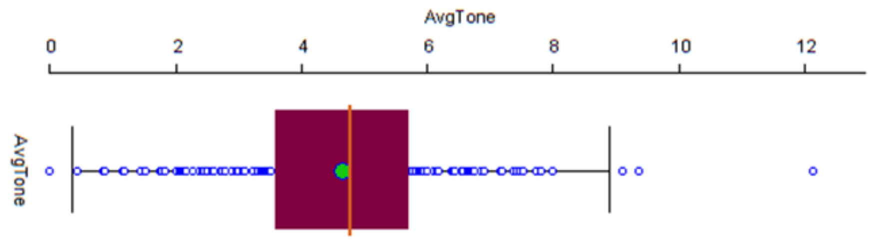
Economic AvgTone Histogram
Figure 13

To continue the exploratory analysis of the two variables in question, identification of the 'value spread' and the outliers for each data set is required. A 'Box-Plot' analysis was conducted using Microsoft Excel 2013 and GeoDa 1.4.3 graphics for both NumArticles and AvgTone. The key components of a Box-Plot analysis are the median, the first and third quartiles (Q1 and Q3 respectively), the interquartile range (IQR – a measure of the range between Q1 and Q3), and the 'whiskers' (demarcation lines on the end of Q1 and Q3). From this, any value less that the value Q1-1.5x(IQR) or greater than Q3+1.5x(IQR) is classified as an outliner. For NumArticles, the critical values are median: 2, Q1: 1, Q3: 5, IQR: 4, lower whisker: -5, and upper whisker: 11. Given these values, the NumArticles dataset has 15 positive outliers and zero negative outliers. This further supports the finding of positive skewness. (Figure 14)



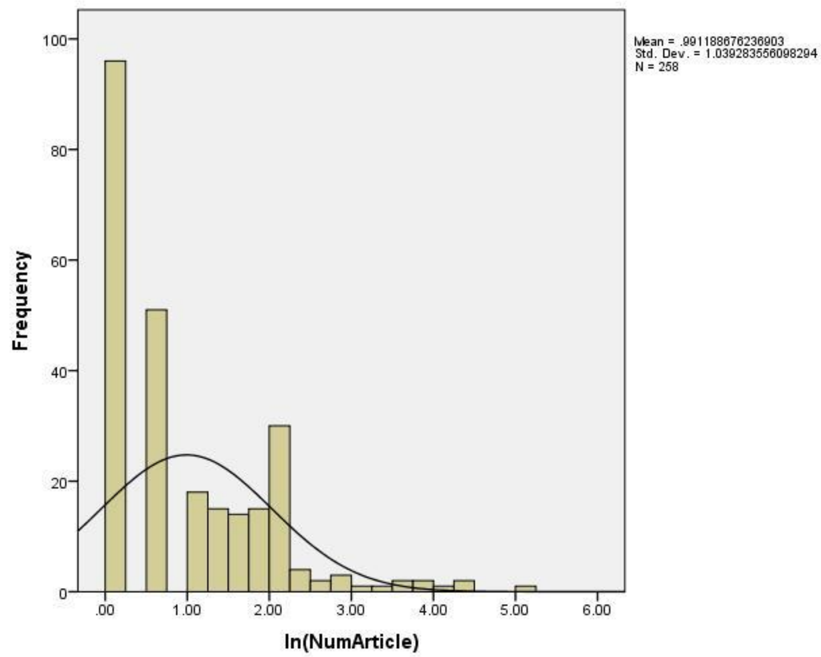
Economic NumArticle Box Plot
Figure 14

For AvgTone, the critical values are median: 4.75, Q1: 3.46, Q3: 5.69, IQR: 2.13, lower whisker: 0.36, and upper whisker: 8.89. Given these values, the AvgTone dataset has three positive outliers and one negative outlier. This further supports the finding of a normal distribution (Figure 15).



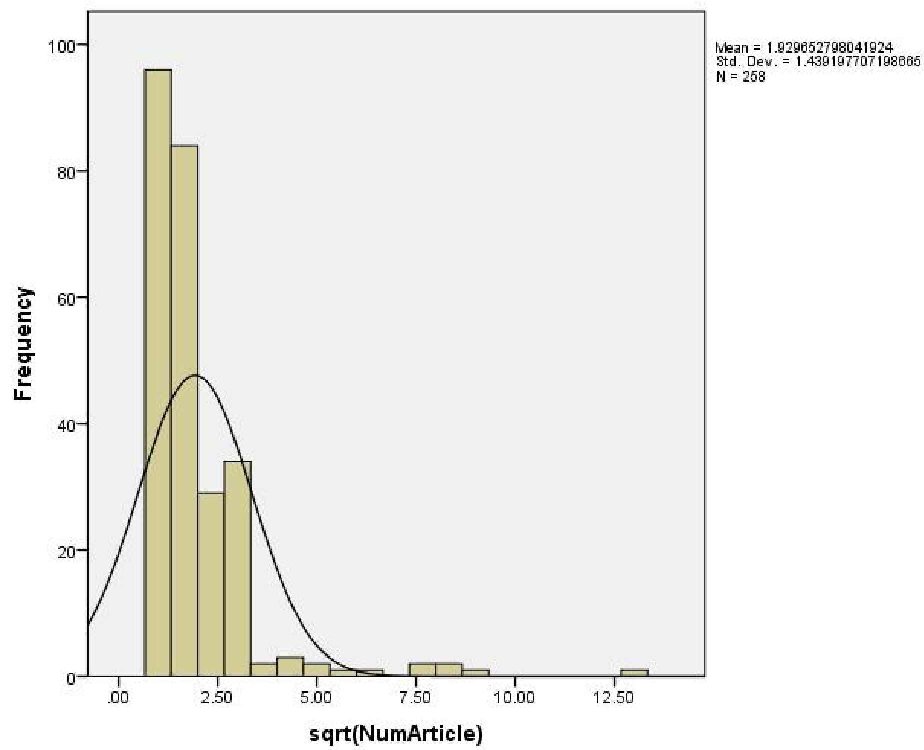
Economic AvgTone Box Plot
Figure 15

Because of the skewness of the NumArticles dataset, various transformations were conducted in order to normalize the data. A normality distrusted data set (i.e. normality) is a vital assumption for many statistical techniques; if your data are not normal, transformations enable a number of tests to be conducted. Due to the positive skewness, the natural logarithm, square root, multiplicative inverse, and Box-Cox transformations were performed (note that the Box-Cox transformation were conducted using the XLSTAT extension for MS Excel, version 2018.5.51886). Each transformed set was then tested for skewness. The square root transformation still exhibited positive skewness with a value of 3.56. The natural logarithm, multiplicative inverse, and Box-Cox (optimized) transformations exhibited relatively normal distributions with values of 1.06, 0.16, and 0.21 respectively. Yet a graphical examination shows the natural logarithm transformation being still slightly positively skewed (Figure 16).



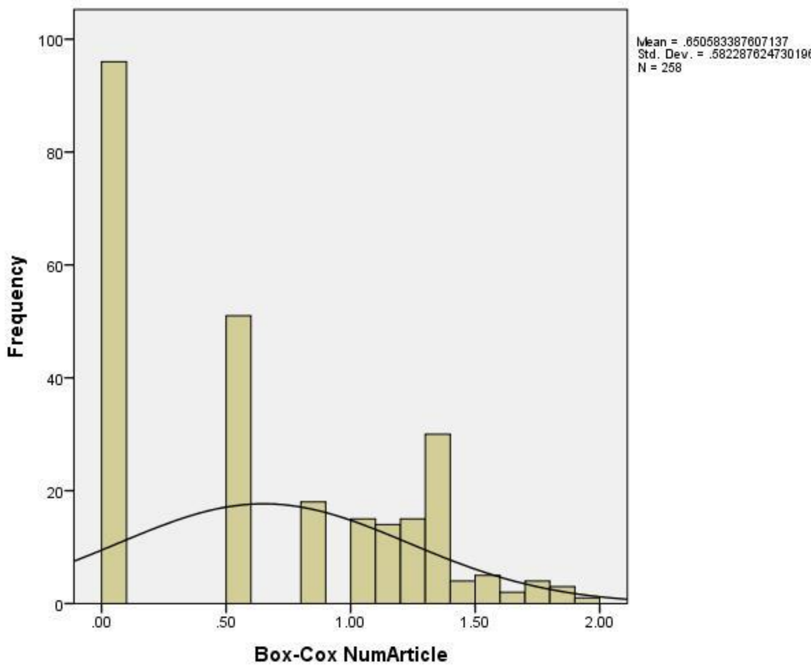
Histogram of Natural Log of NumArticle
Figure 16

A similar finding of relatively positive skewness resulted by graphing the square root transformation dataset (Figure 17).



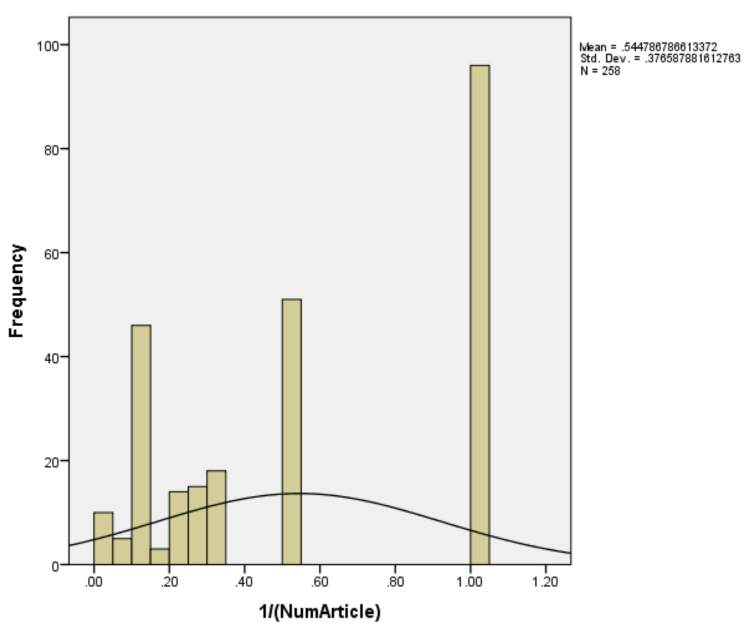
Histogram of NumArticle Square Root
Figure 17

A finding relative normality resulting from graphing the Box-Cox transformation dataset (Figure 18).



Histogram of NumArticle Box-Cox Transformation
Figure 18

And an additional finding relative normality resulting from graphing the multiplicative inverse transformation dataset (Figure 19).



Histogram of NumArticle Multiplicative Inverse Transformation
Figure 19

As a final analysis of normality, the Kolmogorov-Smirnov (K-S) process was applied to the data sets. The K-S algorithm within SPSS 24 was used for the calculations. First, the Z values for NumArticles, AvgTone, and the natural logarithm, and multiplicative inverse transformations of NumArticles were calculated. Then K-S process was applied using the null hypothesis that the distribution of the various z-scores were normal with a mean of zero and a standard deviation of one. Each of the resulting p-values for the NumArticles variables were less than 0.05, causing rejection of the normality null hypothesis. The resulting p-value for the Economic AvgTone was greater than 0.05 (0.069) reflecting a failure to reject the normality null hypothesis; in other words the observation of a relatively normal distribution was reinforced.

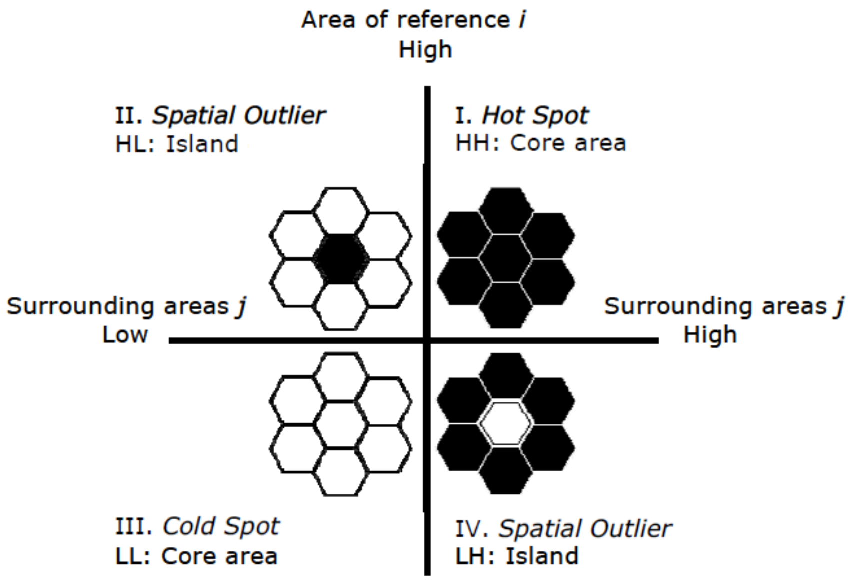
7.2.2 Robust Statistics and Global Outlier Identification

Whether or not normally distributed, both NumArticles and AvgTone can still provide good performance statistics. As mentioned, the condition is known as 'robustness' or robust statistics.[273] The identification of outliers, or the lack of outliers, does not fully indicate a great amount of magnitude or intensity. What is required is a determination of 'how high is high?' or 'how low is low?'. In order to achieve this with non-parametric variables, a procedure called bootstrapping is performed. Bootstrapping creates a new distribution approximating the distribution for a sample mean where the size of the population is not known.[274] It allows development of accuracy measures (i.e. variance, confidence intervals, etc.) to sample estimates. The procedure was conducted using the XLSTAT extension for MS Excel using the bias corrected accelerated (BCa) technique which aids in obtaining more accurate intervals for non-parametric samples.[275] For NumArticles the bootstrap confidence interval for the mean has a lower bound of 4.09 and an upper bound of 7.49. Thus, of the 258 Economic variable events reported Iraq during the month of September 2008, 180 ‘lower level magnitude’ events and 49 ‘higher level magnitude’ events are identified. For AvgTone the bootstrap confidence interval for the mean, the lower bound was 4.43 with an upper bound value of 4.86. Thus, of the 258 Economic variable events reported Iraq during the month of September 2008, 104 were of lower impact/intensity with 120 events deemed of higher impact/intensity.

By identifying the non-parametric characteristics of both NumArticles and AvgTone, and then applying robust statistical methods to these datasets, it is possible to statistically support what is ‘high’ or ‘low’ to the entire sample. While the sample containing these high and low values are determined partly by geographic orientation, the designation of being high or low has no connection to any spatial orientation. In other words, the relationship of ‘high’ and ‘low’ extends across the entire sample and does not account for relative comparisons by proximity. This ‘global outlier’ identification is a necessary but not sufficient part required to fulfill CIM’s mission to spatially analyze the Stability Operational area.

7.2.3 Global Spatial Autocorrelation

With identification of the non-parametric characteristics of both variables and establishment of concentration for the magnitude NumArticles variable but none for the intensity AvgTone variable, it is necessary to identify where they geographically agglomerate. This act of geographic clustering is measured by spatial autocorrelation, the determination of a variable values’ interdependence pattern over space.276 Initially this is done using the Moran’s ***I*** Global Index.[277] The purpose is to identify existence of the same pattern or process occurring over an entire geographic area. The ‘Global Moran’s’ measures the correlation of a variable with itself through space.[278] As with other statistical tests, a null hypothesis is established for the purpose of falsification or disproving. The null hypothesis in this case is that there is no (or zero) autocorrelation of the variable values. Mathematically, the z-score for the expected value of a random Moran’s I [E(I) = -1/(n-1)] is less than zero.[279] Because ArcGIS’ Global Moran’s algorithm assumes a normally distributed dataset (not applicable to this case study), analysis of this dataset is conducted using GeoDa. The procedure in GeoDa utilizes a Monte Carlo simulation process. Just as bootstrapping enables accuracy assessment measures (e.g. variance, confidence intervals) for an unknown non-spatial population size through random sampling with replacement, Monte Carlo simulations conduct multiple random samples to obtain the distribution of populations (non-spatial and spatial) that are neither random nor normal.[280] At the time of this study, ArcGIS does not provide the Monte Carlo simulation option. Using the GeoDa Moran’s scatterplot developed by Anselin, the spatial agglomerations are identified as either zero (the null hypothesis), positive (similar high or low values spatial clustered together), or negative (dissimilar values in close location).[281] It classifies the autocorrelation as either spatial agglomerations or spatial outliers. Using a quadrant diagram, the different types of spatial autocorrelation are classified by location within the quadrant (Figure 20).[282]

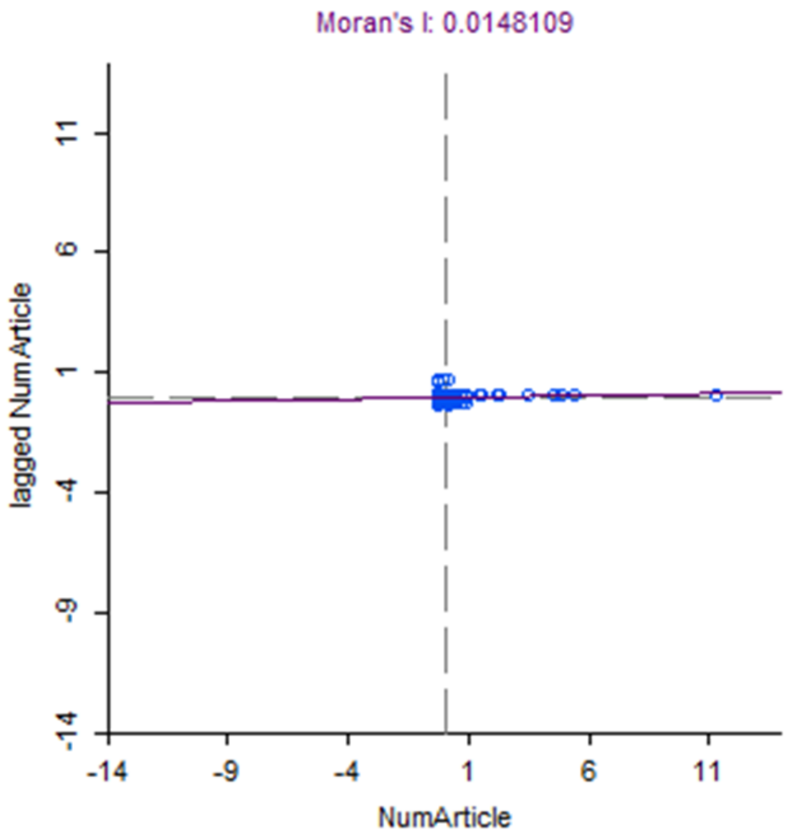


Stylized Categories for Moran's Scatterplot[283]
Figure 20

Positive spatial autocorrelation values are in the lower quadrant to the left (III) and upper quadrant to the right (I). Note that Quadrant III contains low value areas surrounded by low value areas (LL) while Quadrant I include high value areas surrounded by high value areas (HH). The different positive autocorrelations can be alternately described as hot spots (Quadrant I) or cold spots (Quadrant III). Cases in the upper left (II) and lower right (IV) quadrants corresponding to negative spatial autocorrelation are also described as spatial outliers (note: not to be compared to non-spatial outliers in the two standard deviations sense). These cases described as value of one type surrounded by values of the other (i.e. Quadrant II - high values surrounded by low values; Quadrant IV - low values surrounded by high values). Thus, the Moran's scatterplot classifications of global or overall spatial autocorrelation present values as spatial outliers (HL or LH), hotspots (HH), and/or cold spots (LL).[284] It graphically displays the Global Moran's ***I*** statistical significance of cases in the spatial agglomerations and spatial outlier quadrants.

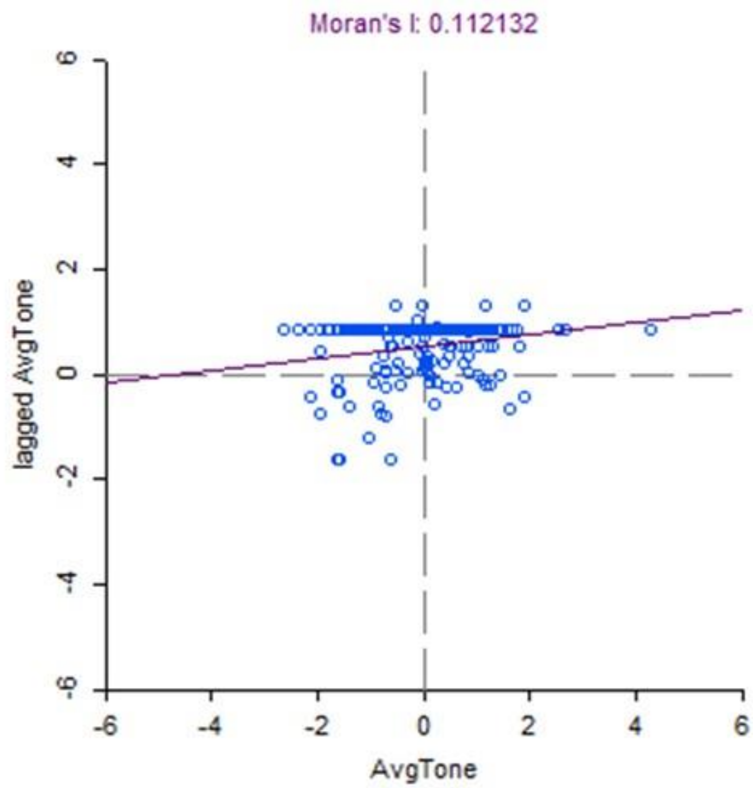
For this example, the Global Moran's analysis is applied to the Economic magnitude variable (NumArticles) and the Economic intensity variable (AvgTone). Since the events studied are geospatially referenced by points unlike in the Treviño example, the necessary spatial weight matrix cannot be calculated using the 'Queen' or 'Rook' contiguity methods designed for polygons. A 'k-Nearest Neighbors' spatial weights matrix was created for both variables (using Geoda version 1.43). While the 'Distance Threshold' method of creating spatial weight matrices is an option, that method often leads to unbalanced connectedness structures.[285] While analysis focusing on adjacency (either immediate neighbor or indirect via intervening neighbors) is preferred for polygon data, since this analysis is based on point data the Nearest Neighbors' spatial weight development is the method that best approximates a matrix calculated for polygons.

For the Economic NumArticles variable, the Global Moran value is 0.0148. Since the use of Monte Carlo simulations has the possibility of the Global Moran's ***I*** producing different results, multiple randomized runs result in the pseudo-p values fluctuating between 0.32 and 0.38 at 999 permutations. Since the values are stable, the null hypothesis of randomness cannot be rejected at an alpha risk of 5% (95% confidence level). The global autocorrelation is not significant the .05 level. As shown in Figure 21, Moran's Scatterplot presents the relatively clustered global distribution of the NumArticle Economic variables (positioning mainly along the non-spatial lag access). With each point referenced to an Iraqi urbanized area within the various provincial geographies, the interpretation is that there is no discernible global spatial effect on the distribution levels (magnitude) of Economic activity reported within provinces within Iraq. Again, the NumArticles variable represents the sheer volume of reports and its Moran's ***I*** represents a general lack of clustering toward high or low levels of reports within the country of Iraq.



Global Moran's *I* – Economic NumArticle
Figure 21

Global Moran's analysis for the intensity variable, AvgTone, presents a different result. The Moran's *I* is 0.0112 with a randomized p-value between 0.02 and 0.03 at a Monte Carlo run of 999 permutations. The null hypothesis of randomness can be rejected at an alpha risk of 5% (95% confidence level). Global Autocorrelation significant the .05 level with the observations are clustering about similar values. The Moran's Scatterplot presents that there are AvgTone Economic variables that are scattered tightly from Quadrant I (hot spot cluster quadrant) through Quadrant III (cold spot cluster) along an approximately positive 11 degree line (the Moran's *I* value). While there some points clustered within the High-Low (quadrant II), there are relatively few points plotted within the Low-High (quadrant IV) spatial outlier regions (Figure 22). With each point referenced to an Iraqi urbanized area within the various provincial geographies, the interpretation is that the intensity of reported Economic activity is relatively positively clustered and not evenly dispersed throughout Iraq.



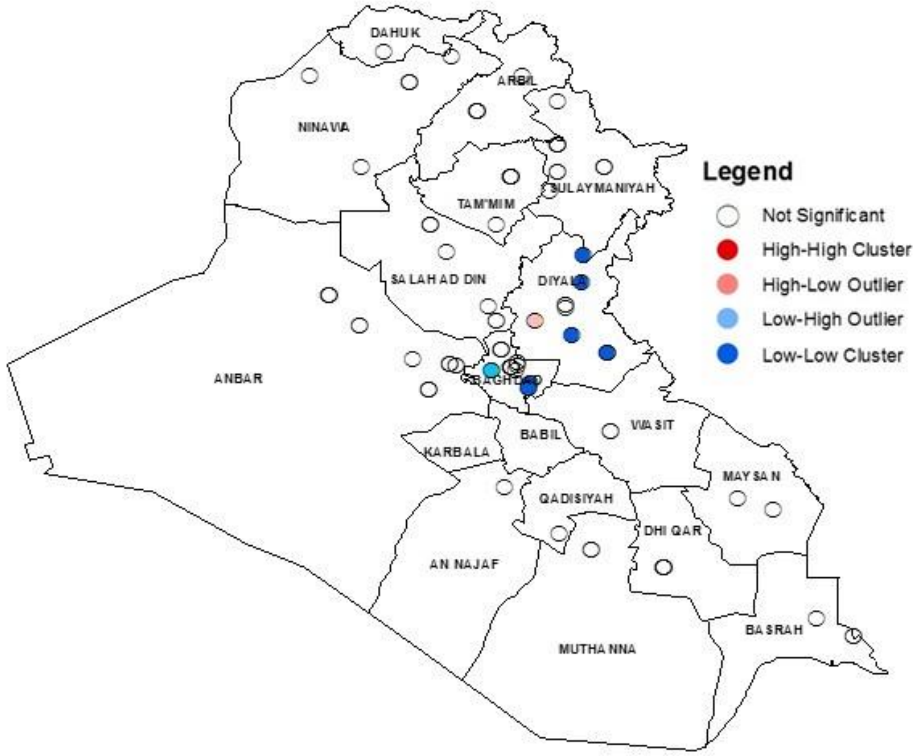
Global Moran's *I* – Economic AvgTone
Figure 22

With the country level (global) identification of the Economic magnitude variable that is statistically random but having an Economic intensity variable as being possibility clustered around High-High (HH) hot spots with Low-High spatial outliers, it is important to identify where the reported Economic activity occurs. Additionally, the lack of statistically significant country wide (global) spatial autocorrelation (clustering) does not preclude the identification of local pockets of reporting magnitude and intensity.

7.2.4 Local Spatial Autocorrelation

The Global Moran's index provides a comprehensive examination of spatial autocorrelation within a geographic population. In order to perform the CIM subtasks of collation and analysis/evaluation on the civilian aspects of the OE, an aggregate or comprehensive examination is not sufficient. Spatial identification of where significant activities are needed to fulfill CIM's geographic display requirements. A LISA measure provides both information on the statistical significance of cases within the spatial agglomerations/spatial outliers and identifies non-statistically significant cases. Simply put, local high values can exist by virtue of being greater than others in their adjacent area and yet not be globally large. This 'Local Moran's index' (Ii) tests its statistical significance of against an absence of spatial autocorrelation (i.e. a spatially randomly distributed variable) null hypothesis (H_0). The H_0 is rejected under the NONO principle (NOn-significant, NOt rejected).[286] LISA provides a capability to examine individual entities against the whole to develop a more nuanced picture of the OE.

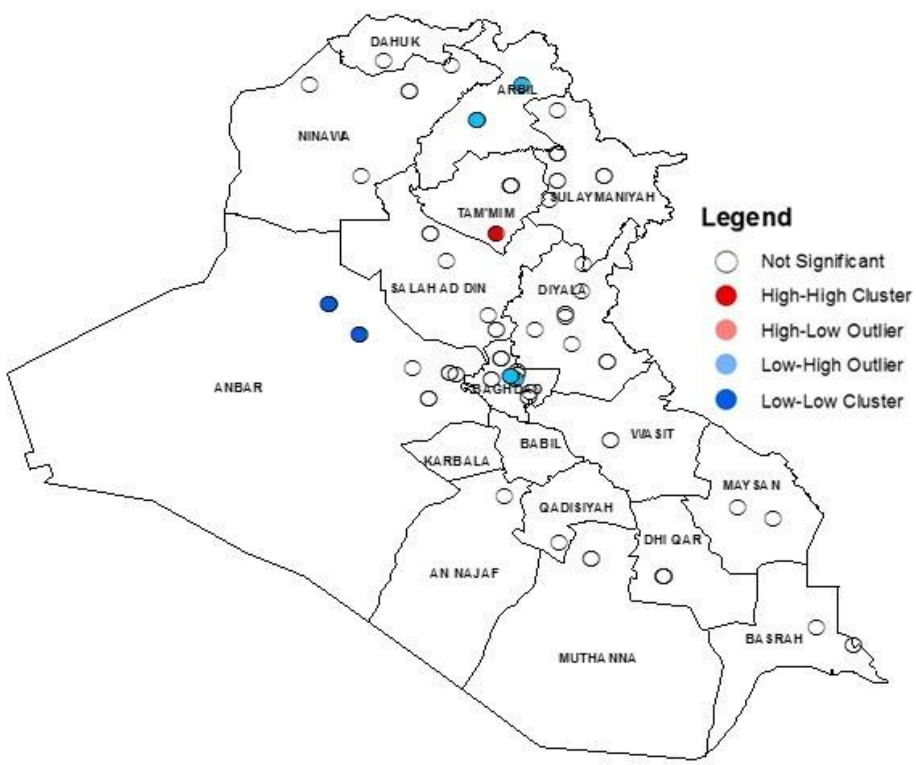
While the Economic NumArticles observations under the Global Moran are deemed independent (not clustered/non-correlated), a LISA calculation was conducted and identified two provinces of Iraq with municipalities having LL or cold spot cluster magnitude variables (Baghdad, Diyala). There are there is one province with LH outliers (Baghdad). The LISA calculation identified one municipality within the province of Diyala as containing HL outliers. For measures of magnitude, there are no HH hot spot clusters identified.[287] This is displayed in Figure 23.



NumArticle Local Moran's *I* Economic Variable
Figure 23

The statistical tests of the NumArticle variables designated as local clusters or outliers reject the absence of spatial autocorrelation null hypothesis at a minimum of the 95% confidence level. While the underlying global spatial distribution of Economic magnitude is not deemed random, an argument is that DoD and DoS program creation and implementation should explicitly incorporate spatial information and account for regional inequalities. The conclusion reached from this test is that there are municipalities within Diyala and Baghdad provinces having relatively low magnitudes of economic aid events reported. An additional conclusion is that there are municipalities within Baghdad province having islands of low magnitude of economic activity reported relative to surrounding municipalities with high magnitudes of economic activity reported. With these municipalities identified as potentials for increased aid, the identification of relatively low aid activity must now be compared to areas where there are potential of greater impact as reflected in intensity.

Based upon the intensity variable AvgTone's Global Moran's value of 0.112, a LISA calculation was conducted and identified four provinces with municipalities having with significant positive autocorrelation. As earlier noted, there were both hot spot and cold spot local clusters as well has LH outliers. One of the municipalities in the Ta'mim province was identified as hot spot (HH) cluster. Two municipalities in the province of Anbar were identified as cold spot (LL) clusters. Low-high outliers were identified in the provinces of Arbil and Baghdad (Figure 24). All of the local positive and negative autocorrelated AvgTone values reject the absence of spatial autocorrelation null hypothesis at a minimum of the 95% confidence level.



AvgTone Local Moran's *I* Economic Variable
Figure 24

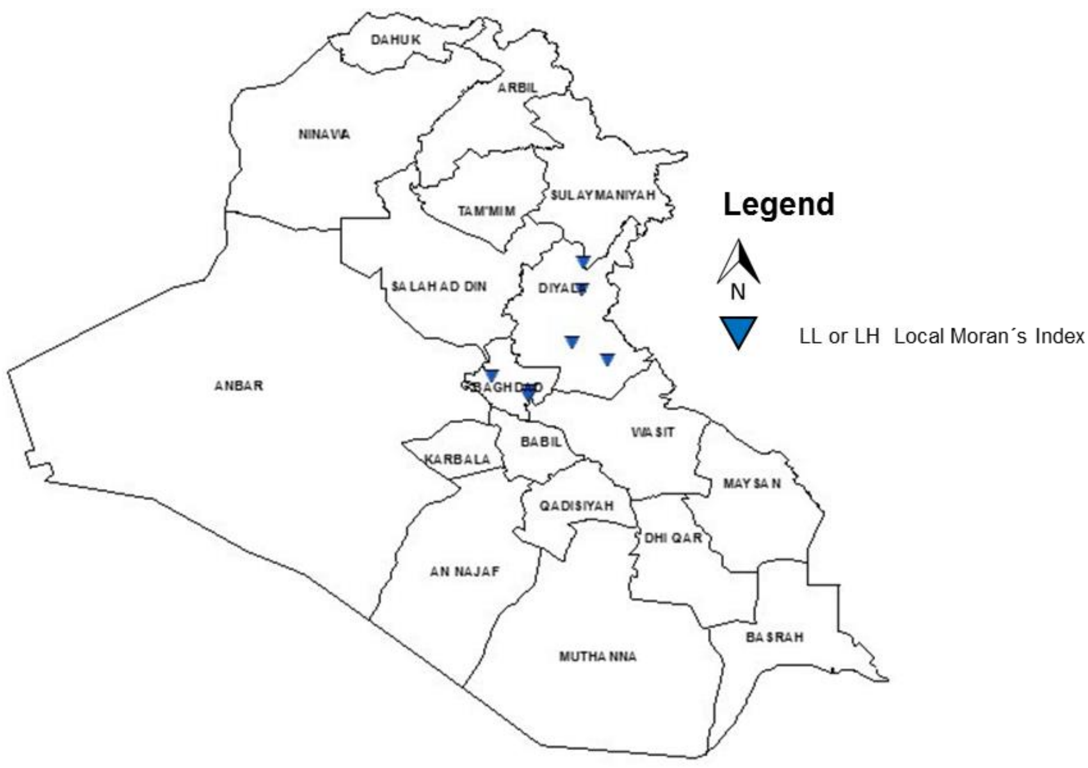
Again, since the report underlying the locational distribution of Economic activity is not random at the local level, an argument is that DoD and DoS program development and implementation should clearly incorporate spatial information in relation to potential impact and be targeted to account for the regional disparities. The conclusion reached from this test is that there are multiple indications of regional spatial intensity. On the surface, an increase in aid to HH hot spots and to other HL spatial islands should provide greater intensity in the positive perception of aid efforts. What is now required is a method for integrating the various measures for both magnitude and intensity in order to reveal areas in which to enhance Economic activity.

7.2.5 First Modification of Treviño's Conglomeration

Treviño, in his analysis of the spatial hierarchy of poverty in Mexico (Treviño, 2010), used GIS to combine the results of outlier identification using the bootstrap statistical method (concentration) with a LISA analysis of spatial autocorrelation (agglomeration). The spatial pattern of poverty analysis required distinction between magnitude and intensity and thus both concentration and agglomeration analysis were conducted on magnitude and intensity separately.[288] The key purpose of his paper was to demonstrate how the identification of priority areas can be improved for policy formulation. The implicit methodological question is how the integration of spatial and non-spatial statistics can identify those priority areas. Treviño used the concept of 'Core and Periphery' analysis.[289] His spatial core consisted of the high values surrounded by high value hot spots (HH) or high values surrounded by low values (HL) as derived from the local Moran´s Index LISA values. The periphery is the set of global values exceeding the upper limit of the 95% confidence level derived from bootstrapping that spatially intersect or surround the core.[290] The process compensates for two issues. First is the spatial inclusion of a locally important area while excluding others that maybe nationally relevant. Second is the converse, the spatial inclusion of a nationally important area while excluding others that possibly relevant locally.[291] By using GIS to integrate the periphery and core area layers via the intersection or union applications, a new map layer containing the resulting conglomerates is created. Preforming the procedure for both magnitude and intensity values as separate and independent tasks, the high values overlay analysis comparison of the two presents a spatial pattern of poverty based upon statistically determined threshold limit values.[292] Essentially, after conducting spatial mathematical analysis on magnitude and intensity, he used a basic sieve mapping analysis to find the intersection of the two spatial sets. Inherent in Treviño's study is the identification of areas with both high magnitude and high intensity. The nature of his research, identification of high poverty concentrations accounting for both local and national significance, required maximization identification of both.

By using Treviño's conglomeration procedure in the MMC, the merging and analyzing aspects of the CIM mission can be accomplished. The specific analysis calls for the identification of areas within Iraq requiring aid after the 2007 'Surge' operation. Implicit in this analysis was identification of areas where aid provision will have a decisive impact. In order to find areas requiring economic activity in which a greater impact is achieved, the first of two modifications in Treviño's conglomeration procedure is required. Impact maximization, as measured by AvgTone, will require identification of high intensity. This is Treviño's original procedure of 'high level' conglomerate identification. But identification of neglected areas requiring more economic activity calls for ‘low level’ conglomerate identification using the NumArticle variables. Specifically, what is desired is low magnitude. In other words, the converse of Treviño’s conglomeration procedure is used by identifying a spatial core consisting of the low values encircled by low value hot spots (LL) or low values encircled by high values (LH) as calculated from the local Moran´s Index LISA values and a periphery consisting of values below the lower limit of the 95% confidence level derived from bootstrapping that spatially intersect or surround the core.

First, identification of the magnitude (NumArticle) all municipalities resulting with LL or LH as Local Moran´s Index values were identified (Figure 25). They located in the Diyala and Baghdad provinces.

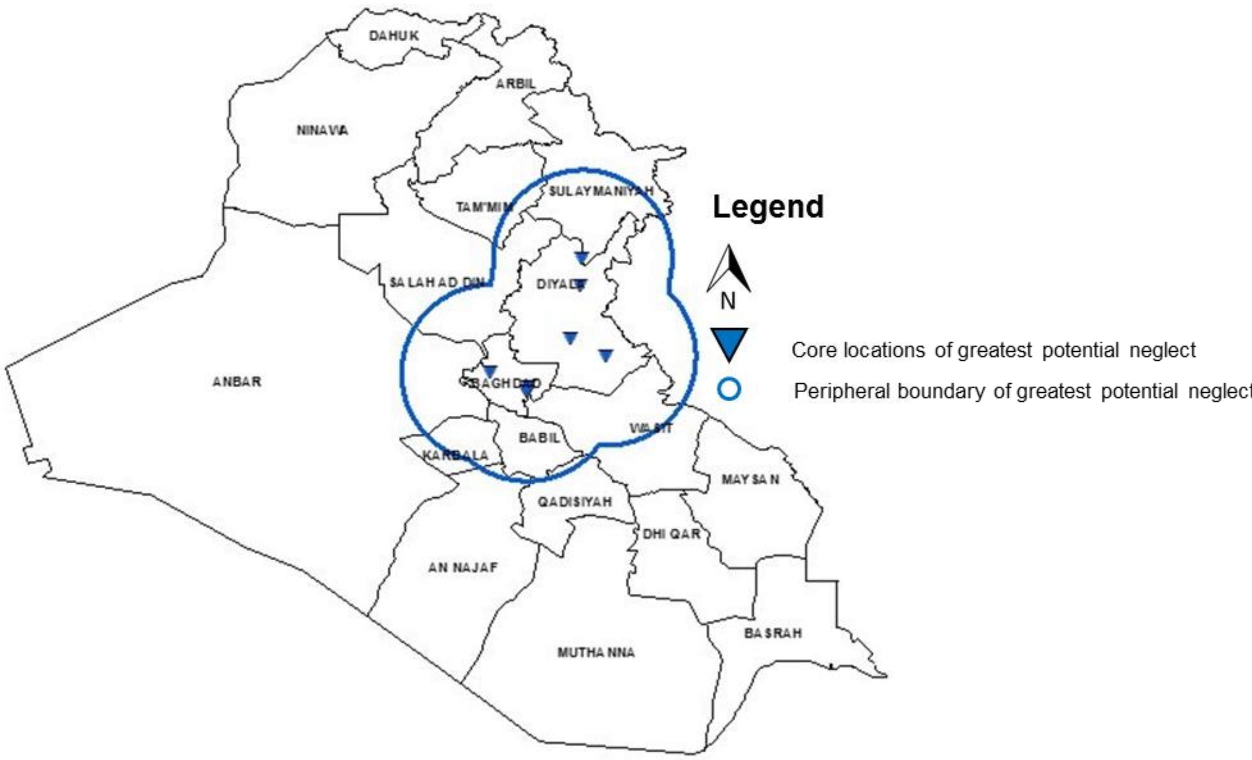


Economic NumArticle Agglomeration
Figure 25

Then, in order to find the NumArticle lower conglomerate core, low level conglomerates are implemented. A BCa bootstrap analysis was conducted on the NumArticle variable resulting in a 95% confidence level with (4.09, 7.49) as the bounds. In order to find the lower conglomerate periphery, an attribute query within ArcGIS identifying all values less than 4.09 (aka: the lower outliers) produces the following spatial concentration (shown in Figure 26).

Economic NumArticle Agglomeration and Concentration
Figure 26

The resulting overlay shows the combination of agglomeration and concentration for the 'low' values of NumArticle (Figure 27). Yet, this in and of itself does not constitute the 'Core and Periphery' of Treviño's conglomeration. His was based on contiguous polygons. Since the data for this study is based upon points, buffers (blue rings) were created around the points of agglomeration. While the spatial weight matrix for the Global and Local Moran's ***I*** is based upon the nearest neighbors' spatial weights matrix calculation, a buffer based upon the distance weight matrix threshold of 0.994 units (decimal degrees) is developed. Thus, any point of concentration with its centroid within the buffer constitutes the periphery.



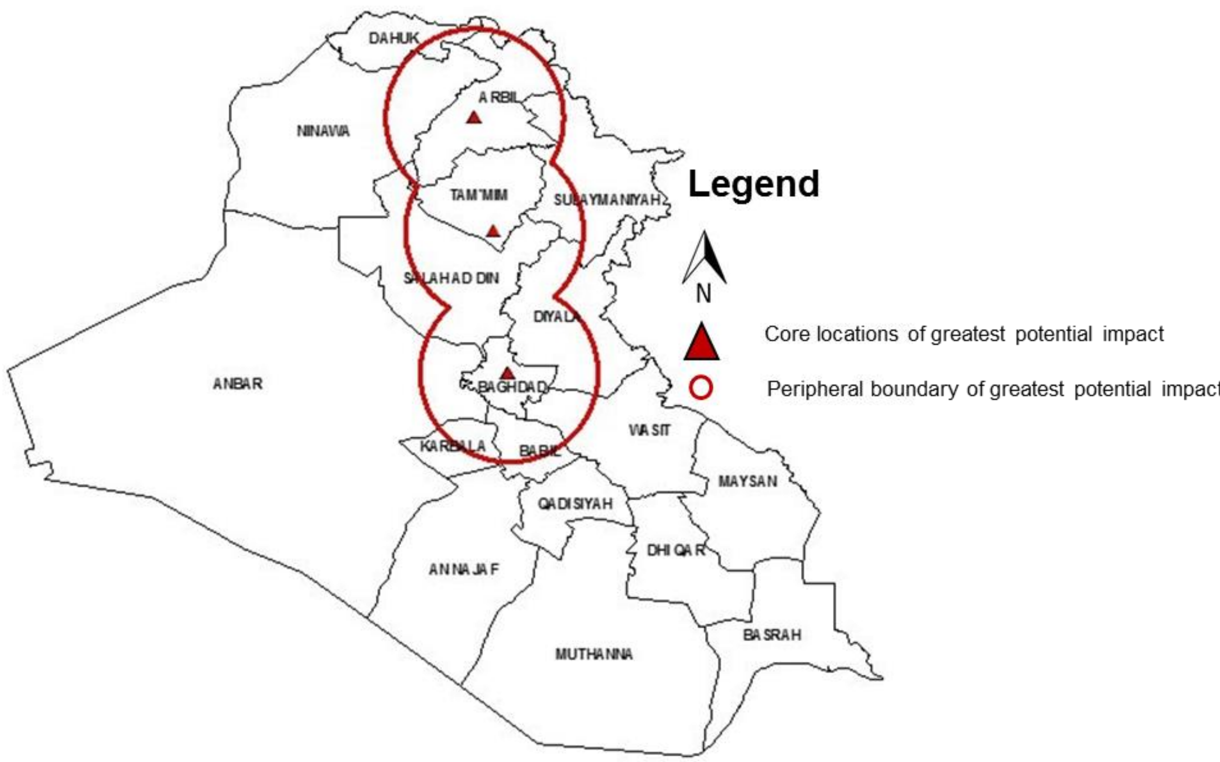
Economic NumArticle Conglomerate
Figure 27

The NumArticle Conglomerate consists of municipalities within the Diyala, and Baghdad provinces. With six sites in total, the collection represents a mixture of territories occupied by Shia, Sunni, and Kurd majorities. These municipalities represent areas of greatest potential neglect for economic activity in comparison to others.

Similarly, identification of the intensity high level conglomerates is implemented. The BCa bootstrap analysis was conducted on the AvgTone variable resulting in a 95% confidence level with (4.43, 4.86) as the bounds. Despite the finding of a relatively normal distribution, bootstrap analysis is applied in order to maintain methodology continuity. In order to find the higher conglomerate periphery, an attribute query within ArcGIS identifying all values greater than 4.86 (i.e., the upper outliers) produces the spatial concentration. Similarly to the analysis for NumArticles, spatial aggregation for AvgTone is identified. Yet in this case the higher conglomerate core is sought. In order to find the AvgTone higher conglomerate core, all municipalities resulting with HH or HL as local Moran´s Index values were identified. The resulting overlay shows the combination of agglomeration and concentration for the 'high' values of AvgTone (Figure 28).

Economic AvgTone Concentration and Agglomeration
Figure 28

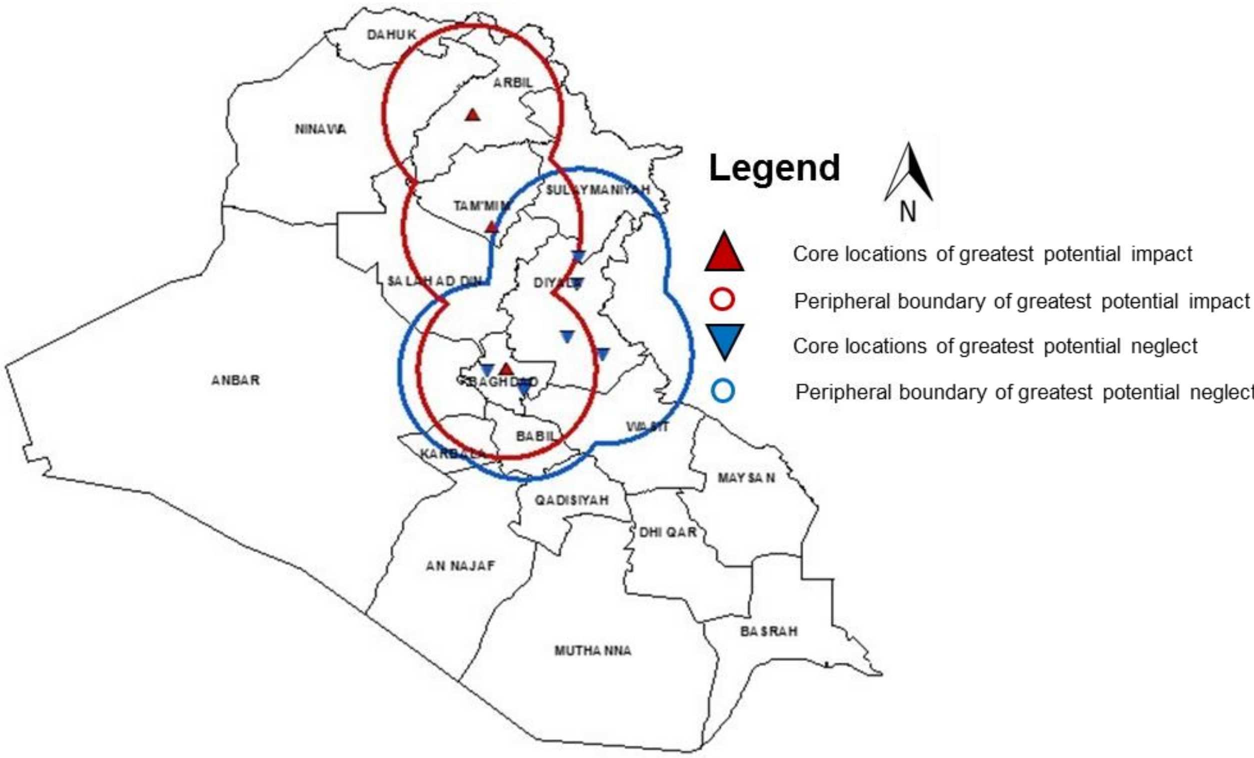
Again, this in and of itself does not constitute the 'Core and Periphery' of Treviño's conglomeration. Since the data for this study is based upon points, buffers (red rings) were created around the points of agglomeration based upon the distance weight matrix threshold of 0.994 units (decimal degrees). Thus, any point of concentration within the buffer constitutes the periphery.



Economic AvgTone Conglomerate
Figure 29

The AvgTone conglomerate consists of municipalities within the Arbil, Baghdad, and Tam'mim provinces. With three sites in total, the collection represents a mixture of territories occupied by Sunni and Kurd majorities. These municipalities represent areas with the greatest potential effectiveness for economic activity in comparison to others.

Once the conglomerates of intensity and magnitude are identified, the next step is to distinguish and classify municipalities reflecting the Economic activity criteria. This section overlaps the two conglomerates of AvgTone (Figure 29) and NumArticle (Figure 27) values to identify the highest priority municipalities (Figure 30). Results identify the highest priority municipalities as Arbil (Arbil province), Jalawla (Diyala province), Baghdad (Baghdad province) and Abd Al-Aziz (Ta'mim province).



Economic Magnitude and Intensity (NumArticle and AvgTone) Overlay
Figure 30

Since conglomerates are the result of overlapping non-spatial (concentration) and spatial (agglomeration) of low values of magnitude or values of high intensity, they are important as representations (relative or absolute) of the Economic variable. These values are assigned the highest spatial priority for strategic and operational policy to the intersection area of both conglomerates. Since remaining municipalities that are not intersected in the intensity or magnitude conglomerates can also be significant, they are arranged or classified to indicate a spatial priority for the decision making process.[293] Allocating spatial priorities to the municipalities based on the core and periphery estimates is direct. Non-intersecting core or periphery values (secondary and tertiary, respectively) are directly attained from the overlapped maps (Figure 30). As anticipated, core areas of intensity and their peripheries (conglomerates of intensity) cover more area, and are situated in lesser populated areas, than those of magnitude that include the major urban areas. Non-intersecting cores and peripheries are secondary and tertiary priorities in both intensity and magnitude, respectively, due to both of stability aid analysis characteristics are equally important.[294] Yet, they are important for different reasons. As the magnitude variable, the NumArticle core and periphery identifies where economic activity waxes and wanes. It is an inverse relationship. Thus, the lower level conglomerates denote where the greatest need is located. The intensity variable represents something entirely different. The AvgTone core and periphery identifies where economic activity provision results in the greatest impact. An alternate way of stating this is 'where can economic action provision produce the biggest bang for the buck?' This initial modification of Treviño's conglomeration procedure allows examination of the stability strategic policy question of where provisional and municipal neglect intersects with maximum results.

7.2.6 Second Modification of Treviño's Conglomeration

Treviño's Conglomeration method concludes with the sieve spatial analysis procedure mapping overlapping areas of magnitude and intensity. But like nominal (categorical) numbers in mathematics, these mapped areas are just labels; they only identify a geographic point with no indication of rank, quantity, or other type of measurement. In order for AHP to work, values must be developed for each geographical area. This is the rational for the second modification to the Treviño's Conglomeration method.

A value for each PMESII Conglomeration point is calculated based upon the 'minimum magnitude/maximum intensity' rule established above. First, because attributes with larger ranges could have undue greater importance in the analysis, both the NumArticle and AvgTone attributes for each PMESII is standardized so that they are of comparable scales. Then analysis rule is applied by calculating intensity (AvgTone) minus magnitude (NumArticle) for each statistically significant raw value of AvgTone and NumArtcle. In the case where a statistically significant value for one of the attributes does not occur (null value), the attribute takes on the value of zero. There are no values calculated for municipalities where both the AvgTone and NumArtcle attributes are not statistically significant. Because of the varying scales of each of the PMESII variables, statistical normalization is applied to create a common scale. For municipalities with multiple values, the mean is applied to the calculated results. The result is nine identified municipalities with values for the Economic operational variable (Table 3). While it is not surprising to find Baghdad on the list of statistically significant Economic operational variables, it is not at the top of the list. This is due to the lack of significant impact any additional economic activity would have as reflected by the lack of magnitude values from the analysis.

Municipality	Latitude	Longitude	Economic Variable
Arbil, Arbil	36.1926	44.0106	1.714850834
Baghdad, Baghdad	33.3386	44.3939	0.807691771
Abu Ghurayb, Baghdad	33.307	44.1869	0.343100921
Jalawla, Diyala	34.2772	45.1779	0.343100921
Salman Pak, Baghdad	33.102	44.5835	0.343100921
Ariz, Diyala	33.5	45.4667	0.271424778
Balad Ruz, Diyala	33.6963	45.0778	0.271424778
Madain, Baghdad	33.15	44.6167	0.271424778
Abd Al-Aziz, Ta'mim	34.9283	44.2303	0.236138412

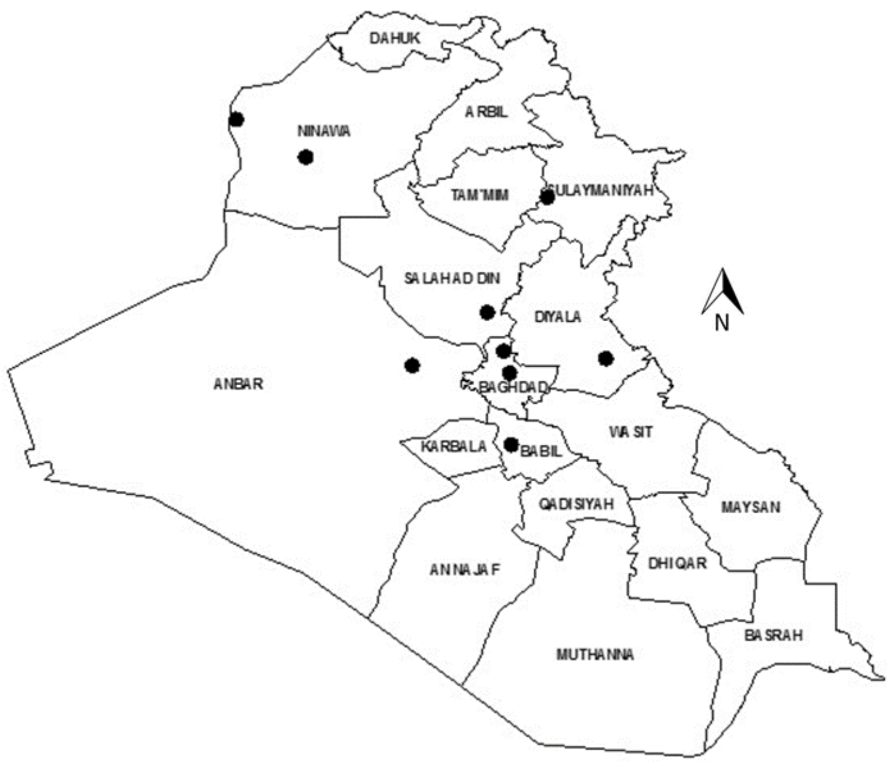
Economic Variables
Table 3

This second modification of Treviño's Conglomeration develops factors from which final scores can be calculated in the AHP MMC model. Based upon the re-coded GDELT data, the procedure is applicable for all of the PMESII operational variables. A secondary effect of this modification is the limitation of analysis to non-transformed GDELT data. Since factor development involves normalization of the GDELT data for scaling purposes, the use of pre-transformed data may cause additional anomalies within the factors that would unduly affect the final score. The is modification is a critical step toward the overall implementation of this study's SDSS.

7.3 PMESII Conglomeration Layers in the MMC

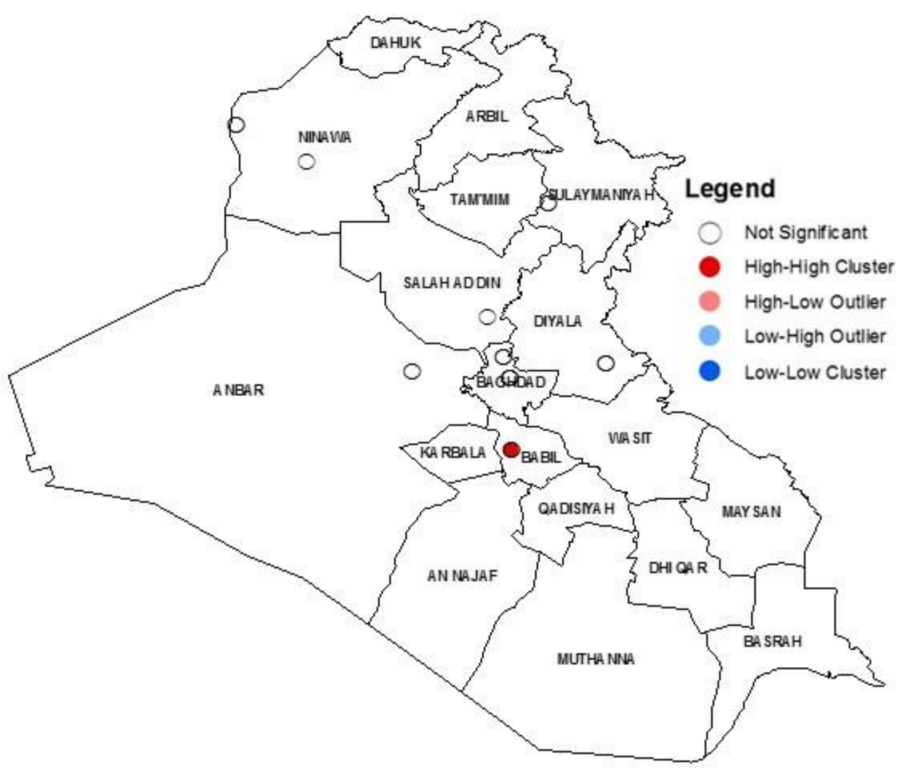
The previous example of the modified Treviño's Conglomeration procedure is used throughout the study. Specific categories from GDELT were used as proxies for each of the PMESII operational variables. The summarized results of this Conglomeration procedure for the remaining PMESII variables follow.

The Political Variable re-coding query of the GDELT Event Code produced results concentrating on phrases containing 'diplomatic cooperation', 'political parties or politicians', 'political dissent', or 'political freedoms'. The SQL query resulted in 40 observations for analysis. A spatial representation of the Political operational variable observations is shown in Figure 31.



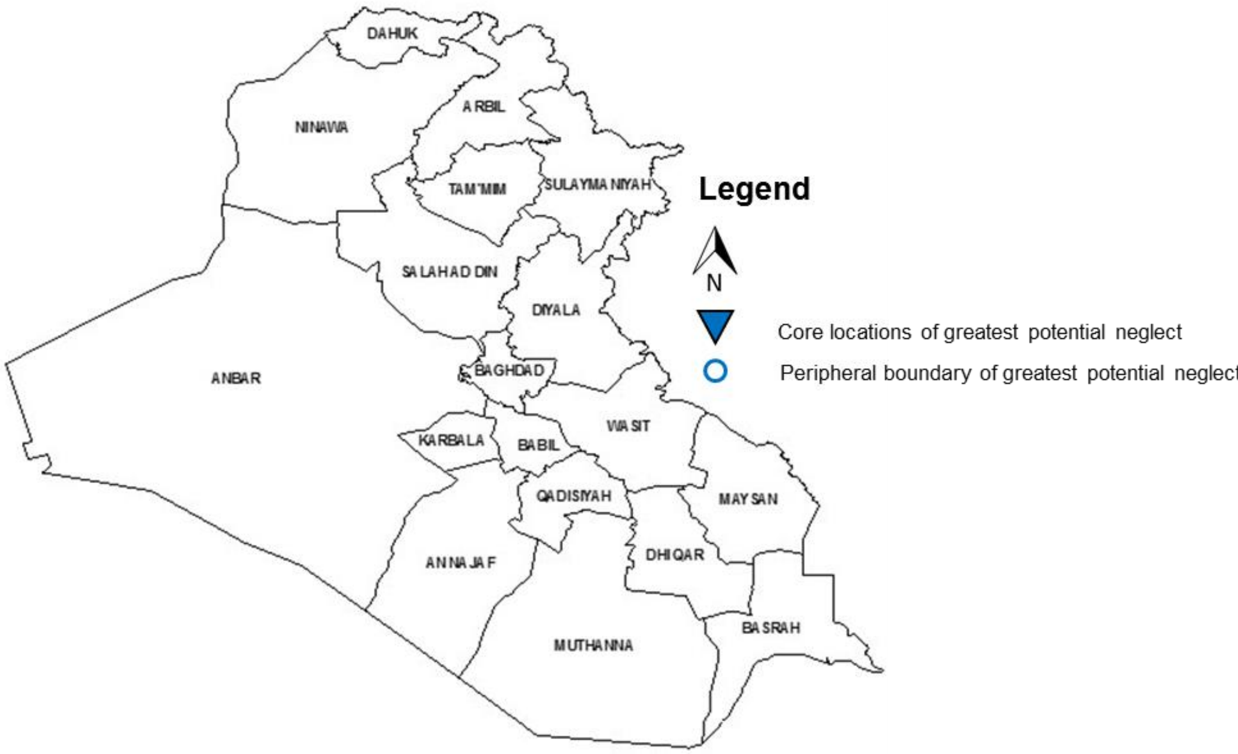
Map of Political Operational Variables
Figure 31

Through the calculation of descriptive statistics, the magnitude (NumArticle) variable attribute has a mean of 4.60, median of 1.00, standard deviation of 6.69, and skewness of 2.4. It is found to be skewed. Additional exploratory analysis of the NumArticle variable attribute via 'Box-Plot' analysis calculates the critical values of Q1: 1.00, Q3: 5.00, IQR: 4.00, lower whisker: -5.00, and upper whisker: 11.00. Given these values, the Political NumArticles dataset has 5 positive outliers and 0 negative outliers. This supports the finding of skewness. The additional K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-values less than 0.05, causing rejection of the normality null hypothesis at the 95% confidence level. Identification of the magnitude low level conglomerates begins with a BCa bootstrap analysis conducted on the NumArticle attribute resulted with (2.87, 7.09) as the bounds with a 95% confidence level. The lower conglomerate periphery attribute query within ArcGIS identifying all values less than 2.87 (i.e.: the lower outliers) produces a spatial concentration reflecting of the 40 Political variable events reported Iraq during the month of September 2008, 27 were of lower magnitude with 8 events deemed of higher magnitude. With identification of the non-spatial, non-parametric characteristics of the Political NumArticle attribute, spatial autocorrelation of the attribute is conducted to identify local Moran´s Index. The Global Moran's results were not significant the .05 level (pseudo-p values ranging between 0.29 and 0.32 at a Monte Carlo run of 999 permutations). The Local Moran's produce only one statistically significant cluster (Figure 32), but it is categorized has HH. There are no points considered as spatial cold spot clusters (LL) or spatially cold outliers surrounded by areas of greater activity (LH) identified.



NumArticle Local Moran's *I* Political Variable
Figure 32

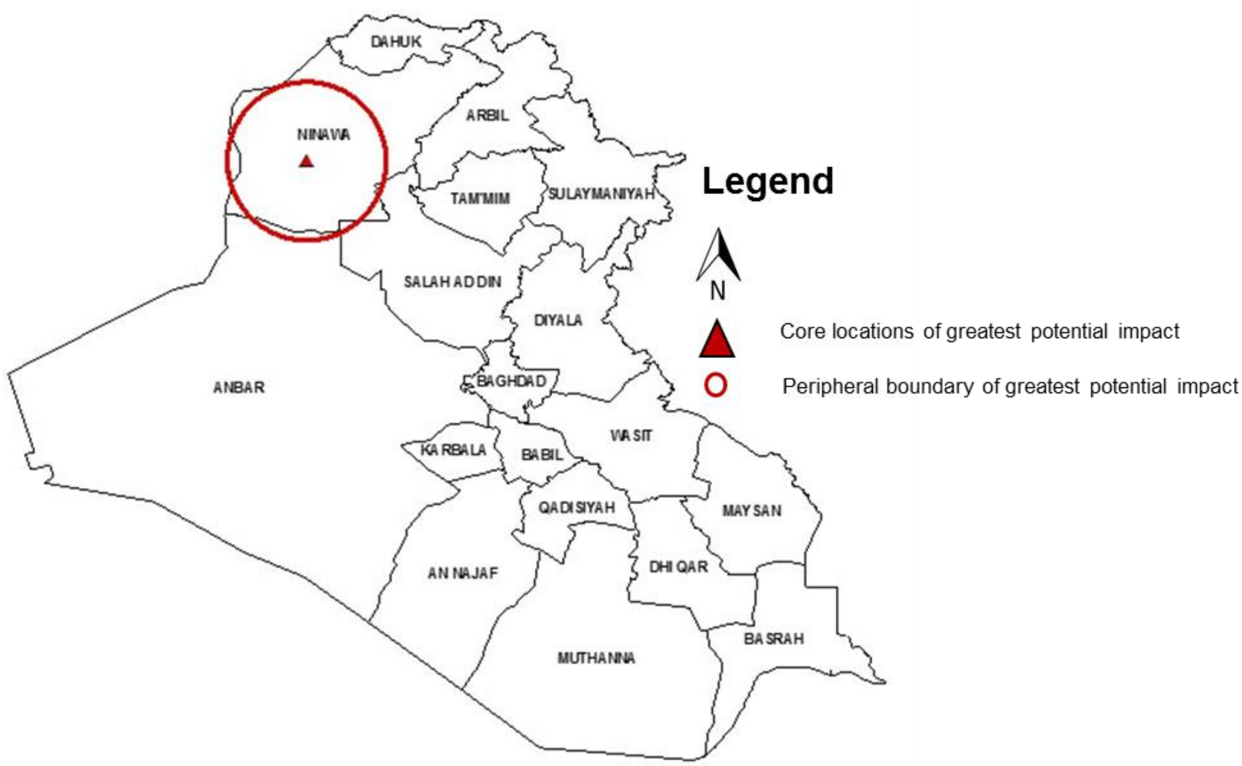
Thus, when combined the concentration (all attribute values less than the bootstrap lower bound) and the spatial agglomerations/spatial outliers (all attribute values designated as LL or LH) produces a map lacking any spatial analysis (Figure 33).



Political NumArticle Conglomerate
Figure 33

The lack of a Political NumArticle Conglomerate can be interpreted as there is not a municipality with a greater potential absence of political activity has compared to others. However, this does not mean that the situation could be described as an extreme condition of political bliss or as an extreme condition of total anarchy.

Continuing with the intensity variable attribute with the same level of SQL query observations (40), AvgTone has a mean of 4.92, median of 4.89, standard deviation of 1.19, and skewness of -0.43. It is not found to be skewed. Additional exploratory analysis of the AvgTone variable attribute via ‘Box-Plot’ analysis calculates the critical values of Q1: 4.46, Q3: 5.65, IQR: 1.19, lower whisker: 2.67, and upper whisker: 7.43. Given these values, the Political AvgTone dataset has one (1) positive outliers and two (2) negative outliers. This supports the finding of a lack of skewness. The additional K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-values greater than 0.05 (0.118) for the basic AvgTone transformed, causing failure to reject the normality null hypothesis at the 95% confidence level. The BCa bootstrap analysis conducted on the AvgTone attribute resulted with (4.53, 5.28) as the bounds with a 95% confidence level. The higher conglomerate periphery attribute query within ArcGIS identifying all values greater than 5.28 (i.e.: the higher outliers) produces a spatial concentration reflecting of the 40 Political variable events reported Iraq during the month of September 2008, 10 were of lower intensity with 14 events deemed of higher intensity. With identification of the non-spatial, non-parametric characteristics of the Political AvgTone attribute, spatial autocorrelation of the attribute is conducted to identify the Global and Local Moran´s Index using a k-Nearest Neighbors weight matrix. The Global Moran’s with a pseudo-p value ranging between 0.34 and 0.38 from a Monte Carlo run of 999 permutations was found not significant at the .05 level. The Local Moran´s Index used to identify spatial hot spot clusters (HH) or spatially hot outliers surrounded by areas of greater activity (HL), resulted in one HH cluster of intensity reports. When combined the concentration (all attribute values greater than the bootstrap upper bound of 5.28) and the spatial agglomerations/spatial outliers (all attribute values designated as HH or HL) produces the following spatial analysis illustrated in Figure 34.



Political AvgTone Conglomerate
Figure 34

Political AvgTone Conglomerate consists of the Badr municipality within Ninawa province. The site is located in territory occupied by mixture of Shia and Kurd. The municipality represent area of greatest potential effectiveness for political engagement in comparison to others.

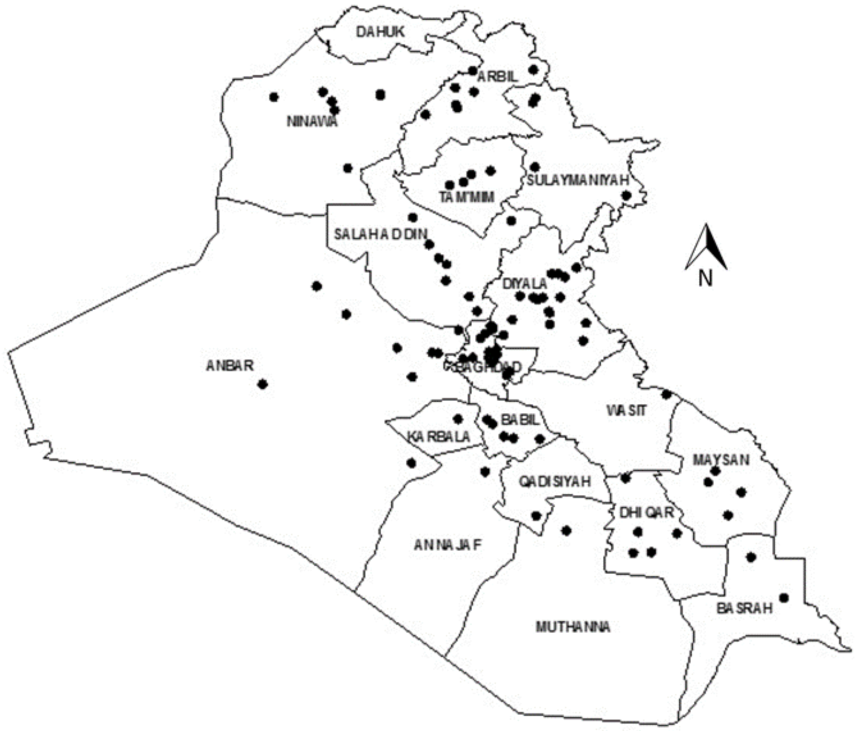
The final conglomeration step of applying the 'minimum magnitude/maximum intensity' rule for the standardized NumArticle and AvgTone attributes is applied. The result is one identified municipality with a value for the Political operational variable (Table 4).

Municipality	Latitude	Longitude	Political Variable
Badr, Ninaw	35.7489	42.1222	0.26704

Political Variables
Table 4

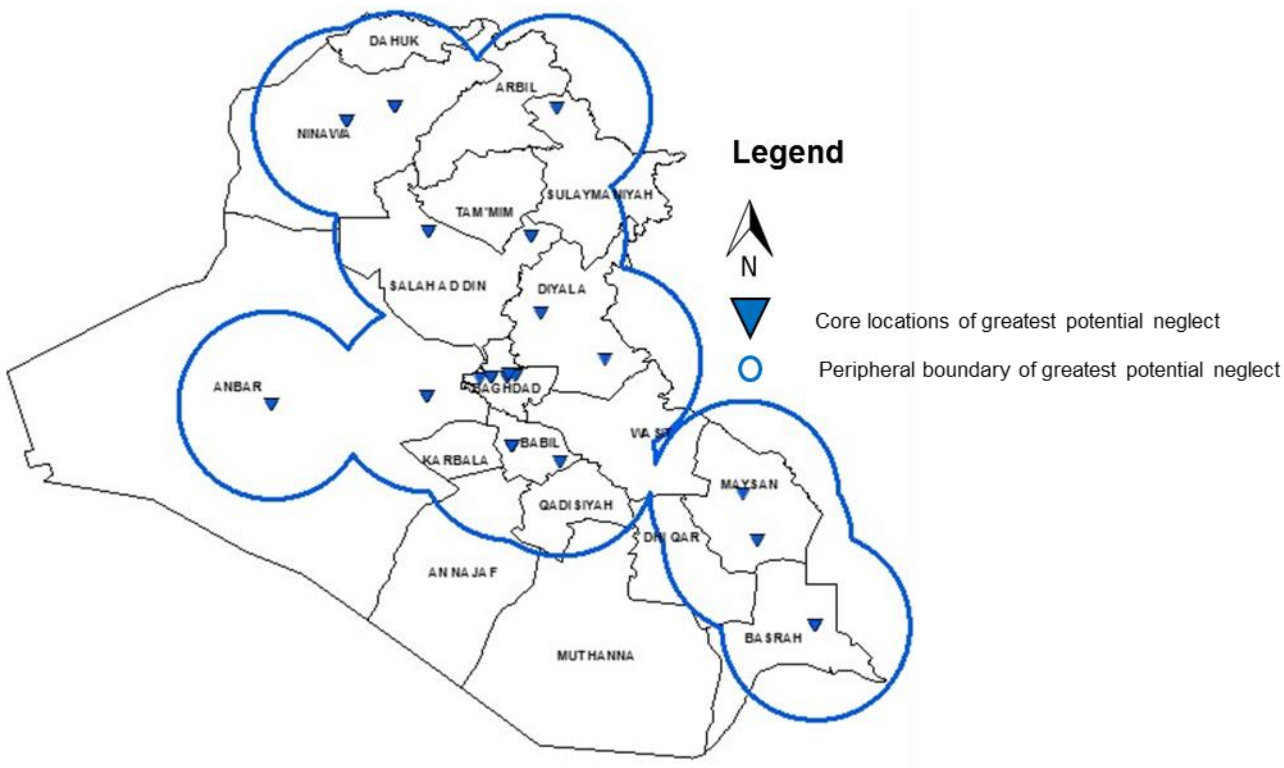
The small town of Badr in Ninaw province also registered a score due to strong intensity values. This is probably due its proximity to the Syrian border and the plurality of Sunni and Kurdish population. While Baghdad would be expected to have a strong Political intensity variable value, being Iraq’s capital, the political variable observations did not aggregate within the city. This denotes an area that may not be under neglect for political activity, but any additional action conducted there may not reap the benefits desired.

Stated in the context of either reducing or increasing the amount of support provided in a designated area, the Military Variable re-coding query of the GDELT Event Code produced results concentrating on phrases containing ‘military protection or peacekeeping’, ‘military engagement’, ‘military aid’, ‘military force’, or ‘military assistance’. For Surge analysis purposes, ‘Military’ incorporates security requirements.



Map of Military Operational Variables
Figure 35

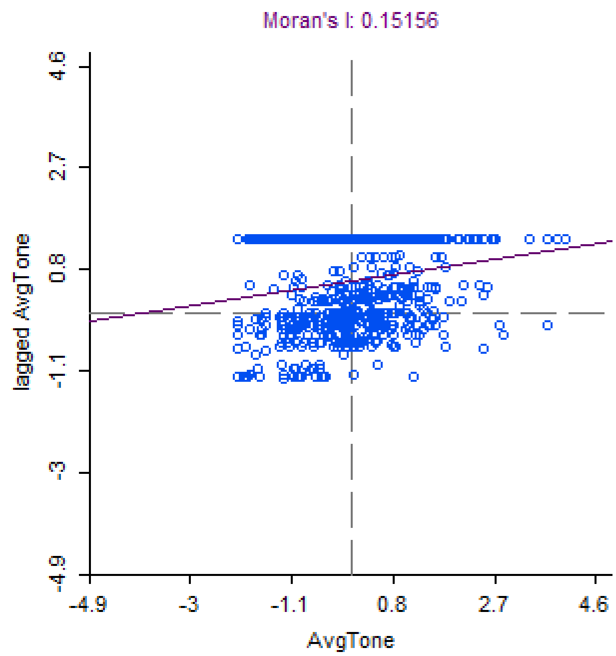
The Military operational variable SQL query resulted in 1,450 observations for analysis (Figure 35). The high volume of observations is to be expected due to the period of the requested reports in Iraqi (September 2008 – the end of the Surge). Through calculation of descriptive statistics, the magnitude (NumArticle) variable attribute has a mean of 5.79, median of 2.00, standard deviation of 9.75, and skewness of 6.90. It is found to be skewed. Additional exploratory analysis of the NumArticle variable attribute via 'Box-Plot' analysis calculates the critical values of Q1: 1.00, Q3: 7.00, IQR: 6.00, lower whisker: -8.00, and upper whisker: 16.00. Given these values, the Military NumArticles dataset has 113 positive outliers and zero negative outliers. This supports the finding of skewness. The additional K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-values less than 0.05, causing rejection of the normality null hypothesis at the 95% confidence level. Identification of the magnitude low level conglomerates begins with a BCa bootstrap analysis conducted on the NumArticle attribute resulted with (5.31, 6.31) as the bounds with a 95% confidence level. The lower conglomerate periphery attribute query within ArcGIS identifying all values less than 5.31 (i.e.: the lower outliers) produces a spatial concentration reflecting of the 1,450 Military variable events reported Iraq during the month of September 2008, 1,009 were of lower magnitude with 389 events deemed of higher magnitude. With identification of the non-spatial, non-parametric characteristics of the Military NumArticle attribute, spatial autocorrelation of the attribute is conducted to identify Global and Local Moran´s Index using a k-Nearest Neighbors weight matrix. The Global Moran's with a randomized pseudo-p value ranging between 0.13 and 0.17 from a Monte Carlo run of 999 permutations was found not significant at the .05 level. At a country level there was no clustering or spatial outliers found for the magnitude attribute of the Military reports. Yet, the Local Moran's analysis identified 13 municipalities considered as spatial cold spot clusters (LL) or spatially cold outliers surrounded by areas of greater activity (LH). When combined the concentration (all attribute values less than the bootstrap lower bound) and the spatial agglomerations/spatial outliers (all attribute values designated as LL or LH) produces the following spatial analysis shown in Figure 36.



Military NumArticle Conglomerate
Figure 36

Military NumArticle Conglomerate consists of municipalities within the Anbar, Basrah, Babil, Baghdad, Diyala, Maysan, Ninawa, Sala ad Din, Sulaymaniyah, and Tam'mim provinces. With 18 sites in total, the collection represents a mixture of territories occupied by Shia, Sunni, and Kurd majorities. These municipalities represent areas of greatest potential neglect of Military (security) engagement in comparison to others.

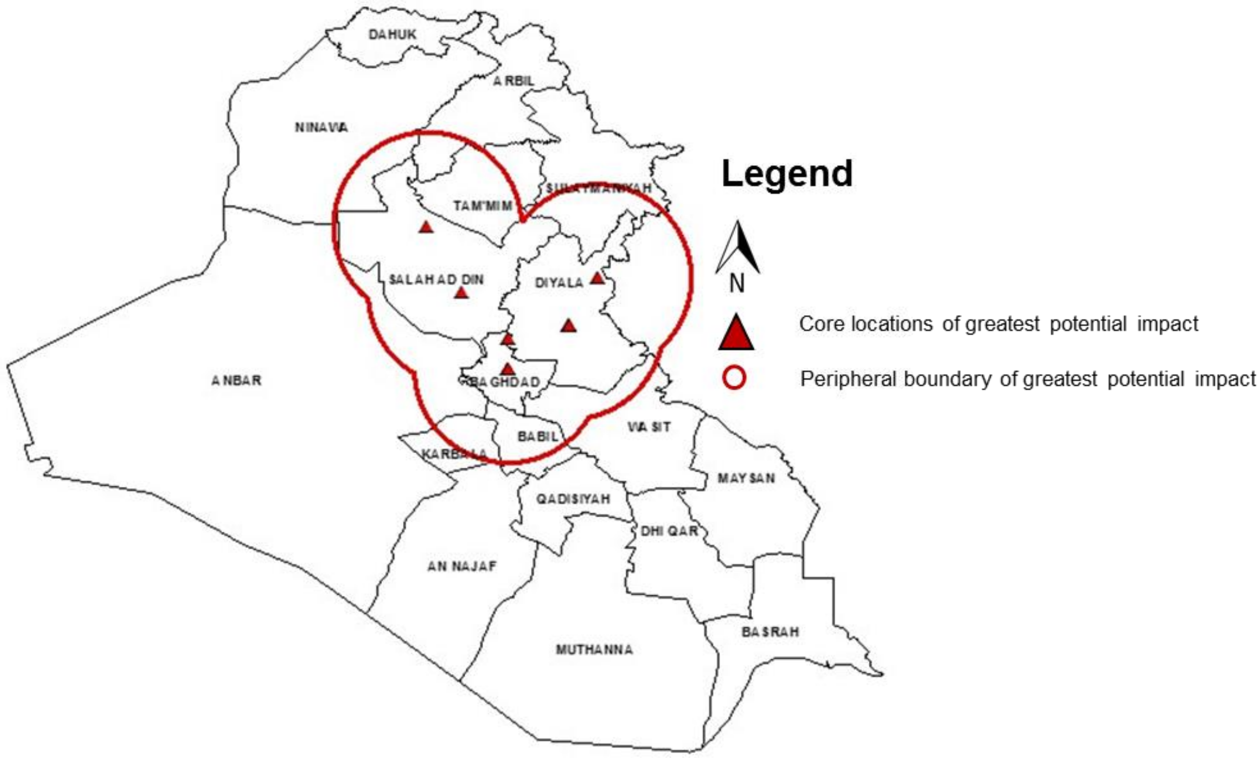
Continuing with the intensity variable attribute with the same number of SQL query observations (1,450), AvgTone has a mean of 3.56, median of 3.51, standard deviation of 1.66, and skewness of 0.29. This dataset is initially found not to be skewed. Additional exploratory analysis of the AvgTone variable attribute via 'Box-Plot' analysis calculates the critical values of Q1: 2.39, Q3: 4.59, IQR: 2.21, lower whisker: -0.92, and upper whisker: 7.90. Given these values, the Military AvgTone dataset has 17 positive outliers and zero negative outliers. This does not support the finding of a lack of skewness. The additional K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-value (0.006) less than 0.05, causing rejection of the normality null hypothesis at the 95% confidence level. Because of the ambiguity of skewness in the data, the Bootstrap transformation is used to find a concentration level to conduct the analysis. Identification of the intensity high level conglomerates begins with a BCa bootstrap analysis conducted on the AvgTone attribute resulted with (3.48, 3.64) as the bounds with a 95% confidence level. The higher conglomerate periphery attribute query within ArcGIS identifying all values greater than 3.64 (i.e.: the higher outliers) produces a spatial concentration reflecting of the 1,450 Military variable events reported Iraq during the month of September 2008, with 705 being of lower intensity with 694 events deemed of higher intensity. In contrast to the NumArticle attribute, the spatial autocorrelation analysis of the Military AvgTone attribute, both Global and Local Moran's, provide significant results. As per the established procedure, the Moran´s Index was conducted using a k-Nearest Neighbors weight matrix. The Global Moran's Index value of 0.15 is found to be significant at the 0.05 level. This was verified with multiple randomize Monte Carlo runs of 999 permutations. Throughout the runs the pseudo-p value is consistent at 0.001 (Figure 37).



Global Moran's *I* – Military AvgTone
Figure 37

The positive value of this Global Moran's denotes active spatial clustering of the Military AvgTone values with the country of Iraq. The majority of the clusters are in the third (LL) quadrant of the chart, followed by the first (HH) quadrant. Given that the analysis of AvgTone attributes emphases on 'high magnitude value' clusters, the targeting local high magnitude value clusters for Military/security efforts not only helps those municipalities, but also creates positive security affects for the entire country.

The Local Moran's analysis identified points of both Low and High concentrations. Conglomeration analysis for the Military AvgTone attribute focuses on those considered to be spatial hot spot clusters (HH) or spatially hot outliers surrounded by areas of lesser activity (HL). When intersected, the concentration (all attribute values greater than the bootstrap upper bound of 3.64) and the spatial agglomerations/spatial outliers (all attribute values designated as HH or HL) produces the spatial analysis illustrated in Figure 38.



Military AvgTone Conglomerate
Figure 38

Military AvgTone Conglomerate consists of municipalities within the Baghdad, Diyala, and Sala ad Din provinces. With a total of seven sites, the collection represents a mixture of territories occupied by Shia and Sunni majorities, and area consisting of a Shia/Sunni plurality. These municipalities represent areas of greatest potential effectiveness for Military engagement in comparison to others.

The final conglomeration step of applying the 'minimum magnitude/maximum intensity' rule for the standardized NumArticle and AvgTone attributes is applied. The result is 17 identified municipalities (an additional three non-municipalities are also mapped) with values for the Military operational variable within the Babil, Baghdad, Basrah, Diyala, Ninawa, and Sala ad Din provinces (Table 5).

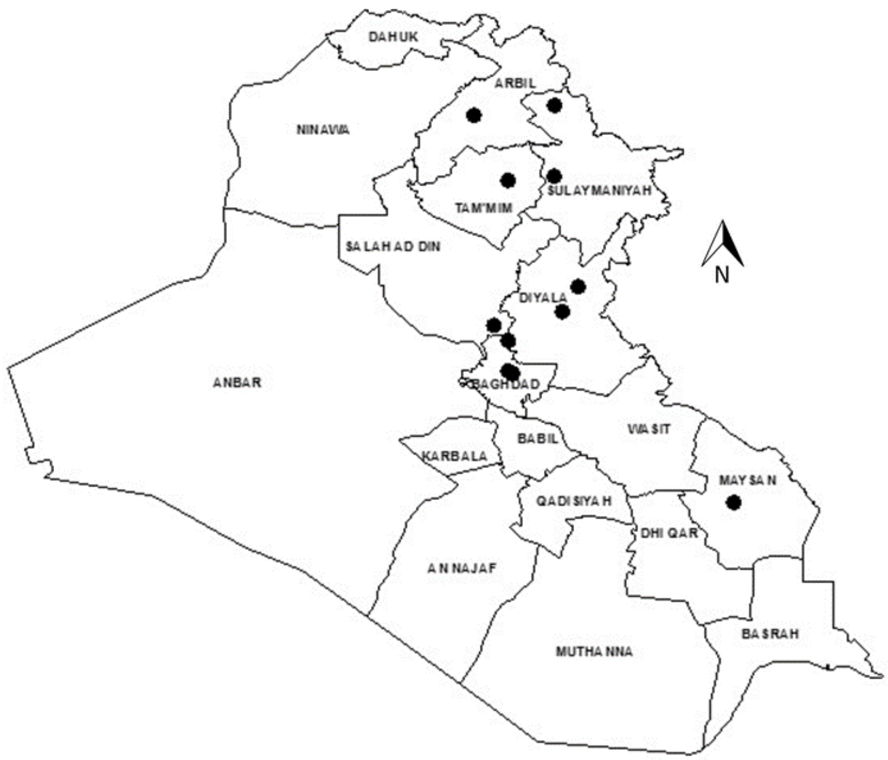
Municipality	Latitude	Longitude	Military Variable
Khanaqin, Diyala	34.3482	45.3906	1.164943956
Mahdi, Diyala	33.8241	45.0788	0.966876454
Hasan Nasrallah, Diyala	33.8403	45.0690	0.891796791
Baghdad, Baghdad	33.3386	44.3939	0.853466415
Baiji, Sala ad Din	34.9307	43.4931	0.504495464
Abu Ghurayb, Baghdad	33.307	44.1869	0.490984184
Harthiyah, Baghdad	33.303	44.3711	0.490984184
Ali Kazim, Babil	32.3669	44.9621	0.490984184
Muthanna, Baghdad	33.3491	44.4682	0.490984184
Basra, Basrah	30.533	47.7975	0.490984184
Imam Mansur, Diyala	34.0209	44.7355	0.490984184
Khan Dari, Baghdad	33.2941	44.0726	0.490984184
Mosul, Ninawa	36.335	43.1189	0.490984184
Tuz Khurmatu, Sala ad Din	34.8881	44.6326	0.490984184
Zayyunah, Baghdad	33.327	44.4515	0.490984184
Samarra, Sala ad Din	34.1966	43.8739	0.478283275
Tarmiyah, Baghdad	33.6744	44.3958	0.211580455

Military Variables
Table 5

The results of the Military analysis were expected as the locations are generally concentrated in provinces deemed routine for anti-Iraq forces activity and extremist actions before the Surge took place. While the Surge may have deceased these events in total, their relative intensity would still be greater than other areas. The variable serves as highlight the importance of security issues within the overall Stability Operations analysis.

While the Social Operational variable by definition is the broadest in scope, dealing with the beliefs, values, customs, and behaviors that determine the social, religious, and racial/tribal makeup within an OE, the actual re-coding query of the Social

GDELT Event Code produced results concentrating on crime. Specifically the terms ‘corruption’, ‘human rights abuses’, ‘crime’, and ‘ethnic cleansing’ were the only items that could be queried for this operational variable.

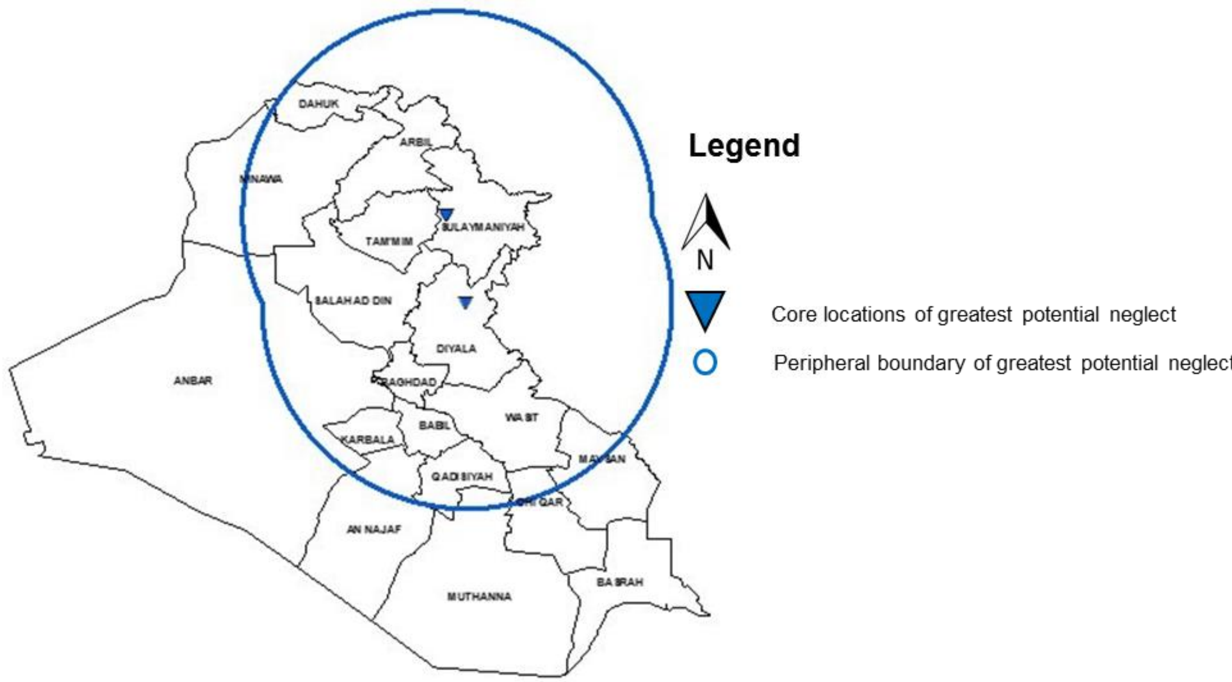


Map of Social Operational Variables
Figure 39

The SQL query resulted in 44 observations for analysis. While this operational variable focuses on issues varying from language and culture to population and migration flows, reports during the study period centered on crime, corruption, and human rights. Through calculation of the descriptive statistics, the magnitude (NumArticle) variable attribute has a mean of 5.05, median of 3.00, standard deviation of 4.90, and skewness of 1.50. It is found to be skewed. The Box-Plot analysis exploratory of the NumArticle variable attribute provides the critical values of Q1: 1.00, Q3: 8.25, IQR: 7.25, lower whisker: -9.88, and upper whisker: 19.13. Surprisingly, the

Social NumArticles dataset has no positive nor negative outliers. While a histogram of the data support skewness, the lack of positive outliers does not support the finding of skewness. The additional K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-values less than 0.05, causing rejection of the normality null hypothesis at the 95% confidence level as thus re-supporting the belief that the data are skewed. Identification of the magnitude low level conglomerates begins with a BCa bootstrap analysis conducted on the NumArticle attribute resulted with (3.75, 6.59) as the bounds with a 95% confidence level. The lower conglomerate periphery attribute query within ArcGIS identifying all values less than 3.75 (i.e.: the lower outliers) produces a spatial concentration reflecting of the 44 Social variable events reported Iraq during the month of September 2008, 23 were of lower magnitude with 13 events deemed of higher magnitude.

The p-values for the Global Moran's conducted with a Monte Carlo run of 999 permutations fluctuate between 0.13 and 0.17. The finding is that global autocorrelation is not significant the .05 level. The global pattern does not appear to be significantly different than random. Social initiatives conducted at locations deemed neglected, or lacking in reporting, would not likely have strong positive externalities for the country. The Local Moran´s Index of the Social NumArticle attribute using a k-Nearest Neighbors weight martix identified two points considered as spatial cold spot clusters (LL) or spatially cold outliers surrounded by areas of greater activity (LH). When intersected, the concentration (all attribute values less than the bootstrap lower bound of 3.75) and the spatial agglomerations/spatial outliers (all attribute values designated as LL or LH) produce the spatial analysis shown in Figure 40.



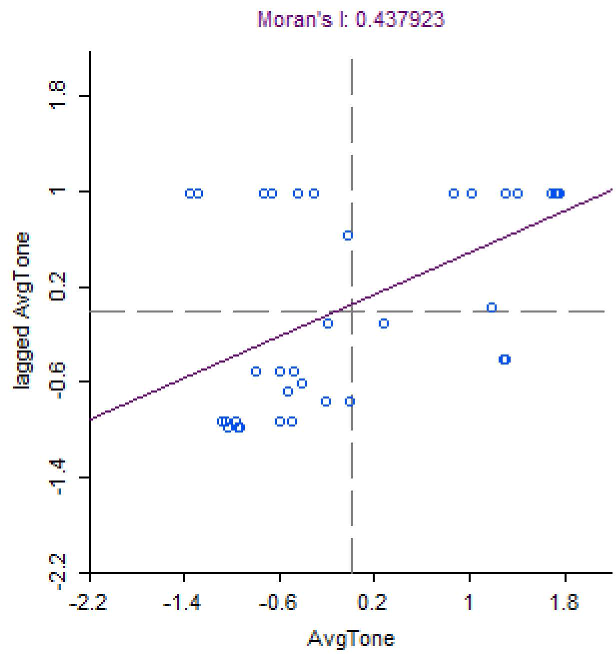
Social NumArticle Conglomerate
Figure 40

The Social NumArticle Conglomerate consists of municipalities within the Diyala, and Sulaymaniyah provinces. Two sites in total, the collection represents mainly Kurdish occupied areas. These municipalities represent areas of greatest potential neglect of Social engagement in comparison to others.

Continuing with the intensity variable attribute with the same level of SQL query observations (44), AvgTone has a mean of 3.38, median of 2.77, standard deviation of 1.67, and skewness of 0.60. It is not found to be skewed. While the histogram of data does not approximate the prototypal ‘bell-shape’, the graph appears relatively normal. Additional exploratory analysis of the AvgTone variable attribute via ‘Box-Plot’ analysis calculates the critical values of Q1: 2.13, Q3: 5.13, IQR: 3.00, lower whisker: -2.38, and upper whisker: 9.64. As with the Social NumArticle data, the Social AvgTones dataset has zero positive outliers and zero negative outliers. This supports the finding of a lack of skewness. Yet, the K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-values less than 0.05 (.003), causing rejection of the normality null hypothesis at the 95% confidence level. Because of the ambiguity of skewness in the data and because there are no values greater than the Box-Plot upper whisker, the Bootstrap transformation is still used to find a concentration level to conduct the analysis. The BCa bootstrap analysis conducted on the AvgTone attribute resulted with (2.91, 3.88) as the bounds with a 95% confidence level. The higher conglomerate periphery attribute query within ArcGIS identifying all values greater than 3.88 (i.e.: the higher outliers) produces a spatial concentration reflecting of the 44 Social variable events reported Iraq during the month of September 2008, 23 were of lower intensity with 13 events deemed of higher intensity.

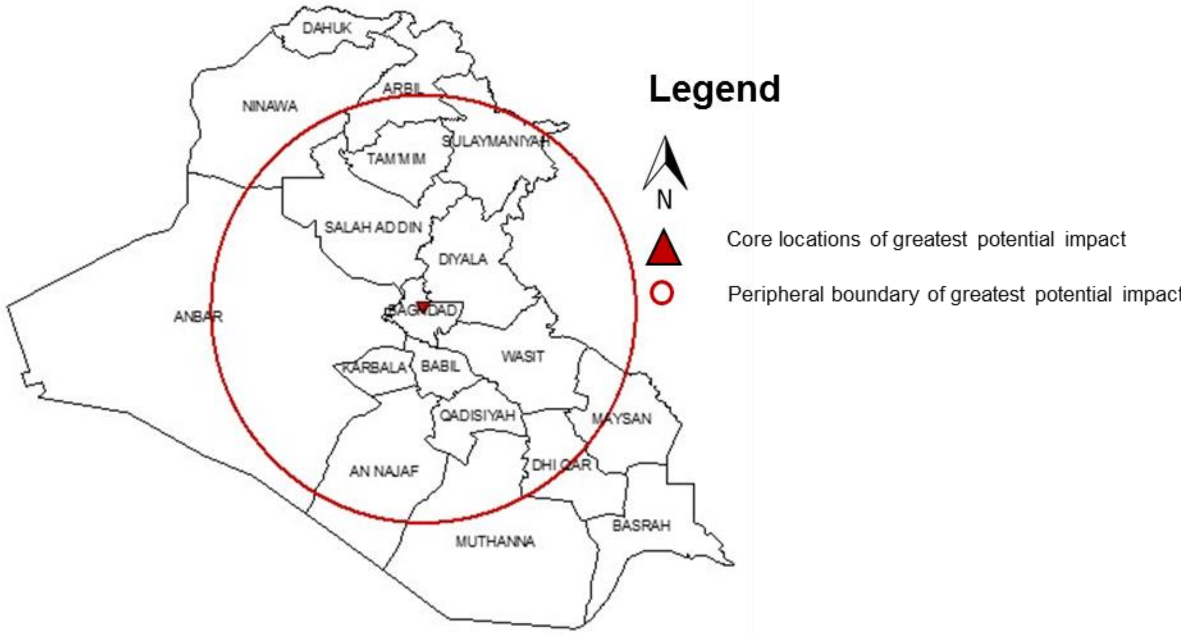
Global spatial autocorrelation of the Social AvgTone attribute conducted using a k-Nearest Neighbors weight matrix produce significant results. The Global Moran's value is 0.44 with p-value ranging from 0.001 to 0.004 for Monte Carlo runs of 999 permutations. The global autocorrelation is significant the .05 level. The majority of clustering occurs in Quadrant III of the Global Moran's chart, identifying low intensity value clustering. Yet, for the purposes of this analysis there is a significant amount clustering in Quadrant I, or the high intensity value portion of the chart. Since the observations are not independent with a clustering of similar values, likelihood that

Social oriented actions conducted at municipalities identified as ‘high intensity’ would result in positive externalities for Iraq as a whole (Figure 41).



Global Moran’s *I* – Social AvgTone
Figure 41

The Local Moran’s index located one point (with 10 observations) considered as either a spatial hot spot cluster (HH) or spatially hot outlier surrounded by areas of lesser activity (HL). When the intersection between the concentration set (all attribute values greater than the bootstrap upper bound of 3.88) and the spatial agglomerations/spatial outliers (all attribute values designated as HH or HL) is conducted, the spatial analysis shown in Figure 42 is produced.



Social AvgTone Conglomerate
Figure 42

The Social AvgTone Conglomerate consists only the of Baghdad municipality representing a Shia/Sunni mixture. While this municipality statistically represents the area of greatest potential effectiveness for Social engagement in comparison to others, this is probably due to a lower level of intensity reported on these issues from other sites.

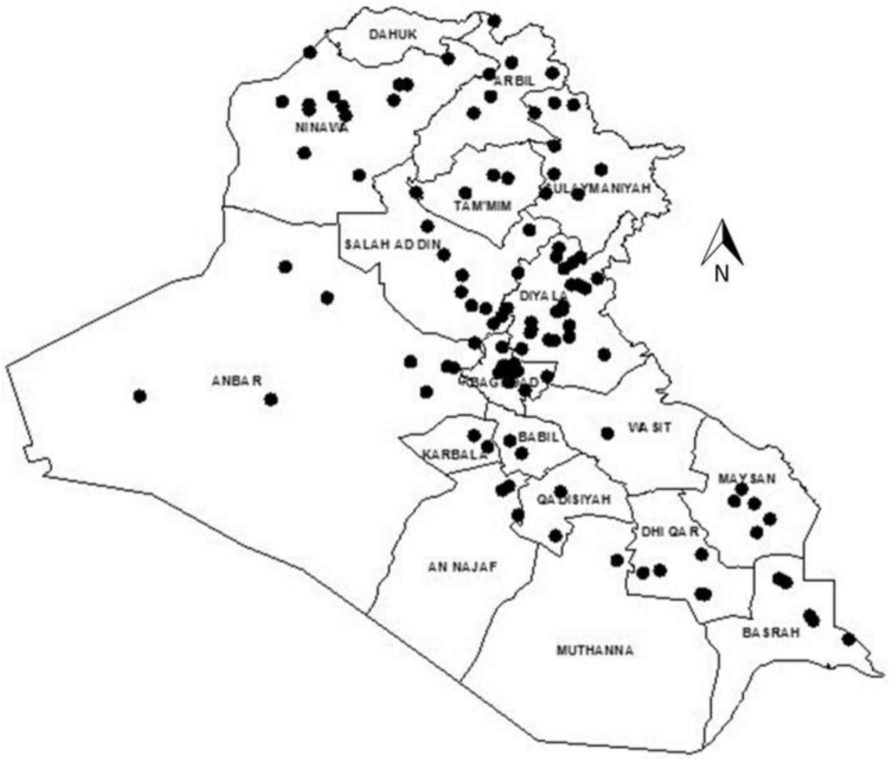
The final conglomeration step of applying the 'minimum magnitude/maximum intensity' rule for the standardized NumArticle and AvgTone attributes for the AHP model. The result is three municipalities with Social variable values (Table 6).

Municipality	Latitude	Longitude	Social Variable
Baghdad, Baghdad	**33.3386**	**44.3939**	**0.608930771**
Mansur, Sulaymaniyah	**35.5119**	**44.9069**	**0.355579501**
Jalawla, Diyala	**34.2772**	**45.1779**	**0.355579501**

Social Variables
Table 6

The Social Operational variable is one of the least observed. The lack of subject matter content available for analysis is primarily due to the period in which the reports were queried against. The Surge undoubtedly bought issues of corruption, human rights abuses, crime, and ethnic cleansing to the forefront. Analysis of the Social variable amplifies the importance of addressing these issues with care in the post-Surge environment. As such, this variable serves as an additional highlight the importance of security issues in the overall Stability Operations analysis.

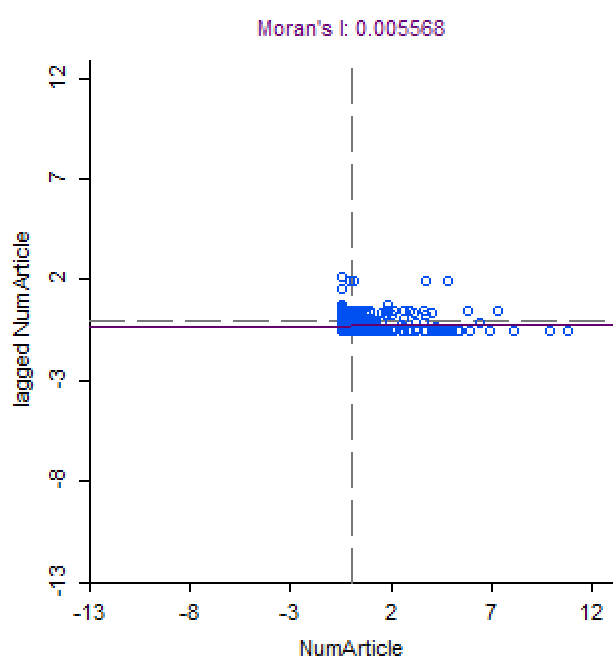
The Information Operational variable is another that is broad in scope but limited in content returns. In dealing with the persons, organizations and systems that collect, process, disseminate, and act on information, the actual re-coding query of this GDELT Event Code produced results concentrating on public communications entities and statements that were either positive, neutral, or negative Iraqi government or collation forces. Specifically, the terms ‘claim responsibility’, ‘deny responsibility’, ‘comment’ (empathetic, optimistic, or pessimistic), ‘share intelligence or information’ or ‘symbolic act’ were the only items that could be queried for against this operational variable. While limited in content analysis scope, it is the variable with the most observations. For the Information Operational variable, the SQL query resulted in 1,563 observations for analysis. These observations occurred in every province of Iraq and in over 106 municipalities and general site locations.



Map of Information Operational Variables
Figure 43

Through calculation of the descriptive statistics, the magnitude (NumArticle) variable attribute has a mean of 4.43, median of 2.00, standard deviation of 6.40, and skewness of 4.36. It is found to be skewed. Additional exploratory analysis of the NumArticle variable attribute via 'Box-Plot' analysis calculates the critical values of Q1: 1.00, Q3: 5.00, IQR: 4.00, lower whisker: -5.00, and upper whisker: 11.00. Given these values, the Information NumArticles dataset has 100 positive outliers and zero negative outliers, supporting the finding of positive skewness. The additional K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-values less than 0.05, causing rejection of the normality null hypothesis at the 95% confidence level. Identification of the magnitude low level conglomerates begins with a BCa bootstrap analysis conducted on the NumArticle attribute resulted with (4.12, 4.79) as the bounds with a 95% confidence level. The lower conglomerate periphery attribute query within ArcGIS identifying all values less than 4.12 (i.e.: the lower outliers) produces a spatial concentration reflecting of the 1,563 Information variable events reported Iraq during the month of September 2008, 1,133 were of lower magnitude and with 430 events deemed of higher magnitude.

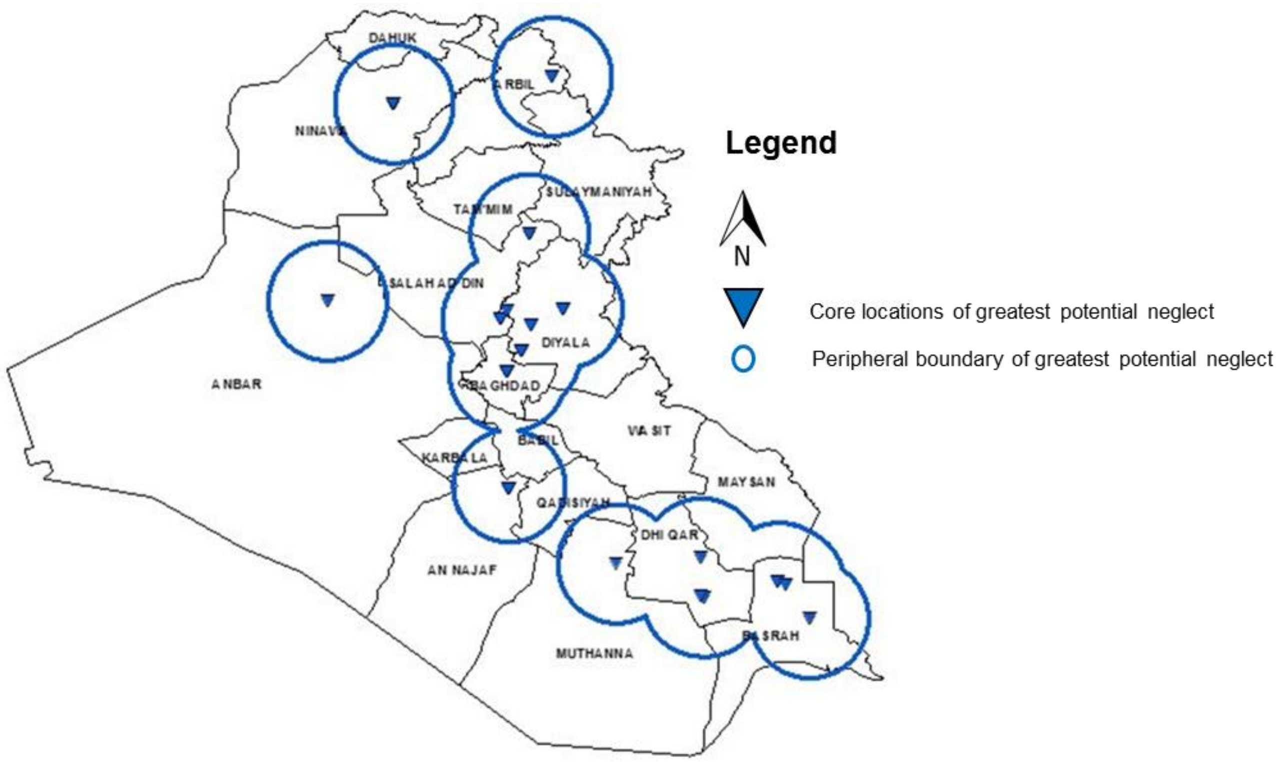
With identification of the non-spatial, non-parametric characteristics of the Information NumArticle attribute established, spatial autocorrelation of the attribute is conducted to identify both Global and Local Moran´s Indexes. Both analysis produced statistically significant results. For the Global Moran's, the positive value of 0.006 is calculated with Monte Carlo simulation p-value ranging from 0.003 to 0.011 for 999 permutations. At the .05 risk level, the global autocorrelation finding are deemed significant.



Global Moran's I – Information NumArticle
Figure 44

The observations are not independent, with similar values clustering mainly in Quadrant I or the ‘high-level magnitude’ values chart section. Despite being a ‘HH’ category of global clustering, actions conducted for municipalities deemed lacking in terms of the Information variable would be beneficial both locally and for Iraq as a whole.

The Local Moran’s analysis identified 18 sites considered as spatial cold spot clusters (LL) or spatially cold outliers (LH) for the magnitude analysis. When the concentration set (all attribute values less than the bootstrap lower bound of 4.12) and the spatial agglomerations/spatial outliers (all attribute values designated as LL or LH) intersect, the following spatial analysis is featured in Figure 45.

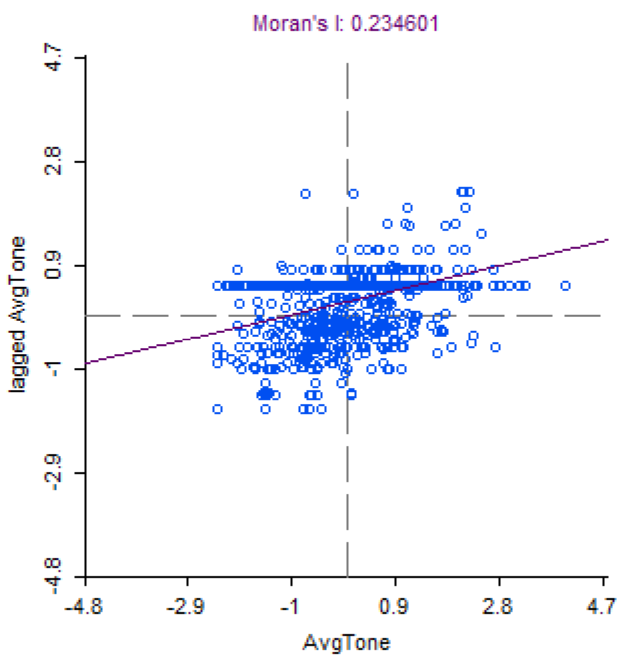


Information NumArticle Conglomerates
Figure 45

The Information NumArticle Conglomerate consists of municipalities and sites within the Anbar, Arbil, Babil, Baghdad, Basrah, Dhi Qar, Diyala, Qadissiya, Muthanna, Najaf, Sala ad Din, Ninawa and Sulaymaniyah provinces. Thirty-four sites with 29 municipalities in total, the collection represents a mixture of territories occupied by Shia, Sunni, and Kurd majorities. These municipalities represent areas of greatest potential neglect of Information engagement in comparison to others.

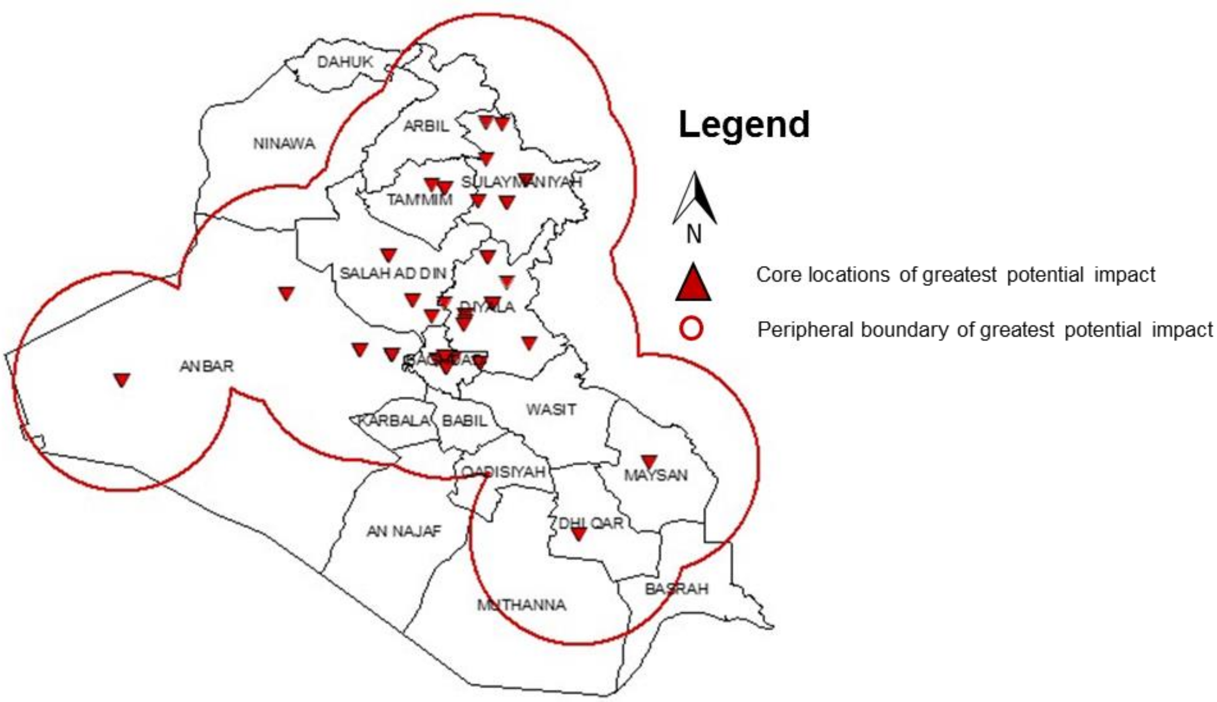
Continuing with the information intensity variable attribute with the same level of SQL query observations (1,536), AvgTone has a mean of 4.55, median of 4.49, standard deviation of 1.90, and skewness of 0.19, an initial finding to be non-skewed. Additional exploratory analysis of the AvgTone variable attribute via 'Box-Plot' analysis calculates the critical values of Q1: 3.33, Q3: 5.67, IQR: 2.42, lower whisker: -0.30, and upper whisker: 9.39. Given these values, the Information AvgTones dataset has 13 positive outliers and no negative outliers. This also supports the finding of a lack of skewness. Yet the Kolmogorov-Smirnov (K-S) conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides a p-value of .01. At the 95% confidence level this causes rejection of the normality null hypothesis and does indicate skewness. Since there is ambiguity amongst the various tests, identification of intensity high level concentration is still conducted using a BCa bootstrap analysis. The analysis conducted on the AvgTone attribute resulted with (4.46, 4.65) as the bounds with a 95% confidence level. The higher conglomerate periphery attribute query within ArcGIS identifying all values greater than 4.65 (i.e.: the higher outliers) produces a spatial concentration reflecting of the 1,536 Information variable events reported Iraq during the month of September 2008, 766 were of lower intensity with 741 events deemed of higher intensity.

With identification of the non-spatial, non-parametric characteristics of the Information AvgTone attribute, spatial autocorrelation of the attribute is conducted to identify both Global and Local Moran´s Index values. Both have statistically significant results. The value the Information AvgTone attribute's Global Moran's is 0.235. With a p-value consistently 0.001 for a Monte Carlo run of 999 permutations, the global autocorrelation analysis is significant the 0.05 level and has a clustering of similar values. There is significant clustering in Quadrants I, II, and III, or the HH, LH, and LL intensity value portions of the chart. Since the observations are not independent with a clustering of similar values, likelihood that Information oriented engagements conducted at municipalities identified as 'high intensity' would result in positive secondary and tertiary results for Iraq as a whole (Figure 46).



Global Moran's *I* – Information AvgTone
Figure 46

Local Moran's *I* for intensity are considered as spatial hot spot clusters (HH) or spatially hot outliers surrounded by areas of lesser activity (HL). When combined the concentration (all attribute values greater than the bootstrap upper bound of 4.65) and the spatial agglomerations/spatial outliers (all attribute values designated as HH or HL) produces the following spatial analysis shown in Figure 47.



Information AvgTone Conglomerate
Figure 47

The Information AvgTone Conglomerate consists of municipalities within the Anbar, Sulaymaniyah, At Ta'mim, Baghdad, Dhi Qar, Diyal, Maysan, and Sala ad Din provinces. Thirty-one sites in total, the collection represents a mixture of territories occupied by Shia, Sunni, and Kurd majorities and pluralities. These municipalities represent areas of greatest potential effectiveness for Information engagement in comparison to others.

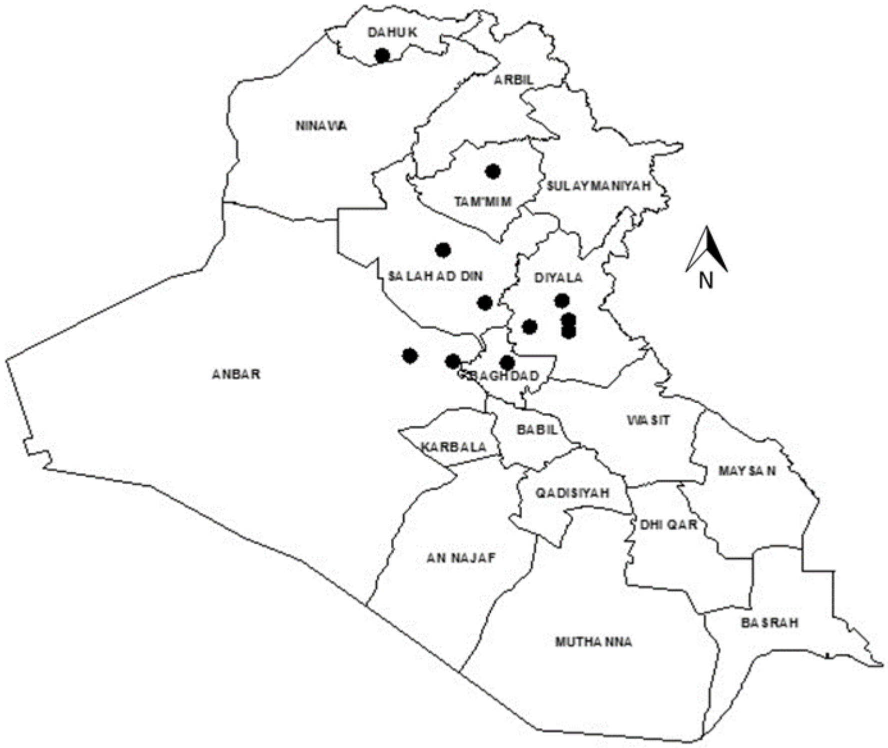
The final conglomeration step of applying the ‘minimum magnitude/maximum intensity’ rule for the standardized NumArticle and AvgTone attributes is performed. The result is 29 identified municipalities with values for the Information operational variable (Table 7).

Municipality	Latitude	Longitude	Information Variable
Sangaw, Sulaymaniyah	35.286	45.1768	2.466252303
Hawr Rajab, Baghdad	33.1936	44.4049	2.19639932
Jabarah, Diyala	34.5925	44.9338	2.168589289
Rutbah, Anbar	33.0372	40.2859	1.737081435
Muhammad Amin, Diyala	33.8583	44.6522	1.644499747
Sulaimaniya, Sulaymaniyah	35.565	45.4329	1.63749696
Quraysh, Diyala	34.4109	44.5058	1.061091212
Kirkuk, At Ta'mim	35.4681	44.3922	1.023813155
Rand, Diyala	34.5267	45.1143	0.896039238
Tikrit, Sala ad Din	34.6158	43.6786	0.734876112
Kifri, Diyala	34.6896	44.9606	0.558963724
Mosul, Ninawa	36.335	43.1189	0.536602735
Al-Latif, Basrah	30.5911	47.7589	0.536602735
Al-Mansuriyah, Diyala	34.0408	45.0058	0.536602735
Dawah, Basrah	30.9583	47.4939	0.536602735
Hafiz, Muthanna	31.2031	45.6084	0.536602735
Hawijah, Diyala	34.0167	44.3833	0.536602735
Kufa, Najaf	32.0347	44.4033	0.536602735
Mahmud Abbas, Sala ad Din	33.9229	44.3193	0.536602735
Nahar, Dhi Qar	30.8333	46.55	0.536602735
Sharqiyah, Dhi Qar	30.8276	46.5914	0.536602735
Tuz Khurmatu, Sala ad Din	34.8881	44.6326	0.536602735
KhBani Saad, Diyala	33.5656	44.5434	0.45840862
Choman, Arbil	36.6367	44.8882	0.45840862
Alberta, Baghdad	33.2533	44.8289	0.431804483
Baghdad, Baghdad	33.3386	44.3939	0.410030579
Haditha, Anbar	34.1348	42.3772	0.306219726
Dora, Baghdad	33.2482	44.4091	0.10083704
Askar, Sulaymaniyah	35.8274	44.911	0.080227287

Information Variable
Table 7

While the presence of the Informational variable is widespread, it is very important to understand where its intensity will have the greatest effect. Despite the lack of subject matter content analyzed results, spatial identification of where positive public communications perceptions that will be amplified (or conversely where generation of negative perceptions will do the greater harm) is a critical part of getting ‘the biggest bang for the buck’ from a Stability Operations initiated activity. This variable is especially influenced by the positive, neutral, or negative tonal evaluations of the reports. By identifying where the impact will have the greatest effect, decision makers can better understand where to focus messaging activities.

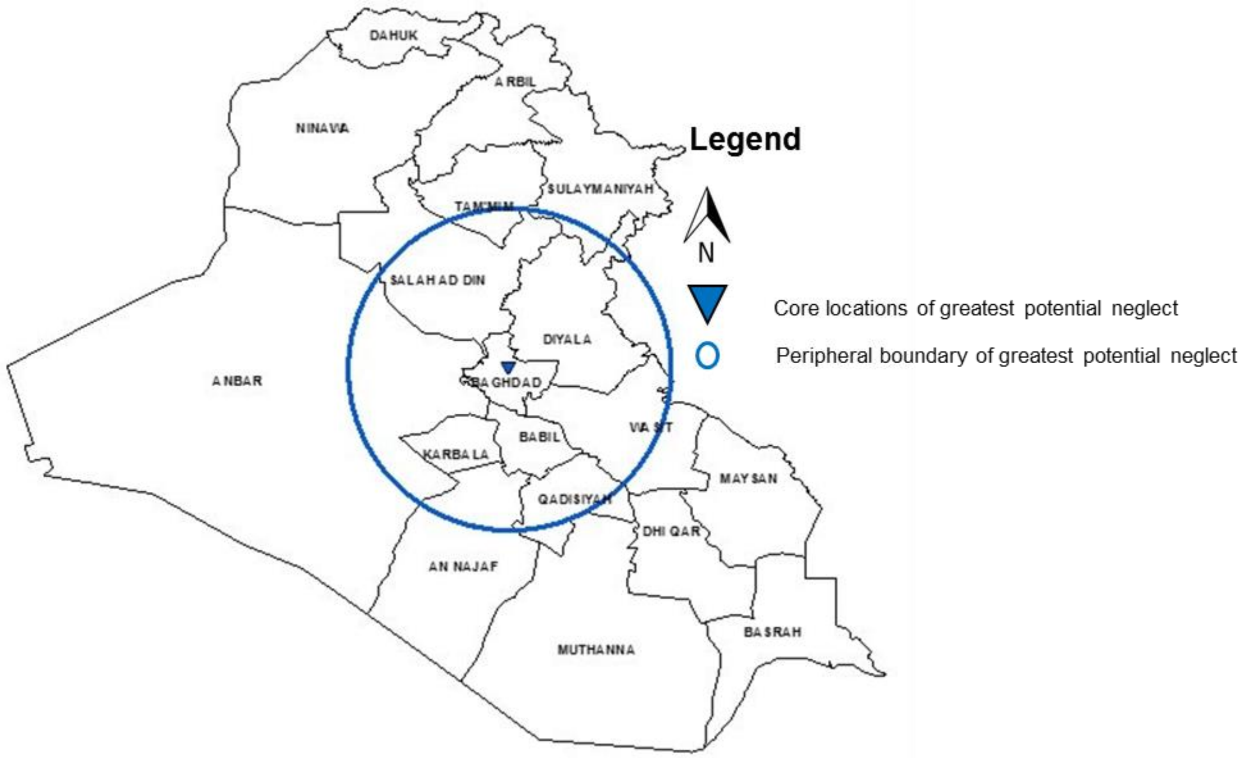
The Infrastructure variable was the most difficult to derive from the GDELT database. Explicit references to the words ‘infrastructure’, ‘utilities’, ‘transportation’, or ‘construction’ within the GDELT various event code descriptions used for the recoding were not present. The only word remotely related was ‘property’. This was referenced in terms of the seizure, release or destruction of stated property. While not optimal, this was used for this variable. For the Infrastructure operational variable, the SQL query resulted in 47 observations for analysis (Figure 48).



Map of Infrastructure Operational Variables
Figure 48

Through calculation of the descriptive statistics, the magnitude (NumArticle) variable attribute has a mean of 3.87, median of 4.00, standard deviation of 3.18, and skewness of 0.89. It is initially found not to be skewed. Additional exploratory analysis of the NumArticle variable attribute via 'Box-Plot' analysis calculates the critical values of Q1: 1.00, Q3: 5.00, IQR: 4.00, lower whisker: -5.00, and upper whisker: 11. Given these values, the Infrastructure NumArticles dataset has one positive outlier and no negative outliers. This further supports the finding of a lack of skewness. The additional K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-values less than 0.05, causing rejection of the normality null hypothesis at the 95% confidence level. Because of the ambiguity of skewness in the data, the Bootstrap transformation is used to find a concentration level to conduct the analysis. Identification of the magnitude low level conglomerates begins with a BCa bootstrap analysis conducted on the NumArticle attribute resulted with (3.10, 4.81) as the bounds with a 95% confidence level. The lower conglomerate periphery attribute query within ArcGIS identifying all values less than 3.10 (i.e.: the lower outliers) produces a spatial concentration reflecting of the 47 Infrastructure variable events reported Iraq during the month of September 2008, 23 were of lower magnitude with 17 events deemed of higher magnitude.

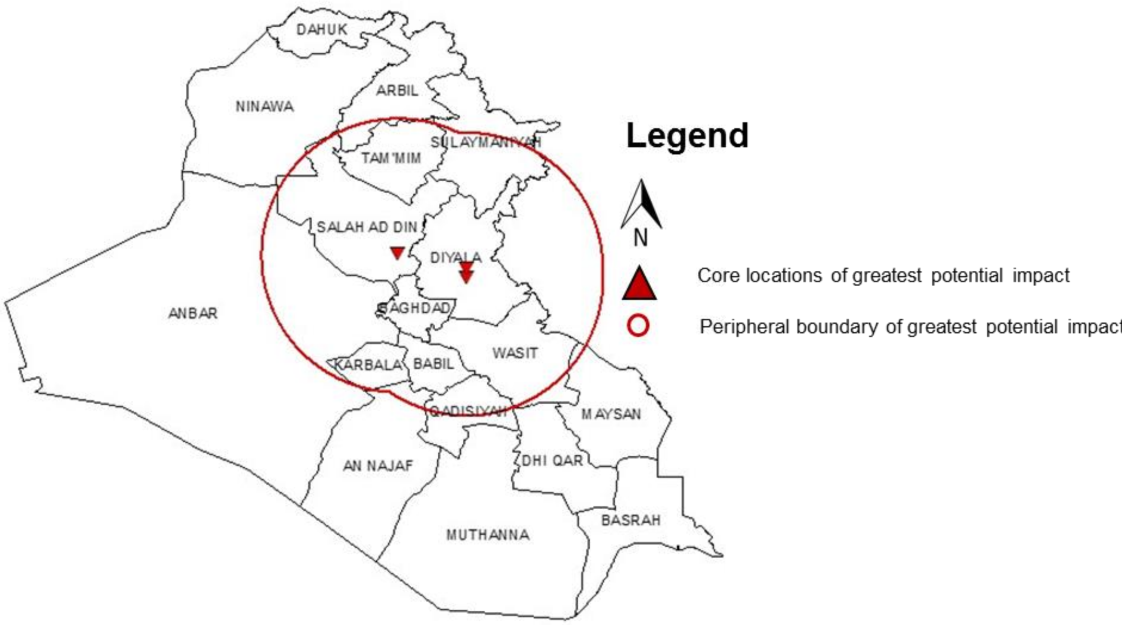
The Infrastructure NumArticle attribute global spatial autocorrelation produces a global pattern that is non-statistically significant (i.e., not different than random). The Local Moran´s Index analysis identifies only one area that can be classified as either a spatial cold spot cluster (LL) or spatially cold outlier surrounded by areas of greater activity (LH). The intersection of the concentration (all attribute values less than the bootstrap lower bound of 3.1) and the spatial agglomerations/spatial outliers (all attribute values designated as LL or LH) produces the following spatial analysis point of statistical significance shown in Figure 49.



Infrastructure NumArticle Conglomerate
Figure 49

The lack of multiple Infrastructure NumArticle Conglomerates does not necessarily mean that there are not multiple reports placed concerning property. In reviewing the Global Moran's Index, the p-value for this Global Moran's *I* is not statistically significant and thus the null hypothesis of the data being randomly distributed cannot be rejected. The spatial distribution is apparently random. There are no municipalities representing greater potential neglect of Infrastructure engagement in comparison to others.

Continuing with the intensity variable attribute with the same number of SQL query observations (47), AvgTone has a mean of 4.56, median of 4.50, standard deviation of 1.33, and skewness of 0.26. It is initially not found to be skewed. Additional exploratory analysis of the AvgTone variable attribute via 'Box-Plot' analysis calculates the critical values of Q1: 3.60, Q3: 5.56, IQR: 2.06, lower whisker: 0.52, and upper whisker: 8.75. Given these values, the Infrastructure AvgTones dataset has no positive outliers nor negative outliers. This supports the finding of a lack of skewness. The additional K-S normality test conducted on the standardize values with a null hypothesis of normal distribution, a mean of zero (0) and a standard deviation of one (1) provides p-values greater than 0.05 (0.20), causing a failure to reject the normality null hypothesis at the 95% confidence level. Despite of the lack of skewness in the data, the Bootstrap transformation is used to find a concentration level to conduct the analysis (methodology continuity). The AvgTone BCa bootstrap analysis conducted resulted with (4.198, 4.998) as the bounds with a 95% confidence level. The higher conglomerate periphery attribute query within ArcGIS identifying all values greater than 4.998 (i.e.: the higher outliers) produces a spatial concentration reflecting of the 47 Infrastructure variable events reported Iraq during the month of September 2008, 17 were of lower intensity with 17 events deemed of higher intensity. With identification of the non-spatial but parametric characteristics of the Infrastructure AvgTone attribute, spatial autocorrelation of the attribute is conducted to identify local Moran´s Index and which ones are considered as spatial hot spot clusters (HH) or spatially hot outliers surrounded by areas of lesser activity (HL). When combined the concentration (all attribute values greater than the bootstrap upper bound of 4.998) and the spatial agglomerations/spatial outliers (all attribute values designated as HH or HL) produces the spatial analysis illustrated in Figure 50.



Infrastructure AvgTone Conglomerate
Figure 50

The Infrastructure AvgTone Conglomerate consists of municipalities within the Diyal, Sala ad Din provinces. Three sites in total, the collection represents a mixture of territories occupied by Sunni, and Kurd pluralities. These municipalities represent areas of greatest potential effectiveness for Infrastructure engagement, in comparison to others.

The final conglomeration step of applying the 'minimum magnitude/maximum intensity' rule to the standardized NumArticle and AvgTone attributes is applied. The result is three identified municipalities with values for the Infrastructure operational variable (Table 8).

Municipality	Latitude	Longitude	Infrastructure Variable
Tikrit, Sala ad Din	**34.6158**	**43.6786**	**0.947684463**
Baqubah, Diyala	**33.7466**	**44.6437**	**0.892147966**
Baghdad, Baghdad	**33.3386**	**44.3939**	**0.815156456**

Infrastructure Variable
Table 8

The Infrastructure variable does not present any major spatial outliers but does have areas of statically significant spatial concentration in Diyala and Sala ad Din. The implication of so few spatial hotspots is that these locations have relatively higher dynamics in terms of property (or, as an extension property rights). While not an initially obvious conclusion, bear in mind that a critical factor in Stability Operations is the allocation (or the ability to adequately track the allocation) of public goods. The first step in this is to identify for a society what is a public good (in terms of both services and property). This is not a completely settled or decided issue. Beyond the obvious extremes of property rights between strict capitalism, strict marxism (socialism), and strict communist economic systems, individual societies and nations practice some hybrid form of economic system in which the designation between private and public goods can radically deviate from the understood U.S. norm. The analysis of the Infrastructure variable designates flashpoint locations as well the importance of addressing structural improvement in tandem with host nation governments in the post-Surge environment.

Statistically overlapping conglomerates of magnitude and intensity for each individual PMESII variable enabled identification highest priority areas for variable. . Each PMESII highest priority areas is identified by calculating intensity (AvgTone) minus magnitude (NumArticle) for each statistically significant raw value of AvgTone and NumArtcle. Application the ‘minimum magnitude/maximum intensity’ rule develops factors from which final scores can be calculated in the AHP MMC model. Without this modification of Treviño’s original Conglomeration procedure, completion of the SDSS’ MMC could not take place.

7.4 AHP in the MMC

As stated above, the method of jointly analyzing the PMESII operational variables in this study is AHP. As a Full Aggregation MCDA modeling technique, a score for each selected judgment criterion is developed and then combined into a global score for each alternative. While this analysis can be conducted within GIS using rasterized data for polygon geographies, efficiency in using point data calls for conducting the same Boolean operation raster algebra style calculations within a database/spreadsheet construct without conversion of the spatial representation from vector to raster. Because the point locations are identical (matched using latitude/longitude), a sieve procedure is used to conduct the overlay allowing the 'Boolean-like' calculations.

The AHP procedure evaluates a set of alternative options based upon a set of criteria for determination of which alternative is the better decision for a stated goal. Users of AHP should note that, when dealing with criteria that can be interdependent and somewhat intangible, the best option is not the one which generally optimizes each single criterion, but is the one which accomplishes the goal based upon prioritization of the different criteria.[295] Built into the tree-like criteria and alternatives hierarchy, the alternatives are evaluated with respect to each criterion and each criterion is weighted according to a collective stakeholders' or decision makers' importance assessment.[296]. The scoring system allows the ranking of alternatives from best to worst to include equal ranking of alternatives. Again, the three general hierarchical steps are: goal identification, criteria selection, and alternative sets determination (courses of action). For this analysis the goal is identification of municipalities in which to concentrate

Stability Operations efforts after the 2008 Iraqi Surge. The criteria are the PMESII operational variables. The alternatives are the municipalities within the country of Iraq. The higher score determines the greater overall preference among the municipalities.

The beginning of criterion weight development first involves ranking of criteria. In this case, the Delphi participants (four in total) are asked to rank-order the interrelated PMESII operational variables in respect to each one's importance to the 2008 post-Surge OE. This set of criteria was selected due its pervasive use as aspects of the OE describing not only the military aspects but also the population's influence on them. The populace's influence is a main factor for the effectiveness of Stability Operations. The ranking procedure is from one (1) to six (6) with one having the greatest priority. The composite ranking developed using the median average value of the four Delphi participants for each of the PMESII operational criterion resulted following collective ranking shown in Table 9.

Rank #1	**Rank #2**	**Rank #3**	**Rank #4**	**Rank #5**	**Rank #6**
Political	Military	Infrastructure	Information	Economic	Social

Collective Operational Variable Ranking for post-Surge AHP
Table 9

The analysis is continued with the construction of a pairwise comparison matrix. Each of the PMESII operational criterion, in collective rank order, are compared to the PMESII criterion in the level immediately below with respect to its rank. These pairwise comparisons result in weights for application to each PMESII value within each Iraqi province. Again, the Delphi participants are a proxy for the military staff within MDMP.

Each Delphi panel participant is asked to prioritize the rank-ordered PMESII operational criterion by pair-wise comparing them for preference. The numbered scale serves as an indication of how many times more important one PMESII criterion is over another. Table 10 demonstrates the scale.

Intensity of Importance	Definition	Explanation
1	Equal Importance	The row criterion is valued equal to the column criterion
3	Moderate importance	The row criterion is valued slightly more important to the column criterion
5	Strong importance	The row criterion is valued more important to the column criterion
7	Very strong importance	The row criterion is valued intensely more important to the column criterion
9	Extreme importance	The row criterion is valued exceptionally more important to the column criterion
Intensities of 2,4,6, and 8 are used for intermediate values.		

AHP Pair-Wise Comparison Scale[297]
Table 10

The pair-wise comparison procedure is conducted using a six-by-six square matrix illustrated in Table 11. The order of each row and column is determined by the consolidated ranking conducted in the previous questionnaire. Each row criterion is compared individually to each column criterion within the matrix using the values as defined in the Pairwise Comparison Scale. Comparisons between the same criterion in both the row and column positions receives a value of one (criterion is valued equal to itself). This 'diagonal row' is highlighted in yellow. The reciprocal values are entered in its transpose position highlighted in gray (Table 11).

	Political	Military	Infrastructure	Information	Economic	Social
Political	1.00	1.50	3.00	3.00	4.50	3.50
Military	0.67	1.00	4.00	2.50	5.00	3.00
Infrastructure	0.33	0.33	1.00	0.63	2.00	2.50
Information	0.33	0.40	1.60	1.00	3.50	1.50
Economic	0.22	0.20	0.50	0.29	1.00	2.00
Social	0.29	0.33	0.40	0.67	0.50	1.00

Median AHP Weight Development Matrix
Table 11

The rank ordered pairwise comparison square matrix are used to calculate an eigenvector. Developed from matrix algebra, eigenvectors are a special set of scalars (either in a single row or single column) associated with a linear system of equations (aka characteristic roots). The values of the eigenvector are the used as weights for application with respect to the PMESII variable scores for each municipality calculated. The calculated weight values are presented in Table 12.

Political	Military	Economic	Social	Information	Infrastructure
.343	.275	.109	.149	.065	.061

AHP Weight Values for Operational Variables
Table 12

Additionally, as per the AHP method, a check for consistency is conducted. The Consistency Ratio (CR) measures how consistent the judgments have been relative to large samples of purely random judgments. AHP evaluations are based on the assumption that the decision-maker is rational (i.e., if A is preferred to B and B is preferred to C, then A is preferred to C). When the relationship between pairwise comparisons does not hold, then the situation is inconsistent. Inconsistency can occur due to vaguely defined problems or insufficient information (aka bounded rationality).[298] If the CR is greater than 10 percent (0.1), then the judgements are deemed unreliable due too closeness to randomness, making the exercise valueless and in need of repeating.

To calculate the CR, first conduct matrix multiplication of the original rank ordered pairwise comparison square matrix by its eigenvector which generates a product vector. Next, a value termed λmax (pronounced lambda max) is calculated by averaging the quotients of each product vector cell value against its corresponding eigenvector cell value. The following calculation is the Consistency Index (CI). CI is found by formula: CI = (λmax-number of rows) ÷ (number of rows -1). Finally, the CR is calculated via taking the CI and dividing it by a Random Index (RI) value as the denominator. The RI is the consistency index value if the entries of the rank ordered pairwise comparison square matrix were completely random using the Saaty comparison scale. This average value of random matrices was developed by Forman and is based upon the number of rows within the selected pairwise comparison square matrix.299 For the necessary RI, find the value corresponding to the number of matrix rows in the Table 13. This gives a λmax of 6.471489191. Thus, the value for CI is (6.471489191 - 6) ÷ (6 -1) or 0.0942984. Since this matrix had six rows, CR = CI/RI = 0.0942984/1.24, or 0.07604664 (≈ 0.08). Since this value of CR is less than 0.10, the weights are found to be consistent.

# Rows	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Value	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Values of the Forman/Saaty Random Index (RI)
Table 13

With both the individual municipality PMESII operational variables values and the PMESII weights computed, the final AHP step is to compute a scores for the various municipal alternates for Stability Operations main effort selection. For each of the 292 municipalities under consideration, each one requires the specific PMESII value multiplied its corresponding PMESII weight. Then, for each municipality, the PMESII products are summed for a total score. The highest score is selected as the post-Surge Stability Operations main effort. While a deliberate procedure aided by the fact that many of the individual PMESII scores for many of the municipalities are zero, the actual management of this task require use (once again) of the MS Access relational database management system (RDBMS) and MS Excel for the computations.

While a full mathematical explanation of the AHP is beyond the scope of this study, details of the calculations conducted using an open source MS Excel model from SCB Associates of London, England are contained in the Appendix.

7.5 Final Results

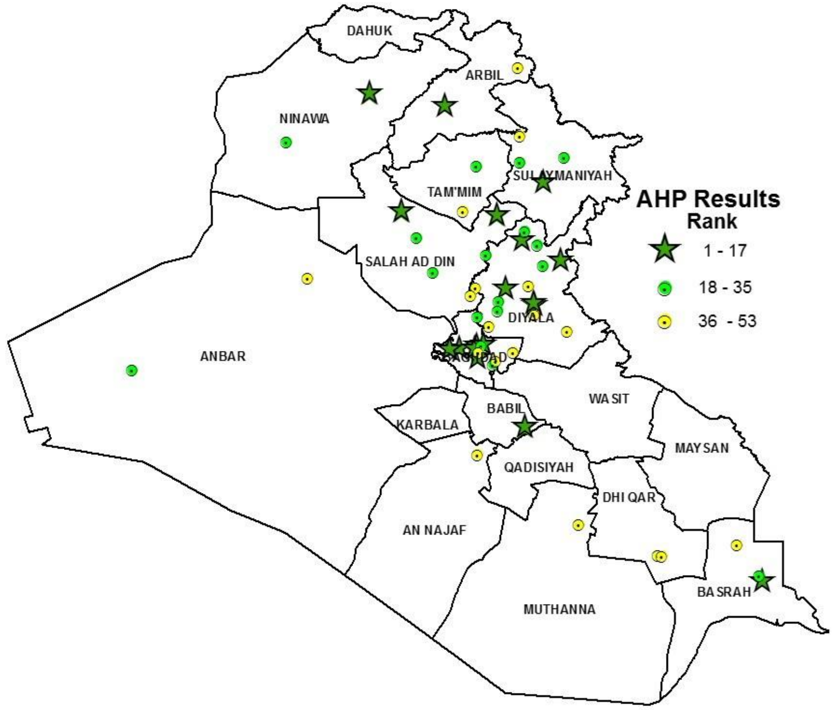
As noted in Table 14, the national capital of Baghdad is the highest ranked municipality according to the AHP calculations of the ranked PMESII coded and Treviño's Conglomeration analyzed GEDLT data. Mosul, the originally selected main effort municipality, ranked seventh of all of the municipalities with statistically significant values.

Rank	Municipality	Latitude	Longitude	Final AHP Score
1	Baghdad, Baghdad	33.3386	44.3939	0.4898
2	Khanaqin, Diyala	34.3482	45.3906	0.3204
3	Mahdi, Diyala	33.8241	45.0788	0.2659
4	HasNasrallah, Diyala	33.8403	45.0690	0.2452
5	Arbil, Arbil	36.1926	44.0106	0.1869
6	Abu Ghurayb, Baghdad	33.3070	44.1869	0.1724
7	Mosul, Ninawa	36.3350	43.1189	0.1699
8	Tuz Khurmatu, Sala ad Din	34.8881	44.6326	0.1699
9	Sangaw, Sulaymaniyah	35.2860	45.1768	0.1603
10	Hawr Rajab, Baghdad	33.1936	44.4049	0.1428
11	Jabarah, Diyala	34.5925	44.9338	0.1410
12	Baiji, Sala ad Din	34.9307	43.4931	0.1387
13	Al-Harthiyah, Baghdad	33.3030	44.3711	0.1350
14	Ali Kazim, Babil	32.3669	44.9621	0.1350
15	Basra, Basrah	30.5330	47.7975	0.1350
16	Imam Mansur, Diyala	34.0209	44.7355	0.1350
17	KhDari, Baghdad	33.2941	44.0726	0.1350
18	Muthanna, Baghdad	33.3491	44.4682	0.1350
19	Zayyunah, Baghdad	33.3270	44.4515	0.1350
20	Samarra, Sala ad Din	34.1966	43.8739	0.1315
21	Rutbah, Anbar	33.0372	40.2859	0.1129
22	Muhammad Amin, Diyala	33.8583	44.6522	0.1069
23	Sulaimaniya, Sulaymaniyah	35.5650	45.4329	0.1064
24	Tikrit, Sala ad Din	34.6158	43.6786	0.1056
25	Badr, Ninaw	35.7489	42.1222	0.0916
26	Jalawla, Diyala	34.2772	45.1779	0.0904

27	Quraysh, Diyala	34.4109	44.5058	0.0690
28	Kirkuk, Ta'mim	35.4681	44.3922	0.0665
29	Rand, Diyala	34.5267	45.1143	0.0582
30	Tarmiyah, Baghdad	33.6744	44.3958	0.0582
31	Baqubah, Diyala	33.7466	44.6437	0.0544
32	Ali Mansur, Sulaymaniyah	35.5119	44.9069	0.0530
33	SalmPak, Baghdad	33.1020	44.5835	0.0374
34	Kifri, Diyala	34.6896	44.9606	0.0363
35	Al-Latif, Basrah	30.5911	47.7589	0.0349
36	Al-Mansuriyah, Diyala	34.0408	45.0058	0.0349
37	Dawah, Basrah	30.9583	47.4939	0.0349
38	Hafiz, Muthanna	31.2031	45.6084	0.0349
39	Hawijah, Diyala	34.0167	44.3833	0.0349
40	Kufa, Najaf	32.0347	44.4033	0.0349
41	Mahmud Abbas, Sala ad Din	33.9229	44.3193	0.0349
42	Nahar, Dhi Qar	30.8333	46.5500	0.0349
43	Sharqiyah, Dhi Qar	30.8276	46.5914	0.0349
44	KhBani Saad, Diyala	33.5656	44.5434	0.0298
45	Choman, Liwa' Irbil	36.6367	44.8882	0.0298
46	Ariz, Diyala	33.5000	45.4667	0.0296
47	Balad Ruz, Diyala	33.6963	45.0778	0.0296
48	Madain, Baghdad	33.1500	44.6167	0.0296
49	Alberta, Baghdad	33.2533	44.8289	0.0281
50	Abd Al-Aziz, Ta'mim	34.9283	44.2303	0.0257
51	Haditha, Anbar	34.1348	42.3772	0.0199
52	Dora, Baghdad	33.2482	44.4091	0.0066
53	Askar, Sulaymaniyah	35.8274	44.9110	0.0052

Municipal Rankings for Post-Surge Stability Operations
Table 14

Since the purpose of this research is to provide a spatial composite depiction of the conditions, circumstances, and influences affecting capability employment and a commander's decision making process (aka., the COP), the AHP results are mapped. Because the AHP values represent an integration of key socio-economic factors within the OE, these plotted points presented in a geographical hierarchy. While multiple methods of selecting the categories are available, the most direct is to divide the 53 identified municipalities in three sections. Figure 51 is a depiction of a Stability COP for the evaluated post-Surge OE conditions.



Map of Municipal Rankings for Post-Surge Stability Operations
Figure 51

The first thing to notice is that the vast majority of top identified municipalities are not in the northwestern provinces (Ninawa, Arbil, and Duhuk) were the majority of the Kurdish population, military forces, and government were. The top third ranked municipalities, represented by dark green stars, are oriented in the central and eastern provinces of Iraq. While issues of population and reporting frequency can account for some discrepancies, another unrecognized issue is highlighted. The provinces of Sulaymaniyah, Diyala, and even Baghdad are in close proximity and influence on Iran. If the variables used do represent Stability Operations as a measure of an area's resistance to political, economic, social and structural degradation, then the top tier municipalities not only embody areas that projects could provide greater returns against insurgent influence but also identify areas of contention from Iran's attempt at regional hegemony. With the assumption that a robust security presence would still be needed throughout the country after the Surge, the issues of Stability projects must address those components that would strengthen the nation of Iraq as a whole.

8. POLICY IMPLICATIONS AND RECOMMENDATIONS

The ability to conduct relevant research for the implementation of location-based policy initiatives is critical to issues concerning reestablishing safe and secure environments, providing critical government services, reconstructing disaster preparedness infrastructure, and establishing humanitarian aid. Such research must incorporate the fact that the tailoring of policy initiatives to local environments is necessary due to the situational variations across space geographies. SDSS models, such as the one presented in this research, provide a policy support system that assists in the decision making of semi-structured spatial problems. While generally associated with urban planners during land use decision making analysis, the use of SDSS proves to be applicable to location decisions during Stability Operations.

The purpose of this study is to advance a new analysis methodology for the conduct of Civil Information Management for the U. S. Army. The policy implications addressed are at both a micro (specific SDSS model) and micro (U.S. Army implementation) level. At the micro level the results of the joint Content Analysis – Conglomeration - Multicriteria Decision Analysis method of SDSS applied to the post-Serge case study shows that a different Stability Operations main effort from Mosul was identified. Both Content Analysis and Conglomeration are required as parts of the processing and analysis/evaluation CIM steps to prepare the data for the transformation to information and knowledge. The use of AHP is a traditional method of multicriteria decision making and is extremely applicable within the MDMP construct. Additionally, the use of this Content Analysis – Conglomeration - Multicriteria Decision Analysis method has possibilities beyond use in Stability Operations. The following begins with an examination of each Content Analysis – Conglomeration - Multicriteria Decision Analysis SDSS component for micro level policy adjustment.

8.1 Micro Level Policy Implications

The use of Content Analysis, while not conducted within this study, is necessary for converting written qualitative data into quantitative data that can be spatially presented and analyzed. While GDELT was used, it is a quantitative conversion of written news articles. Content Analysis is used by many social science fields like ethnography, anthropology, and urban planning to turn qualitative data (field reports) into quantitative data beyond simple word counts. The Civil Affairs equivalent of social science field reports (Stability SITREPS) can be transformed by Content Analysis for quantitative analysis in both non-spatial and spatial environments. This is critical in making positive use of little utilized data for Stability Operations.

Use of the Treviño's Conglomeration procedure enables CIM's process and analysis of civilian data through multiple social science models. The success in mitigating informational problems and aiding decision making for public policy and applied social sciences such as urban planning is transferable to Stability Operations. Most of stability's civilian data are qualitative. The use of content analysis enables use of Treviño's Conglomeration for merging of various civil variables, facilitating holistic understandings various populations and their issues within an OE. CIM cells can use Conglomeration to conduct sub-geography and sub-population analysis to reveal combined social characteristics. These results can be spatially displayed and inform military leader's actions within the operational area when conducting specific stability activities. Part of the value of conglomeration is its relative simplicity (if not ease). The method enables the overlay of non-spatial and spatial data for variables of magnitude and intensity separately, then combines the results in another overlay to identify key locations concerning a specific social issue. In order to gain the processing and analyzing capabilities of the CIM cell mission, use of Treviño's Conglomeration is presented as an option.

The AHP method differs very little to decision making applications conducted during the Army's MDMP. Specifically, AHP is but one of many valid methods to conduct Step 5 of MDMP – Course of Action (COA) Comparison. The most used method for COA comparison is a decision matrix. Generally, the decision matrix is the summation of subjective criteria weights applied to criteria value of each actionable alternative (COA). AHP provides a formalized method for subjective weight development that is not arbitrary. For the purposes of this research, AHP is also a technique applicable to spatial analysis.

8.2 Macro Level Policy Implications

At a macro level, any concept development or new policy implication recommendation within the U.S. DoD will focus on identification of capability gaps in implementing any new analysis methodology. The organization responsible for managing this process and approving such proposals is the U.S. Army Training and Doctrine Command (TRADOC). As part of the overall U.S. Department of Defense Joint Capabilities Integration and Development System (JCIDS), the template used to assess either the non-material or materiel approaches required for addressing such capability gaps focuses on the subjects of doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF).[300] The Doctrine analysis examines how the military fights battles with emphasizes on ground maneuver combat. The Organization analysis examines how the Army is preprogrammed for fighting to see if there is a better structure that can be developed. The Training analysis examines how the Army prepares forces to function from basic training, advanced individual training, various types of unit training, joint exercises, and other ways to see if improvement can be made. The Materiel analysis examines all the necessary systems and equipment that are needed by Army forces to effectively fight and operate and examines where new systems are needed. The Leadership and Education analysis examines how the military prepares leaders to lead the fight thought out their overall professional development cycle. The Personnel analysis examines availability of qualified Soldiers for peacetime, wartime, and various contingency operations. The Facilities analysis examines military property, installations and industrial facilities that support the armed forces.

Currently, CIM cells lack the ability to conduct SDSS style analysis. While potential analysts and system developers from SDSS' stakeholder components are identified within the Army's Civil Affairs units, the skill set proficiencies currently held are necessary but not sufficient for CIM effectiveness. This constitutes a capability gap as defined by the JCIDS. CIM depends on three interconnected skill sets: social science research, analysis, and evaluation capability; installation, operation, and maintenance of information systems (both geographic and non-spatial); and geo-spatial knowledge management (including, by definition, both information management and analysis/evaluation capabilities) and presentation of the OE. For the U.S. Army, these capabilities supposedly are spread between three enlisted military occupational specialties (MOS) and an officer career field/branch.

Geospatial engineers (MOS 12Y) install, manage, and utilize geographic information systems, but their training is focused toward terrain and infrastructure analysis. They lack practical training geospatial analysis applications toward social science issues. While the skill set is the same for developing the basic layers required in GIS, the type of geospatial analysis training required to display and analyze the socio-econ-political aspects of the civil environment is more statistically grounded and not part of the Army's geospatial engineer curriculum.

Information systems operators (MOS 25B) install and maintain necessary computer information systems, but lack the skills to develop and manage database systems (again both geographic and non-spatial). A critical component of CIM is the ability to conduct knowledge discovery in databases (KDD, aka Data Mining), the process of data selection, preparation, cleaning, pattern extracting, appropriate prior knowledge incorporation, and proper results interpretation are jointly conducted ensuring that useful knowledge results from the analysis.[301] The term often used in conjunction with Data Mining, 'Big Data', is misleading because issue with the datasets in question is not one of dataset size but one of useful information and knowledge extracted.[302] The difficulty is not only due to size, but correspondingly to the complexity and 'messiness' of the data. Key to the 'data selection, data preparation, data cleaning' is a basic ability to operate databases in order to gather, arrange and organize the raw data needed for CIM analysis. Database operation includes the abilities to update, query, join, and quality control the data with a database. These are the skills lacking from the 25B MOS.

Civil Affairs Officers (Career field/branch 38A) and Civil Affairs Non-commissioned officers (CA NCOs - MOS 38B) provide tactical-level knowledge of the civil environment but often lack advanced socio-econ-political (Stability) spatial analysis capabilities to include how to integrate those stability factors spatially into a maneuver commander's decision-making cycle. While the CA qualification courses for both active and reserve components, and the CA NCO classification and reclassification courses provide in depth training in socio-economic aspects of an OE, the training stops short of teaching how to integrate them towards a decision during Stability Operations. All Army officers approaching the rank or at the rank of Major are required to attend Intermediate Level Education (ILE), a program for mid-career officers preparing for battalion command or other field-grade positions at the division, brigade, or battalion levels and a curriculum including instruction on the Military Planning and Decision Making Processes (MDMP). NCOs assigned to battalion or higher operational coordinating staff positions attend the Battle Staff NCO course where they are instructed in the intricacies of MDMP. While MDMP is an effective standard for developing and analyzing courses of action, its implementation in the Army is generally Combat operationally focused. The listed cell entity issues described above constitute gaps in the organization, training, personnel, and material perspectives of the JCIDS assessment for CIM.

Four possible remedies are offered. The first one address the training JCIDS gap aspect. Each CIM cell entity can gain the required additional training needed for true mission capability. For the 12Y and 25B MOS soldiers, the additional required skills can be obtained through local community colleges and universities. As an incentive, Soldiers within these MOS could be specially designated to receive funding under various Army Reserve educational programs. For the 38A officer and the 38B NCO, much of the advanced analysis capability is obtainable through the Security, Stability and Development in Complex Operations (SSDCO) certificate program at the Naval Postgraduate School (NPS). While probably the least expensive, this course of action is problematic in implementation. It is not a deliberate action to ensure, as much as possible, each unit's CIM cell personnel receives the requisite additional training required to fulfill the mission.

A second possibility addresses the training, and personnel JCIDS perspectives. It calls for the creation of an additional skill identifier (ASI) for the Civil Affairs noncommissioned officers (38B MOS) in place of the 12Y MOS. The CIM ASI integrates Civil Affairs cultural training with the critical geo-spatial analysis and database management skills. Plan of instruction (POI) management would need to originate at the CA proponent (Special Warfare Center and School - SWCS). A possible alternative or equivalent ASI certification could be obtained through civilian higher education facilities and may mitigate cost. While funding and time would affect the training aspect of this option, there would be a delay on units deemed 'ready' due to time it would take to have the designated 38B NCOs gain the ASI.

The third possibility also addresses the training, and personnel JCIDS perspectives in calling for creation of a manned Geospatial Engineering Technician Warrant Officer position (125D) in addition to the enlisted 12Y MOS . This option involves the organization, training, and personnel JCIDS perspectives. The intent is to use the 125D Warrant's current duty description in conjunction with the socio-economic analysis requirements for CIM. A 125D current duties includes: assimilation, integration and management of Geospatial-Intelligence (GEOINT) data and products, implementation of analysis aiding the commander and his staff's visualization and understanding of the terrain's impact upon operations, and participation with the planning staff in each step of the Military Decision Making Process (MDMP) facilitating decision making with accurate information. The 125D Warrant often serves as the Officer in Charge (OIC) of a GEOINT cell, working with analysts for production of mission-focused products that enable situational understanding.[303] In order to gain the 'civil' component knowledge needed to be an OIC of a CIM cell, the 125D would be required to attend the SSDCO certificate program at NPS or similarly structured course. Analysis of the 'civil' component supplants the 'intelligence' focus found in a GEOINT cell. The Warrant Officer position would potentially replace a Commissioned Officer as the cell chief, or at least serve as the second in charge replacing the Non-commissioned Officer in Charge (NCOIC – normally the second in charge). Funding and time would affect this option the least in comparison to others. The most difficult part of implementing this option is the availability of 125D Warrants willing to take the additional SSDCO the training required.

The final possibility is creation of a 'CIM Warrant Officer'. This option involves the organization, training, and personnel JCIDS perspectives. The intent is to consolidate most of the interconnected skill sets into one position. A Warrant Officer 380A position would combine capabilities of a senior Civil Affairs NCO, Battle Staff operations NCO, social science analyst and geo-spatial knowledge manager. The skill merger would create subject matter experts in Stability Operations, civil knowledge management, and CMO planning and execution at the Civil Affairs Battalion through CAPOC echelons. The creation of CA Warrant Officer billet has been one of contention, with many Army officials stating that the Civil Affairs branch is attempting to model itself after U.S. Army Special forces despite the reserve CA branch having been removed from the U.S. Army Special Operations Command (USASOC) in 2006. This option is probably the most time consuming, most expensive, and most difficult to implement. As with the ASI option, POI management would need to originate at SWCS. Conversely to the ASI option, an organizational change would be needed. This Warrant Officer position would also potentially replace a Commissioned Officer as the cell chief. Additionally, personnel available will have a greater delay than the ASI option due to time it would take to both complete Warrant Officer school and the SWCS developed POI (a rough estimate of two years, minimum). There is an additional personnel concern with development of a CIM specific CA Warrant Officer creation. With the limited availability of positions (approximately 40 to 50 positions would be created within U.S. Army Reserve Civil Affairs units) qualified 38B NCOs may be discourage from applying due to unit locations and lack of proximity to candidate civilian residences.

All of these options are dependent upon material issues. Despite many of the CIM discussions focusing upon what computer system will serve as the ‘coin of the realm’, the minimum needs for a CIM cell is a suite of four laptop computers with specifications to run a GIS program (2.2 GHz computer speed, 8 GB memory, 256 MB graphics card, and 6 GB or more of diskspace); a SQL (Structured Query Language) server to function as a RDBMS; and a GIS program capable of conducting the spatial statistical analysis conducted earlier in this study. The suite of computers is similar to what is found in Mission Planning Kits (MPK), a standalone local area network (LAN) group of computers with associated devices that share a collective communications line. While these MPKs are capable of interconnecting to a larger tactical local network, the purpose here is to create a closed or partially closed system in order to employ a division of labor for the joint Content Analysis – Conglomeration - Multicriteria Decision Analysis method for the MMC. The computers would be configured with three computers to breakout the individual parts of the MMC with one computer to serve as an internal SQL server in order to allow data and information exchange between the other breakout computers.

The options presented for a Stability COP capable CIM are valid ones, meeting the military review protocol of being FAS: Feasible, Acceptable, and Suitable. Feasible in terms of being capable of accomplishment within designated time, location, and resource contraints. Acceptable meaning capable of balancing the cost/risk with the reward gained. Suitable regarding capable accomplishment within the commander‘s intent and planning guidance. Regardless of any of the presented options, or others not presented here, additional capabilities are required for the proper conduct of CIM's collate, process and analyze/evaluate steps.

8.3 Policy Implications Beyond Stability Operations

The use of this Content Analysis – Conglomeration - Multicriteria Decision Analysis method has potential beyond Stability Operations. Cities and towns conduct community surveys in order to gage the satisfaction of various customer service initiatives. These surveys tend to be heavily oriented to closed-ended survey questions that limit the response to a pre-selected option list. With the addition of a structured open-ended questions focused on a specific analysis framework topics, the Content Analysis – Conglomeration - Multicriteria Decision Analysis method can be used to identify needful sub-city areas strong potential of positive impact. Specifically, the analysis would be useful in determining what urban policies (housing, economic development, transportation, anti-poverty) could be combined for maximum effect.

9. CONCLUSIONS

9.1 Overview

This study is an attempt to apply the Spatial Decision Support System methodology to the analysis of military Stability Operations, the conduct of Civil Information Management (CIM), and the creation of a Stability orientated Common Operational Picture. Unlike the majority of discussions in the U.S. Army concerning CIM concentrating on what computer program system should be adopted, the concepts presented focus on implementation of social-economic analysis skills applicable across various multiple computerized analysis platforms. The study addressed the following research questions:

- How can SDSS integrate qualitative political and socioeconomic factors into a singular visualization of the Stability Operational Environment (OE)?
- How can SDSS help provide a holistically spatial approach and systematic analysis adaptable to multiple situations and socioeconomic settings?
- How does SDSS facilitate cooperative planning and support all echelons in achieving situational awareness and decision making?

The study demonstrates that SDSS integrates qualitative data through use of the Content Analysis – Conglomeration - Multicriteria Decision Analysis MMC method that transforms text data into geographically referenced, statistically analyzed data for use as decision criteria. Thorough use of a generalized analysis framework or heuristic (e.g., PMESII) as the decision criteria for an AHP model, this research demonstrated that SDSS is adaptable to multiple situations and provides the capability of achieving a spatially holistic approach. Such analysis frameworks are designed to partition key social, economic, and demographic aspects of an OE, while the scoring, factor weighting, and factor aggregation conducted within AHP combines the analysis framework values for each location into a holistic value for comparison with other locations within the OE based on the decision maker's priorities. Finally, this study demonstrates how SDSS facilitates collaborative planning toward situational awareness and decision making through its use of the Delphi survey technique to produce statistical weight to apply individual criteria values for each location in order to decide where to apply resources. Overall, this study is significant for expanding both the Urban Planning and SDSS fields of study and providing technical and methodological capabilities to the U.S. Army Civil Affairs, Peacekeeping, and Stability Operations communities.

9.2 Strengths and Limitations of the SDSS Method

The Spatial Decision Support System methodology for Stability Operations/Peacekeeping analysis and the conduct of Civil Information Management presented both strengths and limitations. The major strengths of the system include:

- Flexibility – this SDSS allows for various methods to be used, especially in the model management component (MMC). Various analysis frameworks are available for both the Content Analysis and Multicriteria Decision Analysis portions of the MMC.

- Adaptability – this SDSS can be applied during multiple phases of theater operations. Additionally, it can incorporate interoperability between joint U.S. military taskforces, U.S. interagency collaborations, multinational military coalitions, and Non-governmental organizations (NGOs) coordination.

Many limitations were overcome, as the methodology endured a myriad of revisions. A summary of the limitations includes:

- Data – As stated in the beginning of this study, the GDELT dataset is a proxy for military SITREP and other governmental reports that would describe various aspects of the operational environment. GDELT is based upon broadcast, print, and web news articles and required a re-coding of the data for use in the PMESII analysis framework. Conducting the Content Analysis – Conglomeration - Multicriteria Decision Analysis MMC method with reports designed to directly support the PMESII analysis framework or any other designated analysis framework should improve the results.

- Content Analysis - Specifically, with the GDELT, running the Tonal Analysis model require some experience with statistical spatial analysis. It is specific to the GDELT database. With the use of other datasets, the specific Tonal Analysis model would not be needed to run the SDSS.

- Skill requirements – analysis using this model is difficult for one person to conduct alone. It requires a unique set of skills for a single individual to possess: GIS spatial analysis, statistical analysis, database management, and socio-cultural expertise just as a base. While it is not impossible to identify a person with all of these capabilities, the pool for such persons is limited. This Content Analysis - Conglomeration - Multicriteria Decision Analysis model requires a team of individuals with the collective skills mentioned.

9.3 Further Study Recommendations

Based on the research results and policy implications stated above, multiple areas of research and development have been identified for future improvement of SDSS use in CIM and Stability Operations analysis. The first is to attempt the Content Analysis – Conglomeration – Multicriteria Decision Analysis model with raw (qualitative written reports) data to conduct actual content analysis. This would require use of

SITREPs from real world missions (most of which are classified or designated as ‘For Official Use Only – FOUO’).

Another recommendation is the use of other analysis frameworks or heuristics besides PMESII. The use of an analysis framework affects both the conduct of Content Analysis (coding) and Multi-Criteria analysis (decision criteria). While PMESII is the ‘overarching’ variable set for use in operational analysis, the needs of the maneuver commander or the situation at the time of analysis (aka., the specific phase of the ‘Continuum of Military Operations’) might dictate a more nuanced approach. From the commanders’ perspective, they may want to understand how Stability Operations support the individual Lines of Effort (LOE – groupings of multiple tasks based upon purpose that focus efforts towards establishing operational and strategic end states). The listed end states become the criteria which the data are organized, and the decisional analysis is built upon. From an operational phase perspective, the pre-combat or ‘Shaping’ and ‘Deter’ phases (Phase 0 and Phase 1 respectively) might require a risk management evaluation or vulnerability assessment of governmental systems needed for post-combat recovery. The CARVER (Criticality, Accessibility, Recuperability, Vulnerability, Effect and Recognizability) analysis matrix is useful for categorizing and prioritizing high risk facilities, systems and assets that are more critical to mission success.[304] During the ‘Stabilize the Environment’ and ‘Enable Civilian Authority’ phases (number four and number five respectively), the Tactical Conflict Assessment and Planning Framework (TCAPF) is more applicable. This heuristic is an outgrowth the theoretical underpinnings from USAID’s Conflict Assessment Framework (CAF) developed in 2005.[305] While the CAF is strategically focused, the TCAPF, developed in 2006, adapts the CAF to tactical and operational level actions and links conflict assessments to planning at the local level.

Additionally, if the scope of the OE is beyond U.S. governmental participation, use of the various framework tools developed by both academicians and practitioners during stability activities are available. The ‘Measuring Progress in Conflict Environment’ (MPICE) framework is a top-down outcome-based system designed to measure both operational and strategic advancements in stabilization environments. Using both quantitative and qualitative indicators, MPICE measures three stability development levels: imposed, assisted and self-sustaining.[306] Another is the ‘Sphere Project’, developed jointly by humanitarian nongovernmental organizations and the Red Cross/Red Crescent society. The framework outlines six humanitarian response critical areas: nutrition, water supply, food aid, shelter, sanitation, food security and health services.[307] Within these six indication areas there are multiple individual indices which provide the ability to set benchmarks for aid and monitor tipping point demarcations of societies transitioning from danger to viability.

The use of analytical frameworks leads to another subject of study, scoring. In this research the initial scores (factors) were developed from standardizing the raw GDELT data. As mentioned above, researchers at West Point used Principal Component Analysis (PCA) to develop factors. This is a possible avenue to explore for content analysis data use.

Yet another recommendation concerns the use of an alternate spatial autocorrelation models. The Getis-Ord Gi* is a statistic identifying point clusters of higher value than would be found by random chance.[308] The statistic jointly evaluates the spatial dependency effect of the observed occurrence and attribute values within the construct of the conceptualized spatial relationship. Regular point pattern analysis concludes if the distribution of point events results from random or a systematic clustered/regular patterns. Methods like nearest-neighbor distances, kernel density estimation, and K-function concentrate on the point event distributional phenomena. While spatial information is accounted for in basic point pattern analyses, each point is equally weighted regardless of their characteristics. Spatial autocorrelation methods are an advanced point pattern detection incorporating not only the positions of events but also, if appropriately defined, their associated values. Like the Local Moran's *I*, Getis-Ord Gi* discriminates between hot spots and cold spots. Unlike the Local Moran's *I,* it is solely dependent on a statistical method requiring only the use of vector data to identify the positions of statistically significant hot and cold spots and the aggregation of points to polygons for the analysis. Additionally, since the Local Moran's *I* can be calculated for vector polygons as well as the point used for this research, the analysis could be conducted by aggregating the points to their corresponding province. Such aggregation would change the focus of what municipality is best for as the Stability main effort to what province would be best.

A final recommendation concerns the use of an alternate Multicriteria Decision Analysis model. As stated above, AHP is but one MCDA method. The pairwise comparison method is useful when the economic utility of each criterion is not known. This is the environment in which CIM is normally deployed; however, there are other pairwise comparison methods which could be utilized such as the MACBETH (Measuring Attractiveness by Categorical Based Evaluation Technique).[309] The major difference between AHP and MACBETH is that the former method’s comparisons are based on a ratio scale while the latter method’s comparisons are based on an interval scale.

APPENDIX

Delphi Questionnaires

Questionnaire #1 Participant # ______

The "Surge" in context of Operation Iraqi Freedom (OIF) is the military operation intended to help the Iraqi Government to secure neighborhoods, protect the local population, and provide security within the Baghdad and Al Anbar Provinces through the use of an increased American tactical presence. Once this offensive military operation was deemed effective, a transition to Stability Operations was conducted. Stability operations are best summarized as various coordinated mission conducted to maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief. The general start time period of this Post-Surge Stability Operation is September-October 2008 with the theater main effort located in the city of Mosul, Nineveh province of northern Iraq.

In order to effectively conduct any military operation, there must be an understanding of the Operational Environment (OE). The OE is a composite analysis of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander. The geographical representation of the OE is known as a Common Operating Picture (COP) and is difficult to achieve during Stability Operations due to general characteristics of socio-economic data not being readily practical for meaningful graphical presentation. Both the OE and resulting COP presentation can and should aid the analysis of where Stability Operations should be conducted.

This first round of questions are open-ended ones designed to establish why and how the Nineveh province was selected as the main effort. The questions are meant to describe the procedure(s) used to identify and describe the Post-Surge composite civil OE and how this OE was used in the designation of the main effort area.

1. What were the factors leading to the designation of Nineveh province as the theater main effort?

2. Did these factors focus on civil / socio-economic issues or was the focus more toward security issues?

3. What procedures were used in the analysis of the Post-Surge Operational Environment (OE)?

4. Were the conditions, circumstances, and influences affecting force capabilities and bearing on the commander's decisions geographically displayed in an integrated fashion? If so, did it effectively aid in the decision to designate Nineveh province as the theater main effort?

Questionnaire #2 Participant # ______

1. In this second round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is an analytic approach for solution to the problem of where should the main effort for post Surge Stability Operations be designated (i.e. which Iraqi municipality). This involves the ranking of criteria in a similar procedure used in the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.
2. Each Delphi panel participant is asked to rank-order the interrelated operational variables used by the U.S. military to analyze the 2008 Post-Surge OE. Known as PMESII, these operational variables are: political, military, economic, social, information, and infrastructure. They are the criterion for analysis. This set of criterion was selected due its pervasive use as aspects of the operational environment describing not only the military aspects but also the population's influence on it. The populace's influence is a key factor in the effectiveness of Stability Operations.
3. The ranking procedure is from one (1) to six (6) with one having the greatest priority. A composite ranking will be developed using the median value for each of the PMESII operational criterion.

____ **POLITICAL**

____ **MILITARY**

____ **ECONOMIC**

____ **SOCIAL**

____ **INFORMATION**

____ **INFRASTRUCTURE**

Questionnaire #3 Participant # ______

In this third round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is a continuation of the analytic approach solution to where the main effort for post Surge Stability Operations should be designated (i.e. in which Iraqi municipality). This involves construction of a set of pairwise comparison matrices. Each of the PMESII operational criterion, in rank order, are compared to the PMESII criterion in the level immediately below with respect to its rank. These pairwise comparisons results in weights for application to each PMESII value within each Iraqi province. Again, this is a similar procedure used within the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.

Each Delphi panel participant is asked to prioritize the rank-ordered PMESII operational criterion by pair-wise comparing them for preference. The numbered scale serves as an indication of how many times more important one PMESII criterion is over another. Comparing the results from the pair-wise comparison method called a relative model to these results from the ratings model. The table below demonstrates the scale.

Intensity of Importance	Definition	Explanation
1	Equal Importance	The row criterion is valued equal to the column criterion
3	Moderate importance	The row criterion is valued slightly more important to the column criterion
5	Strong importance	The row criterion is valued more important to the column criterion
7	Very strong importance	The row criterion is valued intensely more important to the column criterion
9	Extreme importance	The row criterion is valued exceptionally more important to the column criterion
Intensities of 2,4,6, and 8 are used for intermediate values.		

Pairwise Absolute Number Comparison Scale

The pair-wise comparison procedure is conducted within a six-by-six matrix presented below. The order of each row and column is determined by the consolidated ranking conducted in the previous questionnaire. Each row criterion is compared individually to each column criterion within the matrix using the values as defined in the Pairwise Comparison Scale. Comparisons between the same criterion in both the row and column positions receives a value of one (criterion is valued equal to itself). This "diagonal row" is highlighted in yellow. Please enter the whole numbers in the unshaded cells. The reciprocal will be entered for you in its transpose position highlighted in gray.

	POLITICAL	MILITARY	INFRASTRUCTURE	INFORMATION	ECONOMIC	SOCIAL
POLITICAL	1					
MILITARY		1				
INFRASTRUCTURE			1			
INFORMATION				1		
ECONOMIC					1	
SOCIAL						1

Pairwise Comparison Matrix

Delphi Questionnaire Responses

Questionnaire #1 Participant # 1

The "Surge" in context of Operation Iraqi Freedom (OIF) is the military operation intended to help the Iraqi Government to secure neighborhoods, protect the local population, and provide security within the Baghdad and Al Anbar Provinces through the use of an increased American tactical presence. Once this offensive military operation was deemed effective, a transition to Stability Operations was conducted. Stability operations are best summarized as various coordinated mission conducted to maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief. The general start time period of this Post-Surge Stability Operation is September-October 2008 with the theater main effort located in the city of Mosul, Nineveh province of northern Iraq.

In order to effectively conduct any military operation, there must be an understanding of the Operational Environment (OE). The OE is a composite analysis of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander. The geographical representation of the OE is known as a Common Operating Picture (COP) and is difficult to achieve during Stability Operations due to general characteristics of socio-economic data not being readily practical for meaningful graphical presentation. Both the OE and resulting COP presentation can and should aid the analysis of where Stability Operations should be conducted.

This first round of questions are open-ended ones designed to establish why and how the Nineveh province was selected as the main effort. The questions are meant to describe the procedure(s) used to identify and describe the Post-Surge composite civil OE and how this OE was used in the designation of the main effort area.

1. What were the factors leading to the designation of Nineveh province as the theater main effort?

   In context, the Surge stabilized Baghdad, Anbar and other areas. Mosul was the least secure. But the overriding issue was political. It was an opportunity for the national government to prove that they could provide for their own security and that the national government could properly deal with minority populations (i.e.: Kurd). Key to this was trying to establish if the national government controlled resources or if sectional areas controlled them. This fed into the information operations. Political deal with both U.S. and Iraqi domestic political issues.

2. Did these factors focus on civil / socio-economic issues or was the focus more toward security issues?

The focus was mainly on political issues with efforts toward security. It was all about proving a functional national government could be operated.

3. What procedures were used in the analysis of the Post-Surge Operational Environment (OE)?

   While PMESII was used, there was understanding of the tribal and religious issues and the external factors (Iran, foreign fighter from Syria, Turkey's concern over Kurdish independence quest)

4. Were the conditions, circumstances, and influences affecting force capabilities and bearing on the commander's decisions geographically displayed in an integrated fashion? If so, did it effectively aid in the decision to designate Nineveh province as the theater main effort?

   Not some much. Some maps with infrastructure, tribe location, who owned what physical assets. Mostly physical or kinetic (combat) actions were mapped. Main overlay analysis dealt with kinetic actions versus project locations.

Questionnaire #1 Participant # 2

The "Surge" in context of Operation Iraqi Freedom (OIF) is the military operation intended to help the Iraqi Government to secure neighborhoods, protect the local population, and provide security within the Baghdad and Al Anbar Provinces through the use of an increased American tactical presence. Once this offensive military operation was deemed effective, a transition to Stability Operations was conducted. Stability operations are best summarized as various coordinated mission conducted to maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief. The general start time period of this Post-Surge Stability Operation is September-October 2008 with the theater main effort located in the city of Mosul, Nineveh province of northern Iraq.

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1. What were the factors leading to the designation of Nineveh province as the theater main effort?

   MND-C was coalition forces, MND-N was totally under U.S. which enabled focus of U.S. assets more easily. Primary an issue of controlling resource. Also, "bad guys" were in Anbar but Surge projects like the "Sons of Iraq" helped to mollify the situation there. Insurgent activity increased in Talifar and Mosul, and also along the Iranian border. The less hazardous option was to conduct operations in Mosul and Talifar and not risk some type of confrontation along the board.

2. Did these factors focus on civil / socio-economic issues or was the focus more toward security issues?

   Security was primary but used the political, economic threads to hep to support and maintain security. There was a PRT in Mosul and the regional U.S. Embassy which would provide good support to Stability efforts.

3. What procedures were used in the analysis of the Post-Surge Operational Environment (OE)?

   Unsure if an actual analysis process was used beyond security and the ability to leverage the U.S. Regional Embassy.

4. Were the conditions, circumstances, and influences affecting force capabilities and bearing on the commander's decisions geographically displayed in an integrated fashion? If so, did it effectively aid in the decision to designate Nineveh province as the theater main effort?

   The COP was strictly kinetic. There was some infrastructure but not a Stability COP.

Questionnaire #1 Participant #3

The "Surge" in context of Operation Iraqi Freedom (OIF) is the military operation intended to help the Iraqi Government to secure neighborhoods, protect the local population, and provide security within the Baghdad and Al Anbar Provinces through the use of an increased American tactical presence. Once this offensive military operation was deemed effective, a transition to Stability Operations was conducted. Stability operations are best summarized as various coordinated mission conducted to maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief. The general start time period of this Post-Surge Stability Operation is September-October 2008 with the theater main effort located in the city of Mosul, Nineveh province of northern Iraq.

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This first round of questions are open-ended ones designed to establish why and how the Nineveh province was selected as the main effort. The questions are meant to describe the procedure(s) used to identify and describe the Post-Surge composite civil OE and how this OE was used in the designation of the main effort area.

1. What were the factors leading to the designation of Nineveh province as the theater main effort?

   It was not readily apparent to this participant that Mosul was the post-Surge main effort.

2. Did these factors focus on civil / socio-economic issues or was the focus more toward security issues?

   It was approximately equal between security and other socio-economic issues. The OE still needed security but stability began to emerge as an equal piece. As the security increased it gave greater possibility for stability operations.

3. What procedures were used in the analysis of the Post-Surge Operational Environment (OE)?

   While both PMESII and DIME were used, the most important thing was the decentralization of effort; getting off the large FOB into the communities. Greater integration among the population countering the enemies influence.

4. Were the conditions, circumstances, and influences affecting force capabilities and bearing on the commander's decisions geographically displayed in an integrated

fashion? If so, did it effectively aid in the decision to designate Nineveh province as the theater main effort?

The participant did not see any of these socio-economic issues place on the map for analysis.

Questionnaire #1 Participant #4

The “Surge” in context of Operation Iraqi Freedom (OIF) is the military operation intended to help the Iraqi Government to secure neighborhoods, protect the local population, and provide security within the Baghdad and Al Anbar Provinces through the use of an increased American tactical presence. Once this offensive military operation was deemed effective, a transition to Stability Operations was conducted. Stability operations are best summarized as various coordinated mission conducted to maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief. The general start time period of this Post-Surge Stability Operation is September-October 2008 with the theater main effort located in the city of Mosul, Nineveh province of northern Iraq.

In order to effectively conduct any military operation, there must be an understanding of the Operational Environment (OE). The OE is a composite analysis of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander. The geographical representation of the OE is known as a Common Operating Picture (COP) and is difficult to achieve during Stability Operations due to general characteristics of socio-economic data not being readily practical for meaningful graphical presentation. Both the OE and resulting COP presentation can and should aid the analysis of where Stability Operations should be conducted.

This first round of questions are open-ended ones designed to establish why and how the Nineveh province was selected as the main effort. The questions are meant to describe the procedure(s) used to identify and describe the Post-Surge composite civil OE and how this OE was used in the designation of the main effort area.

1. What were the factors leading to the designation of Nineveh province as the theater main effort?

While Baghdad had the largest pop, there were multiple fracture lines (Sunni/Shia/Kurd) with the added issues of the northern provinces bordering Syria and Turkey. There was internal political conflict within the U.S. Army command. In 2006 the al-Askari Mosque (Shi’a Shrine - City of Samarra) was bombed with accusations between the Shai and Sunni factions and the al-Qaeda insurgents being blamed. Problems between the ethnic / religious factions became paramount in the post-Surge Operational Environment. Problems between the ethnic / religious factions became paramount in the post-Surge Operational Environment.

2. Did these factors focus on civil / socio-economic issues or was the focus more toward security issues?

Security became the most important issue.

3. What procedures were used in the analysis of the Post-Surge Operational Environment (OE)?

From 2004 to 2007 there was a combative focus and there was a relation that the Iraqi. The analysis was more focused on troop to task. There was little analysis on the root causes of the violence.

4. Were the conditions, circumstances, and influences affecting force capabilities and bearing on the commander's decisions geographically displayed in an integrated fashion? If so, did it effectively aid in the decision to designate Nineveh province as the theater main effort?

There were "heat maps" created but it focused permissive area, points of market locations, etc. It was not certain if that information when upward. Much of spatial data was not able to be place on CPOF due to difficulty of technical issue and concern on information overload with combat COP.

Questionnaire #2 Participant # 1

In this second round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is an analytic approach for solution to the problem of where should the main effort for post Surge Stability Operations be designated (i.e. which Iraqi municipality). This involves the ranking of criteria in a similar procedure used in the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.

Each Delphi panel participant is asked to rank-order the interrelated operational variables used by the U.S. military to analyze the 2008 Post-Surge OE. Known as PMESII, these operational variables are: political, military, economic, social, information, and infrastructure. They are the criterion for analysis. This set of criterion was selected due its pervasive use as aspects of the operational environment describing not only the military aspects but also the population's influence on it. The populace's influence is a key factor in the effectiveness of Stability Operations.

The ranking procedure is from one (1) to six (6) with one having the greatest priority. A composite ranking will be developed using the median value for each of the PMESII operational criterion.

1 POLITICAL

2 MILITARY

4 ECONOMIC

6 SOCIAL

3 INFORMATION

5 INFRASTRUCTURE

Questionnaire #2 Participant # 2

In this second round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is an analytic approach for solution to the problem of where should the main effort for post Surge Stability Operations be designated (i.e. which Iraqi municipality). This involves the ranking of criteria in a similar procedure used in the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.

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The ranking procedure is from one (1) to six (6) with one having the greatest priority. A composite ranking will be developed using the median value for each of the PMESII operational criterion.

1 POLITICAL

2 MILITARY

6 ECONOMIC

3 SOCIAL

5 INFORMATION

Questionnaire #2 Participant # 3

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The ranking procedure is from one (1) to six (6) with one having the greatest priority. A composite ranking will be developed using the median value for each of the PMESII operational criterion.

2 POLITICAL

5 MILITARY

3 ECONOMIC

6 SOCIAL

1 INFORMATION

4 INFRASTRUCTURE

Questionnaire #2 Participant # 4

In this second round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is an analytic approach for solution to the problem of where should the main effort for post Surge Stability Operations be designated (i.e. which Iraqi municipality). This involves the ranking of criteria in a similar procedure used in the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.

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The ranking procedure is from one (1) to six (6) with one having the greatest priority. A composite ranking will be developed using the median value for each of the PMESII operational criterion.

3 POLITICAL

1 MILITARY

5 ECONOMIC

4 SOCIAL

6 INFORMATION

2 INFRASTRUCTURE

Questionnaire #3 Participant # 1

In this third round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is a continuation of the analytic approach solution to where the main effort for post Surge Stability Operations should be designated (i.e. in which Iraqi municipality). This involves construction of a set of pairwise comparison matrices. Each of the PMESII operational criterion, in rank order, are compared to the PMESII criterion in the level immediately below with respect to its rank. These pairwise comparisons results in weights for application to each PMESII value within each Iraqi province. Again, this is a similar procedure used within the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.

Each Delphi panel participant is asked to prioritize the rank-ordered PMESII operational criterion by pair-wise comparing them for preference. The numbered scale serves as an indication of how many times more important one PMESII criterion is over another. Comparing the results from the pair-wise comparison method called a relative model to these results from the ratings model. The table below demonstrates the scale.

Intensity of Importance	Definition	Explanation
1	Equal Importance	The row criterion is valued equal to the column criterion
3	Moderate importance	The row criterion is valued slightly more important to the column criterion
5	Strong importance	The row criterion is valued more important to the column criterion
7	Very strong importance	The row criterion is valued intensely more important to the column criterion
9	Extreme importance	The row criterion is valued exceptionally more important to the column criterion
Intensities of 2,4,6, and 8 are used for intermediate values.		

Pairwise Absolute Number Comparison Scale

The pair-wise comparison procedure is conducted within a six-by-six matrix presented below. The order of each row and column is determined by the consolidated ranking conducted in the previous questionnaire. Each row criterion is compared individually to each column criterion within the matrix using the values as defined in the Pairwise Comparison Scale. Comparisons between the same criterion in both the row and column positions receives a value of one (criterion is valued equal to itself). This "diagonal row" is highlighted in yellow. Please enter the whole numbers in the unshaded cells. The reciprocal will be entered for you in its transpose position highlighted in gray.

	POLITICAL	MILITARY	INFRASTRUCTURE	INFORMATION	ECONOMIC	SOCIAL
POLITICAL	1	2	4	3	5	6
MILITARY		1	4	3	5	6
INFRASTRUCTURE			1	¼	2	4
INFORMATION				1	4	5
ECONOMIC					1	3
SOCIAL						1

Pairwise Comparison Matrix

Questionnaire #3 Participant # 2

In this third round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is a continuation of the analytic approach solution to where the main effort for post Surge Stability Operations should be designated (i.e. in which Iraqi municipality). This involves construction of a set of pairwise comparison matrices. Each of the PMESII operational criterion, in rank order, are compared to the PMESII criterion in the level immediately below with respect to its rank. These pairwise comparisons results in weights for application to each PMESII value within each Iraqi province. Again, this is a similar procedure used within the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.

Each Delphi panel participant is asked to prioritize the rank-ordered PMESII operational criterion by pair-wise comparing them for preference. The numbered scale serves as an indication of how many times more important one PMESII criterion is over another. Comparing the results from the pair-wise comparison method called a relative model to these results from the ratings model. The table below demonstrates the scale.

Intensity of Importance	Definition	Explanation
1	Equal Importance	The row criterion is valued equal to the column criterion
3	Moderate importance	The row criterion is valued slightly more important to the column criterion
5	Strong importance	The row criterion is valued more important to the column criterion
7	Very strong importance	The row criterion is valued intensely more important to the column criterion
9	Extreme importance	The row criterion is valued exceptionally more important to the column criterion
Intensities of 2,4,6, and 8 are used for intermediate values.		

Pairwise Absolute Number Comparison Scale

The pair-wise comparison procedure is conducted within a six-by-six matrix presented below. The order of each row and column is determined by the consolidated ranking conducted in the previous questionnaire. Each row criterion is compared individually to each column criterion within the matrix using the values as defined in the Pairwise Comparison Scale. Comparisons between the same criterion in both the row and column positions receives a value of one (criterion is valued equal to itself). This "diagonal row" is highlighted in yellow. Please enter the whole numbers in the unshaded cells. The reciprocal will be entered for you in its transpose position highlighted in gray.

	POLITICAL	MILITARY	INFRASTRUCTURE	INFORMATION	ECONOMIC	SOCIAL
POLITICAL	1	1	2	3	7	1
MILITARY		1	3	2	9	2
INFRASTRUCTURE			1	¼	1	3
INFORMATION				1	6	1
ECONOMIC					1	2
SOCIAL						1

Pairwise Comparison Matrix

Questionnaire #3 Participant # 3

In this third round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is a continuation of the analytic approach solution to where the main effort for post Surge Stability Operations should be designated (i.e. in which Iraqi municipality). This involves construction of a set of pairwise comparison matrices. Each of the PMESII operational criterion, in rank order, are compared to the PMESII criterion in the level immediately below with respect to its rank. These pairwise comparisons results in weights for application to each PMESII value within each Iraqi province. Again, this is a similar procedure used within the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.

Each Delphi panel participant is asked to prioritize the rank-ordered PMESII operational criterion by pair-wise comparing them for preference. The numbered scale serves as an indication of how many times more important one PMESII criterion is over another. Comparing the results from the pair-wise comparison method called a relative model to these results from the ratings model. The table below demonstrates the scale.

Intensity of Importance	**Definition**	**Explanation**
1	**Equal Importance**	**The row criterion is valued equal to the column criterion**
3	**Moderate importance**	**The row criterion is valued slightly more important to the column criterion**
5	**Strong importance**	**The row criterion is valued more important to the column criterion**
7	**Very strong importance**	**The row criterion is valued intensely more important to the column criterion**
9	**Extreme importance**	**The row criterion is valued exceptionally more important to the column criterion**
Intensities of 2,4,6, and 8 are used for intermediate values.		

Pairwise Absolute Number Comparison Scale

The pair-wise comparison procedure is conducted within a six-by-six matrix presented below. The order of each row and column is determined by the consolidated ranking conducted in the previous questionnaire. Each row criterion is compared individually to each column criterion within the matrix using the values as defined in the Pairwise Comparison Scale. Comparisons between the same criterion in both the row and column positions receives a value of one (criterion is valued equal to itself). This "diagonal row" is highlighted in yellow. Please enter the whole numbers in the unshaded cells. The reciprocal will be entered for you in its transpose position highlighted in gray.

	POLITICAL	**MILITARY**	**INFRASTRUCTURE**	**INFORMATION**	**ECONOMIC**	**SOCIAL**
POLITICAL	1	1	2	1	2	2
MILITARY		1	5	2	2	2
INFRASTRUCTURE			1	1	2	1
INFORMATION				1	3	1
ECONOMIC					1	2
SOCIAL						1

Pairwise Comparison Matrix

Questionnaire #3 Participant # 4

In this third round your input will aid the establishment of a decisional Common Operation Picture (COP) for Post-Surge operational environment (OE). This is a continuation of the analytic approach solution to where the main effort for post Surge Stability Operations should be designated (i.e. in which Iraqi municipality). This involves construction of a set of pairwise comparison matrices. Each of the PMESII operational criterion, in rank order, are compared to the PMESII criterion in the level immediately below with respect to its rank. These pairwise comparisons results in weights for application to each PMESII value within each Iraqi province. Again, this is a similar procedure used within the Army's analytic approach known as the military decision making process (MDMP). In this case the Delphi participants are a proxy for the military staff within MDMP.

Each Delphi panel participant is asked to prioritize the rank-ordered PMESII operational criterion by pair-wise comparing them for preference. The numbered scale serves as an indication of how many times more important one PMESII criterion is over another. Comparing the results from the pair-wise comparison method called a relative model to these results from the ratings model. The table below demonstrates the scale.

Intensity of Importance	Definition	Explanation
1	Equal Importance	The row criterion is valued equal to the column criterion
3	Moderate importance	The row criterion is valued slightly more important to the column criterion
5	Strong importance	The row criterion is valued more important to the column criterion
7	Very strong importance	The row criterion is valued intensely more important to the column criterion
9	Extreme importance	The row criterion is valued exceptionally more important to the column criterion
Intensities of 2,4,6, and 8 are used for intermediate values.		

Pairwise Absolute Number Comparison Scale

The pair-wise comparison procedure is conducted within a six-by-six matrix presented below. The order of each row and column is determined by the consolidated ranking conducted in the previous questionnaire. Each row criterion is compared individually to each column criterion within the matrix using the values as defined in the Pairwise Comparison Scale. Comparisons between the same criterion in both the row and column positions receives a value of one (criterion is valued equal to itself). This "diagonal row" is highlighted in yellow. Please enter the whole numbers in the unshaded cells. The reciprocal will be entered for you in its transpose position highlighted in gray.

	POLITICAL	MILITARY	INFRASTRUCTURE	INFORMATION	ECONOMIC	SOCIAL
POLITICAL	1	2	4	6	4	5
MILITARY		1	4	7	5	4
INFRASTRUCTURE			1	6	2	2
INFORMATION				1	1	2
ECONOMIC					1	2
SOCIAL						1

Pairwise Comparison Matrix

AHP Calculations

PMESII Variable	Median	Spread	Final Rank
POLITICAL	1.5	2	1
MILITARY	2	4	2
ECONOMIC	4.5	3	5
SOCIAL	5	3	6
INFORMATION	4	5	4
INFRASTRUCTURE	4	3	3

Median Average of Participants' Rankings
Table 15

PMESII Variable	Median	Spread	Final Rank
POLITICAL	1.5	2	1
MILITARY	2	4	2
INFRASTRUCTURE	4	3	3
INFORMATION	4	5	4
ECONOMIC	4.5	3	5
SOCIAL	5	3	6

Median Average of Participants' Rankings in Rank Order
Table 16

	POLITICAL	MILITARY	INFRASTRUCTURE	INFORMATION	ECONOMIC	SOCIAL
POLITICAL	1.00	1.50	3.00	3.00	4.50	3.50
MILITARY	0.67	1.00	4.00	2.50	5.00	3.00
INFRASTRUCTURE	0.33	0.33	1.00	0.63	2.00	2.50
INFORMATION	0.33	0.40	1.60	1.00	3.50	1.50
ECONOMIC	0.22	0.20	0.50	0.29	1.00	2.00
SOCIAL	0.29	0.33	0.40	0.67	0.50	1.00

Median Average of Participants' Pairwise Comparisons
Table 17

	POLITICAL	MILITARY	INFRASTRUCTURE	INFORMATION	ECONOMIC	SOCIAL
POLITICAL	1	2	3	3	5	4
MILITARY	2/3	1	4	3	5	3
INFRASTRUCTURE	1/3	1/3	1	1/2	2	3
INFORMATION	1/3	2/5	8/5	1	4	2
ECONOMIC	2/9	1/5	½	2/7	1	2
SOCIAL	2/7	1/3	2/5	2/3	½	1

Median Average of Participants' Pairwise Comparisons (Fractional Format)
Table 18

	POLITICAL	MILITARY	INFRASTRUCTURE	INFORMATION	ECONOMIC	SOCIAL
POLITICAL	1	2	3	3	5	4
MILITARY	1/2	1	4	3	5	3
INFRASTRUCTURE	1/3	1/4	1	1/2	2	3
INFORMATION	1/3	1/5	2	1	4	2
ECONOMIC	1/5	1/5	½	1/4	1	2
SOCIAL	1/4	1/3	2/5	1/2	1/2	1

Median Average of Participants' Pairwise Comparisons (Rounded Fractional Format)
Table 19

This is the format used in the model from SCB Associates of London, England. The model rounds values to fractions containing a numerator of one if the value is not equal or greater than one.

Base and PMESII SQL Queries of the GDELT Database

Base Data Query

SELECT [200809Data].SQLDATE, [200809Data].MonthYear, EventFullCode.E_FullCode_Descr, [200809Data].EventCode, EventBaseCode.E_BaseCode_Descr, [200809Data].EventBaseCode, EventRootCode.E_RootCode_Descr, [200809Data].EventRootCode, [200809Data].NumArticles, [200809Data].AvgTone, [200809Data].ActionGeo_Lat, [200809Data].ActionGeo_Long, [200809Data].ActionGeo_CountryCode, [200809Data].ActionGeo_FullName, [200809Data].ActionGeo_Type, [200809Data].Actor1Geo_FullName, [200809Data].Actor1Geo_CountryCode, [200809Data].Actor1Geo_ADM1Code

FROM ((200809Data INNER JOIN EventBaseCode ON [200809Data].EventBaseCode = EventBaseCode.EventBaseCode) INNER JOIN EventRootCode ON [200809Data].EventRootCode = EventRootCode.EventRootCode) INNER JOIN EventFullCode ON [200809Data].EventCode = EventFullCode.EventFullCode

WHERE ((([200809Data].ActionGeo_CountryCode)="IZ") AND (([200809Data].ActionGeo_FullName)<>"Iraq") AND (([200809Data].Actor1Geo_CountryCode)="IZ"));

Military Data Sub Query

SELECT [Base Query].SQLDATE, [Base Query].MonthYear, [Base Query].E_FullCode_Descr, [Base Query].EventCode, [Base Query].E_BaseCode_Descr, [Base Query].EventBaseCode, [Base Query].E_RootCode_Descr, [Base Query].EventRootCode, [Base Query].NumArticles, [Base Query].AvgTone, [Base Query].ActionGeo_Lat, [Base Query].ActionGeo_Long, [Base Query].ActionGeo_CountryCode, [Base Query].ActionGeo_FullName, [Base Query].ActionGeo_Type

FROM [Base Query]

WHERE ((([Base Query].E_FullCode_Descr) Like "*Military*") AND (([Base Query].E_RootCode_Descr)<>"PROVIDE AID"));

Political Data Sub Query

SELECT [Base Query].SQLDATE, [Base Query].MonthYear, [Base Query].E_FullCode_Descr, [Base Query].EventCode, [Base Query].E_BaseCode_Descr, [Base Query].EventBaseCode, [Base Query].E_RootCode_Descr, [Base Query].EventRootCode, [Base Query].NumArticles, [Base Query].AvgTone, [Base Query].ActionGeo_Lat, [Base Query].ActionGeo_Long, [Base

Query].ActionGeo_CountryCode, [Base Query].ActionGeo_FullName, [Base Query].ActionGeo_Type

FROM [Base Query]

WHERE ((([Base Query].E_FullCode_Descr) Like "*Political*" Or ([Base Query].E_FullCode_Descr) Like "*Policy*") AND (([Base Query].E_RootCode_Descr)<>"MAKE PUBLIC STATEMENT"));

Economic Data Sub Query

SELECT [Base Query].SQLDATE, [Base Query].MonthYear, [Base Query].E_FullCode_Descr, [Base Query].EventCode, [Base Query].E_BaseCode_Descr, [Base Query].EventBaseCode, [Base Query].E_RootCode_Descr, [Base Query].EventRootCode, [Base Query].NumArticles, [Base Query].AvgTone, [Base Query].ActionGeo_Lat, [Base Query].ActionGeo_Long, [Base Query].ActionGeo_CountryCode, [Base Query].ActionGeo_FullName, [Base Query].ActionGeo_Type

FROM [Base Query]

WHERE ((([Base Query].E_FullCode_Descr) Like "*Econ*") AND (([Base Query].E_RootCode_Descr)<>"PROVIDE AID")) OR ((([Base Query].E_FullCode_Descr) Like "*material*") AND (([Base Query].E_RootCode_Descr)<>"PROVIDE AID"));

Social Data Sub Query

SELECT [Base Query].SQLDATE, [Base Query].MonthYear, [Base Query].E_FullCode_Descr, [Base Query].EventCode, [Base Query].E_BaseCode_Descr, [Base Query].EventBaseCode, [Base Query].E_RootCode_Descr, [Base Query].EventRootCode, [Base Query].NumArticles, [Base Query].AvgTone, [Base Query].ActionGeo_Lat, [Base Query].ActionGeo_Long, [Base Query].ActionGeo_CountryCode, [Base Query].ActionGeo_FullName, [Base Query].ActionGeo_Type

FROM [Base Query]

WHERE ((([Base Query].E_FullCode_Descr) Like "*religious*" Or ([Base Query].E_FullCode_Descr) Like "*ethnic*" Or ([Base Query].E_FullCode_Descr) Like "*cultural*" Or ([Base Query].E_FullCode_Descr) Like "*Education*" Or ([Base Query].E_FullCode_Descr) Like "*Crim*" Or ([Base Query].E_FullCode_Descr) Like "*judicial*" Or ([Base Query].E_FullCode_Descr) Like "*population*" Or ([Base Query].E_FullCode_Descr) Like "*human rights*" Or ([Base Query].E_FullCode_Descr) Like "*demograph*" Or ([Base Query].E_FullCode_Descr) Like "*social*"));

Information Data Sub Query

SELECT [Base Query].SQLDATE, [Base Query].MonthYear, [Base Query].E_FullCode_Descr, [Base Query].EventCode, [Base Query].E_BaseCode_Descr, [Base Query].EventBaseCode, [Base Query].E_RootCode_Descr, [Base Query].EventRootCode, [Base Query].NumArticles, [Base Query].AvgTone, [Base Query].ActionGeo_Lat, [Base Query].ActionGeo_Long, [Base Query].ActionGeo_CountryCode, [Base Query].ActionGeo_FullName, [Base Query].ActionGeo_Type

FROM [Base Query]

WHERE ((([Base Query].E_FullCode_Descr) Like "*Information*")) OR ((([Base Query].EventCode)>9 And ([Base Query].EventCode)<19));

Infrastructure Data Sub Query

SELECT [Base Query].SQLDATE, [Base Query].MonthYear, [Base Query].E_FullCode_Descr, [Base Query].EventCode, [Base Query].E_BaseCode_Descr, [Base Query].EventBaseCode, [Base Query].E_RootCode_Descr, [Base Query].EventRootCode, [Base Query].NumArticles, [Base Query].AvgTone, [Base Query].ActionGeo_Lat, [Base Query].ActionGeo_Long, [Base Query].ActionGeo_CountryCode, [Base Query].ActionGeo_FullName, [Base Query].ActionGeo_Type

FROM [Base Query]

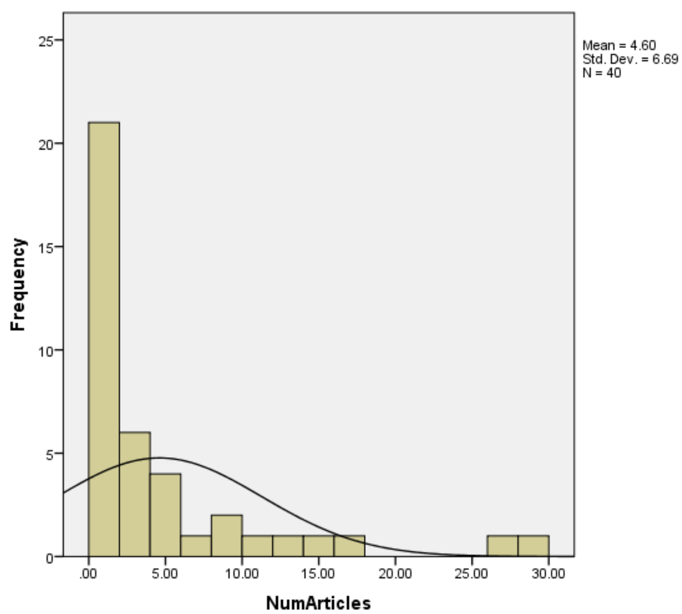
WHERE ((([Base Query].E_FullCode_Descr) Like "*Infrastructure*" Or ([Base Query].E_FullCode_Descr) Like "*Property*"));

Exploratory Data Analysis Statistical Charts

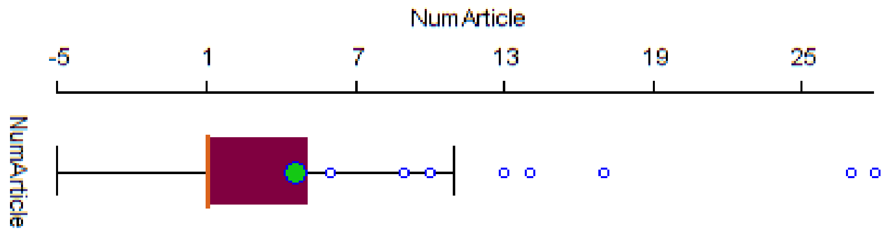
Descriptives

			Statistic	Std. Error
NumArticles	Mean		4.60	1.058
	95% Confidence Interval for Mean	Lower Bound	2.46	
		Upper Bound	6.74	
	5% Trimmed Mean		3.53	
	Median		1.00	
	Variance		44.759	
	Std. Deviation		6.690	
	Minimum		1	
	Maximum		28	
	Range		27	
	Interquartile Range		4	
	Skewness		2.400	.374
	Kurtosis		5.614	.733

Political NumArticles Summary Statistics
Table 20



Political NumArticles Histogram
Figure 52



Political NumArticles Box Plot
Figure 53

One-Sample Kolmogorov-Smirnov Test

		z-score NumArticle
N		40
Normal Parameters[a,b]	Mean	-.266747257
	Std. Deviation	5.643969285
Most Extreme Differences	Absolute	.326
	Positive	.326
	Negative	-.295
Test Statistic		.326
Asymp. Sig. (2-tailed)		.000[c]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

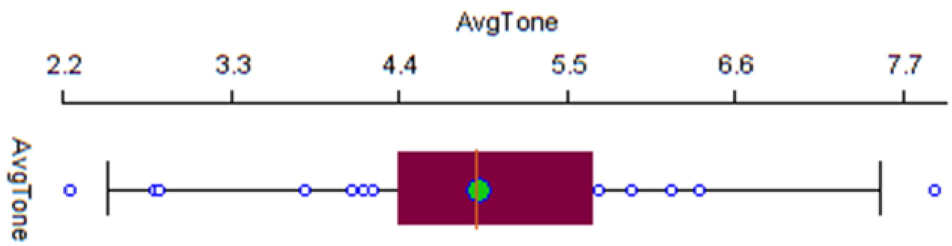
Political NumArticles Normality Test
Table 21

Descriptives

			Statistic	Std. Error
AvgTone	Mean		4.916195281	.1874240964
	95% Confidence Interval for Mean	Lower Bound	4.537094263	
		Upper Bound	5.295296299	
	5% Trimmed Mean		4.941519741	
	Median		4.888779416	
	Variance		1.405	
	Std. Deviation		1.185374066	
	Minimum		2.242152466	
	Maximum		7.903873406	
	Range		5.661720939	
	Interquartile Range		1.344608787	
	Skewness		-.435	.374
	Kurtosis		.769	.733

Political AvgTone Summary Statistics
Table 22

Political AvgTone Histograms
Figure 54



Political AvgTone Box Plot
Figure 55

One-Sample Kolmogorov-Smirnov Test

		AvgTone
N		40
Normal Parameters[a,b]	Mean	4.916195281
	Std. Deviation	1.185374066
Most Extreme Differences	Absolute	.125
	Positive	.087
	Negative	-.125
Test Statistic		.125
Asymp. Sig. (2-tailed)		.118[c]

a. Test distribution is Normal.

b. Calculated from data.

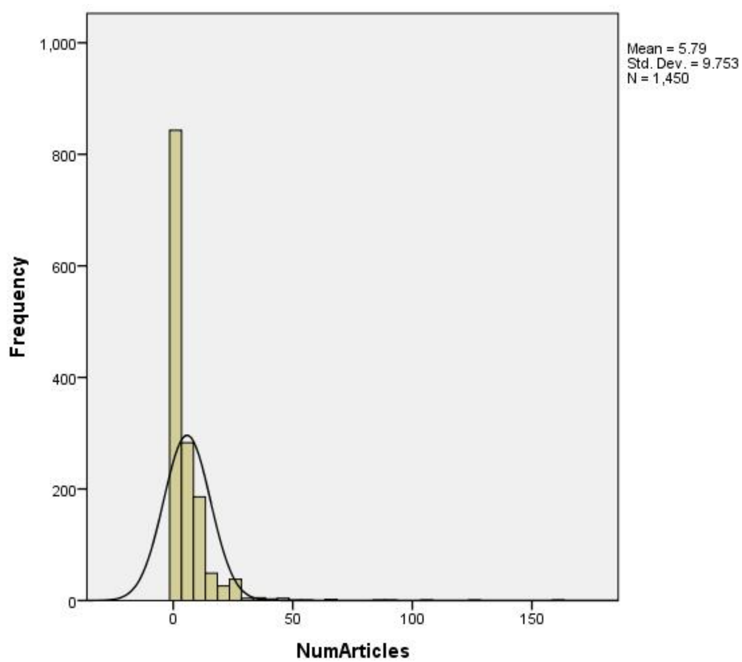
c. Lilliefors Significance Correction.

Political AvgTone Normality Test
Table 23

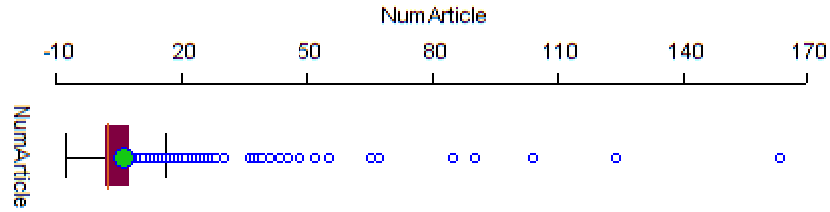
Descriptives

			Statistic	Std. Error
NumArticles	Mean		5.79	.256
	95% Confidence Interval for Mean	Lower Bound	5.28	
		Upper Bound	6.29	
	5% Trimmed Mean		4.36	
	Median		2.00	
	Variance		95.120	
	Std. Deviation		9.753	
	Minimum		1	
	Maximum		163	
	Range		162	
	Interquartile Range		6	
	Skewness		6.901	.064
	Kurtosis		77.884	.128

Military NumArticle Summary Statistics
Table 24



Military NumArticles Histogram
Figure 56



Military NumArticle Box Plot
Figure 57

One-Sample Kolmogorov-Smirnov Test

		NumArticles
N		1450
Normal Parameters[a,b]	Mean	5.79
	Std. Deviation	9.753
Most Extreme Differences	Absolute	.312
	Positive	.232
	Negative	-.312
Test Statistic		.312
Asymp. Sig. (2-tailed)		.000[c]

a. Test distribution is Normal.

b. Calculated from data.

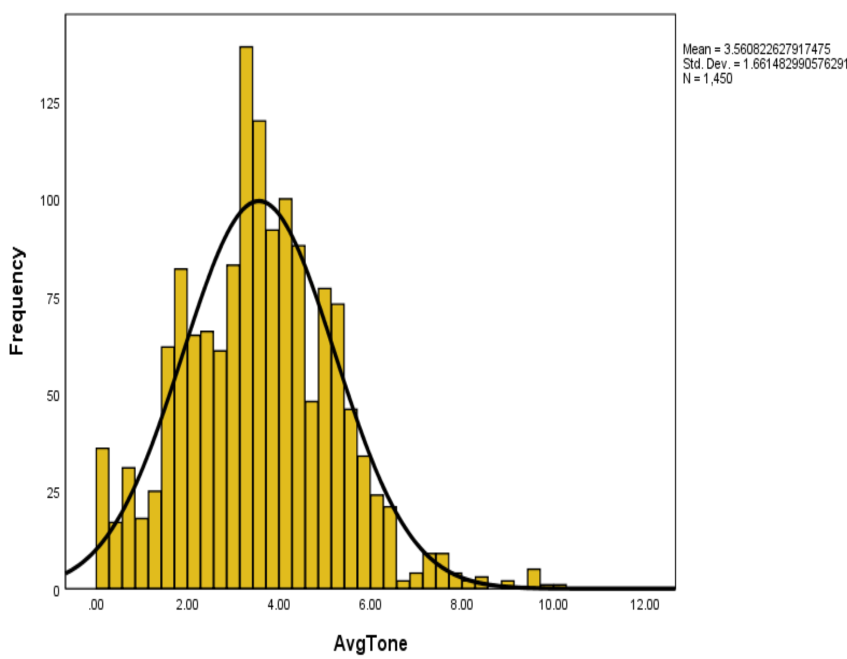
c. Lilliefors Significance Correction.

Military NumArticle Normality Test
Table 25

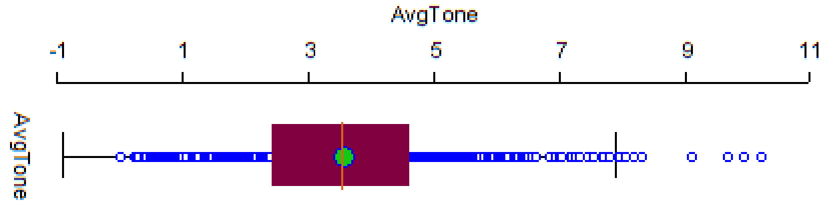
Descriptives

			Statistic	Std. Error
AvgTone	Mean		3.560822628	.0436326809
	95% Confidence Interval for Mean	Lower Bound	3.475232652	
		Upper Bound	3.646412604	
	5% Trimmed Mean		3.536001355	
	Median		3.513174404	
	Variance		2.761	
	Std. Deviation		1.661482991	
	Minimum		.0000000000	
	Maximum		10.22727273	
	Range		10.22727273	
	Interquartile Range		2.211547494	
	Skewness		.289	.064
	Kurtosis		.567	.128

Military AvgTone Summary Statistics
Table 26



Military AvgTone Histogram
Figure 58



Military AvgTone Box-Plot
Figure 59

One-Sample Kolmogorov-Smirnov Test

		AvgTone
N		1450
Normal Parameters[a,b]	Mean	3.560822628
	Std. Deviation	1.661482991
Most Extreme Differences	Absolute	.029
	Positive	.025
	Negative	-.029
Test Statistic		.029
Asymp. Sig. (2-tailed)		.006[c]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

Military AvgTone Normality Test
Table 27

Descriptives

			Statistic	Std. Error
NumArticles	Mean		5.79	.870
	95% Confidence Interval for Mean	Lower Bound	4.07	
		Upper Bound	7.50	
	5% Trimmed Mean		3.49	
	Median		2.00	
	Variance		195.406	
	Std. Deviation		13.979	
	Minimum		1	
	Maximum		163	
	Range		162	
	Interquartile Range		4	
	Skewness		7.365	.152
	Kurtosis		69.009	.302

Economic NumArticles Summary Statistics
Table 28

One-Sample Kolmogorov-Smirnov Test

		NumArticles
N		258
Normal Parameters[a,b]	Mean	5.79
	Std. Deviation	13.979
Most Extreme Differences	Absolute	.366
	Positive	.335
	Negative	-.366
Test Statistic		.366
Asymp. Sig. (2-tailed)		.000[c]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

Economic NumArticles Normality Test
Table 29

Descriptives

			Statistic	Std. Error
AvgTone	Mean		4.645497534	.1097216680
	95% Confidence Interval for Mean	Lower Bound	4.429429511	
		Upper Bound	4.861565557	
	5% Trimmed Mean		4.637206477	
	Median		4.753521127	
	Variance		3.106	
	Std. Deviation		1.762390950	
	Minimum		.0000000000	
	Maximum		12.13636364	
	Range		12.13636364	
	Interquartile Range		2.155157412	
	Skewness		.134	.152
	Kurtosis		.755	.302

Economic AvgTone Summary Statistics
Table 30

One-Sample Kolmogorov-Smirnov Test

		AvgTone
N		258
Normal Parameters[a,b]	Mean	4.645497534
	Std. Deviation	1.762390950
Most Extreme Differences	Absolute	.054
	Positive	.037
	Negative	-.054
Test Statistic		.054
Asymp. Sig. (2-tailed)		.069[c]

a. Test distribution is Normal.

b. Calculated from data.

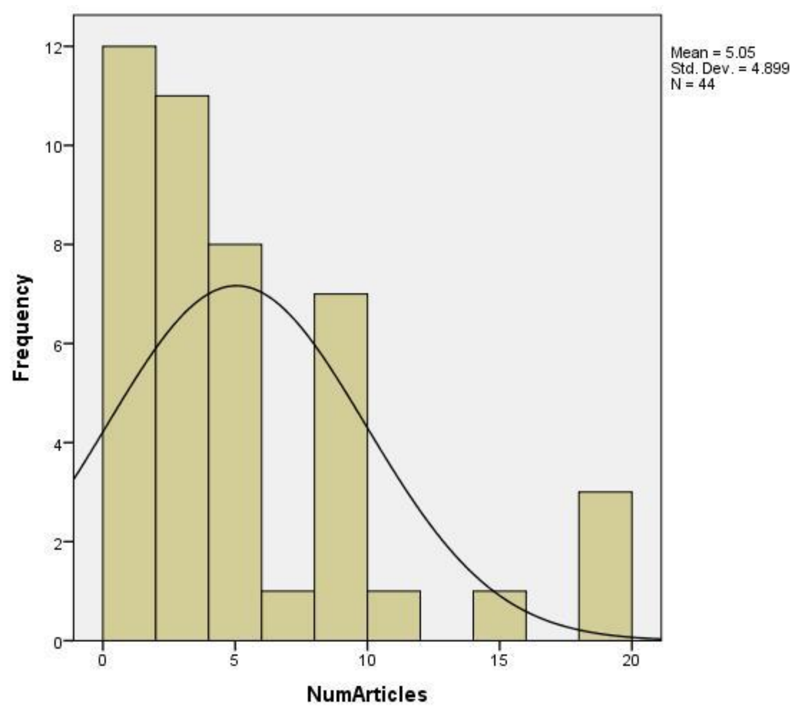
c. Lilliefors Significance Correction.

Economic AvgTone Normality Test
Table 31

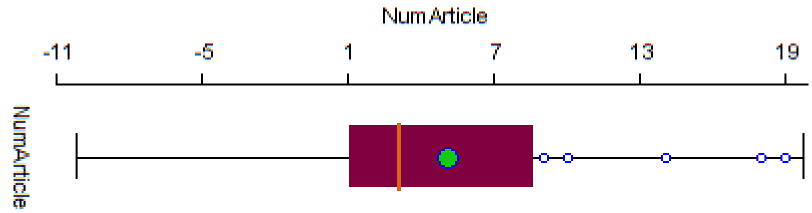
Descriptives

			Statistic	Std. Error
NumArticles	Mean		5.05	.739
	95% Confidence Interval for Mean	Lower Bound	3.56	
		Upper Bound	6.53	
	5% Trimmed Mean		4.53	
	Median		3.00	
	Variance		23.998	
	Std. Deviation		4.899	
	Minimum		1	
	Maximum		19	
	Range		18	
	Interquartile Range		8	
	Skewness		1.501	.357
	Kurtosis		1.741	.702

Social NumArticle Summary Statistics
Table 32



Social NumArticles Histogram
Figure 60



Social NumArticles Box-Plot
Figure 61

One-Sample Kolmogorov-Smirnov Test

		NumArticles
N		44
Normal Parameters[a,b]	Mean	5.05
	Std. Deviation	4.899
Most Extreme Differences	Absolute	.210
	Positive	.210
	Negative	-.204
Test Statistic		.210
Asymp. Sig. (2-tailed)		.000[c]

a. Test distribution is Normal.

b. Calculated from data.

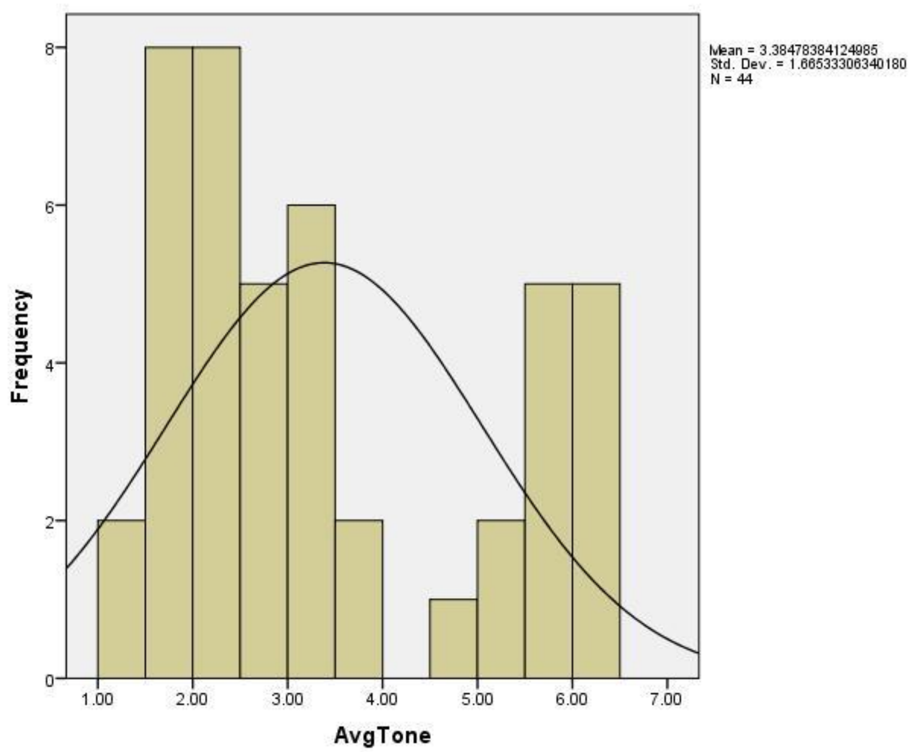
c. Lilliefors Significance Correction.

Social NumArticle Normality Test
Table 33

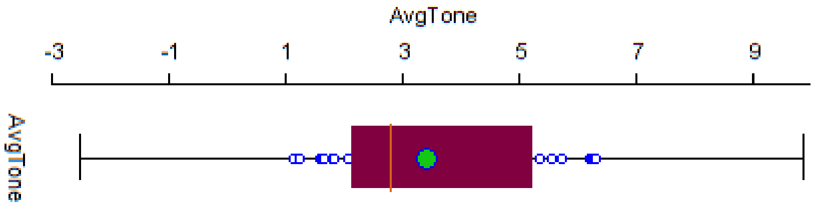
Descriptives

			Statistic	Std. Error
AvgTone	Mean		3.384783841	.2510584056
	95% Confidence Interval for Mean	Lower Bound	2.878476313	
		Upper Bound	3.891091369	
	5% Trimmed Mean		3.344858869	
	Median		2.766723779	
	Variance		2.773	
	Std. Deviation		1.665333063	
	Minimum		1.109057301	
	Maximum		6.300813008	
	Range		5.191755707	
	Interquartile Range		3.194423986	
	Skewness		.600	.357
	Kurtosis		-1.110	.702

Social AvgTone Summary Statistics
Table 34



Social AvgTone Histogram
Figure 62



Social AvgTone Box-Plot
Figure 63

One-Sample Kolmogorov-Smirnov Test

		AvgTone
N		44
Normal Parameters[a,b]	Mean	3.384783841
	Std. Deviation	1.665333063
Most Extreme Differences	Absolute	.169
	Positive	.169
	Negative	-.129
Test Statistic		.169
Asymp. Sig. (2-tailed)		.003[c]

a. Test distribution is Normal.

b. Calculated from data.

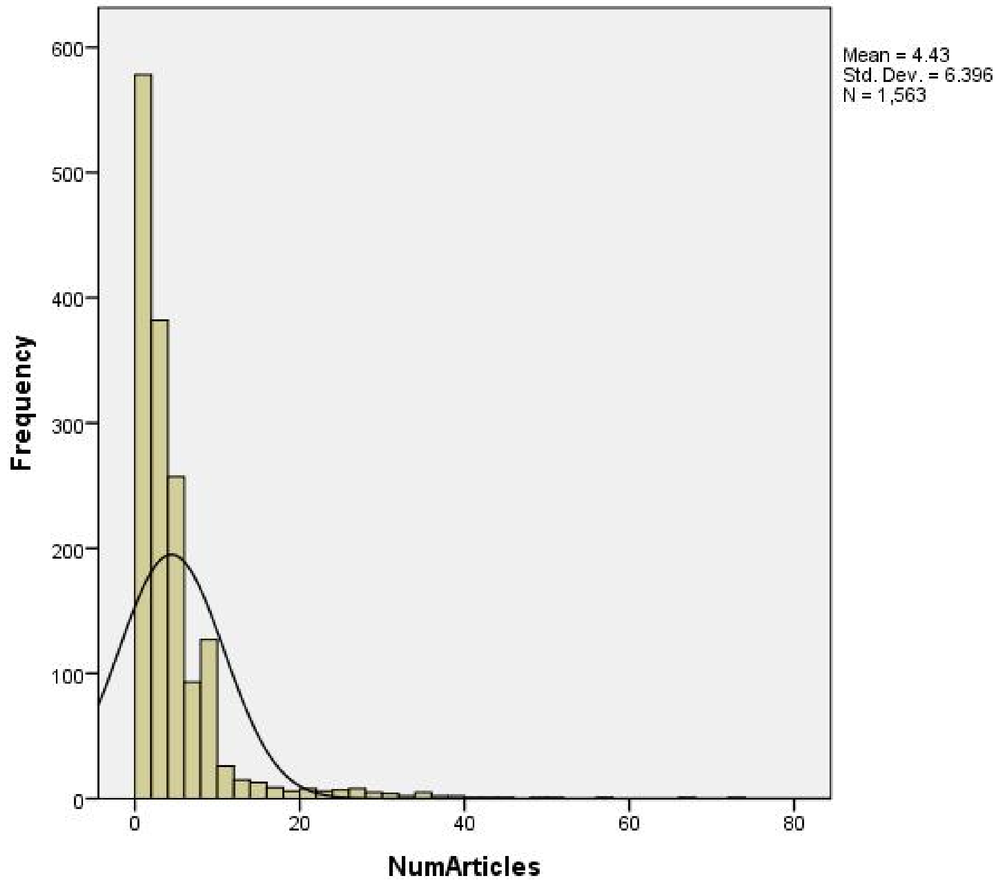
c. Lilliefors Significance Correction.

Social AvgTone Normality Test
Table 35

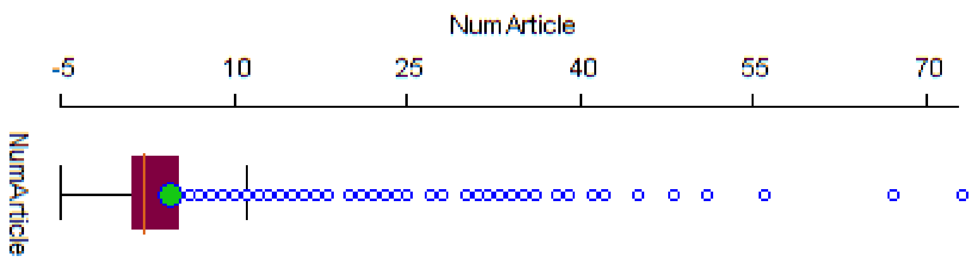
Descriptives

			Statistic	Std. Error
NumArticles	Mean		4.43	.162
	95% Confidence Interval for Mean	Lower Bound	4.11	
		Upper Bound	4.75	
	5% Trimmed Mean		3.37	
	Median		2.00	
	Variance		40.914	
	Std. Deviation		6.396	
	Minimum		1	
	Maximum		73	
	Range		72	
	Interquartile Range		4	
	Skewness		4.362	.062
	Kurtosis		26.988	.124

Information NumArticle Summary Statistics
Table 36



Information NumArticle Histogram
Figure 64



Information NumArticle Box-Plot
Figure 65

One-Sample Kolmogorov-Smirnov Test

		NumArticles
N		1563
Normal Parameters[a,b]	Mean	4.43
	Std. Deviation	6.396
Most Extreme Differences	Absolute	.296
	Positive	.252
	Negative	-.296
Test Statistic		.296
Asymp. Sig. (2-tailed)		.000[c]

a. Test distribution is Normal.

b. Calculated from data.

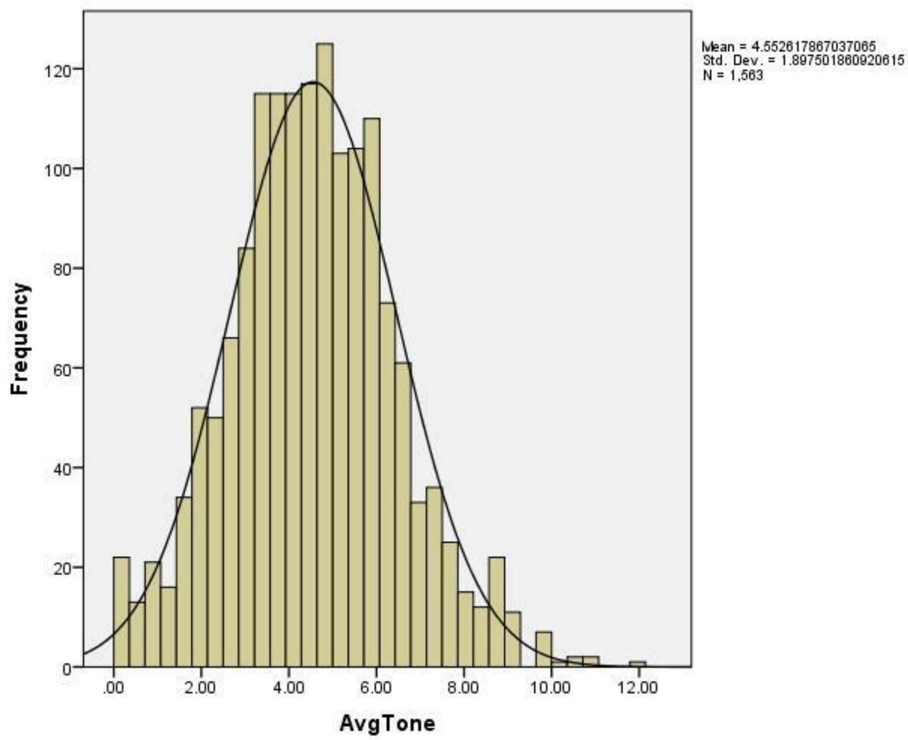
c. Lilliefors Significance Correction.

Information NumArticle Normality Test
Table 37

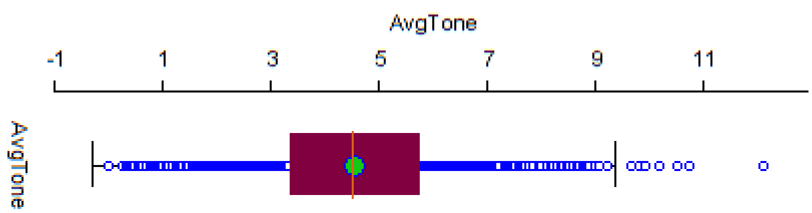
Descriptives

			Statistic	Std. Error
AvgTone	Mean		4.552617867	.0479957433
	95% Confidence Interval for Mean	Lower Bound	4.458474990	
		Upper Bound	4.646760744	
	5% Trimmed Mean		4.530721922	
	Median		4.491725768	
	Variance		3.601	
	Std. Deviation		1.897501861	
	Minimum		.0000000000	
	Maximum		12.13636364	
	Range		12.13636364	
	Interquartile Range		2.425828970	
	Skewness		.180	.062
	Kurtosis		.222	.124

Information AvgTone Summary Statistics
Table 38



Information AvgTone Histogram
Figure 66



Information AvgTone Box-Plot
Figure 67

One-Sample Kolmogorov-Smirnov Test

		AvgTone
N		1563
Normal Parameters[a,b]	Mean	4.552617867
	Std. Deviation	1.897501861
Most Extreme Differences	Absolute	.027
	Positive	.027
	Negative	-.018
Test Statistic		.027
Asymp. Sig. (2-tailed)		.010[c]

a. Test distribution is Normal.

b. Calculated from data.

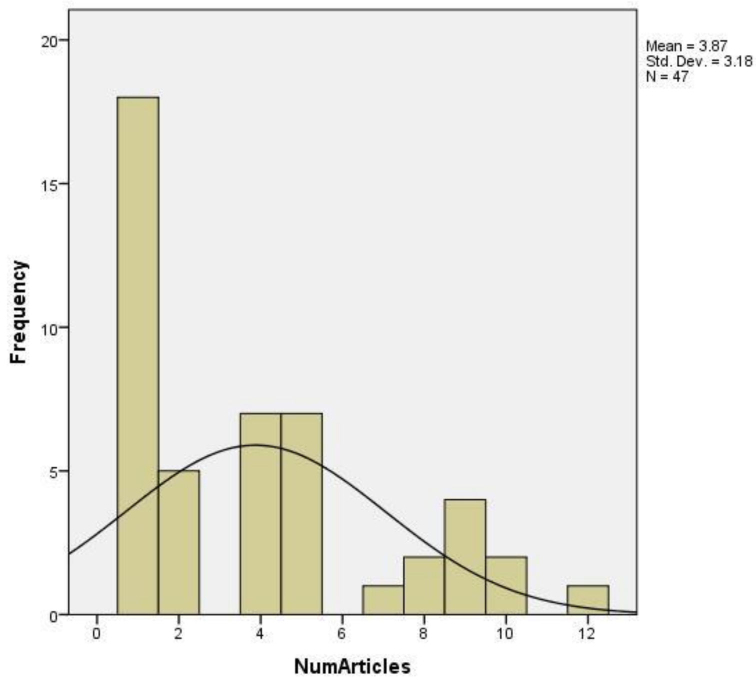
c. Lilliefors Significance Correction.

Information AvgTone Normality Test
Table 39

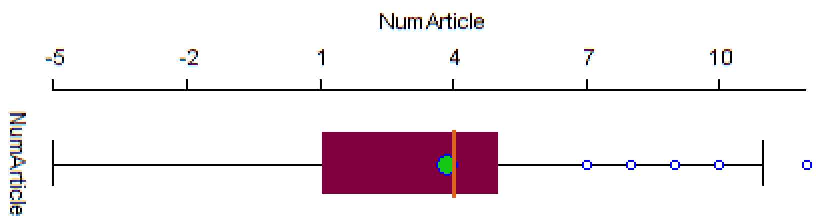
Descriptives

			Statistic	Std. Error
NumArticles	Mean		3.87	.464
	95% Confidence Interval for Mean	Lower Bound	2.94	
		Upper Bound	4.81	
	5% Trimmed Mean		3.64	
	Median		4.00	
	Variance		10.114	
	Std. Deviation		3.180	
	Minimum		1	
	Maximum		12	
	Range		11	
	Interquartile Range		4	
	Skewness		.888	.347
	Kurtosis		-.319	.681

Infrastructure NumArticles Summary Statistics
Table 40



Infrastructure NumArticles Histogram
Figure 68



Infrastructure NumArticles Box Plot
Figure 69

One-Sample Kolmogorov-Smirnov Test

		NumArticles
N		47
Normal Parameters[a,b]	Mean	3.87
	Std. Deviation	3.180
Most Extreme Differences	Absolute	.211
	Positive	.211
	Negative	-.183
Test Statistic		.211
Asymp. Sig. (2-tailed)		.000[c]

a. Test distribution is Normal.

b. Calculated from data.

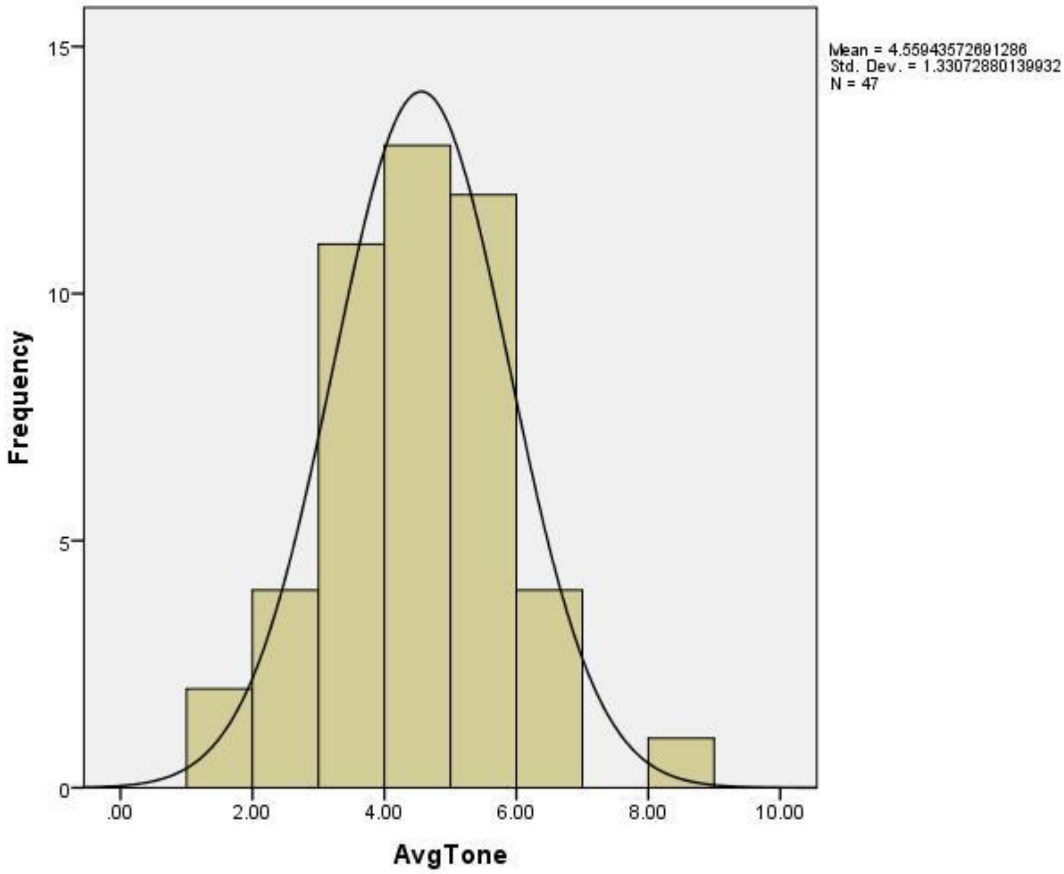
c. Lilliefors Significance Correction.

Infrastructure NumArticles Normality Test
Table 41

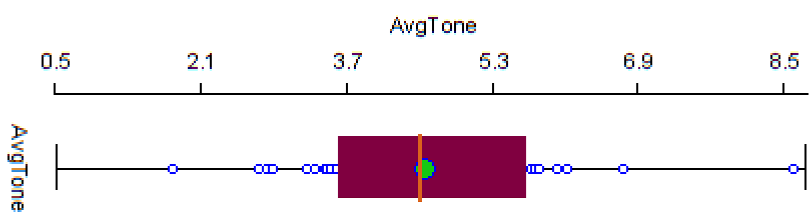
Descriptives

			Statistic	Std. Error
AvgTone	Mean		4.559435727	.1941067453
	95% Confidence Interval for Mean	Lower Bound	4.168719114	
		Upper Bound	4.950152340	
	5% Trimmed Mean		4.545313252	
	Median		4.500000000	
	Variance		1.771	
	Std. Deviation		1.330728801	
	Minimum		1.785714286	
	Maximum		8.608271375	
	Range		6.822557090	
	Interquartile Range		2.058319039	
	Skewness		.258	.347
	Kurtosis		.698	.681

Infrastructure AvgTone Summary Statistics
Table 42



Infrastructure AvgTone Histogram
Figure 70



Infrastructure AvgTone Box Plot
Figure 71

One-Sample Kolmogorov-Smirnov Test

		AvgTone
N		47
Normal Parameters[a,b]	Mean	4.559435727
	Std. Deviation	1.330728801
Most Extreme Differences	Absolute	.092
	Positive	.092
	Negative	-.076
Test Statistic		.092
Asymp. Sig. (2-tailed)		.200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

Infrastructure AvgTone Normality Test
Table 43

Resampled Statistics (Bootstrapping) Tables

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/5/2018 at 1:08:35 PM / End time: 7/5/2018 at 1:08:51 PM
Quantitative data: Workbook = PoliticalAspaitalData.xlsx / Sheet = Sheet1 / Range = 'Sheet1'!$C$1:$C$41 / 40 rows and 1 column
Method: Bootstrap
Sample size: 40
Number of samples: 1000
Significance level (%): 5
Seed (random numbers): 1253677953

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
NumArticles	40	0	40	1.000	28.000	4.600	6.690

Results of the resampling (NumArticles):

Parameters	Estimator	Estimator (Bootstrap)	Standard deviation (Bootstrap)	Lower bound (Standard bootstrap interval)	Upper bound (Standard bootstrap interval)	Lower bound (B.C. percentile interval)	Upper bound (B.C. percentile interval)
Sum	184.000	183.132	42.509	98.017	269.983	114.000	282.000
Mean	4.600	4.578	1.063	2.450	6.750	2.874	7.092
Variance (n)	43.640	42.238	17.621	7.998	79.282	13.330	84.206
Variance (n-1)	44.759	43.321	18.073	8.203	81.315	13.673	86.365
Standard deviation (n)	6.606	6.344	1.413	3.748	9.464	3.651	9.176
Standard deviation (n-1)	6.690	6.425	1.431	3.796	9.584	3.698	9.293
Median	1.000	1.410	0.542	-0.096	2.096	1.000	1.000
1st Quartile	1.000	1.001	0.024	0.952	1.048	1.000	1.000
3rd Quartile	5.000	5.167	2.347	0.253	9.747	2.000	9.250
Variation coefficient	1.436	1.394	0.166	1.100	1.772	1.149	1.773
Standard error of the mean	1.058	1.016	0.226	0.600	1.515	0.585	1.469
Mean absolute deviation	4.620	4.516	1.206	2.181	7.059	2.627	7.375
Median absolute deviation	0.000	0.410	0.542	-1.096	1.096	0.000	0.000
Geometric mean	2.299	2.330	0.407	1.476	3.122	1.714	3.362
Geometric standard deviation	2.958	2.907	0.320	2.311	3.605	2.378	3.636
Harmonic mean	1.558	1.575	0.159	1.237	1.879	1.315	1.956
1-Percentile	1.000	1.000	0.000	1.000	1.000	1.000	1.000
99-Percentile	27.610	24.808	4.351	18.808	36.412	13.000	28.000
2.5-Percentile	1.000	1.000	0.000	1.000	1.000	1.000	1.000
97.5-Percentile	27.025	22.577	6.215	14.454	39.596	10.075	28.000
5-Percentile	1.000	1.000	0.000	1.000	1.000	1.000	1.000
95-Percentile	17.500	18.447	6.427	4.500	30.500	9.050	28.000

Political NumArticles Resampled Statistics
Table 44

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/5/2018 at 1:59:35 PM / End time: 7/5/2018 at 1:59:51 PM
Quantitative data: Workbook = PoliticalAspaitalData.xlsx / Sheet = Sheet1 / Range = 'Sheet1'!e1:e41 / 40 rows and 1 column
Method: Bootstrap
Sample size: 40
Number of samples: 1000
Significance level (%): 5
Seed (random numbers): 817705740

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
AvgTone	40	0	40	2.242	7.904	4.916	1.185

Results of the resampling (AvgTone):

Parameters	Estimator	Estimator (Bootstrap)	Standard deviation (Bootstrap)	Lower bound (Standard bootstrap interval)	Upper bound (Standard bootstrap interval)	Lower bound (B.C. percentile interval)	Upper bound (B.C. percentile interval)
Sum	196.648	196.951	7.525	181.426	211.869	181.148	211.351
Mean	4.916	4.924	0.188	4.536	5.297	4.529	5.284
Variance (n)	1.370	1.336	0.340	0.681	2.059	0.814	2.203
Variance (n-1)	1.405	1.370	0.349	0.699	2.111	0.835	2.259
Standard deviation (n)	1.170	1.146	0.149	0.869	1.471	0.903	1.484
Standard deviation (n-1)	1.185	1.161	0.151	0.881	1.490	0.914	1.503
Median	4.889	5.017	0.194	4.496	5.281	4.706	5.250
1st Quartile	4.457	4.433	0.306	3.838	5.076	2.817	4.831
3rd Quartile	5.647	5.643	0.183	5.278	6.017	5.041	5.749
Variation coefficient	0.238	0.233	0.034	0.169	0.307	0.178	0.309
Standard error of the mean	0.187	0.184	0.024	0.139	0.236	0.145	0.238
Mean absolute deviation	0.867	0.863	0.127	0.610	1.124	0.662	1.153
Median absolute deviation	0.713	0.620	0.139	0.432	0.994	0.512	1.066
Geometric mean	4.752	4.764	0.211	4.326	5.178	4.336	5.162
Geometric standard deviatic	1.322	1.314	0.054	1.212	1.431	1.210	1.424
Harmonic mean	4.555	4.575	0.243	4.064	5.045	4.083	5.029
1-Percentile	2.242	2.395	0.260	1.717	2.767	2.242	2.242
99-Percentile	7.304	7.113	0.637	6.015	8.592	6.087	7.904
2.5-Percentile	2.242	2.503	0.379	1.475	3.010	2.242	2.242
97.5-Percentile	6.403	6.778	0.699	4.990	7.817	5.922	7.904
5-Percentile	2.768	2.754	0.492	1.772	3.764	2.242	2.816
95-Percentile	6.365	6.442	0.459	5.437	7.292	5.657	6.365

Political AvgTone Resampled Statistics
Table 45

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/23/2018 at 10:41:48 AM / End time: 7/23/2018 at 10:56:10 AM
Quantitative data: Workbook = MilitaryAspaitalData.xlsx / Sheet = MilitaryData / Range = 'MilitaryData'!$C$1:$C$1451 / 1450 rows and 1 column
Method: Bootstrap
Sample size: 1450
Number of samples: 999
Significance level (%): 5
Seed (random numbers): 4434548

Results of the resampling (NumArticles)

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
NumArticles	1450	0	1450	1.000	163.000	5.787	9.753

Results of the resampling (NumArticles):

Parameters	Estimator	Estimator (Bootstrap)	Standard deviation (Bootstrap)	Lower bound (B.C. percentile interval)	Upper bound (B.C. percentile interval)
Mean	5.787	5.799	0.259	5.308	6.305
Standard deviation (n)	9.750	9.716	1.137	7.711	12.078
Standard deviation (n-1)	9.753	9.719	1.137	7.714	12.082
Median	2.000	2.207	0.400	2.000	2.000

Military NumArticles Resampled Statistics
Table 46

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/23/2018 at 11:12:51 AM / End time: 7/23/2018 at 11:20:01 AM

Quantitative data: Workbook = MilitaryAspaitalData.xlsx / Sheet = MilitaryData / Range = 'MilitaryData'!d1:d1451 / 1450 rows and 1 column

Method: Bootstrap

Sample size: 1450

Number of samples: 999

Significance level (%): 5

Seed (random numbers): 487866391

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
AvgTone	1450	0	1450	0.000	10.227	3.561	1.661

Results of the resampling (AvgTone):

Parameters	Estimator	Estimator (Bootstrap)	Standard deviation (Bootstrap)	Lower bound (B.C. percentile interval)	Upper bound (B.C. percentile interval)
Mean	3.561	3.561	0.042	3.480	3.640
Standard deviation (n)	1.661	1.659	0.034	1.597	1.735
Standard deviation (n-1)	1.661	1.660	0.034	1.597	1.736
Median	3.513	3.524	0.054	3.429	3.651

Military AvgTone Resampled Statistics
Table 47

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/10/2018 at 9:14:55 AM / End time: 7/10/2018 at 9:17:24 AM
Quantitative data: Workbook = EconAspaitalData.xlsx / Sheet = Bootstrap Analysis / Range = 'Bootstrap Analysis'!$C$1:$C$259 / 258 rows and 1 column
Method: Bootstrap
Sample size: 258
Number of samples: 9999
Significance level (%): 5
Seed (random numbers): 4420556

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
NumArticles	258	0	258	1.000	163.000	5.787	13.979

Results of the resampling (NumArticles):

Parameters	Estimator	Estimator (Bootstrap)	Standard deviation (Bootstrap)	Lower bound (Standard bootstrap interval)	Upper bound (Standard bootstrap interval)	Lower bound (B.C. percentile interval)	Upper bound (B.C. percentile interval)
Sum	1493.000	1492.052	222.499	1054.846	1931.154	1123.000	2017.000
Mean	5.787	5.783	0.862	4.089	7.485	4.353	7.818
Variance (n)	194.648	193.754	100.569	-3.397	392.694	59.852	474.001
Variance (n-1)	195.406	194.508	100.961	-3.410	394.222	60.085	475.846
Standard deviation (n)	13.952	13.444	3.609	6.845	21.058	7.736	21.772
Standard deviation (n-1)	13.979	13.470	3.616	6.858	21.099	7.751	21.814
Median	2.000	2.012	0.107	1.789	2.211	2.000	2.000
1st Quartile	1.000	1.000	0.000	1.000	1.000	1.000	1.000
3rd Quartile	5.000	5.706	0.931	3.166	6.834	3.000	5.000
Variation coefficient	2.411	2.293	0.373	1.677	3.145	1.688	3.003
Standard error of the mean	0.870	0.839	0.225	0.427	1.314	0.483	1.358
Mean absolute deviation	5.741	5.735	1.213	3.353	8.130	3.804	8.701
Median absolute deviation	1.000	1.012	0.107	0.789	1.211	1.000	1.000
Geometric mean	2.694	2.699	0.175	2.351	3.038	2.387	3.069
Geometric standard deviation	2.827	2.821	0.157	2.519	3.136	2.548	3.168
Harmonic mean	1.836	1.839	0.079	1.680	1.992	1.694	2.007
1-Percentile	1.000	1.000	0.000	1.000	1.000	1.000	1.000
99-Percentile	70.720	68.537	21.901	27.591	113.849	31.300	115.690
2.5-Percentile	1.000	1.000	0.000	1.000	1.000	1.000	1.000
97.5-Percentile	36.575	38.546	15.170	6.701	66.449	15.000	69.000
5-Percentile	1.000	1.000	0.000	1.000	1.000	1.000	1.000
95-Percentile	15.450	16.058	6.450	2.749	28.151	9.000	28.350

Economic NumArticles Resampled Statistics
Table 48

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/10/2018 at 9:28:42 AM / End time: 7/10/2018 at 9:31:25 AM
Quantitative data: Workbook = EconAspaitalData.xlsx / Sheet = Bootstrap Analysis / Range = 'Bootstrap Analysis'!d1:d259 / 258 rows and 1 column
Method: Bootstrap
Sample size: 258
Number of samples: 9999
Significance level (%): 5
Seed (random numbers): 587784294

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
AvgTone	258	0	258	0.000	12.136	4.645	1.762

Results of the resampling (AvgTone):

Parameters	Estimator	Estimator (Bootstrap)	Standard deviation (Bootstrap)	Lower bound (Standard bootstrap interval)	Upper bound (Standard bootstrap interval)	Lower bound (B.C. percentile interval)	Upper bound (B.C. percentile interval)
Sum	1198.538	1198.506	28.356	1142.698	1254.378	1142.375	1253.063
Mean	4.645	4.645	0.110	4.429	4.862	4.428	4.857
Variance (n)	3.094	3.082	0.316	2.471	3.717	2.556	3.807
Variance (n-1)	3.106	3.094	0.317	2.481	3.731	2.566	3.822
Standard deviation (n)	1.759	1.753	0.090	1.582	1.936	1.599	1.951
Standard deviation (n-1)	1.762	1.757	0.090	1.585	1.939	1.602	1.955
Median	4.754	4.753	0.080	4.595	4.912	4.551	4.896
1st Quartile	3.560	3.541	0.131	3.302	3.818	3.308	3.768
3rd Quartile	5.691	5.712	0.164	5.368	6.014	5.461	5.996
Variation coefficient	0.379	0.378	0.021	0.338	0.419	0.341	0.422
Standard error of the mean	0.110	0.109	0.006	0.099	0.121	0.100	0.122
Mean absolute deviation	1.362	1.361	0.070	1.225	1.500	1.230	1.503
Median absolute deviation	1.122	1.110	0.083	0.959	1.285	0.955	1.283
Geometric mean							
Geometric standard deviation							
Harmonic mean							
1-Percentile	0.847	0.816	0.274	0.308	1.386	0.000	1.039
99-Percentile	8.464	8.653	0.854	6.783	10.145	7.643	10.549
2.5-Percentile	1.183	1.271	0.278	0.636	1.731	0.607	1.745
97.5-Percentile	7.913	7.825	0.280	7.363	8.464	7.378	8.624
5-Percentile	1.752	1.758	0.170	1.418	2.086	1.137	1.818
95-Percentile	7.382	7.315	0.240	6.910	7.855	6.892	7.808

Economic AvgTone Resampled Statistics
Table 49

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/23/2018 at 7:47:05 PM / End time: 7/23/2018 at 7:47:14 PM
Quantitative data: Workbook = SocialAspaitalData.xlsx / Sheet = SocialData / Range = SocialData!$C$1:$C$45 / 44 rows and 1 column
Method: Bootstrap
Sample size: 44
Number of samples: 9999
Significance level (%): 5
Seed (random numbers): 4525105

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
NumArticles	44	0	44	1.000	19.000	5.045	4.899

Results of the resampling (NumArticles):

Parameters	Estimator	Estimator (Bootstrap)	andard deviation (Bootstra	bound (B.C. percentile int	bound (B.C. percentile interval)
Mean	5.045	5.049	0.727	3.750	6.591
Standard deviation (n)	4.843	4.748	0.682	3.500	6.119
Standard deviation (n-1)	4.899	4.803	0.690	3.540	6.189
Median	3.000	3.175	1.099	2.000	5.000

Social NumArticles Resampled Statistics
Table 50

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/23/2018 at 8:03:17 PM / End time: 7/23/2018 at 8:03:24 PM
Quantitative data: Workbook = SocialAspaitalData.xlsx / Sheet = SocialData / Range = 'SocialData'!d1:d45 / 44 rows and 1 column
Method: Bootstrap
Sample size: 44
Number of samples: 9999
Significance level (%): 5
Seed (random numbers): 348863208

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
AvgTone	44	0	44	1.109	6.301	3.385	1.665

Results of the resampling (AvgTone):

Parameters	Estimator	Estimator (Bootstrap)	andard deviation (Bootstrap	r bound (B.C. percentile int	r bound (B.C. percentile interval)
Mean	3.385	3.382	0.248	2.907	3.883
Standard deviation (n)	1.646	1.623	0.120	1.403	1.854
Standard deviation (n-1)	1.665	1.641	0.122	1.419	1.875
Median	2.767	2.829	0.303	2.374	3.343

Social AvgTone Resampled Statistics
Table 51

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/24/2018 at 5:30:53 PM / End time: 7/24/2018 at 5:39:06 PM
Quantitative data: Workbook = InformationAspaitalDataUpdates.xlsx / Sheet = InfoData / Range = 'InfoData'!c1:c1564 / 1563 rows and 1 column
Method: Bootstrap
Sample size: 1563
Number of samples: 999
Significance level (%): 5
Seed (random numbers): 4503553

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
NumArticles	1563	0	1563	1.000	73.000	4.431	6.396

Results of the resampling (NumArticles):

Parameters	Estimator	Estimator (Bootstrap)	ındard deviation (Bootstrạ	bound (B.C. percentile in	bound (B.C. percentile interval)
Mean	4.431	4.424	0.171	4.119	4.788
Standard deviation (n)	6.394	6.352	0.447	5.571	7.317
Standard deviation (n-1)	6.396	6.355	0.447	5.573	7.320
Median	2.000	2.000	0.000	2.000	2.000

Information NumArticles Resampled Statistics
Table 52

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/24/2018 at 5:43:20 PM / End time: 7/24/2018 at 5:51:42 PM
Quantitative data: Workbook = InformationAspaitalDataUpdates.xlsx / Sheet = InfoData / Range = InfoData!$D$1:$D$1564 / 1563 rows and 1 column
Method: Bootstrap
Sample size: 1563
Number of samples: 999
Significance level (%): 5
Seed (random numbers): 1774257099

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
AvgTone	1563	0	1563	0.000	12.136	4.553	1.898

Results of the resampling (AvgTone):

Parameters	Estimator	Estimator (Bootstrap)	Standard deviation (Bootstrap)	Lower bound (B.C. percentile interval)	Upper bound (B.C. percentile interval)
Mean	4.553	4.554	0.048	4.459	4.646
Standard deviation (n)	1.897	1.895	0.035	1.836	1.969
Standard deviation (n-1)	1.898	1.896	0.035	1.836	1.969
Median	4.492	4.495	0.064	4.362	4.643

Information AvgTone Resampled Statistics
Table 53

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/25/2018 at 7:39:21 PM / End time: 7/25/2018 at 7:39:25 PM
Quantitative data: Workbook = InfrastructureAspaitalDataUpdate.xlsx / Sheet = InfraData / Range = 'InfraData'!c1:c48 / 47 rows and 1 column
Method: Bootstrap
Sample size: 47
Number of samples: 999
Significance level (%): 5
Seed (random numbers): 670245819

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
NumArticles	47	0	47	1.000	12.000	3.872	3.180

Results of the resampling (NumArticles):

Parameters	Estimator	Estimator (Bootstrap)	tandard deviation (Bootstrap	er bound (B.C. percentile inte	er bound (B.C. percentile interval)
Mean	3.872	3.888	0.468	3.103	4.814
Standard deviation (n)	3.146	3.102	0.289	2.612	3.718
Standard deviation (n-1)	3.180	3.136	0.292	2.641	3.758
Median	4.000	3.102	1.108	1.000	4.000

Infrastructure NumArticles Resampled Statistics
Table 54

XLSTAT 2018.5.51886 - Resampled statistics - Start time: 7/25/2018 at 7:37:59 PM / End time: 7/25/2018 at 7:38:04 PM
Quantitative data: Workbook = InfrastructureAspaitalDataUpdate.xlsx / Sheet = InfraData / Range = InfraData!$D$1:$D$48 / 47 rows and 1 column
Method: Bootstrap
Sample size: 47
Number of samples: 999
Significance level (%): 5
Seed (random numbers): 4524359

Summary statistics

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
AvgTone	47	0	47	1.786	8.608	4.559	1.331

Results of the resampling (AvgTone):

Parameters	Estimator	Estimator (Bootstrap)	Standard deviation (Bootstrap)	Lower bound (B.C. percentile interval)	Upper bound (B.C. percentile interval)
Mean	4.559	4.547	0.199	4.198	4.998
Standard deviation (n)	1.316	1.296	0.154	1.056	1.643
Standard deviation (n-1)	1.331	1.310	0.155	1.067	1.661
Median	4.500	4.545	0.261	3.656	4.966

Infrastructure AvgTone Resampled Statistics
Table 55

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