TOWARDS AN ABM FOR CIVIL REVOLUTION

MODELING EMERGENCE OF PROTESTERS, MILITARY DECISIONS, AND RESULTING STATE OF THE INSTITUTION

HIGHLIGHTS

- An agent-based model was developed to explore the outcomes for a State when citizens rebel (or don't) and the response of the military to such rebellions.
- The visual representation, along with diffusion and agent vision was modeled as a Netlogo model.
- There are two agent classes: Military and Citizens, each with their own rules and behaviors along with calculated randomness.
- Results show an outcome that is very comparable to the results of the recent revolutions as part of initial and continued Arab Spring events.
- The model has the potential to enlighten a State's military and economic policies for the members of the military and its citizens respectively.

ABSTRACT

The recent string of events in the Middle East, dubbed as Arab Spring transcended rapidly. There was no mechanism to predict them or their outcome. While there are a few models that forecast rebellion (Epstein, 2002; Moro, 2014), none of them take into account different factors such as emotional threshold, of both the citizens agents and military agents the ability to be influenced by vision of what is going around the agent geographically, and the influence of media/communication channels all combined in one model. This paper explores an agent-based model whose agents react based on economic and emotional levels and a revolt ensues. Once the revolt has ensued, there are several other factors in the agent-based model that decide the outcome of the model including agents being killed, their geographic vision, their inclement towards news/media and being influenced by current events, and also their personality type of A or B (Eysenck, 1991). Kuran notes that the speed of a movement's success illustrates the dynamics of an unanticipated revolution (as cited in Wright, 1999). This results of the model are rendered in a short duration of time, as one would expect of revolutions, except for those that plunder into a civil war state. The model does not explore in-fighting among the different rebel factions, as empirical data has verified that factious in-fighting did not emerge until after civil war ensued in these nations or after the government was overthrown (Dodge, 2012). The model forms a basis for forecasting future rebellions based on the economic and emotional plight of citizens and military alike.

KEYWORDS

Agent-based modeling; Arab Spring; Civil Revolution; Revolts; Regime Change; Anarchy; Rebellion; Economic Policy; Military Decisions, Media Influence, Communication Factors.

SOFTWARE AVAILABILITY

MS Excel 2011(used for result synthesis); NetLogo 5.3.

1. INTRODUCTION

Arab Spring and its continued resurgence have elevated concerns in policy making, militaristic, and academic circles. Asongu and Nwachukwu (2015) mention several qualitative studies that have been examined after and during the Arab Spring events focusing on causes, consequences, trends, and circumstances leading to the Arab Spring. However, their focus remains on the aftermath and other qualitative causes. The extent or predictability of Arab Spring is still elusive and there is very scarce quantitative literature about it. Could policies and measures have ben adopted or applied had the phenomena been predictable? While Asongu and Nwachukwu (2015) reference several mathematical and empirical models that examine "causes, consequences, trends, and circumstances leading to the Arab Spring", these models are either lacking in agent representation or do not account for the various factors in one comprehensive model. Different models use different factors – emotions, hardships, communication/media, but none take into account the effect of the presence of all the factors together.

In this model, we examine using qualitative variables, if civil uprising can be predicted and if so, what could be done to mitigate them or what policy changes should be instituted based on the results of the model. The model hopes to introduce a quantitative solution, which can be used to predict if the phenomenon is foreseeable, something that has remained an empirical challenge and debate in militaristic, foreign affairs and policymaking domains (Gause III, 2011). Academics knew that the Arab Regimes where unpopular with the citizens, yet the focus was mostly on the persistence of the undemocratic rulers. The interplay of the military with the citizens was largely neglected. This model hopes to use those factors as the main agents and determinants of any uprising and hence paint a picture of what variables factor in and what can be forecasted and hence prevented to an extent possible.

2. BACKGROUND

Arab countries have long held regimes with the largest string of self-elected dictators or even democratic dictators. Egypt was ruled under the same power since 1981, while Yemen held the same President since 1978. In Syria, the Assad family coagulated power since 1970s, while in Jordan the Hashemites have been ruling since the 1920s. Saudi Arabia and Bahrain have also held ruling power very closely since the 1930s and Libya's dictator had taken charge since 1969. While there are several formal theoretical models that explain the cross-country income inconsistencies documented in the context of the neoclassical growth models and recently extended to the fields of economic development (Bruno et al.,2012), these models stop short of quantifying it in way it could be forecasted using information that has been available empirically or through literature.

Epstein's model of rebellion (2002) which has been implemented in Netlogo presents a model on civil violence, which is presented in two variants of the civil violence model are presented. In the first a central authority seeks to suppress decentralized rebellion. In the second a central authority seeks to suppress communal violence between two warring ethnic groups. However, besides grievance the model does not factor in any other agent behaviors including none for the central authority. The military does not play a role in suppressing or decentralizing the central authority. The cops who execute the orders of the central authority do have some vision, which are lattice points that are north, south, east and west to the cop's current position.

Makowsky and Rubin (2013) take civil rebellion model a slight further to test the impact of authority centralization and social network technology on preference falsification and institutional change. Their MASON (Java libraries) model is mostly interested in exploring the cascading effect of preference revelation and institutional change based on it from centralized and decentralized states. The model's focus is two features - highly centralized power and widespread information and communication technology (ICT), which are highly instrumental in determining the outcome of the revolution.

Moro's model (2014) on violent political revolutions works with three classes of agents, where rebels are an agent class and always existent, along with citizens and cops. However, the cops are designated to always be loyal and suppress the revolution, which in case of Arab Spring, as has been reported as not true. The military turnover in uprisings in Egypt, Tunisia and Syria were very instrumental in determining the final outcome of the State (Barany, 2011). The different stances taken by the military can

largely explain the different outcomes for the same kind of protests in countries governed by the same types of dictatorial powers.

Some other models that build on revolution and democracy while not agent based are Acemogh and Robinson's (2011) model of economic origins of democracy and Ellis and Fender (2011) derive conditions under which democracy arises peacefully when it occurs after a revolution and oligarchic government persists. However, those are both economic models, not built on agent behaviors.

This model builds on military benefits, citizen's grievances and other factors such as geographic vision, empathy, personality type A or B, and media impact and tendency. Though Kuran (1991 and 1995) criticizes the idea of automatic relationship between social grievance and revolution, arguing that most historical revolutions were unanticipated, as people who dislike the government tend to conceal their political preferences as long as the opposition seems weak. And this is what our model builds on, which is also supported by Makowsky and Rubin (2013) in their centralization hypothesis. While agents with grievances do not rebel, until their threshold is reached or until they see active rebellion around them, when they join in. This model blends in neatly with the varied ideas proposed by different models above to form a cohesive model, which also takes into consideration agent's personalities, ability to bear income hardships and a choice in the face of futility.

3. CONCEPTUAL MODEL

In this section, the model is described based on the Overview, Design concepts, and Details (ODD) protocol by Grimm et al. (2006). The purpose of the ODD protocol is to "standardize the published descriptions of individual-based and agent-based models (ABMs)." In this section the purpose of the model is examined, the variables and scales assessed and described along with the scheduling of the processes, the observations, initialization of the model, and both inputs and outputs.

PURPOSE

The purpose of the model is to analyze the interplay between citizens who rebel, and who don't and the consequences their actions have with the military's various behaviors. To accomplish this, the model is intended to forecast three different states of being for a State. One of the states is when the government wins, the second when the citizens win, and finally the third state is when the model goes over 150 runs (each run is equivalent of 2 weeks hence equating to 1.4 years) the model stops as it presumes that a state of civil war has been reached. During these runs the model also

outputs the number of total citizens along with those in different states: happy, rebelling, unhappy, neutral, and killed. The same is true of the military whose state is counted as defected or unhappy.

In order to analyze the interaction component of the model, we make a number of calculated assumptions that are factored into the model with regard to behavior, state variables and scale which are described in the sections below.

STATE VARIABLES AND SCALE

The model has two variables with various states and attributes. The citizen agents have an income that is drawn from a normal distribution. And based on the income, their income-level is calculated as poor, middle, or rich. Emotions are also a variable associated with citizens and emotions are drawn from an exponential distribution. Another state variable is the status of the agent which could be happy, dissatisfied or neutral (do-not-care), which is based on various factors as the model gets executed. Based on various psychological studies of the total number of agents that get initiated, 30% are initiated with personality A-type (alpha) and the remaining 70% with personality B-type (passive). Citizens also can get killed, jailed and have vision around them to see others get killed, jailed or revolting. The agents also have memory to remember how many times they get jailed and their income.

The military has comparable state variables as citizens, just not as many. Military's income is defined as benefits they have from the government which could be low, middle, or high. They too have emotions which are drawn from an exponential distribution. They have a status of happy or sad and can be active as in loyal or defected from the military. They too have a vision and can see citizens revolting or getting killed or could kill citizens themselves.

The interface itself can be used to select the probability that military has to kill revolting citizens. There is a switch for Information, Communication and Technology (ICT) which can be turned ON or OFF, to determine if agents are getting news (defined in the model by having the vision to see the model based on the user definition of how far it can extend around them and see if other agents are revolting or getting killed and in case of the military to have the vision to see the same – rebels or citizens getting killed. There is also a slider for the probability for the citizens and military to hear the news. This determines the probability that they will get the news or not.

PROCESS OVERVIEW AND SCHEDULING

At each time step, both the agents go through several steps of processing and determining their next state. It starts with the citizen agents checking their income

which has been normally distributed. If their income is greater than 105.24399, which is the mean and standard deviation, the agent is rich in income-level, if the income is greater than 94.75601 the agent has middle income-level and the agent is poor in income-level for income after that. After checking their income-level, each agent could result in being happy, unhappy or neutral. If they are unhappy, then based on their personality type they can revolt. If they are personality A, the agents revolt if anyone around them is revolting. However if they are personality B, and in an unhappy state, they revolt based on the percentage of revolting population, if that percentage is greater than 20%. If the status of the agent is neutral or happy, they then check to see if anyone around them is being killed as a factor of revolting, and if that has reached their emotional threshold. That state check can lead an agent to be happy or unhappy or neutral again, and the decision making from personality A or B resumes again. This loop circulates until a final state for the State has been reached. Image 1 below maps the decision making process that determines the state of the agent at each step.

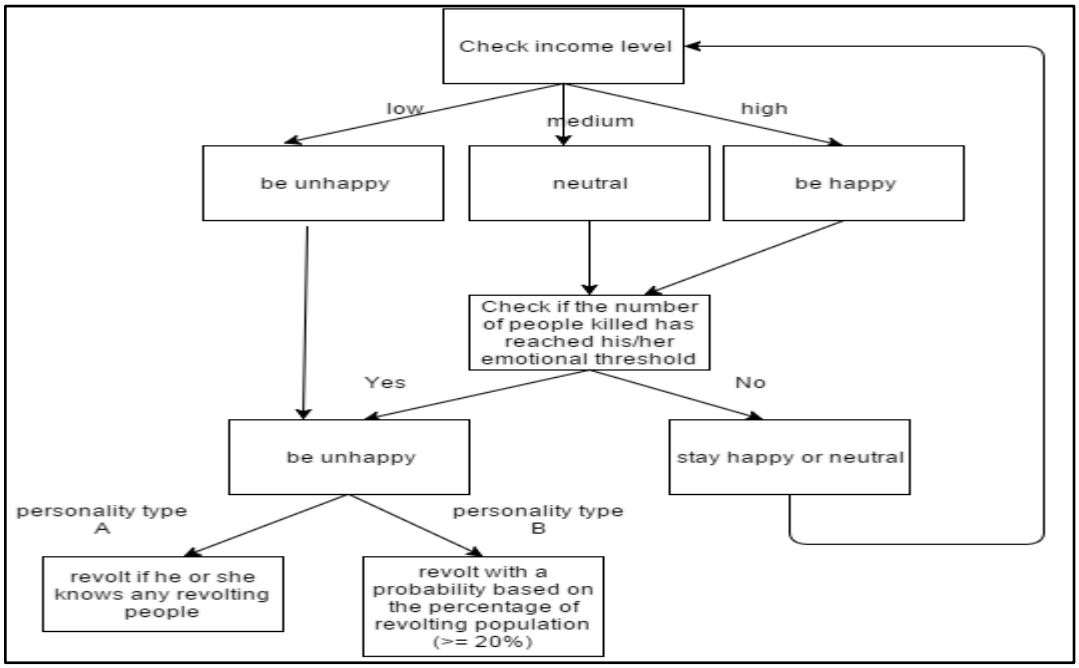

Image 1: Decision Making State for Citizen-Agent

The military agents undergo a similar process of decision making which decides their next state. The military start by checking their benefits which could range from low, medium, to high. If their benefits are low, and they see citizens revolting, the agents defect if members around them have defected with a probability of greater than 20%.

However, if their benefits are medium, the agents also check to see if the number of citizen agents being killed around them has reached their emotional threshold. If it has, their state turn unhappy and then they defect too in keeping with the same probability as defined above. However, if the killed citizen agents has not reached their emotional threshold, they continue to stay in the state of being happy. All happy agents, check to see if there are any rebelling citizen agents in their vision, if there are, the military agent can jail or kill them based on the user defined parameter and then go back to checking their benefit level. Image 2 below demonstrates in a flowchart, the process overview for the military agents.

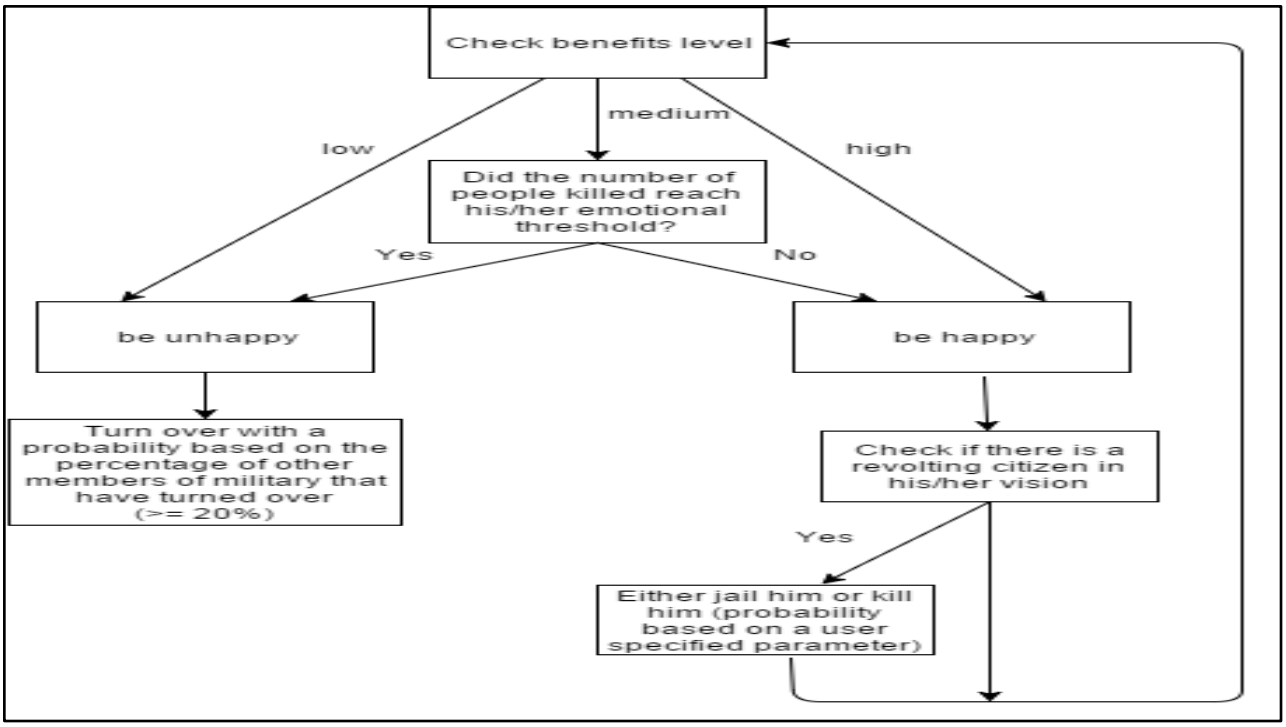

Image 2: Process Overview for the Military Agents

MODEL INPUTS

The model relies on user inputs for defined behaviors for the agents. The population of the agents can be varied by the user on a slider scale from 0 to 1000 and the military is set to half the population varying from O to 500. The choice of the military to citizen ration was decided based on the empirical data available for military force population in the Arab state nations where the ration is approximately at 1:2 or 1:3 (Reuters, 2012). Other inputs include physical vision of the agents, which is the number

of lattices around it that it can see. The threshold to kill is a manual user defined number. The benefits of the military can be set using the chooser scale and there is a slider for the probability with which the military will kill a rebelling citizen agent. The ICT switch can be turned ON or OFF and user can decide the probability with which the news will be known by the citizen and military agent based on a slider scale, if the ICT is ON.

The jailed agents are depicted by a bar icon, the neutral agents are brown neutral faces and the angry agents are red faces. Military is depicted by a military uniform. Image 3 below shows the different agent visualizations.

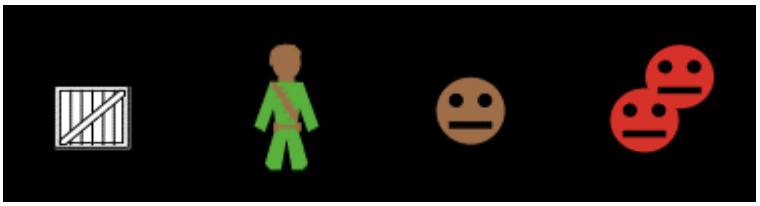

Image 3: Visualizations of the Different States of Agents

INITIALIZATIONS

The model for the purposes of the paper is initialized at 300 citizens with 60 military members, setting the citizen to military ratio at 5:1. The model is initialized at a higher rate for citizens to military to better understand if States with fewer military members change their output based on the ration of the citizens to military. The vision is set to 10 lattices around the agent, where the model world wraps around at 30 to 30 coordinates. The threshold to seeing other citizens killed is set to 20, which is between low to medium. The probability to kill for a military member is set to 0.05, as most militaries resist the instinct to kill initially, unless explicitly instructed to do so. And the probability of hearing the news is set to 50% if the ICT is ON. Image 4 shows the basic initializations of the model for this article.

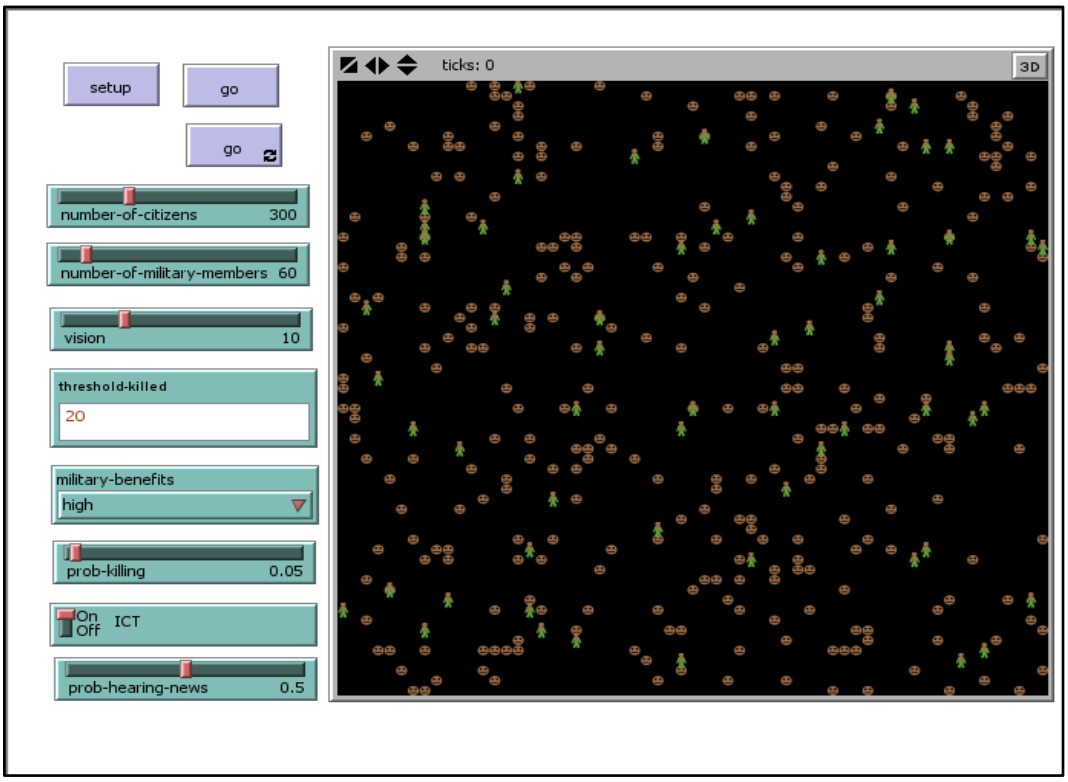

Image 4: Basic Model Initialization

MODEL OUTPUTS

The major output from the model is the resulting state of the Institution/State, which is displayed in the Command Center. However other outputs are also displayed. For the citizen agents the citizen count along with happy, unhappy, killed and rebelling citizens is displayed. The numbers are also plotted on a graph for visual comparison. For the military agents, the defected and unhappy count is displayed. A final graphical output is a plot that charts the count of the citizens to the rebels and the defected military.

4. RESULTS

The basic setting for our model results in some very unpredictable, yet applicable results. When tried with different settings, different models were realized as expected. When the military benefits are high with ICT is ON with a probability of 0.5, over 10 runs the model results are as indicated by image 5 below:

--Benefits High
--ICT ON at 50%

	Resulting State of Institution	Ticks	Citizen Count	Unhappy Citizens	Citizens Killed	Defected Military	Unhappy Military
1	Civil War	150	46	33	254	0	0
2	Civil War	150	58	40	242	0	0
3	Civil War	150	61	37	239	0	0
4	Civil War	150	39	28	261	0	0
5	Civil War	150	161	8	139	0	0
6	Government Wins	60	212	15	88	0	0
7	Civil War	150	123	49	177	0	0
8	Government Wins	99	182	9	118	0	0
9	Government Wins	103	207	14	93	0	0
10	Government Wins	69	229	8	71	0	0

Image 5: Resulting State of the Institution after 10 runs (20 weeks) with ICT at ON at 50% and Military Benefits at LOW

Simulating the model with the same parameter but keeping ICT off, results in a different set of results as shown in Image 6 below.

--Benefits High
--ICT OFF

	Resulting State of Institution	Ticks	Citizen Count	Unhappy Citizens	Citizens Killed	Defected Military	Unhappy Military
1	Government Wins	50	18	4	282	0	0
2	Government Wins	39	23	10	277	0	0
3	Government Wins	50	22	9	278	0	0
4	Government Wins	40	24	7	276	0	0
5	Government Wins	66	9	4	291	0	0
6	Civil War	150	70	2	230	0	0
7	Government Wins	41	95	13	205	0	0
8	Government Wins	51	93	7	207	0	0
9	Civil War	150	51	4	249	0	0
10	Government Wins	116	56	3	244	0	0

Image 6: Resulting State of the Institution after 10 runs (20 weeks) with ICT at OFF and Military Benefits at HIGH

For the next set of results, the model was simulated under military benefits at middle while ICT was set to ON at 50% probability of hearing the news. Image 7 below shows the compiled result set.

--Benefits Middle --ICT is ON at 50%

	Resulting State of Institution	Ticks	Citizen Count	Unhappy Citizens	Citizens Killed	Defected Military	Unhappy Military
1	Government Wins	123	2	1	298	25	25
2	Civil War	150	3	2	297	24	24
3	Civil War	150	7	6	293	17	17
4	Government Wins	57	9	6	291	17	17
5	Government Wins	59	7	4	293	20	20
6	Government Wins	95	3	0	297	23	18
7	Government Wins	49	9	7	291	21	26
8	Civil War	150	7	6	293	29	25
9	Government Wins	70	7	3	293	24	25
10	Government Wins	81	3	2	297	28	28

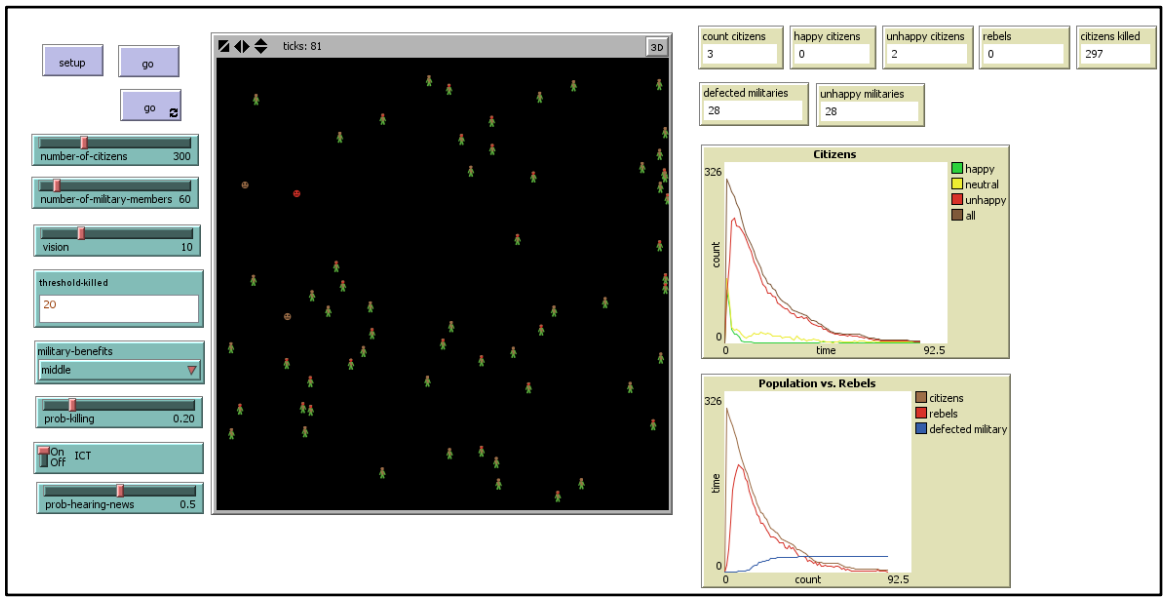

Image 7: Resulting State of the Institution after 10 runs (20 weeks) with ICT at ON @50% and Military Benefits at MIDDLE

For the same set of parameters, the model was simulated under military benefits at middle while ICT was set to OFF so there was no probability of hearing the news. Image 8 below shows the compiled result set.

--Benefits Middle --ICT is OFF

	Resulting State of Institution	Ticks	Citizen Count	Unhappy Citizens	Citizens Killed	Defected Military	Unhappy Military
1	Government Win	54	89	7	211	11	11
2	Government Win	41	125	14	175	12	12
3	Government Win	57	94	9	206	17	17
4	Government Win	83	72	3	228	20	20
5	Government Win	40	112	7	188	16	16
6	Government Win	117	59	2	241	18	18
7	Government Win	128	63	0	237	24	24
8	Government Win	68	83	25	217	14	14
9	Government Win	62	89	3	211	14	15
10	Civil War	150	43	2	257	22	22

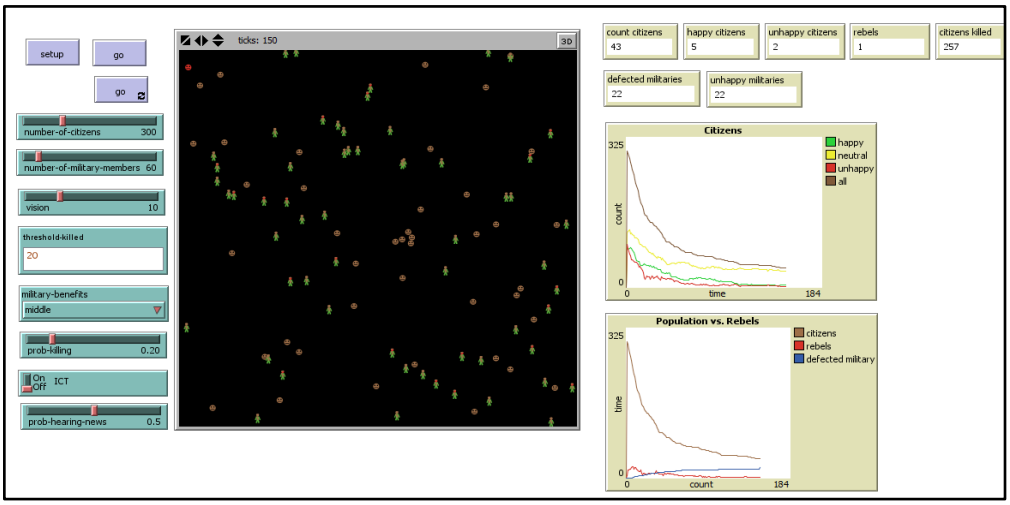

Image 8: Resulting State of the Institution after 10 runs (20 weeks) with ICT at OFF and Military Benefits at MIDDLE

For the final grouping set of results, the model was simulated under military benefits at low while ICT was set to ON at 50% probability of hearing the news. Image 9 below shows the compiled result set.

--Benefits LOW -- ICT is ON at 50%

	Resulting State of Institution	Ticks	Citizen Count	Unhappy Citizens	Citizens Killed	Defected Military	Unhappy Military
1	Citizens Win	5	279	160	21	61	60
2	Citizens Win	6	289	78	11	60	60
3	Citizens Win	5	276	182	24	60	60
4	Citizens Win	5	290	123	10	60	60
5	Citizens Win	5	284	112	16	60	60
6	Citizens Win	5	279	223	21	60	60
7	Citizens Win	5	284	163	16	60	60
8	Citizens Win	5	289	79	11	60	60
9	Citizens Win	4	290	74	10	60	60
10	Citizens Win	5	284	166	16	60	60

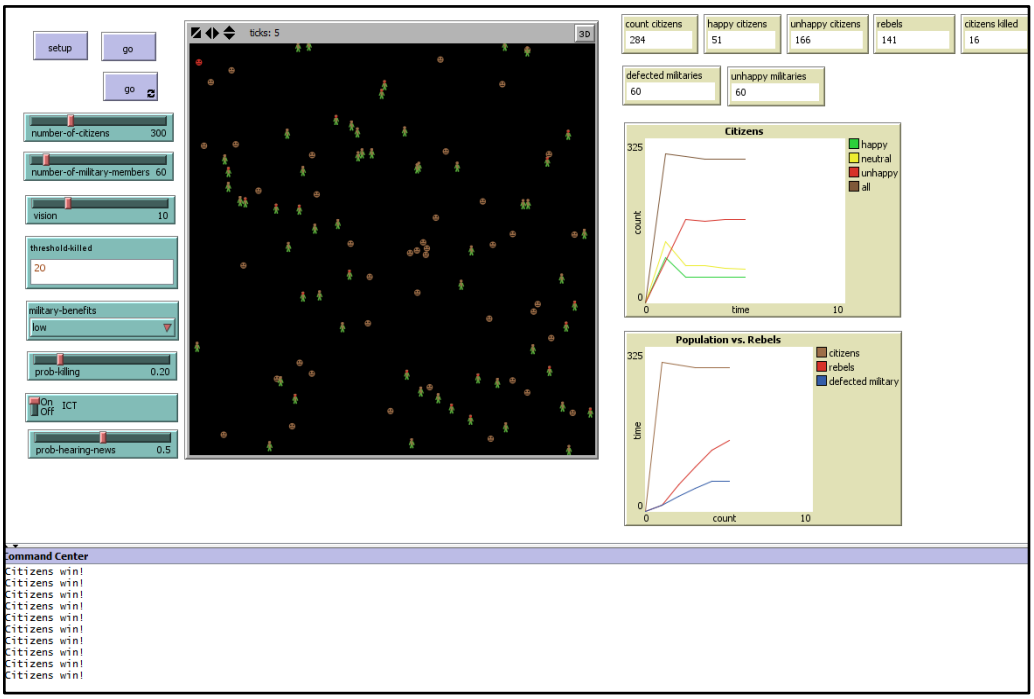

Image 9: Resulting State of the Institution after 10 runs (20 weeks) with ICT at ON at 50% and Military Benefits at LOW

For the same set of parameters, the model was simulated under military benefits at low while ICT was set to OFF so there was no probability of hearing the news. Image 10 below shows the compiled result set.

Benefits LOW ICT is OFF

	Resulting State of Institution	Ticks	Citizen Count	Unhappy Citizens	Citizens Killed	Defected Military	Unhappy Military
1	Citizens Win	4	292	80	8	60	60
2	Citizens Win	4	290	98	10	60	60
3	Citizens Win	5	290	82	10	60	60
4	Citizens Win	6	280	76	20	60	60
5	Citizens Win	5	283	79	17	60	60
6	Citizens Win	5	290	71	10	60	60
7	Citizens Win	5	280	72	20	60	60
8	Citizens Win	5	286	71	14	60	60
9	Citizens Win	5	288	88	12	60	60
10	Citizens Win	4	288	72	12	60	60

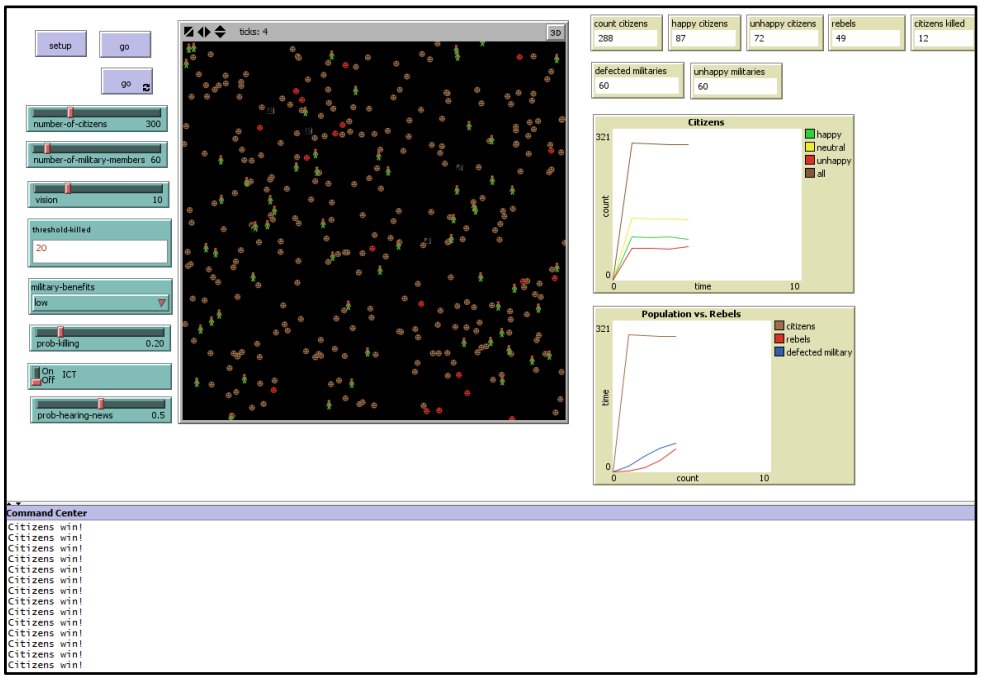

Image 10: Resulting State of the Institution after 10 runs (20 weeks) with ICT at OFF and Military Benefits at LOW

Overall, it can be concluded that when the benefits for the military are low, the chances of defection are high resulting in a win for the citizens as no military members are left to prevent the revolution. The result does not change whether ICT is ON or OFF. When the ICT if turned OFF, there are better chances of the government winning over a civil war occurring and with middle level benefits, there is an approximately equal chance that the government could win or a civil war could ensue. However, when ICT is switched ON at a probability of 50%, then even with military benefits being high, the chances of a civil war are at the same proportion as that of the government winning, hence crushing the revolution. However, when the military benefits are low, there is a higher chance of a civil war raging over the government winning. Image 11 below summarizes the results compendiously.

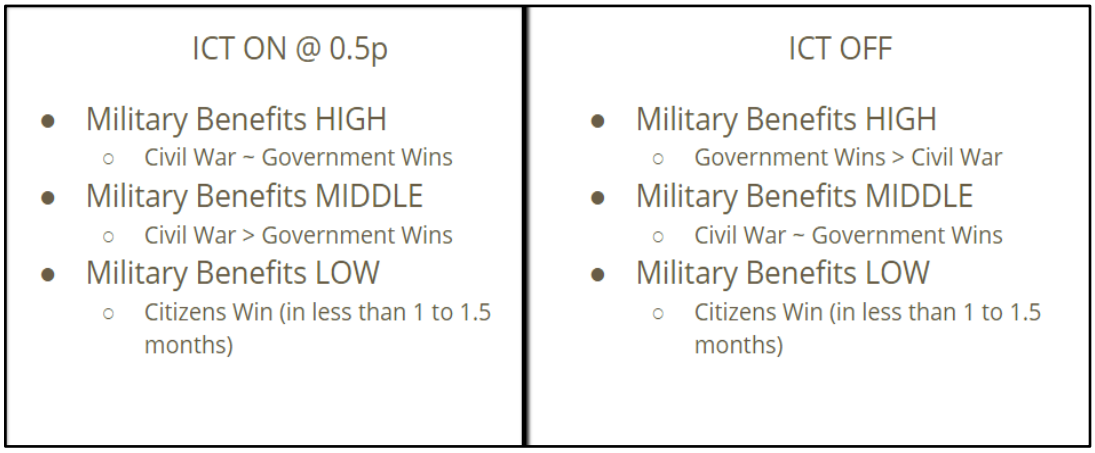

Image 11: Summary of the Results and the State of the Institution

5. SENSITIVITY ANALYSIS

Thiele et al. (2014) state that sensitivity analysis is an important part of the development and analysis of any simulation model. By exploring the sensitivity of model output to changes in parameters, we learn about the relative importance of the various mechanisms represented in the model and how robust the model output is to parameter uncertainty. These insights helped us in fostering the understanding of this model and its use for theory development and applications to policy making and militaristic diplomacy. Vision is one of the most sensitive parameter in this model. When vision is turned off, the chances of the government winning are much higher than when it is not. This can also be evidenced by observational data where regimes often

turn off the communication channels and news when there are rebellions and revolts in order to contain the revolution (Yang, 2013).

Another parameter that is quickly affected when altered is the probability of killing. When military members have a high probability of killing, even with middle benefits the model takes significant amount of time to reach a state of completion and the government always wins and very few military members defect, and this is while ICT is ON or OFF. This was an interesting observation because when the probability was set to a lower scale there was an equal chance of a civil war and more chance of a civil war with ICT being turned ON.

A final parameter tested in the sensitivity analysis was the emotional threshold of citizens, which when lowered always produced a civil war whether benefits of the military were middle. This helps attest to the fact that more citizens were rebelling, whether personality A or B as their threshold of emotions was so low in seeing how many of their fellow citizens were being killed.

6. VERIFICATION AND VALIDATION

Verification of the model was performed by conducting code walkthroughs, profiling and parameter testing to ensure the model was working as intended. These tests ensured that the model was working and there were no logical errors made in translation of the model into the code, and that there were not programming errors. After carrying out these tests, we feel confident that the model behaves as it is intended and matches its design.

Validation was also performed on this model to ensure that this model was designed as sufficiently as accurate to solve the research problem on hand. Three kinds of validations were performed on this model based on Robinsons' (1997) discussions on V&V: Conceptual validation, black box validation and white box validation as mentioned in the Image 12: Verification and Validation below.

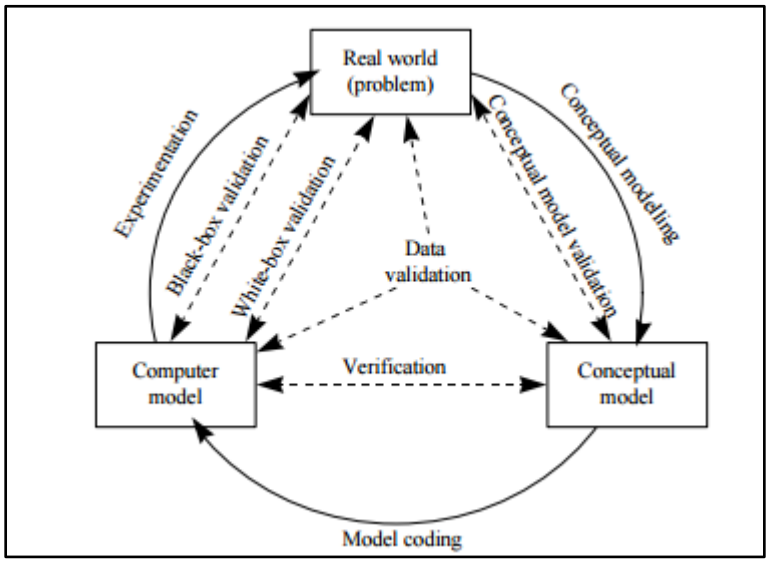

Image 12: Verification and Validation (Robinson, 1997)

Further empirical research was also aligned with the results of the model to ensure its validity.

Conceptual Model Verification: In order to develop a conceptual model verification, Verification Level 1 (Axtell and Epstein, 1994), an understanding of the real world issues should be tackled. Based off that understanding, the model can be designed on those objectives.

White Box Validation: This method ensures that the content of this model are true to the real world. The code was checked to ensure that correct data has been entered. And the code was also expressed in a non-technical format, as a written concept and explained to the class of CSS610 at George Mason University, where non-experts were provided with an overview of the data and the logic. Output from different parts of the model was compared and tested, and the results were traced through progression over the 100 runs with different parameter initializations to ensure the model was validating appropriately.

Black Box Validation: Black Box validation for this model was split up into two categories. Validation was performed by comparing the relationship between the inputs and outputs of the model, this latter was used as an alternative for validating in comparison with real system. Image 13: Black Box Validation below gives an overview of how to perform a black box validation.

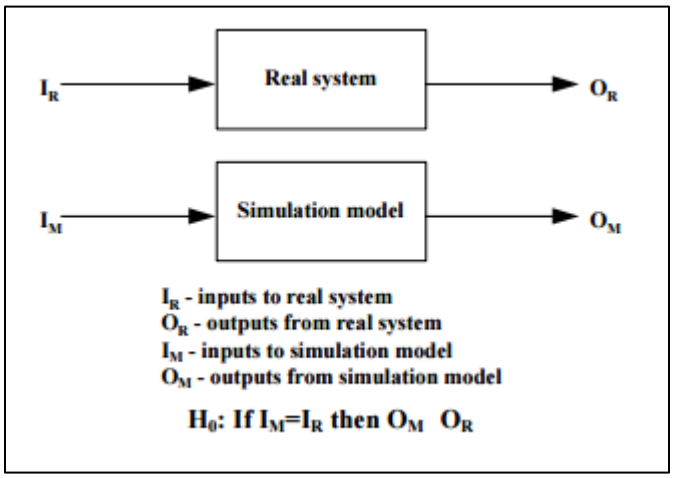

Image 13: Input to Output BlackBox Validation (Robinson, 1997)

Two other validation approaches were used to validate the model further. Empirical validity (face validity) (Xiang et al, 2005) was used based on the news stories and other factual data from the Arab Spring revolutions. Our model's outcomes pair very close to the actual outcomes. In countries like Bahrain and Saudi Arabia, where the military is very well encumbered, the rebellions and protests were quelled rather quickly. But in countries such as Egypt, Tunisia, Yemen and Libya, where military members were in the same economic status of low income as the citizens, the government was disposed of rather soon as the military turned an eye or even supported the citizens. And in countries such as Syria and Lebanon, where the military is paid between middle to high income, some members have defected as their emotional threshold of seeing other getting killed was reached and others have not (Sayigh, 2014; Reuters, 2010).

Another form of validation was Model-to-Model Validation (Xiang et al., 2005), where we compared our results against four other models:

1. Willenksy's Rebellion Model, based on Epstein's Civil Violence Model (NetLogo Model, 2002)
2. Moro's Understanding the Dynamics of Violent Political Revolutions in an Agent-Based Framework (NetLogo Model. 2014)
3. Makowsky and Rubin's An Agent-Based Model of Centralized Institutions, Social Network Technology, and Revolution (MASON simulation, JAVA library, 2013)
4. Lawson and Oak's Apparent Strength Conceals Instability in a Model for the Collapse of Historical States (Mathematical Model, 2014)

The results from all four models reciprocate our results based on similar settings. While our model mashes several settings from the different models above, the outcomes are quite similar in the overall theory for the resulting state of the Institution.

Based off these several methods of verification and validation, the model lends enough credibility in its outcomes and results that the users of this model should gain sufficient confidence in the results output by this simulation.

7. DISCUSSION AND CONCLUSION

This model strives to make an attempt to consolidate different behaviors and factors that play a role in the start of a revolution and pave its direction. It has implications for the governments to realize where their State is leaning toward if a revolution were to occur and make economic and diplomatic changes in accordance with it. The model also paves way to better forecast the outcomes of a revolution and the role ICT plays in channeling its direction.

The model for purposes of this project has been simulated in a few, limited runs. It hold tremendous potential to be enhanced. Future work into using spatially explicit ABM techniques to better aim military and citizen placement are merited. This study's model does not include variation among agents based on demographic groups, which in Arab countries can play a critical role. The model also needs to be enhanced for more inclusion of more factors when military benefits are low.

In conclusion, this model despite the existence of other mathematical, economic and AB models that have tried to study Arab Spring revolutions, has a niche in the study of how revolutions can shape the outcome of a State in the Middle East as it focusses on combining several factors including ICT and the personality of the citizens. While there are several potential enhancements that the model could benefit from such as exploring the role of inter-factional rebel in-fighting, in its current state it is still very robust and could inform economic, policy making and military decisions for a State. Because the model has been designed to show several outputs, it is easier for non-modelers to understand and form decision making policies based on the outcome and results that this model reveals.

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