

Course project
Decision Theory

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Strategies for Achieving an Efficient Government: A Comprehensive Decision-Making Framework

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In 1789, when Louis XVI learned of the conquest of the Bastille by the angry French people, he asked:

"Is this a revolt?"

And the Duc de la Rochefoucauld answered:

"No sir, this is a revolution!"

Introduction

Throughout history, individuals and societies have grappled with oppressive systems and the challenges they present. In the face of such adversity, people have often found themselves at a crossroads: whether to passively endure their circumstances while yearning for a brighter future or to explore various avenues to address the issues posed by corrupt and inefficient governments. A harsh reality persists wherein those living under oppression tend to perceive the power of the ruling class as insurmountable, making the prospect of effecting change seem daunting. Even when collective action is taken to instigate change, many of these endeavors often prove futile and are easily quashed.

When confronted with an ineffectual government, the populace must weigh their options, aiming to minimize the societal cost while maximizing the government's cost. This endeavor can manifest in diverse forms, ranging from attempts at reform and incremental change to full-scale revolution and the overthrow of the existing regime. Over time, people may come to the realization that previous paths have borne little fruit and opt to chart a different course. Undoubtedly, all human efforts aimed at achieving a more comfortable life, a brighter future, and a fairer system are commendable.

Project Approach and Framework

This research embarks on an exploration of strategies for addressing and transforming ineffective governments, with a particular focus on the phenomenon of revolution. The insights gained from this exploration will inform the alternatives considered in the subsequent Analytic Hierarchy Process (AHP) survey. The following sections will shed light on when and under what circumstances it may be justified to overthrow a government, delving into expert opinions, legal considerations, and the concept of the "right to revolution." Additionally, the importance of navigating legal frameworks in this context will be discussed.

Drawing from historical examples, notably the 1957 Iranian revolution, the paper will elucidate the pivotal factors contributing to public dissatisfaction and their influence on decisions related to dealing with an inefficient government.

In the section titled "What can the government do?" we will employ the Minimax method to model government alternatives and decision-making processes. Subsequently, we will use game theory to examine the problem from the perspective of the populace, exploring the conditions and potential gains that might motivate people to unite against their ineffective governments. The role of social networks as crucial elements in 21st-century decision-making and their potential to reduce the costs of revolution will also be addressed. This section will employ utility concepts and decision nodes to model multi-stage decision processes. Detailed specifications regarding considerations, models, assumptions, goals, limitations, options, alternatives, and possibilities will be outlined.

The subsequent sections of the paper mark the conclusion of the case study and literature review. Subsequently, based on the research findings, a questionnaire has been crafted to gauge the perceived importance of various criteria among different individuals. To facilitate the realization of these ideals and criteria within the context of effective governance, a selection of options has been presented for respondents to consider in defining their preferred course of action. Finally, leveraging the results obtained from the survey, we will employ the AHP method to evaluate and report on the criteria and alternatives as perceived by the respondents.

How Can a Dysfunctional Government Be Held Accountable?

There are several methods through which people can seek to address governance issues and bring about change:

1. **Peasant Rebellion:** One approach is through peasant rebellions. In these uprisings, rural communities come together to voice their demands or protest against oppressive government policies. Often, these communities are seeking attention for their local issues or requesting government support to resolve their problems. However, their primary goal is typically not to change the entire government itself [1].
2. **Bread Riots:** Another form of protest arises when a large number of people express their dissatisfaction with food scarcity or high prices. These bread riots often involve people seizing food supplies, reminiscent of Robin Hood, and distributing them to the needy. A common demand during these riots is the implementation of price controls or government subsidies, highlighting the economic roots of these protests [2].
3. **Strikes:** Workers often resort to strikes to improve their working conditions, such as wages, working hours, and labor rights. While strikes usually start at the local or industrial level, they can escalate and become political movements with national implications. Notably, strikes played a pivotal role in challenging and bringing down communist regimes in Eastern Europe [1,2].
4. **Reform Movements:** Some movements aim to reform existing government institutions rather than overthrow them. These movements, which can even be initiated by high-ranking government officials, seek to reduce corruption and assert the rights of various groups within society. The Meiji reforms in Japan in 1868 serve as an example of such initiatives [1].
5. **Forced Overthrow (Coup):** In certain cases, governments are forcibly overthrown by the upper class or military elites in what is known as a coup. Coups typically occur without public mobilization or significant social conflicts. The leaders of coups often justify their actions by claiming to restore order and combat corruption, with the intention to step down once these objectives are achieved [1,2].
6. **Radical Social Movements:** These movements are typically localized and centered around specific groups or regions. However, they tend to face swift suppression by authorities, as seen in Victor Hugo's portrayal of the student movement in "Les Misérables" [2].
7. **Civil Wars:** Civil wars can erupt for various reasons, including disputes over leadership, ethnicity, or religion. Some leaders can rally large followings and persuade them to engage in armed struggle. Interestingly, civil wars can involve factions loyal to the previous government fighting against revolutionary forces, as witnessed in the Russian White Army's conflict with the Reds from 1913 to 1920 [2].

These are some of the methods through which people can address dysfunctional governments and strive for change. The concept of revolution, another significant avenue for government change, will be discussed later.

Definition of Revolution

Revolution is a phenomenon that occurs relatively infrequently compared to instances of injustice and suffocation. It emerges when those in power are weakened and isolated, while the elite and wealthy class withdraw their support. It is during this specific juncture that individuals identify themselves as part of a united and morally just collective capable of effecting change [1,2].

A revolution encompasses a confluence of elements, including the forceful overthrow of the government, mass mobilization, the realization of a vision for social justice, and the establishment of new institutions. Consequently, revolutions represent a process in which leaders harness the power of the masses to bring about transformation [2].

There exist two contrasting perspectives regarding public perceptions of revolutions. One perspective views revolution as a heroic undertaking, where oppressed people are guided by benevolent leaders to ultimately overthrow an ineffective and corrupt regime. Although revolutions often entail violence to dismantle the old order and its adherents, a new order must be born from this chaos. This viewpoint can be traced back to ancient Greece and Rome and has found support throughout history, with proponents like the French and American revolutionaries. Later, Marx infused it with new meaning through his theory of the inevitable triumph of the impoverished over the affluent [1,2].

On the contrary, another perspective regards revolution as a manifestation of mass anger resulting in nothing but chaos. According to this view, despite the noble ideals and intentions of revolutionaries, the unleashed energy and anger of the populace lead to a violent upheaval that engulfs everything, even the leaders themselves. In the pursuit of their ideals, these revolutionaries often squander societal resources and cause destruction and loss of life. This viewpoint was initially articulated by English critics of the French Revolution and subsequently raised by critics of the Russian and Chinese revolutions [1,2].

In reality, revolutions represent a fusion of these two perspectives. They manifest in various forms, some non-violent and others culminating in protracted and bloody civil conflicts. Some revolutions give rise to democratic systems, while others usher in autocratic dictatorships that may be even more oppressive than the previous regime. Several revolutions, such as the collapse of the Soviet Union, the Eastern European revolutions of the 1990s, and the Arab Spring in 2011, have taken the world by surprise, leaving an indelible mark on the global order [2].

In the ensuing sections, we will delve into an analysis of revolutions, drawing insights from a range of articles. Initially, we will explore the underlying causes of revolutions and categorize them. Subsequently, we will assess the strategies and responses of governments when faced with this internal threat, employing the Minimax method to minimize potential damages. Furthermore, utilizing game theory, we will examine how people unite to confront autocratic dictators and achieve victory. Finally, we will scrutinize the role played by mass media and social networks in the success of revolutionary movements.

When Is It Justified to Overthrow a Government?

This question has resonated throughout history, prompting many to ponder under what circumstances they can rise against their rulers and bring about a change in leadership. During the emergence of democratic movements in the 18th century, numerous thinkers argued that

revolutions from the right were the very catalyst for the formation of governments. Subsequently, influenced by these ideals, both France and America acknowledged the legitimacy of such movements. In contemporary times, many governments have incorporated similar principles, with the aim of reminding policymakers that genuine authority emanates from the people. This serves to ensure the safeguarding of the rights of a diverse society. However, it is worth noting that some autocratic leaders, often having seized power through means such as a coup, have cynically employed these laws to justify their illegal actions and present a more benevolent facade [3].

In general, resistance and rebellion are viewed as the last resort, to be employed only in dire circumstances. It becomes legally justifiable when the country's institutions and structures are markedly misaligned with the will of the populace, and when the voices of protestors go unheard or prove futile. Consequently, the right to resist is distinct from civil resistance; the latter is non-violent and typically directed against specific policies, while the former may resort to violence and target the entire governing apparatus. Thus, there exists a necessity to define a threshold of governmental cruelty and misconduct that would warrant the use of violence by the people. A clear distinction can also be drawn between the right to resist and the concept of revolution; the former seeks to rectify the current state of affairs and restore the rule of law, essentially aiming for a "return to normal," whereas the latter aspires to completely overhaul institutions and legal frameworks [3].

The right to revolt operates within certain parameters: firstly, there must be an external standard against which the behavior of rulers can be measured. Secondly, it assumes that people have the capacity to establish justice autonomously and surmount all challenges. Thirdly, rebellion encompasses actions that would be deemed unacceptable under normal circumstances but can be justified in critical situations. Consequently, if a government suppresses protestors despite such conditions, it may be deemed culpable and subject to international (or even domestic) legal proceedings following its overthrow [3].

What Factors Lead to an Uprising or Revolution?

To begin, it's important to clarify the precise definition of a "reason." A reason is something upon which the achievement of a result depends. Therefore, reasons possess four key characteristics: [4]

1. They must precede the result.
2. There exists a logical relationship between the reason and the result.
3. The reason must be sufficient to bring about the result. (This does not imply that there can only be one reason for everything or that every result has only one reason.)
4. The reason is also a necessary condition for the result to occur.

Historical events are typically intricate, often having multiple causes. However, in most instances, a specific trigger transforms them into reality, taking a seemingly ordinary event and elevating it to significance due to preceding circumstances. This trigger isn't necessarily a complete explanation for the event. The causes of a revolution can be categorized in various ways. To illustrate, let's examine the Iranian Islamic Revolution as an example for each case. Generally, these reasons can be classified into three categories: [4,5,6]

1. **Economic Factors:** People may become disenchanted with the prevailing economic conditions and seek structural changes to fulfill their aspirations. Economic growth and development also lead to cultural and ideological shifts in society. This shift results in the replacement of long-standing traditional values with secular ones. Dissatisfaction among people in not attaining these ideals can simmer for a long time until a single event triggers a full-scale explosion. For instance, in the late 1970s, a significant drop in oil prices caused economic issues in Iran's oil-dependent economy, leading to a sharp rise in inflation. Income inequality, stemming from the economic development strategy aided by private sector entrepreneurs, also fueled discontent. The opulence and corruption within the Shah's inner circle further exacerbated people's frustrations.
2. **Type of Regime:** The nature of the governing regime can significantly influence the likelihood of an uprising or revolution. Many revolutions occur under totalitarian, military, or dictatorial rule. In contrast, democracies tend to experience fewer revolutions because they offer ample space for debate and discourse among citizens. Autocratic regimes may attempt to modernize over time but often lag behind the pace of global change, leaving many dissatisfied. Communist regimes, characterized by one-party systems and limited civil liberties, tend to foster high levels of societal dissatisfaction and a greater propensity for revolution. For example, Iran's one-party state and the events surrounding the August 28 coup fall into this category and contributed to public discontent.
3. **Government Inefficiency:** Many undesirable regime types are highly inefficient, with their institutions failing to perform adequately. Policies often fail to yield desired outcomes, and certain social groups may be marginalized in terms of participation or advancement. These conditions contribute to widespread dissatisfaction and increase the likelihood of an uprising or revolution. Despite the Shah's efforts to drive growth and development, primarily through oil revenues, he couldn't align the rapidly changing society of Iran with his vision. The pace of these changes proved too rapid for many, particularly religious traditionalists, leading to profound dissatisfaction that ultimately manifested in the Islamic Revolution.

The causes of an uprising or revolution can be categorized differently: [5,6]

- **Incitement:** Public dissatisfaction with various conditions such as high prices, low wages, corruption, rent, military or diplomatic failures, etc., can incite a desire for change. At least one of these factors is typically present in all revolutions. These grievances not only provide people with motivation and a cause to fight for but also attract conservative elements. These provocations often have economic origins. In the context of the Islamic Revolution, factors like high inflation in the late 50s, corruption among the elite, and the issue of capitulation rights played significant roles.
- **Public Opinion:** The discontent of some members of society alone is insufficient for a rebellion or revolution to occur. People must be confident and fully aware that others share their dissatisfaction and can unite for a common cause. Iran during the revolution saw the presence of numerous political groups with diverse ideologies, but they managed to set aside their differences and contribute to the revolution's success. Additionally, revolutionaries were convinced that they had sufficient popular support to overthrow the Shah.

- **Hope:** Hope stems from the belief that there is a plan for improvement and reform. During the 1957 revolution, revolutionaries hoped that a religious government could realize their ideals and guide the country toward their desired direction.
- **Leadership:** Trusted leaders who can unify and guide people, providing assurance that their plans will come to fruition, strengthen this hope. Leadership can emerge for various reasons, including youth discontent, social conditions, new thinking, and personal charisma. In the case of the Iranian Revolution, leaders of various political groups played pivotal roles in the revolution's success. Ultimately, Ayatollah Khomeini's group emerged victorious.
- **Government Weakness:** The weakening of government forces is one of the immediate triggers for rebellion or revolution. When the government wields excessive power, the presence of the preceding four reasons alone may not lead to an uprising. However, when the government's authority weakens, the situation can quickly shift in favor of the revolutionaries. In 1957, the revolutionaries capitalized on the fact that the army and the Shah, despite their advanced tools, no longer possessed the will to suppress the people, using this to their advantage.

Nevertheless, these factors alone are insufficient; they merely bring society to the brink of upheaval. Ultimately, an event transforms society's wounds into soldiers, sparking a revolution. An example is the Tunisian street vendor Mohamed Bouazizi, who immolated himself in front of a municipal building in 2010 in protest against the confiscation of his goods and his humiliation. This act became the catalyst for Tunisia's Jasmine Revolution and subsequently the Arab Spring.

What Options Are Available to the Government?

The primary objective of any government is its own survival, and to achieve this goal, it must make strategic decisions. Governments are constantly faced with a range of both internal challenges, such as rebellions and uprisings, and external threats like war, all of which pose risks to their security. Therefore, a government must devise strategies to mitigate these potential risks posed by various actors, necessitating a delicate balancing act. In this complex scenario, political players often grapple with uncertainty, unsure of their counterparts' intentions or the feasibility and desirability of initiating conflicts like war or rebellion. They can, however, form estimates regarding the potential outcomes of their decisions by analyzing existing conditions. Making decisions in such circumstances is exceptionally challenging because even a slight shift in information can radically alter a player's assessment. Nevertheless, it is generally assumed that all players act rationally [7].

The focus of this research, as per its subject matter, is limited to examining the roles of the government and domestic players. Domestic actors must make choices between instigating a rebellion or maintaining the status quo, while the government must determine its response based on the probabilities associated with these options. Each player can calculate an expected utility for the occurrence of rebellion or revolution by multiplying the probabilities of these events with their corresponding utilities. However, alterations in the country's conditions can not only modify the probabilities but also introduce new variables into the game. For instance, the emergence of a new vision or ideology can heighten the desirability of revolution and mobilize new groups to join the uprising [7].

For a government to effectively implement its policies, it requires a support base. Consequently, the government and internal groups maintain intricate relationships. The government acquires resources from various domestic groups (as well as external sources) and utilizes these resources to provide goods and services. Every segment of society can derive benefits from their association with the government, although comparing the desirability of this relationship among different groups can be challenging due to the diverse opinions within a society. Nonetheless, it is possible to assess and monitor changes in the desirability of this relationship for each group over time [7].

The state of society can evolve through two primary mechanisms:

1. Altering the existing societal relationships.
2. Modifying the relationships themselves.

The characterization of these changes can be determined based on the nature of the relationships and the specific circumstances involved. The first scenario represents a stochastic shift in the distribution, while the second results in a fundamental transformation of the distribution [7].

Governments possess the capacity to bolster their authority within the country through various means, such as investing in law enforcement or enhancing public satisfaction. It is important to note, however, that the law of diminishing returns applies here; the higher a government's internal power, the more costly it becomes to increase it by one unit. Meanwhile, internal groups can also alter their relative power. When power dynamics within a society become skewed in favor of internal groups, it can potentially lead to a rebellion or revolution, although this is not a sufficient condition in itself [7].

In general, governments aim to ensure that the expected utility of the current state of affairs exceeds that of revolution, which holds true in most instances. Revolutions and rebellions do not occur spontaneously or without reason; rather, they develop over time as a consequence of a series of events and evolving conditions [7].

Finally, based on the explanations provided, the government's response to internal risks and its potential failure in managing these risks can be modeled as follows [7]:

$$\sum P_k \times R_k \times S_k$$

In this context, we have three key variables: P_k , representing the number or ratio of connections between the government and each societal group; R_k , denoting the probability of a catalyst for revolution; and S_k , indicating the probability of rebellion or revolution's success. By summing up this expression across all societal groups (k), we obtain a comprehensive view of the total internal risks confronting the government.

The primary objective of the government is to minimize the highest potential internal risk it faces. Consequently, the government employs the Minimax method as its strategy for risk mitigation [7].

$$Z = \min \{ \max \sum P_k \times R_k \times S_k \}$$

This means that the government categorizes segments of society based on their perceived risks and then concentrates its efforts on mitigating the risks associated with those individuals or groups who are more likely to pose a threat or who have a higher potential for gaining influence. However, in practical terms, once the government successfully reduces the risk within one

group, another group often begins to ascend in power. It's as if governments are constantly playing a game of Whack-A-Mole, with no foreseeable end in sight [7].

When the government reallocates resources from one group to bolster its domestic authority, it diminishes the likelihood of being challenged by any of the other groups. Nevertheless, this resource extraction tends to breed discontent among these groups, potentially leading to a decline in their overall satisfaction with the current state of affairs. Consequently, the probability of these groups rebelling increases over time [7].

One of the key takeaways from this model is that governments facing tense situations, such as war or revolution, tend to seek additional resources. They may do so by enlisting the support of domestic factions or seeking assistance from foreign countries. However, any effort to shift resources by the government can alter the desirability of the current situation for the targeted group or country, potentially exerting pressure on the government from that quarter. Consequently, governments often seek help from multiple countries or groups, distributing the burden so that it doesn't rest solely on one supporter. This approach allows them to strategically manage both their most reliable supporters and their most formidable competitors, engaging with them in a sequence that suits their interests [7].

How and When Do Individuals Come Together in Solidarity?

Without a doubt, numerous societal transformations require the involvement of all its members, and a revolution is certainly no exception. However, there is often the temptation for some to take a passive stance, reaping the benefits of the movement without actively contributing to the popular uprising. In this context, it can be hypothesized that, in a general sense, members of society face a choice between active engagement and free-riding [8].

One can utilize game theory to model the process of people uniting for a common cause. Let's envision a two-player game where "participation" signifies unity, and "non-participation" equates to free-riding. If both individuals opt for participation, the revolution is likely to succeed, but the allure of free-riding typically leads to more individuals choosing this option, ultimately affecting the outcome [8].

Situations in Which Ruled Class Members Cannot Unite

		Second person choices	
		Unite	Freeride
First person choices	Unite	68, 68	54, 81
	Freeride	81, 54	<u>60, 60</u>

The values presented in the table above have been sourced from various surveys and research studies, providing a realistic depiction of the prevailing conditions. In this context, it's evident that the income generated through the alliance is relatively low when compared to the current circumstances. However, when individuals opt for taking a different route, they stand to gain higher returns. Consequently, this situation closely resembles the classic "Prisoner's Dilemma" game. Hence, it becomes apparent that members of society are unable to come together to effect change, despite the fact that the current state of affairs is less favorable for them than it would be following a revolution [7,8].

Conditions in Which Ruled Class Members Divide into Revolutionaries and Free Riders

		Second person choices	
		Unite	Freeride
First person choices	Unite	104, 104	72, 108
	Freeride	<u>108, 72</u>	60, 60

The current situation is even more dire than the previous one. In this scenario, if both players opt out of participation, their circumstances become considerably less favorable compared to other potential outcomes. Consequently, individuals must be willing to take on the risks and responsibilities associated with initiating a revolution, despite the numerous hardships they are likely to endure. It's worth noting, however, that their ultimate gains may still fall short of those who choose a less challenging path [8].

This situation closely resembles what is known as the "Chicken Game," where each player attempts to convince the other to yield and collaborate unilaterally. If neither player manages to do so, they must make the sacrifice and shoulder the responsibility of driving societal improvement. This particular situation is far from ideal, as it may foster resentment and discontent among the revolutionaries, potentially leading to unresolved conflicts down the line [7,8].

Situations in Which All Ruled Class Members Consolidate and Revolutionize

		Second person choices	
		Unite	Freeride
First person choices	Unite	<u>160, 160</u>	100, 150
	Freeride	100, 150	60, 60

In this scenario, a critical juncture is reached where the members of society can finally come together to enact a revolution and transform their country's circumstances. Under these circumstances, the effectiveness of political party alliances experiences a significant upsurge, with the anticipated benefits of cooperation surpassing those of remaining unaligned. Consequently, individuals in this particular context find themselves compelled to unite, leaving no room for indecision or hesitation [8].

Situations in Which Ruled Class Members Are Satisfied with the Present Situation and Don't Cause a Revolution

		Second person choices	
		Unite	Freeride
First person choices	Unite	56, 56	48, 72
	Freeride	72, 48	60, 60

In this particular scenario, the present circumstances prove to be the most favorable option. Attempting to unite and bring about a revolution would actually lead to a deteriorated situation for both parties involved. If someone were to instigate a revolution, they would ultimately find themselves in a significantly worse predicament compared to the current state of affairs. Consequently, there is a reluctance to pursue revolution, and society continues to persist in its current condition [8].

Gain Structure That Determines Unity / Freeride Problem of the Ruled Class Members

We can assess the individual's productivity within the existing circumstances as "S" (Status Quo) and their productivity within the revolutionary context as "F" (Fruit). Additionally, we introduce a coefficient, denoted as "h," representing the cost associated with participating in the revolutionary movement. This coefficient ranges from zero to one. Each person incurs a price for their involvement in the revolution, which could include absenteeism from work, the risk of physical assault in the streets, psychological stress, or even potential arrest and imprisonment.

Now, we can express this relationship in parametric form as follows [8]:

		Second person choices	
		Unite	Freeride
First person choices	Unite	$h(S + 2F), h(S + 2F)$	$h(S + F), S + F$
	Freeride	$S + F, h(S + F)$	S, S

In this model, different states can be produced by altering the values of S , F , and h .

1. The first scenario involves conditions where people cannot unite, exemplified by the prisoner's dilemma:

$$\frac{h}{1-h}F < S < \frac{2h}{1-h}F$$

2. The second scenario addresses the conditions in which society members fall into two distinct categories: Revolutionaries and Riders, akin to the chicken game.

$$\frac{(2h-1)}{1-h}F < S < \frac{h}{1-h}F$$

3. The third scenario encompasses conditions where people are inclined to unite.

$$S < \frac{2h-1}{1-h}F$$

4. The fourth scenario deals with circumstances where no one desires a revolution.

$$\frac{2h}{1-h}F < S$$

To extend these scenarios and games to accommodate N people, we can proceed as follows. Initially, let's assume that m individuals within the community opt to take rides from others. Consequently, there are slight adjustments to the parameter values outlined above:

$$\text{Additional Gains: } N \times m$$

Additionally, the efficiency of participation is denoted as $C(m)$, while the efficiency of freeriding is represented by $D(m)$.

$$\begin{cases} C(m) = h(S + N \times m \times F) \\ D(m) = S + (N \times m) \times F \end{cases}$$

Therefore, we can generalize the four situations as follows for a group of N people:

1. Conditions in which people cannot unite (prisoner's dilemma):

$$\frac{h}{1-h}F < S < \frac{2h}{1-h}F$$

2. The conditions in which society members are divided into two categories: Revolutionaries and Riders (chicken game):

$$\frac{hN - N + 1}{1-h}F < S < \frac{h}{1-h}F$$

3. Conditions in which people unite:

$$(1-h)S < \frac{1 - (1-h)N}{1-h}F$$

4. Circumstances in which no one wants to revolution:

$$\frac{Nh}{1-h}F < S$$

It's important to note that unifying a smaller community is considerably easier than uniting a larger one. As the number of individuals increases, each person tends to prioritize their own interests and seeks immediate satisfaction, often neglecting the long-term well-being of the group. Conversely, some individuals rely on the assumption that others will take care of the collective effort and join forces accordingly. Hence, devising a comprehensive strategy to unite large populations and harnessing innovative tools for this endeavor becomes imperative.

The Role of Social Networks in Revolutions

In challenging living conditions within a country, the power of collective action to effect change becomes apparent. However, the success of such endeavors hinges greatly on community-wide participation. Social networks, by bringing together diverse segments of society, can wield significant influence in toppling dictatorial regimes.

Recent revolutions have exhibited a noteworthy trend—the pivotal role played by social networks. These platforms enable individuals to gauge the willingness of others to join the uprising by providing a window into their decisions. In societies under dictatorial rule, where fear and oppression cast a heavy shadow, people often remain unaware of their compatriots' revolutionary desires. Virtual networks bridge this information gap.

Moreover, in many autocratic systems, government control over public media outlets such as radio and television impedes the free flow of information. Social media steps in to unveil the true face of society, providing an alternative narrative. These platforms are user-friendly and incur minimal costs. Given these advantages, it's not surprising that many autocrats contemplate restricting them, recognizing their pivotal role in fomenting revolution [9].

“It is a question of coordinating people’s beliefs, I need to know if other people agree with me and are willing to act. What really stops people who are oppressed by a regime from protesting is the fear that they will be part of an unsuccessful protest. When you are living in these regimes, you have to be extremely afraid of what happens if you participate and the regime doesn’t change.” – Daron Acemoglu

To investigate how networks influence the organization of people, we will examine the impact of two communication technologies: mass media and social media. In this context, mass media serves as a means for people to acquire information about the current state of the revolution, while social media reveals the decisions made by others up to that point in time. For instance, individuals may share their intentions regarding participation in protests and their reasons through platforms like WhatsApp groups or tweets. Notable examples of revolutions effectively utilizing virtual spaces include the Hong Kong Umbrella Revolution, the Yass Revolution in Tunisia, the Egyptian Revolution, and the broader Arab Spring movement [9].

The population can be divided into two main groups: those who aspire to change the government and those who are content with the existing status quo. It is assumed that the first group, if fully engaged, possesses the collective power to bring about a change in government. Consequently, the desired societal outcome is a change in governance. However, if their participation falls below a critical threshold, the dictator remains in power and may even inflict severe punishments on participants. In situations where individuals' information is kept private and unknown to others, following the decisions of fellow citizens can be a rational strategy to maximize individual payoffs [9].

Based on the aforementioned explanations, a model can be formulated to elucidate the role of social networks in this context. Let's suppose there are N individuals within the society, including a dictator. These individuals face a choice between supporting a revolution (denoted as " r ") or remaining passive (denoted as " s "). Furthermore, they can be categorized into two distinct groups: $\tau_i = w$ (representing those who desire revolution) and $\tau_i = x$ (representing those who do not wish to participate in revolution). Among this population, the total number of individuals belonging to group w is denoted as W , which falls within the range of zero to n . Based on these considerations, it is possible to establish connections or vectors between each member of society. Vectors where at least one individual seeks revolution correspond to $\binom{n}{w}$, indicating that the probability of any vector forming is uniform. To successfully overthrow the dictator, a minimum of t individuals are required, and in this society, it is assumed that $t \leq W$. Importantly, everyone is aware of the total number of individuals in group w , ensuring that the society possesses the necessary critical mass for a successful revolution. The benefits or payoffs for individuals can be defined based on their characteristics and decisions regarding revolution or staying at home [9].

1. $u_{w,s}$: This represents the utility of a revolutionary person if they choose to stay at home.
2. $u_{w,r,F}$: This is the utility of a revolutionary person if they decide to participate in the revolution, but unfortunately, the revolution fails. In this scenario, the revolutionaries may face punishment by the dictator, representing the potential cost of participating in the revolution.

3. $u_{w,r,R}$: This denotes the utility of a revolutionary person if they participate in the revolution and it succeeds.

The order of these benefits can be summarized as follows:

$$u_{w,r,F} < u_{w,s} < u_{w,r,R}$$

Additionally, we have the following terms for individuals who do not wish to participate in the revolution:

4. $u_{x,r}$: This signifies the reciprocity or utility of a person who initially has no intention of joining the revolution but decides to participate.
5. $u_{x,s}$: This represents the utility of a person who does not wish to participate in the revolution and chooses to stay at home.

Based on the benefits and returns mentioned earlier, the most desirable outcome for society, often referred to as the "First Best," involves the collaboration of the revolutionaries leading to the overthrow of the dictator. This preference arises because even reluctant individuals, who would otherwise remain inactive at home, yield the same utility. In contrast, the revolutionaries experience a higher level of utility when they actively participate in the revolution [9].

In this scenario, individuals engage in sequential decision-making processes, relying on the available communication technology to inform their choices. There are three distinct technological contexts to consider:

- 1) **Without technology**: In this circumstance, individuals lack knowledge of the choices made by others in previous rounds. They are only aware of their own type.
- 2) **Mass media**: With access to mass media, individuals possess general information about past events, specifically the number of participants in the riots. In this case, they make decisions based on information disseminated through government-controlled radio and television broadcasts.
- 3) **Social networks**: In this context, individuals have the ability to scrutinize and independently consider the decisions made by others in previous situations. Consequently, they can glean information about the types of other participants.

Let's now assume we are dealing with a society comprising four individuals, with three of them being revolutionaries (represented as black circles). For the sake of simplicity, the decision tree for only one person is depicted in the figures below. At the outset of the game, nature randomly selects one of the vectors. It is also assumed that individuals can only observe the actions taken by others and not their respective types, resulting in grayed-out representations for individuals in the remainder of the decision tree.

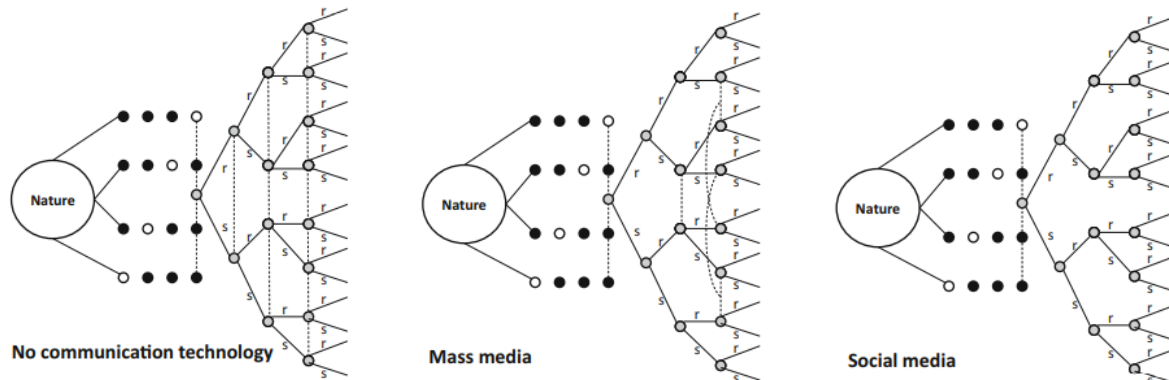


Figure 1 - Reduced extensive-form representation of a society with $n = 4$ and $W = 3$

In the first scenario, where there is no information technology involved, individuals make decisions without knowledge of their previous actions. Consequently, all the participants in a given situation lack access to a set of historical information. When we shift to the context of utilizing mass media, people are aware of the number of individuals who participated in prior events or riots. For instance, the fourth person is aware that two individuals were involved in the previous riot, but they cannot identify the specific individuals. Moving forward, in the realm of social networks, individuals can accurately discern the sequence of decisions and the specific modes used, and this setup provides them with a comprehensive set of information.

Within the first scenario, multiple equilibrium points exist. Consequently, individuals may opt for inaction, failing to achieve the desired societal outcome. Visibility of individuals' characteristics plays a pivotal role in this dynamic. When both types of communication technologies are employed and people's characteristics are discernible, it can lead to societal revolutions. Conversely, in situations where individuals' characteristics are not visible, equilibrium may be reached when using mass media, potentially resulting in a lack of revolution, especially when the costs of participation and failure are high. In contrast, the use of social networks consistently results in successful revolutions, irrespective of the visibility of individuals' characteristics.

Analysis and Review with the Help of AHP

In the preceding sections, we delved into the various alternatives and criteria presented in the literature to address the issue of ineffective government. To lend practical significance to the findings of these studies—especially from our perspective—we embarked on the task of gauging these alternatives and criteria in real-world scenarios. Assessing and weighing these alternatives and criteria in a real-world context endowed them with greater relevance to us, as it allowed us to scrutinize their applicability within a smaller statistical community, comprised of individuals in our immediate vicinity.

While our previous sections undertook an exploration and analysis of the problem at hand through the lenses of game theory and utility theory, we found the Analytic Hierarchy Process (AHP) to be a more straightforward, appealing, and fitting analytical methodology among those we encountered during the semester.

The allure of this approach lies in its inclusiveness of a wide array of alternatives and criteria, which can be readily employed with input from our peers, even without expertise in decision-making theory. The method's outward simplicity, resembling a typical survey, lends itself to straightforward implementation without substantial challenges. Additionally, this approach piqued our interest due to its potential for involving a larger number of individuals in the decision-making process—a process inherently demanding collective participation. Ultimately, it results in a unified voice working toward the realization of an efficient government.

From the outset, a limitation that loomed large was the quantity of alternatives and criteria. The most formidable aspect of crafting this survey was the selection of suitable alternatives and their corresponding criteria. An excessive number of these elements could discourage participants from completing the survey, rendering the output meaningless. Conversely, reducing their number might compromise the depth of the final analysis, impeding our ability to gain a comprehensive understanding of the situation within the studied statistical population. Furthermore, expanding the list of alternatives and criteria would exponentially inflate the number of survey questions, a situation deemed unfavorable for participants.

After investing substantial hours in deliberating the selection of alternatives and criteria based on our literature review, the following results emerged—a concise summary of what can be gleaned from the existing literature:

Alternatives:

1. Strikes and protests in line with reforms
2. Strikes and protests in line with the revolution
3. Coup d'état
4. Doing nothing

Criteria:

1. **Economic stability:** This encompasses factors such as the independence of the central bank from the government, the existence of a free market, extensive international trade, and maintaining a low unemployment rate.
2. **Freedom of speech and thought:** This relates to political and ideological perspectives, ensuring that individuals can express their opinions without fear of censorship or repression.
3. **Appropriate infrastructure:** Access to global high-speed Internet, clean water, reliable electricity and gas supply, and well-maintained roads all contribute to this criterion.
4. **Environmental situation:** This includes respecting animal rights, addressing air pollution, managing dry lakes, and preventing forest fires.
5. **Social justice:** Ensuring educational justice, fair income distribution, gender equality, and access to medical services are key components of this criterion.
6. **Legitimacy, transparency, and independence of the three branches of government:** This criterion emphasizes the need for a clear separation of powers between the legislative, executive, and judiciary branches, ensuring they operate independently and transparently.

In formulating these criteria, our aim was to avoid scattering specific criteria and instead group them under broader headings. To clarify our intentions for each general criterion, we provided examples in parentheses.

To conduct our survey, we utilized the Google Form tool to structure the questionnaire as follows:

1. **First part; General information of the respondent:** This section collected comprehensive information about the participants, including their gender, age, level of education, and field of employment.
2. **The second part; Criteria:** Here, we presented questions aimed at establishing the initial matrix required for Analytic Hierarchy Process (AHP) by comparing criteria relative to each other. We designed these questions to yield high values in the matrix's diameter, facilitating later inversion. As a result, we only needed 15 questions to form our 6x6 matrix.

3. **The third part; Alternatives:** In this section, we posed questions to create matrices related to the comparison of alternatives within specific criteria. Given that we had six criteria, this section produced six matrices. Similar to the previous part, we designed the questions to generate high values in the matrix's diameter, requiring only six questions for each matrix. In total, this section contained 36 questions.

Some important considerations during the survey design process included:

- To expedite participant responses, we provided predefined options for selection, minimizing the need for open-ended answers. This approach also facilitated efficient data processing and coding. We opted for descriptive options rather than numerical ones to reduce participant confusion during pairwise comparisons.
- Due to the sensitivity of our research topic, we limited the survey's distribution to a select group of individuals in our network and discontinued data collection after two days.
- To ensure randomness and minimize order effects, we randomized the order of questions for each participant.
- We provided introductory explanations about our research and methodology at the beginning of the questionnaire, aiming to encourage more accurate responses. Additionally, we included a link to further explain the Analytic Hierarchy Process (AHP) for participants' reference.

Questions Responses 39 Settings

Section 1 of 3

شیوه‌های تحقق یک حکومت کارآمد

ما جمعی از دانشجویان دانشگاه شریف قصد داریم راه‌های تحقق یک حکومت کارآمد را از منظر تئوری تصمیم‌گیری برای پروژه‌ی درسی خود بررسی کنیم. پرسش‌نامه زیر به بررسی گزینه‌های موجود برای تحقق یک حکومت کارآمد از نگاه معیارهایی می‌پردازد که در ادبیات علوم سیاسی، اقتصادی و اجتماعی از آن‌ها یاد شده است. این پرسش‌نامه هیچ‌گونه سوگیری سیاسی نداشته و صرفاً از منظر علمی خواهان بررسی این مهم است.

این پرسش‌نامه بر اساس روش تحلیل سلسله مراتبی (یا به اختصار AHP) طراحی شده که شما می‌توانید در صورت تمایل به کسب اطلاعات پیش‌تر درباره آن به [این لینک](#) مراجعه کنید. لازم به ذکر است که این پرسش‌نامه به صورت تماماً ناشناس بوده و خروجی آن صرفاً برای پروژه‌ی درسی استفاده خواهد شد.

زمان تقریبی مورد نیاز برای پر کردن پرسش‌نامه: 5 تا 10 دقیقه

بخش نخست: اطلاعات کلی پاسخ‌دهنده

در این بخش، در جهت تحلیل و بررسی نهایی پاسخ‌ها در میان گروه‌های مختلف و پیدا کردن دیدی جامع، ممنون می‌شویم اطلاعات کلی خود را مشخص نمایید

* لطفاً جنسیت خود را مشخص کنید.

☐ زن

☐ مرد

* لطفاً بازه‌ی سنی خود را مشخص کنید.

☐ 15 تا 20 سال

☐ 21 تا 25 سال

Figure 2- Visualization of the prepared survey

The output of the answers resulted in a table comprising 56 columns (representing the number of questions) and 39 rows (representing the number of participants). However, a significant issue arose during our analysis process - the survey outputs were in an incorrect and unreadable format, and despite our best efforts, we were unable to rectify this issue (see Figure 3).

In our pursuit of a solution, we sought assistance from various individuals, but regrettably, none of their suggestions proved effective. Undeterred, we decided to take matters into our own hands and, through some coding wizardry, successfully transformed all the data into a readable format. This was of paramount importance since this table served as the foundational input for all subsequent operations in AHP.

Figure 3- Part of incomprehensible survey output data

It's worth noting that, due to the descriptive nature of the options, they were transformed into their respective numerical representations within a section of the program's code. This conversion enables the computer to carry out calculations based on these values, as illustrated below:

Descriptive Choice	Numerical Value
Much less than	1/7
Less than	1/5
A little less than	1/3
Same as	1
A little more than	3
More than	5
Much more than	7

Once we completed the survey, we processed its results using a pre-prepared computer program. This program is written in the Python programming language and utilizes prominent

libraries like Pandas and NumPy. You can find the file for this program in the project attachments as well.

Initial Survey Findings

Over the course of two days, a total of 39 individuals actively took part in our survey. Among these respondents, 30 were male, constituting 77% of the participants, while 9 were female, making up the remaining 23%. The majority of our survey participants fall within the age bracket of 20 to 25 years and are currently pursuing undergraduate education. Therefore, it is safe to conclude that the feedback gathered predominantly represents the perspectives of a youthful and academically engaged demographic. To delve deeper into the socio-statistical aspects, we have included some graphical representations for your examination:

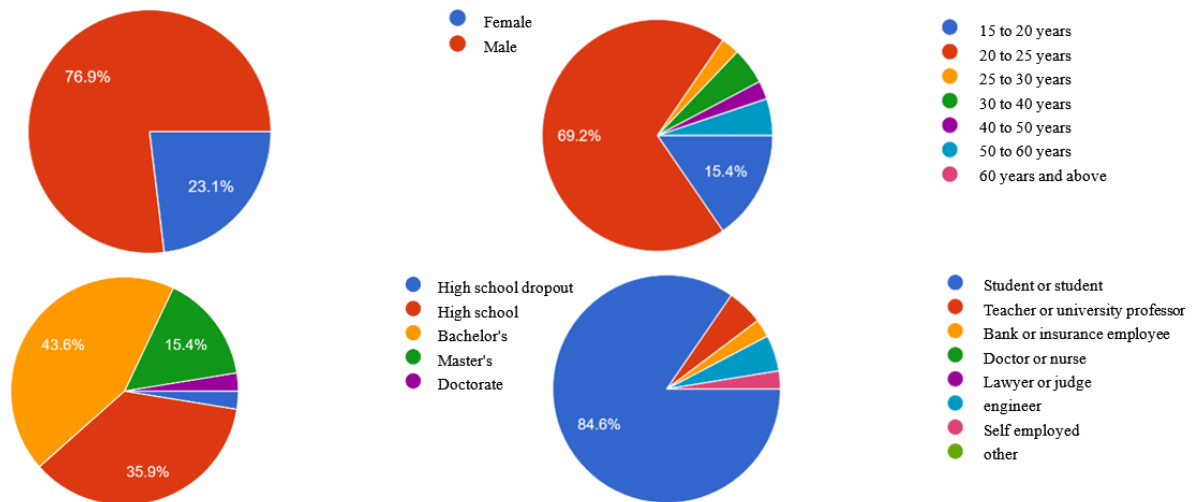


Figure 4- Examining the participants in terms of gender (top left), age (top right), education (bottom left) and occupation (bottom right)

After carefully analyzing the data provided by the participants, we have compiled the following table:

Table 1- The initial output of the Python code and program.

Attendee	Gender	Age	Education	Job	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Alternative1	Alternative2	Alternative3	Alternative4	OCR	Consistency %	
1	Man	20-25	High School Graduate	Student	Economic Stability	Infrastructure	Legitimate Government	Social Justice	Environment	Freedom of Speech	Legitimate Government	Revolution	Coup	Reform	Do Nothing	Inconsistent	0.375
2	Man	20-25	High School Graduate	Student	Economic Stability	Infrastructure	Social Justice	Environment	Economic Stability	Legitimate Government	Infrastructure	Reform	Revolution	Do Nothing	Coup	Inconsistent	0
3	Woman	20-25	Bachelor's Degree	Student	Freedom of Speech	Social Justice	Environment	Economic Stability	Legitimate Government	Infrastructure	Revolution	Do Nothing	Coup	Reform	Inconsistent	0	
4	Man	20-25	Bachelor's Degree	Student	Social Justice	Infrastructure	Economic Stability	Social Justice	Freedom of Speech	Legitimate Government	Environment	Revolution	Coup	Reform	Do Nothing	Inconsistent	0.5
5	Man	20-25	Bachelor's Degree	Student	Infrastructure	Economic Stability	Social Justice	Legitimate Government	Infrastructure	Freedom of Speech	Environment	Reform	Revolution	Coup	Do Nothing	Inconsistent	0.375
6	Man	20-25	High School Graduate	Student	Economic Stability	Social Justice	Legitimate Government	Infrastructure	Freedom of Speech	Environment	Reform	Revolution	Coup	Do Nothing	Inconsistent	0.75	
7	Man	20-25	Bachelor's Degree	Student	Economic Stability	Freedom of Speech	Legitimate Government	Social Justice	Infrastructure	Environment	Revolution	Coup	Do Nothing	Reform	Inconsistent	0.25	
8	Man	20-25	Bachelor's Degree	Student	Freedom of Speech	Social Justice	Legitimate Government	Economic Stability	Infrastructure	Environment	Do Nothing	Revolution	Reform	Coup	Inconsistent	0	
9	Man	20-25	Bachelor's Degree	Student	Freedom of Speech	Social Justice	Infrastructure	Economic Stability	Environment	Legitimate Government	Revolution	Coup	Reform	Do Nothing	Inconsistent	0	
10	Man	20-25	Bachelor's Degree	Student	Infrastructure	Economic Stability	Environment	Social Justice	Freedom of Speech	Legitimate Government	Reform	Revolution	Coup	Do Nothing	Inconsistent	0.125	
11	Man	20-25	Bachelor's Degree	Student	Environment	Infrastructure	Social Justice	Economic Stability	Freedom of Speech	Legitimate Government	Reform	Revolution	Coup	Do Nothing	Inconsistent	0.5	
12	Woman	20-25	Master's Degree	Teacher or Professor	Economic Stability	Infrastructure	Social Justice	Freedom of Speech	Environment	Legitimate Government	Reform	Revolution	Coup	Do Nothing	Consistent	0.875	
13	Man	20-25	Bachelor's Degree	Student	Social Justice	Freedom of Speech	Infrastructure	Economic Stability	Legitimate Government	Environment	Reform	Coup	Do Nothing	Revolution	Inconsistent	0.375	
14	Man	20-25	Bachelor's Degree	Student	Social Justice	Economic Stability	Infrastructure	Freedom of Speech	Environment	Legitimate Government	Reform	Revolution	Do Nothing	Coup	Inconsistent	0	
15	Man	20-25	High School Graduate	Student	Economic Stability	Freedom of Speech	Environment	Infrastructure	Social Justice	Legitimate Government	Reform	Revolution	Coup	Do Nothing	Consistent	0.875	
16	Man	20-25	High School Graduate	Student	Economic Stability	Freedom of Speech	Social Justice	Legitimate Government	Infrastructure	Environment	Reform	Coup	Revolution	Do Nothing	Inconsistent	0	
17	Man	20-25	High School Graduate	Student	Freedom of Speech	Legitimate Government	Social Justice	Infrastructure	Environment	Economic Stability	Revolution	Do Nothing	Reform	Coup	Inconsistent	0.125	
18	Man	20-25	Bachelor's Degree	Student	Social Justice	Freedom of Speech	Environment	Legitimate Government	Infrastructure	Economic Stability	Reform	Revolution	Do Nothing	Coup	Inconsistent	0.125	
19	Man	20-25	High School Graduate	Student	Economic Stability	Infrastructure	Freedom of Speech	Social Justice	Legitimate Government	Environment	Reform	Coup	Do Nothing	Revolution	Inconsistent	0.375	
20	Man	15-20	Bachelor's Degree	Student	Economic Stability	Social Justice	Legitimate Government	Infrastructure	Environment	Freedom of Speech	Reform	Coup	Do Nothing	Revolution	Inconsistent	0.375	
21	Woman	15-20	High School Graduate	Student	Economic Stability	Social Justice	Environment	Infrastructure	Freedom of Speech	Legitimate Government	Reform	Revolution	Coup	Do Nothing	Inconsistent	0.25	
22	Man	20-25	Bachelor's Degree	Student	Economic Stability	Infrastructure	Social Justice	Legitimate Government	Freedom of Speech	Environment	Reform	Do Nothing	Revolution	Coup	Inconsistent	0.5	
23	Woman	15-20	High School Graduate	Student	Freedom of Speech	Legitimate Government	Social Justice	Environment	Economic Stability	Infrastructure	Reform	Coup	Do Nothing	Revolution	Inconsistent	0	
24	Woman	20-25	High School Graduate	Student	Infrastructure	Economic Stability	Freedom of Speech	Social Justice	Environment	Legitimate Government	Revolution	Coup	Reform	Do Nothing	Inconsistent	0.375	
25	Woman	20-25	Bachelor's Degree	Student	Social Justice	Economic Stability	Infrastructure	Freedom of Speech	Legitimate Government	Environment	Reform	Coup	Reform	Do Nothing	Inconsistent	0.125	
26	Man	20-25	Bachelor's Degree	Student	Social Justice	Freedom of Speech	Legitimate Government	Economic Stability	Environment	Infrastructure	Reform	Revolution	Coup	Do Nothing	Consistent	0.875	
27	Man	15-20	High School Graduate	Student	Legitimate Government	Freedom of Speech	Infrastructure	Social Justice	Environment	Economic Stability	Reform	Coup	Revolution	Do Nothing	Inconsistent	0.5	
28	Man	20-25	Bachelor's Degree	Student	Economic Stability	Legitimate Government	Social Justice	Infrastructure	Environment	Freedom of Speech	Infrastructure	Reform	Coup	Do Nothing	Revolution	Inconsistent	0.25
29	Man	20-25	Master's Degree	Student	Economic Stability	Infrastructure	Social Justice	Freedom of Speech	Environment	Legitimate Government	Reform	Revolution	Coup	Do Nothing	Inconsistent	0	
30	Woman	15-20	High School Graduate	Student	Social Justice	Freedom of Speech	Legitimate Government	Economic Stability	Infrastructure	Environment	Reform	Coup	Reform	Do Nothing	Inconsistent	0.25	
31	Man	20-25	High School Graduate	Student	Economic Stability	Infrastructure	Environment	Social Justice	Legitimate Government	Freedom of Speech	Revolution	Coup	Do Nothing	Revolution	Inconsistent	0.375	
32	Man	25-30	Master's Degree	Student	Economic Stability	Freedom of Speech	Environment	Social Justice	Legitimate Government	Infrastructure	Reform	Do Nothing	Revolution	Coup	Inconsistent	0.375	
33	Man	30-40	Doctorate Degree	Self Employed	Economic Stability	Legitimate Government	Social Justice	Infrastructure	Freedom of Speech	Environment	Reform	Do Nothing	Revolution	Coup	Inconsistent	0.125	
34	Man	30-40	Master's Degree	Engineer	Freedom of Speech	Environment	Legitimate Government	Social Justice	Infrastructure	Economic Stability	Reform	Revolution	Do Nothing	Coup	Inconsistent	0.125	
35	Man	50-60	Master's Degree	Engineer	Freedom of Speech	Social Justice	Economic Stability	Legitimate Government	Infrastructure	Environment	Reform	Do Nothing	Revolution	Coup	Consistent	0.625	
36	Woman	40-50	Bachelor's Degree	Teacher or Professor	Economic Stability	Social Justice	Legitimate Government	Infrastructure	Freedom of Speech	Environment	Reform	Revolution	Do Nothing	Coup	Inconsistent	0	
37	Man	20-25	High School Graduate	Student	Environment	Freedom of Speech	Social Justice	Infrastructure	Legitimate Government	Economic Stability	Reform	Revolution	Coup	Do Nothing	Inconsistent	0.375	
38	Man	50-60	Master's Degree	Bank or Insurance Employee	Environment	Infrastructure	Economic Stability	Legitimate Government	Social Justice	Freedom of Speech	Revolution	Coup	Do Nothing	Reform	Inconsistent	0	
39	Woman	15-20	High School Dropout or Less	Student	Environment	Economic Stability	Freedom of Speech	Infrastructure	Environment	Legitimate Government	Revolution	Reform	Coup	Do Nothing	Consistent	0.75	

In this table, you'll find detailed information about each individual, including their characteristics. According to AHP algorithms, we've established their criteria and alternatives,

ranked in order of priority. Factor 1 signifies the most critical criterion for that individual, while Factor 6 indicates the least important. Similarly, Alternative 1 represents the top-priority alternative for them, and Alternative 4 signifies the least important option.

Moving to the penultimate column, you'll see the individual's OCR (Overall Criteria Ranking). Additionally, in the final column, we've calculated the compatibility percentage based on their responses. This percentage reflects the extent to which their answers align with a total of seven matrices, indicating the level of compatibility.

Based on our calculations, the standout observation is the widespread inconsistency among the majority of participants. In fact, only 6 out of the 39 respondents exhibit a high level of overall consistency, with an OCR below 0.1.

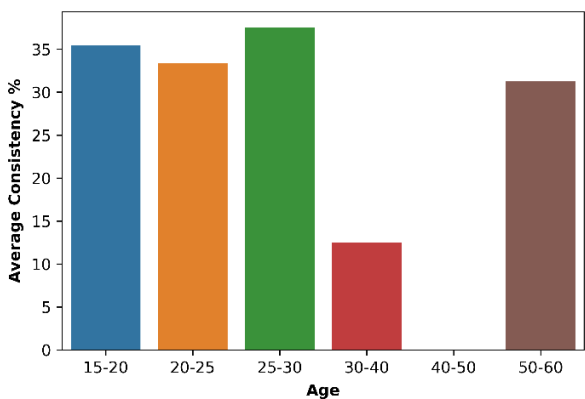


Figure 5- Consistency across ages

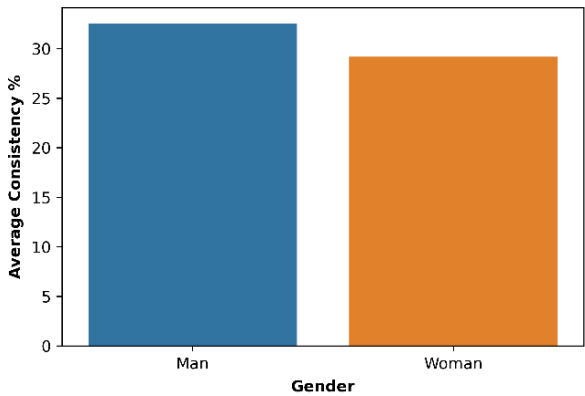


Figure 6- Consistency across genders

We also delved into the degree of inconsistency across different demographic groups. For instance, Figure 5 highlights that individuals aged between 30 and 40 demonstrate the highest level of disparity among all age groups. Conversely, those aged between 25 and 30 exhibit the highest degree of compatibility, accounting for approximately 35% of all responses.

In a broader context, it becomes evident that the compatibility rate across all groups is alarmingly low, consistently falling below the 50% mark. Notably, there appears to be no significant disparity in terms of answer inconsistency between genders. Nevertheless, both male and female groups display remarkably low compatibility rates, hovering around 30%.

Another interesting observation to consider is how respondents' answers vary based on their educational background and occupation. Surprisingly, the sociostatistical

data from this research reveals that individuals who have not yet obtained a diploma exhibit the highest rate of adaptability, while those with a doctorate degree demonstrate the lowest rate (as illustrated in Figure 7 - on the left). On a different note, teachers and university professors exhibit the greatest consistency in their responses, whereas individuals working in freelance positions display the least consistency.

Upon initial examination, the graphs on the following page may appear to present conflicting findings. However, it's crucial to take into account that the category labeled "Student" encompasses individuals across all levels of education, ranging from pre-diploma to doctorate. Consequently, adjustments have been made to ensure its compatibility and have resulted in a reduction of discrepancies.

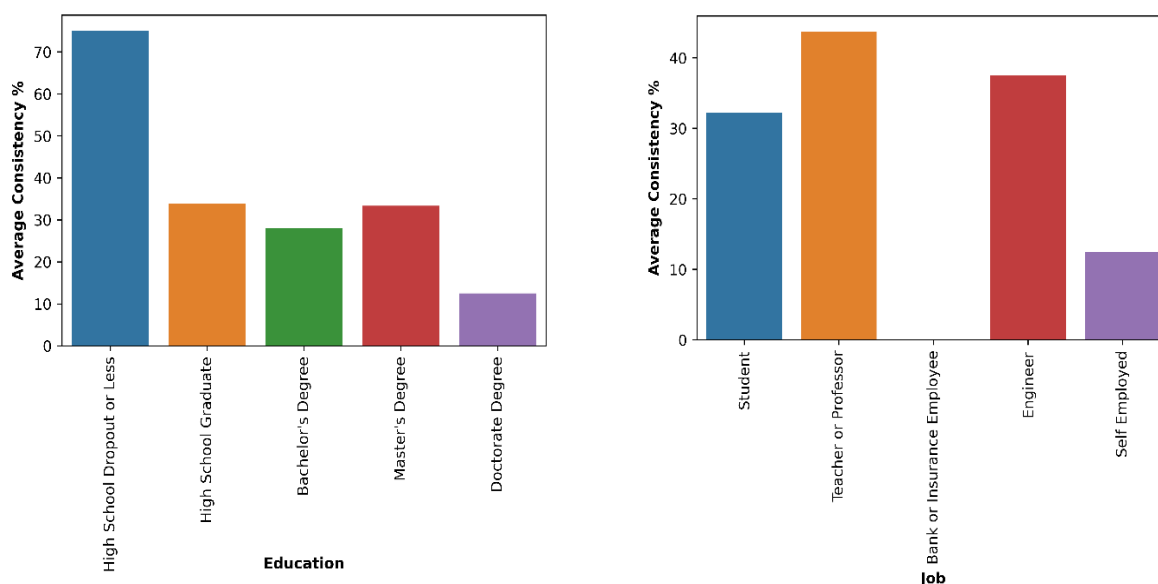


Figure 7- The level of consistency in responses across various education levels (on the left) and among different occupations (on the right).

In the context of teachers and professors, it's worth noting that this category encompasses individuals from various educational levels. Consequently, the impact of this group on the survey results is more significant than that of individuals with doctoral degrees alone. Several factors contribute to the observed inconsistency in the responses, which we can elaborate on as follows:

1. As previously mentioned in this section, the inclusion of an extensive array of alternatives and criteria can overwhelm participants and lead to inconsistent answers. This occurs because the sheer volume of questions can create a sense of urgency, prompting respondents to rush through the survey, sacrificing accuracy. In the subsequent section, we will discuss measures taken to mitigate this sensitivity.
2. In the initial stages of designing the survey options, efforts were made to minimize the inclusion of scattered criteria. The intention was to frame more detailed criteria within broader categories. However, the lack of proper categorization of sub-criteria, leading to participants struggling to organize them mentally, has resulted in vagueness within these broader categories. This confusion, in turn, has contributed to the inconsistency in participants' responses.
3. The topic under consideration is both fundamental and, for many, still unresolved. While initial impressions may suggest that the inconsistency in responses is illogical, a closer examination reveals a reflection of the complexity of our society. If a significant portion of society has not reached a consensus or conviction regarding their preferred methods for achieving effective governance, it manifests as confusion, and this confusion is reflected in their survey responses, at least within the population we have studied. The candid admission by one group member that their opinion has been in flux over the years serves as evidence of this claim.

Although the majority of responses exhibit inconsistency, making it difficult to deem the decisions as valid for this group, it is noteworthy that most decisions seem to favor the option of strikes and protests as a means to facilitate reforms, as indicated in Table 1. In the subsequent section, we will delve into the results of the sensitivity analysis of these responses and propose solutions to enhance their coherence and compatibility.

Streamlining Criteria Selection

In this section, we aim to enhance the overall compatibility of responses by eliminating criteria that exhibit higher inconsistency among participant answers and are more prone to issues. To achieve this, we take the following steps:

1. **Averaging Compatibility Scores:** Initially, we calculate the average compatibility score for each criterion by considering the Consistency Ratio (CR) related to that specific criterion in the matrix of pairwise comparisons of alternatives. This provides us with a quantitative measure of each criterion's compatibility.
2. **Criterion Removal:** Subsequently, we identify the criterion with the highest average value and remove it from consideration. It's important to note that this process assumes that all other participant responses remain constant. To execute this, we eliminate both the row and column corresponding to the chosen criterion in both the matrix of pairwise comparisons of criteria and the matrix of pairwise comparisons of alternatives.

Following these steps, we exclude the second criterion, "freedom of speech and thought," which increases the number of participants with overall compatibility from 6 to 12. In this scenario, the dominant decision among compatible participants, as well as the dominant decision among all participants (both compatible and incompatible), converges on "strikes and protests in line with reforms." In both cases, the secondary choice aligns with "strikes and protests in line with the revolution."

Continuing with this approach, we repeat the above steps, leading to the removal of the "social justice" criterion. By removing criteria 2 and 5, the number of participants with overall compatibility further increases from 12 to 18. Again, the dominant decisions among compatible and all participants align with "strikes and protests in line with reforms," with the secondary choice reflecting "strikes and protests in line with the revolution."

An intriguing observation arising from these outcomes is the relatively problematic nature of the two criteria we excluded: "freedom of speech and thought" and "social justice." This may be attributed, in part, to the majority of the society lacking sufficient experience and consequently, adequate knowledge of these criteria throughout their lives. This deficiency might have led to incorrect prioritization and understanding among participants.

Adjusting the Threshold for Determining Consistency

Another option to consider is modifying the threshold required to establish compatibility between pair matrices. Based on the literature related to Analytic Hierarchy Process (AHP) and our classroom discussions, there exists a suggested and elaborated approach for determining the compatibility of a pair matrix:

$$\text{if } C.R. = \frac{C.I.}{R.C.I.} \leq 0.1 \rightarrow \text{Consistent}$$

$$\text{if } O.C.R. = \frac{\text{Weighted Sum of } C.I.s}{\text{Weighted Sum of } R.C.I.s} \leq 0.1 \rightarrow \text{Consistent}$$

You can track the variations in the number of consistent answers by making slight adjustments to the suggested value of 0.1. To accomplish this, a program was developed, and you can observe the program's output in Figure 8.

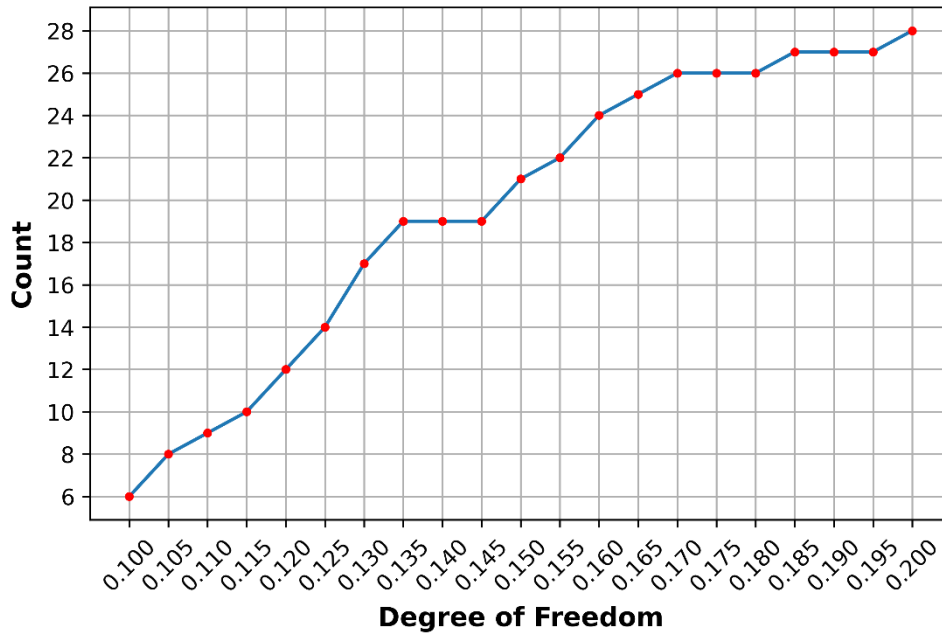


Figure 8- Relationship between consistent responses and degrees of freedom

As depicted in Figure 8, it becomes evident that when we increment the value by 0.1, referred to as the degree of freedom, the count of compatible responses also sees an increase. To be more precise, as we transition from a degree of freedom of 0.1 to 0.2, the number of compatible responses undergoes a shift from 6 to 28.

Analyzing the Final Set of Responses

In order to conduct a comprehensive analysis of the responses provided by participants and gain insights into their chosen criteria and alternatives, we identified individuals whose answers exhibited a higher degree of consistency. Initially, our dataset consisted of responses from only six individuals who had responses that were in alignment.

To augment this dataset, we employed one of the two methods we outlined earlier: "eliminating problematic criteria" or "adjusting the acceptable level for declaring compatibility." Up to this point in our research, we had maintained a questionnaire with a simplified structure to enhance participant engagement and data accuracy. This involved reducing the number of criteria to six.

In light of this, we opted for the second method, increasing the degree of freedom to 0.15, as opposed to the initial 0.1. This adjustment expanded the pool of individuals with consistent responses from six to twenty-one. Subsequently, we conducted a more detailed examination of the answers provided by these twenty-one participants, the results of which are presented below.

Analyzing Factors

All 21 Responses	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Economic Stability	47.6	14.3	4.8	14.3	0	19
Freedom of Speech	9.5	38.1	14.3	9.5	23.8	4.8
Infrastructure	9.5	23.8	9.5	28.6	19	9.5
Environment	9.5	4.8	19	0	28.6	38.1
Social Justice	19	9.5	33.3	33.3	4.8	0
Legitimate Government	4.8	9.5	19	14.3	23.8	28.6

The table above presents the breakdown of priorities assigned to specific criteria in terms of percentages. To illustrate, the initial value in the table reveals that 47.6% of respondents deemed economic stability as their foremost concern (Factor 1). For 19% of participants, social justice emerged as their top priority.

Notably, freedom of speech and thought ranked second in importance among the general public, while social justice occupied the third and fourth positions. Environmental concerns were the fifth priority, with government legitimacy and the environment being the least favored among the public. Interestingly, the criterion of infrastructure held the second spot in both the second and fourth priority rankings among respondents.

These findings hold significant implications. They reflect the prevailing economic instability in our country, which undoubtedly influences the prioritization of this criterion. Likewise, the emphasis on freedom of speech and thought highlights its considerable importance. Conversely, criteria such as the environment, which may not directly impact individuals' livelihoods, and government legitimacy, which could be ambiguous for many, ranked lowest in public priorities.

It's worth noting that the surveyed individuals consisted primarily of students aged 20 to 30. As a result, a more detailed analysis was conducted, focusing solely on gender groups, the results of which are presented below:

Men	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Economic Stability	47.1	5.9	5.9	17.6	0	23.5
Freedom of Speech	11.8	47.1	5.9	5.9	23.5	5.9
Infrastructure	5.9	23.5	11.8	23.5	23.5	11.8
Environment	11.8	5.9	17.6	0	17.6	47.1
Social Justice	17.6	5.9	35.3	35.3	5.9	0
Legitimate Government	5.9	11.8	23.5	17.6	29.4	11.8

Women	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Economic Stability	50	50	0	0	0	0
Freedom of Speech	0	0	50	25	25	0
Infrastructure	25	25	0	50	0	0
Environment	0	0	25	0	75	0
Social Justice	25	25	25	25	0	0
Legitimate Government	0	0	0	0	0	100

Men and women share similar values up until their second priority, but a shift occurs starting from the third priority onward. Among men, the third and fourth most crucial concerns revolve around social justice, while among women, the third priority is freedom of expression and the fourth is infrastructure. For women, the environment ranks fifth in importance, whereas for men, it's the legitimacy of the government. Lastly, the sixth preference for both genders is the exact opposite of their fifth preference.

These disparities can be explored through various lenses, including psychological, social, and even legal factors. In our country, women tend to have more constrained roles and face stricter legal constraints compared to men. Consequently, it's understandable that freedom of expression and infrastructure hold greater significance for women.

Analyzing Alternatives

All 21 Responses	Alternative1	Alternative2	Alternative3	Alternative4
Reform	61.9	19	14.3	4.8
Revolution	38.1	38.1	23.8	0
Coup	0	23.8	47.6	28.6
Do Nothing	0	19	14.3	66.7

In line with the previous section, the table above provides insights into the distribution of priorities among respondents. It illustrates the percentage of individuals who have assigned particular priorities to specific alternatives. For instance, the initial value in this table indicates that 61.9% of respondents deemed reforms (Alternative1) as their top priority, while 38.1% of respondents favored revolution as the most crucial option. Notably, neither coup d'état nor doing nothing emerged as the primary preference for any participant.

When considering secondary and tertiary priorities, the public's second choice leans towards revolution, followed by coup d'état as the third option. For the majority of participants, the fourth priority is to take no action.

These findings yield intriguing insights. The fact that a significant portion of the general public places "doing nothing" as their fourth priority suggests a belief that action is indeed necessary to meet the specified criteria. However, there exists a divergence of opinions regarding what constitutes practical action, as indicated by the data.

Furthermore, these patterns were also examined across gender groups:

Men	Alternative1	Alternative2	Alternative3	Alternative4
Reform	64.7	17.6	11.8	5.9
Revolution	35.3	35.3	29.4	0
Coup	0	23.5	41.2	35.3
Do Nothing	0	23.5	17.6	58.8

Women	Alternative1	Alternative2	Alternative3	Alternative4
Reform	50	25	25	0
Revolution	50	50	0	0
Coup	0	25	75	0
Do Nothing	0	0	0	100

The results show that men's views closely align with the overall findings. However, when we look at women's responses, it becomes evident that both the revolution and reforms hold equal significance as their top priorities. Additionally, it's interesting to note that women unanimously place "doing nothing" as their fourth priority, while this appears to be of lesser importance than usual for men.

These findings may suggest that women are expressing a higher level of dissatisfaction compared to men. They seem to believe that proactive measures are necessary to meet the criteria they've outlined.

Conclusion

In our research, our aim was to gain a comprehensive and overarching perspective on various aspects of the problem, which included data, underlying assumptions, and more. To achieve this, we conducted an extensive examination and review of relevant articles and sources.

To accomplish our goal, we leveraged the decision-making theory tools we had acquired throughout this course. In the section titled "What can the government do?" we utilized the Minimax method to model the government's alternatives and its decision-making process. Subsequently, we adopted game theory to explore the issue from the perspective of the populace, scrutinizing the circumstances under which individuals are inclined to unite against ineffective governments and the associated incentives.

Moreover, we delved into the significance of social networks as a crucial element in 21st-century decision-making, employing concepts of utility and decision nodes to model multi-stage decisions.

In our final phase, we extracted criteria and alternatives from our findings and subjected them to evaluation using the Analytic Hierarchy Process (AHP) as part of a survey. This allowed us to investigate the inconsistency of responses and the underlying reasons. Ultimately, we conducted a comprehensive analysis of the criteria and alternatives based on consistent responses. The outcomes of this stage offered valuable insights into the problem and its related discussions.

Undoubtedly, the issue of selection is multifaceted and rife with complexities, which extend beyond the confines of this course project. In essence, our research aimed to provide a comprehensive and scholarly perspective on political developments, approaching them from a mathematical and decision-making standpoint.

It's worth noting that the survey we conducted is but a small sample in a vast sea of possibilities. Future research endeavors can enhance our understanding by increasing participant numbers, extending the survey duration, broadening its reach across diverse segments of society, and refining the questionnaire. Such efforts have the potential to yield a more comprehensive, precise, and significant analysis. Our research serves as a testament to the potential of these methodologies and underscores the opportunities they offer for further exploration and study.

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