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Understanding Mass Killing in America: A System Dynamics Approach

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Author Note: Dillon Riedlinger completed this research while a First Class Cadet at the United States Military Academy as a part of Independent Study in the Department of Systems Engineering. MAJ Jillian Wisniewski, serving as advisor, provided critical expertise and knowledge in connecting the ideas of this study and in the implementation of systems concepts.

Abstract: This study explores the replication effect of mass killings across the United States. Often news outlets sensationalize emotional stories, such as mass killings, because they increase readership. Increased readership perpetuates the spread of the ideation to commit a mass killing through imitation, with each new incident having the possibility to spark several more throughout the country through increased exposure. This study places greatest focus on the imitation and does not analyze feedback mechanisms that affect other influences of violence. System dynamics modeling provides the framework for examining imitation incidents as an effect of increased exposure via the media.

Keywords: Mass Killing, Imitation, Sensationalism, Media, System Dynamics

1. Introduction

The study attempts to describe the incidents and effects of mass killings in the United States in aggregate. Each state is universally affected by the same risk factors for violence and the sensationalized media coverage of events.

Existing bodies of work in this domain focus on the root causes of violence. States differ in their access to firearms, their demographic and socioeconomic makeup, and their access to mental health care. Individual risk factors for violence include alcohol and drug use, childhood abuse, binge drinking, male gender (Metzl & MacLeish, 2015), social isolation, and major mental stress or strains (Blum & Jaworksi, 2016). Other violent gun crimes, like homicide and suicide, are strongly influenced by demographic and socioeconomic factors (Metzl & MacLeish, 2015) as well as access to mental health care, firearms, and firearm ownership (Towers, Gomez-Lievano, Khan, Mubayi, and Castillo-Chavez, 2015). Towers et al. (2015) fit a contagion model to high profile acts of violence to explain the rise of mass killings. Meindl and Ivy (2017) build on this but argue that imitation is a better representation of the cause of the increase of violence, not a contagious ideation for killing.

The United States is the third largest country in the world, but events happening within the country can be transmitted via media platforms within seconds. Media, on a corporate or individual level, is fueled by views and revenue. Sensational stories, like those frequently seen covering mass killings, garner a lot of views and revenue (Meidl & Ivy, 2017). The frequency of mass killings has increased dramatically in the past 20 years (Follman, Aronsen, and Pan, 2017). This is a problem not only for the victims, survivors, and their families, but also for all Americans. Tthe increase in mass violence and fear may be the result of an unseen and undiagnosed problem.

2. Problem Articulation

Based on the stated influences of violence, the question becomes how can we reduce the number of mass killings perpetrated in the United States? Besides imitation, a natural growth rate is included in our analysis to combine the effects of firearm ownership, access to mental health, and individual risk factors to explain the rise of mass killings with firearms. The prevalence of these exogenous factors on their own does not account for the dramatic rise of mass killings over the past 20 years (Towers et al., 2015). However, imitation can help identify the causes. A similar problem of imitation found in suicides by the World Health Organization resulted in suicide media guidelines to reduce sensationalism, and thus suicides due to imitation (Meindl & Ivy, 2017). According to Meindl and Ivy (2017), imitation is more likely if the person being imitated is similar to the imitator in age, gender, life story, etc., has an elevated social status, is seen being rewarded, and is seen as competent. Sensationalized media detailing the methodology of a killer, their backstory, manifesto, and body counts give notoriety and increase the probability for imitation (Meindl & Ivy, 2017). Unfortunately, the media does not appear to be slowing down sensational news reports of mass killings in the future because of the potential for views and revenue (Meindl &

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Ivy, 2017). The imitation problem is not as noticeable in homicides because the large number of incidents making sensationalism less likely.

Two key variables help to explain this problem graphically in Figure 1: number of mass killings and sensational media coverage. Other key variables include imitation and the total deaths from mass killings. The time horizon will be restricted to 60 months in order to create a model that can fit real world data from 2013- 2017. Sensational media coverage, as measured by number of reports sensationalized, is assumed to grow exponentially because of the reinforcing incentive of revenue and the growth of technology assisted media distribution. Neither Towers et al. or Meindl & Ivy provided any data on media coverage of mass killings in their contagion or imitation analysis. In this analysis, a mass killing is an incident where at least four people are murdered in close proximity of each other.

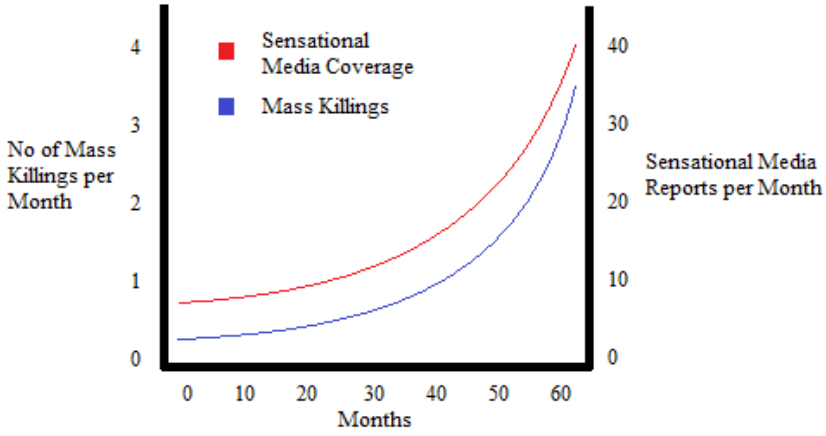

Figure 1. Reference Mode

Both the number of mass killings and percent of coverage sensationalized are low in the beginning of our time horizon. Sensationalized media coverage exponentially grows spurring imitation. Since mass killings with firearms is influenced by imitation, the number of killings per month follows closely behind the reports sensationalized.

3. Formulation of a Dynamic Hypothesis

This hypothesis tries to explain the growth of mass killings through imitation. The feedback mechanisms explored in this article focus on this growth and not on the initial causes that predispose people to violence. The dynamic hypothesis, shown below, has a beginning structure for analyzing the root causes but no feedback mechanisms have been determined yet. The dynamic hypothesis explains the reference mode as follows: After a mass killing, the media begins reporting in order to inform the public. Because of the horrific nature of mass killings and their relative infrequency, the media focuses a lot of its attention on gathering information and presents it to the public as fast as possible. The attention surrounding the event gives immediate fame and elevated social status to the killer. The physical description, life story, and methodology allow citizens across the country to relate to the killer. The reports of those killed and wounded display the competence of the killer. This creates an environment where imitation is not only possible, but also probable. Potentially like-minded people are then influenced either consciously or subconsciously to act similarly in the future. Thus, more mass killings occur.

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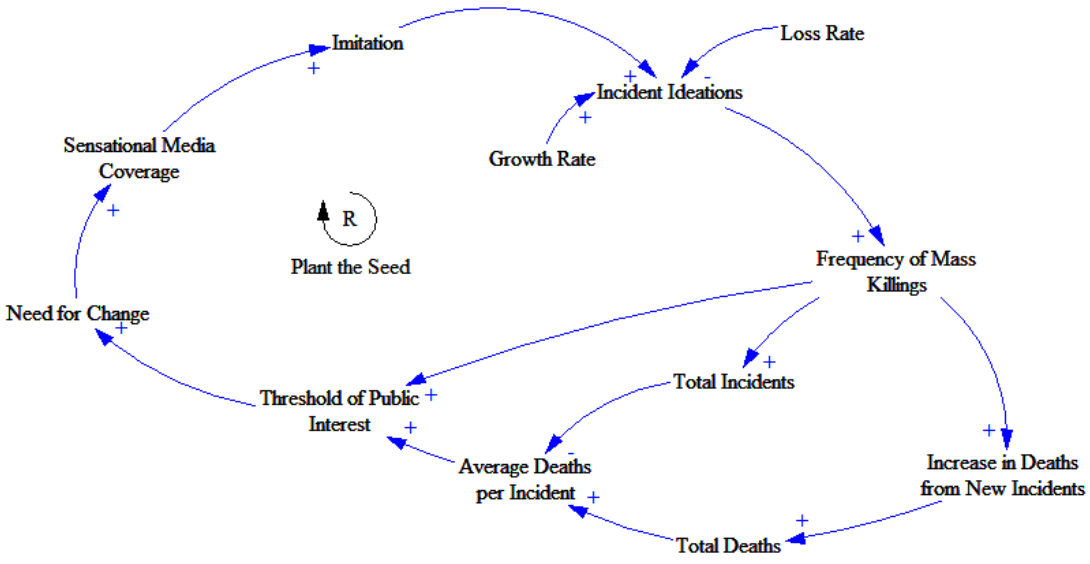

Figure 2. Dynamic Hypothesis

There is one reinforcing loop: Plant the Seed. As seen in Figure 2, the model begins with incident ideations which has a natural growth and loss rate. The incident ideations represent a scenario where a person susceptible to commit an act of violence is presented with a situation to act in a violent manner. These ideations will lead to a frequency of mass killings and here the model splits to track both total incidents and total deaths resulting from mass killings. The incidents and total deaths combine to form the average deaths per incident while this average and the frequency of mass killings are combined to form a deadliness factor: threshold of public interest. If mass killings become either too prevalent or deadly then the social aspect, need for change, will increase. This social movement based on public opinion leads to sensationalized media coverage. This leads to more imitation and an increase in incident ideations.

4. Formulation of a Simulation Model

This model is a combination of an aging chain and a nonconserved coflow. The aging chain models the effect of employee acquisition delays on workplace productivity (Sterman, p. 490) and is used to model the conversion from Incident Ideations for Mass Killing to Total Incidents - Mass Killings. The nonconserved coflow tracks the experience of a labor force (Sterman, p. 505) but is used in this model to track the Total Deaths from Mass Killings. Adding to these models the social aspect of an acceptable level of violence, sensational media coverage, and imitation results in the feedback mechanism.

Many of the exogenous constants within the model have assumed values because of a lack of real world data. This allows the model to work and show the power of imitation but it does not adequately model real life events. Other exogenous variables such as the natural growth rate are a combination of what could be many more exogenous variables in future models.

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Table 1. Variable definitions and relationships

Variable Name & (Units)	**Definition**	**Equation**
Incident Ideations for Mass Killings (Incident)	A susceptible person is presented with a scenario to act in a violent manner	INTEG(Becoming Susceptible-Frequency of Mass Killings- Losing Susceptibility), initial value = 10
Total Incidents- Mass Killings (Incident)	Total number of mass killings	INTEG(Frequency of Mass Killings), initial value = 91
Total Deaths from Mass Killings (Deaths)	Total deaths resulting from mass killings	INTEG(Increase from New Incidents), initial value = 700
Threshold of Public Interest (Death/Month)	Current level of violence	Frequency of Mass Killings*Average Kills per Incident
Sensational Media Coverage (Reports/Month)	Number of sensational reports generated on mass killings per month	Need for Change/Adjustment Time
Imitation (Incident/ Month)	Process by which people repeat behavior exhibited by others	Sensational Media Coverage*Propensity for Imitation
Need for Change (Reports)	Difference between socially accepted levels of violence and actual levels of violence	IF THEN ELSE(Threshold of Public Interest >= Acceptable Level of Violence, Threshold of Public Interest-Acceptable Level of Violence, 0) * Units Modifier
Becoming Susceptible (Incident/Month)	Rate at which people become more susceptible to act violently	Natural Growth Rate+Imitation
Losing Susceptibility (Incident/Month)	Rate at which people become less susceptible to act in violent manner	Incident Ideations for Mass Killing*Loss of Susceptible Fraction
Distribution of Deaths per Incidents (Death/Incident)	Distribution assigning a number of deaths for each mass killing	RANDOM TRIANGULAR(4, 100 , 4 , 4 , 20, 0)
Acceptable Level of Violence (Death/Month)	Society's acceptable level of deaths per mass killing/frequency of mass killings	4
Propensity for Imitation (Incident/Reports)	Number of people who become susceptible per sensational report	1
Natural Growth Rate (Incident/Month)	Increase in susceptibility due to stress/ strains not a result from imitation	.22
Loss of Susceptibility Fraction (1/Month)	Decrease in susceptibility due to conflict resolution or stress/ strain relief	.111
Conversion Rate (Dmnl)	Rate at which people susceptible to violence commit violence	.2101
Assimilation Time (Month)	Time is takes to resource/plan a mass killing	RANDOM NORMAL(0.25, 48, 6, 3, 0)
Adjustment Time (Month)	Time it takes for the media to sensationalize a mass killing	.5

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Variable Name & (Units)	Definition	Equation
Units Modifier (Reports*Month/ Death)	Used to change units of Need for Change to reports	1

The following assumptions are made in this model: Ideation to commit a mass killing can be spread by imitation. There is an acceptable level of violence, below which people will not commit their time to act. There is some conversion rate of people who have the potential to act on an ideation and the people who do act. People can have phases of ideations that if unacted upon will disappear. As the number of mass killings rises, the sensational media coverage will increase indefinitely. There is some adjustment time required before a mass killing can be fully sensationalized.

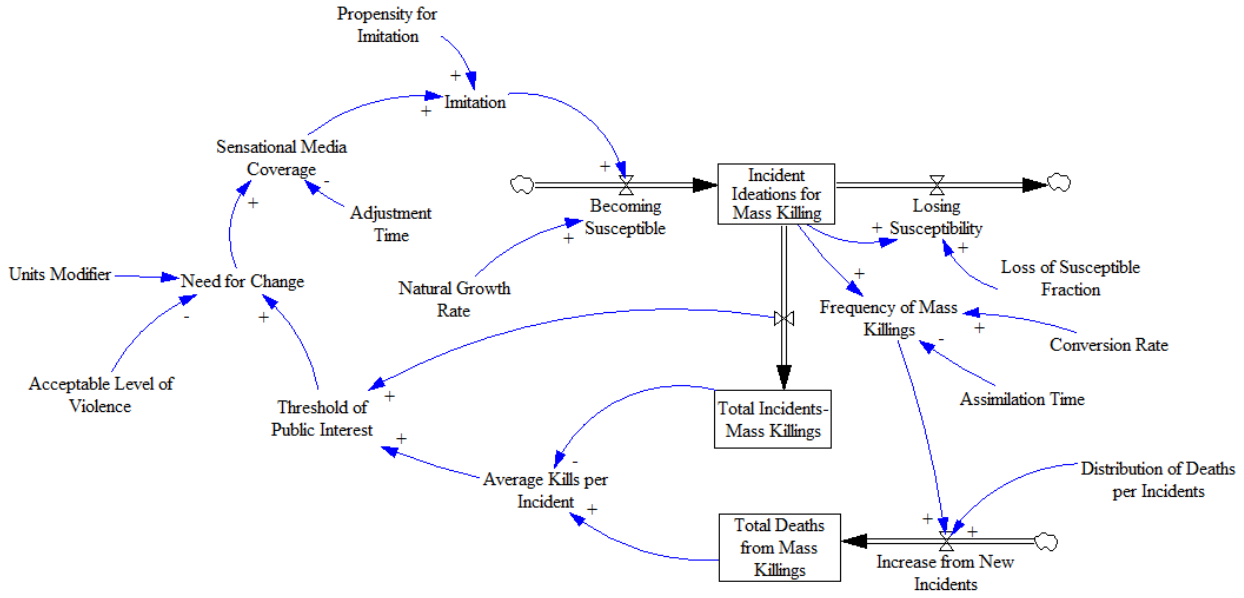

Figure 3. Stock and Flow of Vensim Simulation Model

5. Testing

There are some variables with no real world meaning that are used to make the model dimensionally consistent. This can be improved by adding depth to the model. As seen in Table 2, the “Need for Change” variable has a “Units Modifier” variable. This has no real world meaning. This could potentially be fixed by adding complexity or by modifying the equation to not use an IF statement in its calculation. The “Imitation” variable includes a “Propensity for Imitation” variable that is rudimentary calibrated in this model. While this variable does have some real world meaning, conducting research to find more legitimate values would add validity to the model. The “Frequency of Mass Killings” variable has a similar problem with the conversion rate that can be mended via further research.

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Table 2. Dimensional Consistency

Variable Name	**Definition**	**Equation**	**Units**
Need for Change	Difference between socially accepted levels of violence and actual levels of violence	IF THEN ELSE(Threshold of Public Interest >= Acceptable Level of Violence, Threshold of Public Interest-Acceptable Level of Violence, 0)***Units Modifier**	Reports
Imitation	Process by which people repeat behavior exhibited by others	Sensational Media Coverage***Propensity for Imitation**	Incident/ Month
Frequency of Mass Killings	Number of mass killings occurring per month	Incident Ideations for Mass Killings***Conversion Rate**/ Assimilation Rate	Incident/ Month

To perform a common sense check on the model, extreme conditions testing was utilized. Table 3 shows the three tests conducted. Propensity for imitation was changed from a value of 1 to 0 which lead to zero imitation affecting the growth rate of mass killings. Since the initial value of total incidents- mass killings is 91, only 6 mass killings were perpetrated over the 60 month period as opposed to 21 with imitation.

Lowering the acceptable level of violence to 0 from 4 would mean that any deaths or incidents of a mass killing would result in increased media reporting and therefore increased imitation. This leads to exponential behavior. This is infeasible but this result makes sense within the assumptions of the model.

Increasing the acceptable level of violence should have a similar effect as decreasing the propensity for imitation. If people do not care as much about mass killings, then the media will not have a motivation to sensationalize the events. When the acceptable level of violence increases from 4 to 8, the behavior is almost identical to changing the value of propensity for imitation from 1 to 0. The model behaves as expected.

Table 3. Extreme Conditions

Test	**Input Variable Name/Test Condition**	**Base Test Value**	**Extreme Value**	**Total Incidents- Mass Killings Result Under Base Conditions**	**Total Incidents- Mass Killings Result Under Extreme Conditions**
1	Propensity for Imitation	1	0	112	97
2	Acceptable Level of Violence	4	0	112	2 x 10^18
3	Acceptable Level of Violence	4	8	112	98

Sensitivity analysis was conducted to assess the robustness of the model and its assumptions. The three variables analyzed are found in Table 4. Both the conversion rate and the natural growth rate values are assumed. Increasing these variables even slightly sent the total incidents of mass killings skyrocketing to well past feasible. This could be problematic when attempting to assign a real data point to these values because the model would likely not work. This can be remedied through increasing the complexity of the model and by adding negative feedback loops.

The adjustment time has an initial value of .5 which does have real world validity. Towers et al. found that after a mass killing, another mass killing is most likely to occur within the next two weeks (2015). However this value is not very robust. Halving the adjustment time quickly sends the total incidents of mass killings to infinity.

All three of the variables tested exhibited large numerical and behavior sensitivity. The model is not very robust and the assumptions about the true values may be weak. This can be corrected in future work via continued research.

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Table 4. Sensitivity Analysis

Test	Input Variable Name	Base Test Value	New Value	Total Incidents- Mass Killings Result Under Base Conditions	Total Incidents- Mass Killings Result Under New Conditions
1	Conversion Rate	.2101	.2105	112	19,851
2	Adjustment Time	.5	.25	112	9 x 10^33
3	Natural Growth Rate	.22	.23	112	95

6. Policy Design and Evaluation

The issue being addressed by this model is the imitation caused by sensational media coverage. Therefore policies attempting to reduce the number of mass killings should focus on the causes of imitation. Two policies are presented in this article: the implementation of media guidelines and public safety measures.

To decrease the staggering effect of imitation on the Becoming Susceptible variable, policy can be directly targeted to reduce sensational media coverage. Implementing media guidelines about how news organizations present facts and cover stories of mass killings will reduce the amount of imitation the media coverage causes. Figure 4 shows the modification and graphical effect of the policy. A value of .5 was chosen for this variable meaning that half of the sensational reports were generated as compared to the base case. The result was the total number of mass killings decreasing by over 60% over a 5 year period. This addition does not change the models assumptions however no policy resistance is taken into consideration in the model.

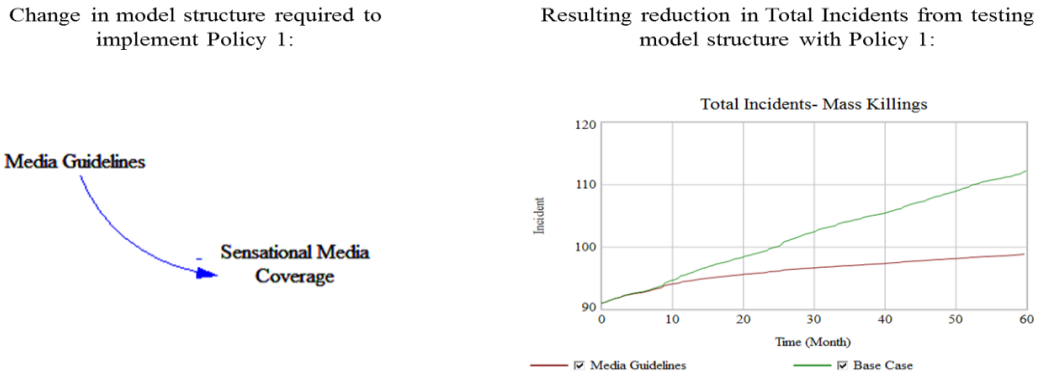

Figure 4: Effect of Media Guidelines on Total Incidents- Mass Killings

Another method of reducing the effect of imitation is to change public opinion on mass killings. By implementing public safety measures, mass killings become less deadly and the threshold of public interest will not exceed the acceptable level of violence as often. The many different types of public safety measures are not described in this model, therefore there is an assumption that whichever public safety measure is implemented has some level of success. Figure 5 shows this addition to the model as well as the output graph supporting the policy's efficacy. This policy would reduce the number of mass killings by over 28% over 5 years. Changing the assumptions about the acceptable level of violence would have an impact as to how effective this policy actually is. This policy can result in definitional issues. In this model, public safety measures reduced the deaths per incident by 1. In this article, a mass killing is an incident where at least four people are murdered. By reducing the number of deaths, the incident may no longer fall in the realm of "mass killings." The model does not address this issue.

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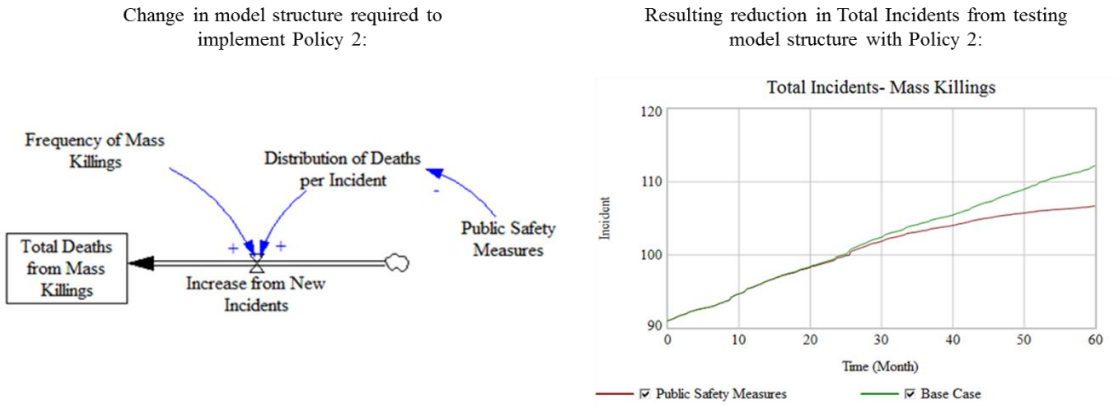

Figure 5. Effect of Public Safety Measures on Total Incidents- Mass Killings

7. Conclusion

The power of this model comes from the ability to see the long term effect of imitation. Based on the assumptions of the problem, sensational media reporting increases mass killings through imitation. System dynamics provides a useful basis for analyzing this behavior via feedback loops and the implementation of policy. While the model is far from complete, it will provide a basis for future work in the study of mass killings in America. Future work includes examining the effect of gun control policies, access to firearms, and individual psychology. Adding complexity and feedback loops to the model will allow it to be more robust and further research will allow the model to provide real world context.

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