The Use of Network Metrics in Building Intelligence Early Warning Systems. The Structural Conduciveness Index

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Abstract: Specific collective behavior forms (for example, mass protests) emerge only if certain conditions are met simultaneously: good structural conduciveness of the group, a pre-existing structural strain, a formed generalized belief, the appearance of precipitating factors, a grass-roots or top-down mobilization for the action and the already-formed perception that the social control instruments are no longer in the authorities' hands. Mass protests seem to follow this 'perfect-storm' recipe, from Tunis' violent protests that kick-started the 'Arab Spring' to the late 2011 riots in London. This paper presents and discusses how structural conduciveness could be measured using network metrics such as k-cores, clustering, cliqueness, reciprocity, cohesion, homophily, structural holes, triad closure.

Keywords: *early warning system, intelligence, network metrics, social strain theory, structural conduciveness Index.*

Setting the problem: collective behavior and intelligence

Throughout history there have been numerous and varied episodes in which forms of collective behavior led to dramatic results. Riots, revolutions, mass-panic episodes and crazes are but a few examples. Understanding such phenomena has not only been a priority for academics, but also for those institutions called to ease tensions, manage potentially explosive situations and deter violent behavior.

Law enforcement and intelligence organizations have long tried to better anticipate, detect the formation of and, when possible, prevent such events.

Smelser (1962) suggested a robust framework for understanding and explaining large-scale forms of sometimes destructive behavior and explained his *social strain* approach (the social strain or value-added theory) as a *perfect-storm* recipe in which collective behavior is the result of a process that goes through six iterative steps.

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This paper proposes a way to *breathe new life* into this theory by indicating how Smelser's perspective could be transformed from ex-post to ex-ante knowledge by building an intelligence-oriented Early Warning System (EWS); 'a chain of information communication systems comprising sensor, detection, decision and broker subsystems, in the given order, working in conjunction, forecasting and signaling disturbances adversely affecting the stability of the physical world […]' (Waidyanatha, 2010:33). Moreover, the potential uses of social network analysis in such an EWS are stressed, by pinpointing the way in which network topology plays a crucial role in the social strain process.

Theory

We embrace Blumer's (1957:130) definition of collective behavior as 'spontaneous processes and events that form outside existing social structure', that is 'formed or forged to meet undefined or unstructured situations'. As such, collective behavior is a highly volatile and unpredictable social process that is not governed by explicit or implicit generally accepted norms.

While different types collective behavior greatly vary in form and manifestation, they all have certain common traits, one of the most easily identified being that of the formation of a generalized belief within the group - common whishes, complaints, hopes etc. – and also a sense of opposition against a sometimes vague *larger-than-life* adversary (Smelser, 1957: 8).

Rumor spread, revolutions, spontaneous gatherings and flash-mobs, diverse as they are, represent different types of collective behavior or crowds (the group of individuals that are subjected to the process). Blumer's (1951:168) taxonomy takes into account 4 types of such groups: *casual, conventional, expressive* and *acting*.

The casual might refer, for instance, to a group of people on a bus: they all have the same purpose (getting from point A to point B), but lack a sense of belonging to a common group. *The conventional* might refer to a group of students attending a class. In this case, all the individuals have the same purpose, they have a sense of *us*, but their actions are limited by mostly implicit norms of behavior; their purpose for gathering is sometimes to debate a problem. *The expressive* might refer to some football fans, gathered to express strong feelings (e.g. anger or joy) in relation to the outcome of a match. In this case, the norms of behavior are *emergent* or *ad-hoc*. *The acting* might refer to crowds that have a clear objective of change or reform implementation. Expressive and acting crowds are of special interest to law enforcement and intelligence organizations, for being an environment that facilitates the appearance of mass violence, mobbing, spread of panic and propaganda etc. The risk for volatile outbreak is always a step away.

If crowds are the environment of collective behavior, the driving mechanisms of crowd forming are equally diverse: *contagion, convergence, emergence of norms, forming complex adaptive systems* (CAS).

One the most famous body of literature on the topic of *contagion*,

Le Bon's *The Crowd: A Study of the Popular Mind* ([1896] 2001), defines crowds as masses of individuals that *lose* their rational judgement under the hypnotic power of the group. People, under the cloak of anonymity, practically abandon their personal responsibility, falling in line with the highly excitable emotional state of the crowd. Thus, Le Bon designates crowds as highly irrational and often violent groups.

In line with the sociological concept of homophily (people tend to relate to those that are similar to them - race, age, sex etc.), the *convergence* approach suggests that people who behave in a similar manner tend to seek each other out. For example, soccer hooligan groups do not turn violent because the group mentality clouds the rational judgment of the individuals, but because like-minded individuals formed preferential attachments and all the members adhere to similar beliefs (violence as a way to express their feelings, little to no regard for police forces etc.). As such, convergence explains why some crowds display heightened behavior intensity, while leaving room for the diffusion of responsibility explanation offered by Le Bon.

Turner and Killian (1993) believe that crowds are heterogeneous, as they are made up of individuals with different motivations and interests. At the same time, given the fact that crowds form outside pre-existing social structures, a sense of what constitutes *acceptable behavior* forms on the spot. For example, if, at a protest, a person decides to smash a window, others might go the same route, because this type of behavior is acceptable on a *now and here* criterion.

CAS theorists believe that contagion, convergence and emergence of norms are just different and complementary instances of CAS synergy (Ginneken, 2003). These types of systems are super-structures capable of learning and adapting to changes. A CAS is basically a network of networks of agents (Holland, 2006).

The Social Strain Theory

Smelser (1965:8) believes that collective behavior is defined by the 'mobilization on the basis of a belief which redefines social action'. In Smelser's perspective, each type of collective behavior follows a specific set of steps and it is based on a number of pre-requisites. For example, panic appears when group members are physiologically (people are tired, underfed, sleep deprived) and psychologically (uncertainty, surprise, anxiety appear) stressed and, on top of that, of that, some sociological determinants are at play - lack of solidarity, unfit leadership etc. Therefore, no collective event, state, phenomena or process can take place if a number of required stages are not met. By borrowing the value-added perspective from economy, Smelser explains that collective behavior is a result of a six-stage process.

First, there was to be structural conduciveness within the group. The group must be large enough and have adequate means of communication between individuals. Information must spread easily from person to person.

Secondly, there has to be a form of structural strain (tension) that affects

the group. Poverty or the feeling of relative inequality are among the most common structural strain factors. People must feel wronged in a certain way.

Thirdly, there has to be a growth and spread of a generalized belief (at this stage, people seek to identify enemies, or *popular devils*) about the social actors stressed by the group as being responsible for the structural strain.

Fourthly, a precipitating factor must appear. An unanticipated event has to trigger action, to pull the crowd from a sort of behavior lethargy.

Fifthly step, participants must be mobilized for action and a sort of *call to arms* must be carried out as to initiate the collective behavior.

And, eventually, at the sixth stage, perception of failure of social control must be instilled in the group's mentality. Participants to the protest must feel (rightfully so or not) that the mechanisms put in place to prevent violent collective behavior are flawed or incapacitated.

As the process goes from step to step there is a narrowing of possibilities that limit the potential outcome. At stage one, a variety of future social processes can take place, but at stage six only violence can appear.

There is also a powerful analogy to economical processes. For instance, *iron*, when extracted, can be used in a number of economical processes. At the end, the raw material could become a support beam for a sky scraper, a fender bumper of a high-priced car, or a skillet. But, as the process unfolds within a specific pattern, the result possibilities narrow because step n is a direct result of step n-1, which in turn is a result of step n-2.

According to Smelser's approach, the six step pattern defines each and every type of violent collective behavior, therefore making the emergence of such phenomena predictable. For intelligence practitioners, the question of interest lies in the measurement capability for each step as a *sine qua non* condition of building an EWS.

Good ex-post explanation: social movements and intelligence

Smelser's perspective provides a good ex-post knowledge regarding all types of social phenomena and processes that shape today's geopolitical landscape. By analyzing diverse social movements such as the 'Twitter Revolution' of Moldova (2009), the 'Arab Spring' protests (2011) or the Occupy protests of 2011 through the social strain theory lenses, one can easily see they share striking similarities. For brevity, Table 1 will only include headlines taken from specific years that pertain to each determinant. It is not meant to be an exhaustive analysis of each factor, but a 'rule-of-thumb' analysis instrument.

Table 1. *Modeling three social movements by applying the Smelser's six-step process*

Determinants	Hosni Mubarak Ousting in Egypt (2011)	'Twitter Revolution' in Moldova (2009)	Occupy Movement in the US (2011)
Structural conduciveness	Egypt's MCIT: Egypt Has 23.51 Million Internet Users, 71.46 Million Mobile Subscribers & 3972 ICT Companies[1]	Moldovan Youth Organize Protests on Twitter[2]	Sociologist Tracks Social Media Role in Occupy Wall Street Movement[3]
Structural strain	Egypt's Poverty, Unemployment, Push Youths to Breaking Point[4]	Moldova's 'Twitter revolutionary' speaks out: 'The election which returned the Communist Party to power was rigged.'[5]	The 99 Percent Rise Up[6]
Generalized belief	Making Fun of Pharaoh: Why Egypt's long-serving dictator makes such a good punch line[7]	Thousands protest in Moldova over rigged election[8]	Occupy Wall Street Protest Names Single Enemy: 'Neoliberalism'[9]
Precipitating factors	Copycat effect: How one man's self-immolation engulfed a region[10]	'Twitter revolution' Moldovan activist goes into hiding[11]	Los Indignados: a movement that is here to stay[12]
Mobilization for action	After Google Executive Sparks Revolution in Egypt, Corporations Wonder Who's Next[13]	Moldova protesters use Twitter to beat Communist censors[14]	Map: Occupy Wall Street, a global movement[15]
Failure of social control	Police Abandon Tahrir Square[16]	Moldovan police retake parliament after uprising[17]	New York police fail to clear park after thousands gather to defend Occupy Wall Street[18]

The role of social network analysis in building an EWS

While Smelser's analytic framework, robust as it is, offers little, the six determinants are not easily quantifiable (with the possible exception of social strain, which can be statistically measured). Nuanced processes such as the forming of generalized beliefs or the forming of the perception of lack of social control are very hard to operationalize and, therefore, almost impossible to precisely measure. Add to that the inherent uncertainty of today's social, political, economic and cultural dynamics, and the task of anticipating possible precipitating factors truly seems as an impossible task.

Social Network Analysis (SNA) can play a key role in discerning the social and psychological processes that shape the six-step birth of violent collective behavior by contributing to the better understanding of structural conduciveness.

The crowds, which are the environment of violent collective behavior, are nothing more than complex networks that form a collaborative architecture. By applying network metrics, one might build a Structural Conduciveness Index (SCI) that would also indicate how fast

beliefs travel (appearance of *popular devils* and spread of the lack-of-social-control perception). SCI could show how *ripe for violence* a group is.

There are three key dimensions that could define a SCI: the *structure* of the network, the *distribution* of the network and the *strength* of the network. Tables 2, 3 and 4 provides a brief presentation of how the three SCI dimensions can be operationalized.

Table 2. *The SCI first dimension, STRUCTURE,* and its corresponding metrics

Dimension	Social Network Analysis metrics	Does the metric evaluate?
STRUCTURE	Size	It shows how big the network is
	Length	
	Average Geodesic Path	It shows how dispersed the network is
	Diameter	It shows how wide the network is.
	Density and Fragmentation	It shows how tightly the network is woven.

Table 2 indicates five SNA metrics that correspond to the first SCI dimension, the STRUCTURE: *the size* (number of nodes), *the length* (number of ties), *the average geodesic path* (Mathematical average of the shortest paths or paths through the network from one node to another that passes through the minimum of edges/ ties), *the diameter* (the maximum eccentricity of any node in the network) and *the density/fragmentation* (the proportion of existing ties in a network relative to the total number possible).

Table 3. *The SCI second dimension, DISTRIBUTION,* and its corresponding metrics

Dimension	Social Network Analysis metrics	Does the metric evaluate?
DISTRIBUTION	Random vs Scale free networks	It shows if the network displays power laws. If the network is scale-free then that architecture is particularly fault-tolerant, although simultaneous targeting of the hubs will collapse the entire network
	K-core	It show the center-periphery distribution
	Clustering	It shows the homogeneity of the network and the presence of the global slowness (information is first 'digested' within the cluster or clique and is sent out after all the members of the subgroup have had access to it)
	Cliqueness	

Table 3 indicates four SNA metrics that correspond to the second SCI dimension, the DISTRIBUTION: *random* vs *scale free*, *K-cores* (successively enclosed substructures of the network), *clustering* (overlapping strong ties within subgroups inside the network, with sparse ties externally) and *cliqueness* (cohesive subgroups with strong ties between their own nodes).

Table 4. *The SCI third dimension, STRENGTH,* and its corresponding metrics

Dimension	Social Network Analysis metrics	Does the metric evaluate?
STRENGTH	Reciprocity	Facet of cohesion (ties with a 'strong' nature – friendship, kinship etc.)
	Cohesion	Shows how important are the ties for the members of the network
	Homophily	Sociological axiom: similarity breeds cohesion
	Structural holes	In closed groups (A to B, B to C, C to A), individuals have equal power. In open groups (A to B, A to C), the node which is the *freest* and most powerful is the node that has ties with neighbors that do not have ties with each other
	Triad Closure	Triads are the smallest possible social groups. Closed triads are the *building blocks* of strong networks

Table 4 indicates five SNA metrics that correspond to the third SCI dimension, the STRENGTH: *reciprocity* (whether the ties are reciprocated between two nodes: A to B and B to A), *cohesion* (the degree to which actors are connected directly to each other through strong bonds), *homophily* (the tendency of humans to associate with similar individuals), *structural holes* (the neighbors of a node do not form connections between themselves) and *triad closure* (presence of the all possible ties between nodes).

Conclusion

Smelser's six-step model (the Structural Strain Theory) is an important reference in building an Early Warning System designed to detect, anticipate and control violent collective behavior. Within this system, SNA is expected to play a key-role for quantifying Smelser's six determinants by supporting the construction of a Structural Conduciveness Index. While the precise algorithm should take into account various SNA metrics, at least three dimensions should be taken into account: the structure, the distribution and the power of the network.

Notes

[1] http://arabcrunch.com/2011/04/egypts-mcit-egypt-has-23-51-million-internet-users-71-46-million-mobile-subscribers-3972-ict-companies.html. Retrieved: October 20, 2013.
[2] https://blogs.law.harvard.edu/idblog/2009/04/07/moldovan-youth-organize-protests-with-twitter/ Retrieved: October 20, 2013.
[3] http://sociology.unc.edu/features/sociologist-tracks-social-media2019s-role-in-occupy-wall-street-movement. Retrieved: October 20, 2013.
[4] http://www.newsmax.com/Newsfront/Egypt-poverty-unemployment-unrest/2011/01/31/id/384555. Retrieved: October 20, 2013.
[5] http://news.bbc.co.uk/2/hi/8018017.stm. Retrieved: October 20, 2013.
[6] http://www.thenation.com/article/163942/99-percent-rise#.

Retrieved: October 20, 2013.

[7] http://www.foreignpolicy.com/articles/2011/01/02/making_fun_of_pharaoh. Retrieved: October 20, 2013.

[8] archives.dawn.com/archives/1871. Retrieved: October 20, 2013.

[9] http://www.ibtimes.com/occupy-wall-street-protest-names-single-enemy-neoliberalism-323631. Retrieved: October 20, 2013.

[10] http://www.france24.com/en/20110119-tunisia-self-immolation-copycat-arab-world-suicide-protest-vendor

[11] http://www.theguardian.com/world/2009/apr/15/moldova-activist-hiding-protests. Retrieved: October 20, 2013.

[12] http://www.opendemocracy.net/georgina-blakeley/los-indignados-movement-that-is-here-to-stay. Retrieved: October 20, 2013.

[13] http://www.foxnews.com/world/2011/02/08/corporations-executives-closely-watching-impact-google-executive-egypt/. Retrieved: October 20, 2013.

[14] http://www.news.com.au/news/protesters-use-twitter-to-beat-censors-story-fna7dq6e-1225699659677#ixzz2dGVCoAZt. Retrieved: October 20, 2013.

[15] http://www.motherjones.com/politics/2011/10/occupy-wall-street-protest-map. Retrieved: October 20, 2013.

[16] http://blogs.wsj.com/dispatch/2011/01/28/police-abandon-tahrir-square/. Retrieved: October 20, 2013.

[17] http://www.telegraph.co.uk/news/worldnews/europe/moldova/5122556/Moldovan-police-retake-parliament-after-uprising.html. Retrieved: October 20, 2013.

[18] http://www.wsws.org/en/articles/2011/10/owsn-o15.html. Retrieved: October 20, 2013.

References

Blumer, H. (1951). 'Collective Behavior'. In A.M. Lee (ed.), *New Outline of the Principle of Sociology*, pp. 166-222. New York: Barnes and Noble.

Blumer, H. (1957) 'Collective Behavior'. In J. B. Gittler (ed.), *Review of Sociology: Analysis of a Decade,* pp. 127 - 158. New York: Wiley

Borgatti, S.P., A. Mehra, D. Brass and G. Labianca (2009) 'Network Analysis in the Social Sciences', http://www.steveborgatti.com/papers/SNA_Review_for_Science.pdf. Retrived: August 26, 2013.

Le Bon, G. ([1896] 2001) *The Crowd. A Study of The Popular Mind.* Kitchener: Batoche Books.

Holland, J. (2006) 'Studying Complex Adaptive Systems'. *Journal of Science and Complexity*, 19(1): 1 - 8.

Smelser, N. (1965) *Theory of Collective Behavior*. New York: The Free Press.

Turner, R. and L. Killian (1993) *Collective Behavior*. New Jersey: Prentice-Hall, Englewood Cliffs.

van Ginneken, J. (2003) *Collective Behavior and Public Opinion - Rapid Shifts in Opinion and Communication*. New Jersey: Erlbaum, Mahwah.

Waidyanatha, N. (2009) 'Towards a typology of integrated functional early warning systems'. *International Journal of Critical Infrastructures*, 6(1): 31 – 51.