Public Policy Challenges: An RE Perspective

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***Abstract*— In this perspective paper, we investigate the parallels between public policy and IT projects from the perspective of traditional RE practice. Using the mainstream media as an information source (as would an average citizen), over a period of approximately one year we captured documents that presented analyses of public policy issues. The documents were categorized into eight topic areas, then analyzed to identify patterns that RE practitioners would recognize. We found evidence of policy failures that parallel project failures traceable to requirements engineering problems. Our analysis revealed evidence of bias across all stakeholder groups, similar to the rise of the "beliefs over facts" phenomenon often associated with "fake news". We also found substantial evidence of unintended consequences due to inadequate problem scoping, terminology definition, domain knowledge, and stakeholder identification and engagement. Further, ideological motivations were found to affect constraint definitions resulting in solution spaces that may approach locally optimal but may not be globally optimal. Public policy addresses societal issues; our analysis supports our conclusion that RE techniques could be utilized to support policy creation and implementation.** *(Abstract)*

***Index Terms*—Requirements engineering, public policy, bias, unintended consequences, mainstream media, ideology and belief, failure.** *(key words)*

I. Introduction

We believe that there is a strong parallel between crafting public policy in response to (societal needs to meet) citizen's goals and software crafted (in response to requirements) to meet stakeholder goals. In this context, we define public policy as the mechanism through which societal challenges are identified and addressed by the creation of policies, laws and regulations as enacted by government. We see sustainability as a significant societal challenge that could be addressed by effective policy creation and implementation.

Requirements Engineering (RE) practices such as goal identification and modeling, requirements analysis, requirements negotiation, prioritization and triage have direct correspondence with the political process of policy identification, policy creation and with resolving challenges associated with realizing policy goals [16]. What is not as clear is the correspondence between RE practices associated with identifying risks, threats and unintended consequences [11], and developing appropriate mitigation strategies for the proposed policies. Unintended consequences and mitigation strategies are particularly important for sustainability initiatives.

Given the perceived correspondence between the domains, we decided to investigate further. However, we are not public policy experts and we chose to investigate the issues just as members of the public would do, using the information source most readily available – the Main Stream Media (MSM), rather than using the (traditional) peer-reviewed literature. In other words, we wanted to know whether public policy initiatives that received MSM coverage appeared to have any characteristics revealed in their reporting that confirmed the analogy with RE for software artifacts. We observed evidence of bias in the reported positions, bias in those doing the reporting and even evidence of "fake news" effects.

Our initial investigations led to the following research questions:

1. Can we identify challenges associated with defining, formulating and realizing public policies?
   1.1. Do the challenges have analogs in RE for software intensive systems?
2. How could RE techniques help mitigate the identified public policy challenges?
   2.1. Can RE techniques be used to proactively identify possible public policy challenges during formulation and before enactment?

To answer these questions, we performed an explorative case study using North American mainstream media and categorized the motivating problem, goals and solutions for eight topics that received significant MSM coverage over the study period. The study materials were gathered by monitoring news feeds (e.g. Google News) for a period of approximately one year and capturing those documents that presented a public policy issue along with analysis or commentary. We reviewed the documents *en masse,* then categorized and coded them.

Our analysis revealed evidence of (apparently unintentional and often large-scale) side effects. These unintended artifacts appear to exhibit many of the classic RE problems that occur during the development of software-intensive systems.

The rest of this paper is organized as follows. In Section 2 we review prior and related work. Section 3 presents the research methodology, research design and discusses threats to validity. Section 4 describes the data collection and analysis efforts and Section 5 presents our observations. A supplementary discussion follows in Section 6 and Section 7 presents the conclusions and directions for future work.

II. PRIOR AND RELATED WORK

We present related work from the topic areas of ideological biases in stakeholders, mainstream media as information source in RE, challenges of data mining versus humanism, and problem analysis in other domains using RE tools.

A. Ideological biases in stakeholders

The works on ideological biases in stakeholders are principally in the area of business policy. For example, in 1986, Shrivastava [45] discusses whether strategic management is ideological, and reviews 20 years of strategic management and business policy research and practice. He points out critical criteria like the denial of contradiction and conflicts as well as the naturalization of the status quo, and advocates for an open conversation between managerial interests and societal stakeholders of organizations. Parts of such an open conversation, albeit very limited, are mass media articles like the ones analyzed in the current work.

Handelmann et al. [25] discuss ideological framing in stakeholder marketing based on a longitudinal analysis of stakeholder dynamics in more than 2,000 articles from 45 years of grocery retail trade. They conclude that the interpenetration of strategic and institutional factors has implications for stakeholder marketing. This ideological influence on institutions is also detectable in the media analyzed in our study.

Entine [16] critiques the myth of social investing based on an analysis of the flaws of proclaimed objective ratings and of 'socially responsible' businesses and their strategies. He concludes that social screening is highly anachronistic and based on ideologically constructed notions of corporate social responsibility. Taking a stance against Entine's analysis, Waddock [52] explores the myths and realities of social investing and provides evidence of the objectiveness of the ratings while noting their remaining issues. We see similar tendencies of critique and counter-critique in some of the news articles we analyzed – two sides with reasonable arguments, and the use of inflammatory terms elicits stronger responses from the public.

B. Mainstream Media as Information Source in RE

Chomsky [14] discusses what makes mainstream media "mainstream". He elaborates that most of mass media is intended to divert attention (consumers as spectators), the elite media is geared towards the educated, wealthy and powerful, and most academic articles are still within the boundaries of institutional obedience. He concludes that, from these characteristics, we can predict what we would expect to find in the current work – and we did.

Kwak et al. [29] compare user-generated content to mainstream-media-generated content, specifically around sport communication, and concludes that message valence had a strong impact on triggering biased source evaluation and attitude. We see a similar tendency in the streams we analyzed.

Newman [32] explores mainstream media and the distribution of news. He highlights the contribution of social media to social discovery and their function as network nodes for social distribution – and points out the disruptive effects this has on the business models of news organizations.

Wright and Hinson [54] analyze the impact of social media on public relations practices and conclude that traditional news media still receive higher credibility than social media.

Maalej [30] and Pagano [33] have used app store reviews to extract requirements. Guzman and Maalei [19] found sentiment analysis to be very insightful. App store reviews are significantly different from the mainstream media analyzed in this paper, but also use public opinions for informing RE practice.

Guzman and Maalei also investigated Twitter messages to understand their potential to help requirements engineers better understand user needs, using the micro-blogging system as an additional information source for RE. In contrast, our research uses RE analysis to understand parallels between RE for software intensive systems and crafting public policy.

C. Challenges of data mining versus humanism

Manovich [31] discusses the promises and challenges of big social data with the optimistic conclusion that the new, enlarged surface and enlarged depth could facilitate asking new types of research questions.

Kirschenbaum [28] explores the opportunity of using data mining for literary criticism in digital humanities. Kirschenbaum rightfully argues that literary criticism rarely uses ground truth, and that data mining could point out outliers that 'provoke' human subject experts. The authors conclude that "While there will hopefully always be a place for long, leisurely hours spent reading under a tree, this is not the only kind of reading that is meaningful or necessary." (p. 5) [28] This result may indicate that the current work may be observing some, or all, of the same characteristics.

Sculley and Pasanek [42] investigate the impact of implicit assumptions in data mining for the humanities and argue that the standards for evidence production in digital humanities should be even more rigorous than in empirical sciences. Their most important conclusion is to keep the "boundary between computational results and subsequent interpretation as clearly delineated as possible."

D. Problem analysis in other domains using RE tools

Chandrasekaran [12] provides a task analysis of design problem solving. Byrd et al. [8] synthesize research on requirements analysis and knowledge acquisition techniques for management information systems.

The requirements engineering community has made significant contributions in the area of legislative work, for traceability and analysis [2][6], for resolving cross-references [38], for conformance checks [2], and for technology transfer [39]. There is further work in the legislative application domains of public governance [1], taxes [46], medical device development [27], procurement [40][41], nuclear [50], aviation [49], automotive [29], and corporate intellectual policy [9]. The work at hand expands this body of work to new areas.

Due to space restrictions, there are large areas of work within RE which this work has not referenced.

III. RESEARCH METHODOLOGY

We conducted an exploratory case study over a period of approximately one year during which we investigated public

policy topics where there was significant Main Stream Media (MSM) press coverage. The MSM was used as an information source, rather than the academic literature, because we were focused upon *public* policy and the MSM is the principal information source for members of the general public.

The MSM was monitored using news feeds such as Google News (https://news.google.com), content aggregators that can be trained (via click through on articles) to perform some degree of filtering upon the vast quantity of available material. Whenever we identified an article related in some way to announced public policy *and* the author's commentary identified inadequate results or unintended consequences, we then captured that article to the document repository for later analysis.

The resulting dataset is a collection of 152 articles or documents on government policies, policy topics or policy initiatives, government procurement and policy implementation strategies. Sustainability was the primary focus of 37 of the articles or documents. In each case, the topic of the article was an initiative that was (seemingly) made with the best of intentions. Unfortunately, the results ranged from simply inadequate to outright failure and the incidence of (potentially large-scale) unintended consequences was high. We include in the category of unintended consequences, policies that even a superficial RE analysis would identify as probably not achievable given the solution constraints. The unintended consequences were either explicitly identified by the author of the article or they were identified after our own analytic efforts (e.g. diverging or contradicting policy goals) or prior domain experience.

As a counterpoint to the MSM sources, we also investigated sustainability policies in California, USA [9][36]. We had access to very detailed policy and implementation plans that had large investments in their development and which we expected to be of significantly higher quality than the MSM documents and to be relatively bias-free.

At the end of the document collection phase, the documents were reviewed in their entirety in two sessions totaling approximately 12 hours. We used researcher triangulation to decrease the subjectivity bias, with the first two authors performing the analysis in discourse and the third author reviewing the coding and interpretation for consistency and correctness. The coding was emergent and led to the following eight categories. Given the topic areas, there is some potential that a document could be coded into more than one category; the final placement was based on discussion among the researchers.

- Algorithms (e.g. big data analysis, artificial intelligence) that have drawn sufficient attention to warrant public policy discussions
- IT projects (e.g. large-scale publicly funded projects, generally in support of some policy goal)
- Social (e.g. free speech, critical thinking, gender issues, fake news, radicalism)
- Privacy (e.g. location data, social media, children's self-determination)
- Policy (e.g. cybersecurity, copyright, taxes, housing)
- Climate change (e.g. resilience, carbon emissions, energy, electric vehicles, pipelines)
- Controlled substances (e.g. state versus federal law, avoiding crime, licensing, taxes)
- Equalization (e.g. income, taxes, resources, cost of living)

During the coding phase, we attempted to identify the challenges that the policies were meant to address and the subsequent problems that arose because of the policy implementation. We then mapped the results to traditional RE nomenclature (e.g. in some articles we found indicators of inadequate stakeholder identification). A sample of the coding sheet is presented in Table 1.

A. Threats to Validity

This study has several validity threats that need to be discussed. One of the significant construct validity threats is the assumption that RE processes and policy crafting processes share a strong parallel. We believe that the collected evidence and discussion presented in the paper provides sufficient evidence to support our claims. Still, further empirical validation of this assumption needs to be performed in the future.

The most significant threat to internal validity is that the observed unintentional effects and consequences have not been statistically analyzed or confirmed. We have not used experimental methods to study the effect of changes in the independent variables on the dependent variables (for example, involving a class of stakeholders in relation to unintended consequences). However, the study has an exploratory nature and we do not claim that the presented consequences are complete or true for all contexts.

Conclusion validity threats have limited impact on this study since we have not used statistical tests to obtain our results. At the same time, We made several efforts to minimize subjectivity and resolve potential conflicts when analyzing and categorizing qualitative evidence. We used researcher triangulation to decrease the subjectivity bias, with the first two authors performing the analysis in discourse and the third author reviewing the coding and interpretation for consistency and correctness.

Since the study is exploratory, external validity remains the main limitation of our work. We aim for analytical generalization rather than statistical generalization [16] and present the case and method details to enable replications and further studies. Still, we studied only a limited dataset of 152 articles on government policies and policy initiatives.

We note that we are taking a humanistic approach to our analysis. While there is a significant body of research in automated processing of news feeds and sources like Twitter, that work generally analyzes large corpuses. Unfortunately, that is not the way "the average person works"; they do not read hundreds or thousands of articles on an issue, they might read one or two. This is a substantial validity threat, but we mitigated this risk by individually reading every article and performing the final coding after discussion.

TABLE 1. DETAILED CODING SAMPLE

ID	Category	Goal	Solution	Unintended Consequences	Keywords	Problems
Reuters AI	Algorithms	Make news faster, more accurate, and more resilient against fake news attempts.	Use 13 AI algorithms that mine Twitter and cluster and extract news	Potential to eliminate the jobs of 2500 highly educated and skilled reporters	News, media, AI, algorithm	Stakeholders not considered
Amazon sales algorithm	Algorithms	Make customers want to buy more and feel well taken care of	Sales algorithm that works well in selling things that are useful because frequently bought together	(1) Suggesting composites that are potentially useful to build explosive devices, (2) could potentially serve to detect potential terrorists	Sales, online, algorithm	Unintended consequences, incorrect interferences
Passport Canada	IT projects / New passport processing system	Make passports safe and secure with physical robustness	Electronic system to produce the new passports	At least $75 million over budget and well behind schedule. The project "did not include a plan for security requirements."	Passport, IT	Failed to consider specific quality requirements
Sight of personal privacy, Google, Facebook	Privacy	Software company needs to make money	Software can be given away for free if we collect the users' data instead	Loss of privacy, complete - unintended by the user. Unintended consequence by the companies is regulatory pushback of various jurisdictions. No understanding of consequences (e.g. why I didn't get the job/loan/etc.)	Privacy	EU has data privacy policies that would make a lot of US startups illegal
Controlled substances summary	Controlled substances	Get people to relax and not be anxious.	Pot legalized.	Potentially reversing policy. You smoke pot in Cali, leave to EU, return, if you deny to have smoked upon return to the US you can be charged, perhaps jailed.	Controlled substances	A federal marshal could walk across the US and throw anyone in jail that has smoked pot.
Equalization summary	Equalization	Ensure that all political regions in the country are able to provide approximately equivalent public services to the citizens	A formula. It is criticized as being far too complex. From a mathematician's perspective the model is grossly inadequate, inaccurate, and simplistic. First year calculus is way more complex than this model, but the general public still perceives it as too complex.	People don't have trust that equalization is fair. Some regions experience greater levels of taxation than others. The people who receive the money say everyone gets taxed the same, but the federal government takes that money and reallocates it as rebates to different regions, so it has the same effect as different taxation.	Equalization	People don't bother to learn – what it costs to deliver a public policy initiative. Stakeholders can't understand a correct solution so they (grudgingly) accept a flawed solution.
California Sustainability Policies summary	California Sustainability Policies	California aspires to be a thought-leader and puts into action a lot of what we have learned on mitigating sustainability challenges over the past years.	How many things are being considered at CSULB and the Port of LA as examples - shows you can make substantial differences but at high costs	Millions of dollars are being spent on these initiatives. What could have been achieved if that money would have been spent somewhere else, e.g. in India or another developing country where it can help far more people with the same resources?	Sustainability policy	Prioritization

IV. REFLECTIONS UPON THE METHODOLOGY

We retrieved and analyzed 152 articles and an excerpt of our analysis is presented in Table 1. The left column indicates the identifier of the news item, then the category into which we classified the article. The bottom three rows are summary rows of the categories Controlled Substances, Equalization, and California Sustainability Policy, as we found the results more insightful on the aggregated level. For each row, we identify the *Goal* as the original intention for the policy and the *Solution* that was chosen. We then identify the *Unintended Consequence* arising from that solution. We further tagged with *Keywords* and identified *Problems* of the scenario.

For example, the first row identifies the issue of the Reuters AI, in the category Algorithms, where the decision makers had the intention of making news faster, more accurate, and more resilient against fake news attempts (in response to public outcry and nascent public policy initiatives). The established solution was to deploy 13 AI algorithms that mine Twitter feeds to identify topics of interest. The (potentially) unintended consequence of the desire to more quickly react to current events is that the jobs of 2,500 highly educated and skilled reporters are potentially being eliminated. We associated the keywords news, media, AI and algorithms, and the main problem that all relevant stakeholders were not considered.

The retrieved articles are dominated by works wherein the author reflects upon some policy initiative and the associated successes and failures. These kinds of articles appear to be inherently biased towards negative critique (perhaps in an effort to generate more page views?) and they became a rich source, perhaps even a treasure trove, of unintended consequences. These articles all contain strong observer bias (they are opinion pieces), but we use them as data sources anyway – for these are the same data sources that shape their reader's opinions and perceptions. After all, just because a source is biased it does not mean that the inherent message is not reality to the reader. We also gathered resources for two instances where policy was reduced to practice (sustainability and environmental policy initiatives at California State University Long Beach and the Port of Long Beach, including significant traditional engineering technology analyses and engineering economic analyses).

The first two authors coded the articles in discussion and we applied significant domain knowledge of their own to provide context for the observations and to enhance the richness of the conclusions. This technique has the potential to provide greater insight but is also a significant threat to validity. We are trying to be humanistic in this work, we are analytical but not coldly so. In other words, we are reacting as people, not as a machine algorithm. We are observing emotional content and there is the potential that we have introduced some of our own emotional bias on some of the topics. For each article, we read the content and (typically) the first 50 to 100 reader comments (assuming that comments are present).

Within the first few months of our study, we realized that our data set would have an inherent bias: it would not be unreasonable to assert that the MSM generally reports upon things in a negative manner, and the associated comments are often more extreme than the studied article.

With this realization we adjusted our research effort, focusing more of our efforts upon those reports wherein there appeared to be unintended consequences of some public policy initiative. We note that there were many, many reports of unintended consequences and not all were negative. We then refined our effort to identifying the unintended consequences and evaluated them using a system model. Our analysis was based on the question "If this was a software system and we were performing a post hoc evaluation using RE techniques, what observations and recommendations would we make?"

The complete codebook is available on Google Drive [15]

V. OBSERVATIONS

We begin each grouping of our results with a descriptive label, present our observations and, generally, present one or more (sometimes rhetorical) questions.

Legislative Contradictions: We observed cases where there are contradictions within legislation – how do the individuals responsible create legislation that contradicts? Are these conflicts deliberately created by those responsible or is there something else influencing (and possibly corrupting) the process? For example, on the topic of marijuana legalization, individual states in the USA have decriminalized personal use while federal law continues to make possession a crime. Legislators in individual states have deliberately chosen to contradict federal law. Would we tolerate conflicting, and unresolved, requirements when designing a software intensive system? Related work represented policy constraints as logic program [44], but that is only a very first step in solving these issues.

Same Old Problems: Despite 50 years of experience in IT systems, the last 30 years of (approximately) which RE has been a formal discipline, we observe that system after system continues to experience problems such as missing requirements and missing stakeholders. For example, the Government of Canada embarked upon the creation of a unified payroll system for all federal government employees. The system must manage the contracts for hundreds of different unions, each of which has their own pay scales, promotions, benefits packages and retirement plans. Individual employees could spend their entire career within a single union or change to a new union each time they change the position in which they are employed. RE practitioners would immediately recognize the likelihood of a combinatorial explosion in the business rules and data elements that must be managed and would identify the issue to the stakeholders. In this case, the issue appears to have been trivialized or ignored, and while we do not have any "insider information" that would allow us to elaborate further, we do note that the project is considered a near-complete disaster by all stakeholders and projected implementation and remediation costs are in excess of 400% of the original budget (the Government recently announced[1] that cost estimates have exceeded $1B CDN and the creation of a task force to find a replacement before this system is even fully functional). Other government IT projects (especially those related to health care) do not seem to fare much better.

Holistic Perspectives: What is possible and highly desired from a political perspective is often not possible from an economic perspective and it seems that policy makers rarely take this holistic view. For example, promoting the use of electric cars should reduce CO_2 emissions and is relatively easy to justify if the only metric used is emissions per distance traveled. However, electric vehicle production creates significant CO_2 emissions [17] and the consumption of significant quantities of rare metals. The electricity used must be generated by low emission sources and (somehow) delivered to the vehicles. It is well-known in electrical engineering practice that the North

[1] http://www.ctvnews.ca/politics/minister-fixing-phoenix-pay-system-could-cost-1b-1.3672663

American electric distribution grid was not designed to deliver this much energy and can only hope to do so with careful demand management (e.g. only charge your vehicle after 9 p.m. if you live in a residential neighborhood) unless significant investments are made in infrastructure improvements. Despite the challenges, to achieve the desired public policy objectives systemic changes and early adopters will be necessary. For this, we can use the foundations of systems thinking [13][21] and apply them to engineering activities [3].

Identifying the "Right" problem: Our review identified numerous cases where those directly involved with a policy or project appear to believe that they have correctly identified the problem, and that their proposed (or actual) solution addresses the problem. However, when other parties look at the problem they quite strongly disagree upon the problem definition – consider the acrimony that exists between perspectives on climate change challenges and proposed solutions. This pattern implies that there is a class of problems where perspective is very important. If that is the case, is our established body of RE practices applicable to those problems? Does RE have to evolve to be able to support these problems or do we just ignore that class of problems? This concern is partly addressed by some work in RE on viewpoints[48], but only on a level of technical representation in requirements documentation. Do these problems also affect RE for (software-intensive and other) systems?

Side Effects: When reviewing the articles, we were repeatedly given the impression that comprehensive analyses of potential complicating factors is either performed badly or not performed. This is an area where RE can significantly contribute beyond the work in [55]. For example, the Swedish government performed an analysis that showed that (in their opinion) too many motor vehicle accidents occurred when overtaking (passing). To reduce the accident levels, flexible posts were installed in numerous stretches of the roads. While these flexible dividers may have reduced the accident rate for cars and trucks, they have made travel more dangerous for motorcycle riders who cannot hit these barriers without serious consequences.

(Magnitude of) Unintended Consequences: The unintended consequences of the policies under investigation have a much larger scope and scale than we expected. And, larger than the original policy intervention necessarily would have made many people believe.

As an example, consider affirmative action policies whose goals are to "level the playing field" between disparate groups. Superficially, these policies obtain at least grudging acceptance by a majority of the populace in North American jurisdictions. However, we see evidence that different special interest groups "weaponize" these policies, in different ways, and use them to increase conflict rather than decrease conflict. As a result, positions become ever more polarized and compromise solutions become more difficult to achieve.

Affected Domains: Different regions within a state, province or country tend to have different social mores and these can translate to differences in local legislation and increased potential for conflicts. In Canada, legislative powers are deliberately split between the federal and provincial levels to help to address these differences. Despite the well-established principle that federal powers overrule provincial powers, individual provinces that do not agree with federal policy on a given topic can, and do, attempt to override the federal policy by crafting confounding or competing legislation within those aspects of exclusive provincial jurisdiction. For example, inter-provincial and international pipelines are clearly placed under federal jurisdiction. Environmental regulatory powers exist at both the federal and provincial levels and anti-pipeline activists attempt to use provincial environmental regulatory powers to impede or completely block any federal approvals for such projects. While conflict identification and resolution have been targeted by [51][4], these policy-level conflicts require a more holistic level of modeling and reasoning than technical requirements.

Privacy: Even though users legally agree to having their data tracked by many of the apps and services that they use, most people grossly underestimate the magnitude of the data trail that they create. While this data collection activity is presented to the user as a way to improve the user experience, more and more users are learning that the same data can also have significant unintended consequences – especially when that data is licensed to a third party. We routinely see reports of individuals that use social media experiencing negative consequences (e.g. denied insurance claims, denied bank financing, inability to get job interviews, etc.) [26].

Public policy is responding to these reports, most notably in the European Union, and there is increasing pressure on the providers of these services to support correction and deletion of data collected about individual users, including the "right to be forgotten" [19] [53]. But, what about the effect that the data had on the analyses before it was modified or deleted? And how does the modification or deletion request propagate to third parties that may have a copy of the original data or analyses that were based upon the original data? How do we construct requirements not just for the originating system but also for third-parties?

Biases in AI and Data Mining: Bias in automated decision-making systems is receiving ever-increasing public policy attention. Closely related to privacy issues, deliberate or unintentional bias has the potential for significant unintended consequences. The specialists in the field don't always know why they are accepting the results they get out of the algorithms, leading to backlash from observers ("Will anyone ever write another positive story about a tech startup? I said probably not" [22]). If the algorithms that are being used to mine these data repositories have biases (intended or unintended), they may amplify negative conclusions about individuals that are unfounded or unwarranted. The same technologies can also be applied to induce bias in users, from addictive video game properties and Facebook's deliberate design to induce emotional reward to the numerous reports of election interference in the US presidential elections[2] and the Brexit campaign.

Significant elements of the technology sector could find themselves regulated, or at least required to justify or defend

[2] https://www.theguardian.com/technology/2017/oct/30/facebook-russia-fake-accounts-126-million

their algorithms in ways that can be comprehended by policy makers and by the general public. What happens when the technology sector answers "We don't know. We just know that it (seems to) work better than anything that we have done before."? What will happen to "technological progress" if everyone believes that they have "the right" to provide input any time that they believe that this class of algorithms is affecting their lives (or they will threaten to claim some form of oppression or human rights violation)? How many companies that rely upon data mining would find their business models at risk in such a regulated environment?

Deployment of these technologies in support of public policy will require us to truly understand what is "going on inside." Otherwise, how do we evaluate whether we are or not excluding people from fair treatment in our society based upon what some algorithm returns as a result. In the world of the movie "Minority Report", precognition was combined with significant technical support to eliminate murder. What happens when we replace precognition with data mining and AI? The computational techniques may be mathematically accurate but how do we know if we are correctly interpreting the results? If, for example, ethnic heritage in combination with neighborhood, socioeconomic status and educational level, leads to a person being identified as a potential future criminal, does that mean the individual is indeed a criminal and should be treated as one? Does that mean that the analysis has identified fundamental flaws or failures in society's structure? Even though these factors often correlate, they are not necessarily causal and, therefore, should we be working on fixing the cause of the problem and not the symptom? Finally, if the models are telling us things we don't want to hear, then maybe the models are simply identifying opportunities for improvement.

Social Perspectives: We identified a pattern of hardening of positions by factions interested in public policy topics. Rather than looking for compromise, it appears that the factions are treating issues as a zero-sum game: "we adopt my position, or else…" Can RE techniques (especially those related to conflict resolution and mediation) be used to find common ground between these stakeholders? What does it mean to practitioners (and society in general) when stakeholders tell us there can be no validity in a common ground? As Brown points out, in our current society there is a "phenomenon of you are either with us or against us." [7] This behavior pattern, if it continues to grow, is serious cause for concern.

For example, this pattern is very evident in people's positions about climate change. Do you believe humans contribute to something that is called climate change? Do you believe that greenhouse gasses can be absorbed by the environment without significant damage or not? Do you feel we should be minimizing our human byproducts and pollution?

You can interpret these questions with sufficient qualifiers such that eventually you will get almost every climate change denier or promoter to agree. For example, many climate change deniers are not against mitigation policies per se, rather they tend to be against specific policies because they do not believe that those policies are a cost-effective solution to the problem. For example, taxing carbon emissions at such a level that people simply cannot afford to travel except in absolute necessity will have the effect of reducing emissions, but is this even possible to implement in a democratic society where people need to travel to work? If you believe that climate change is caused by human intervention, perhaps you could target non-essential travel – for example, ban tourism. Superficially, this would create non-trivial reduction in emissions. However, such a policy would eliminate a significant source of income for many developing nations and seriously impede their ability to offer public services such as health care.

This is a significant unintended consequence. The policy would destroy the livelihoods of everyone in the tourism industry and of many third world nation service industries – is that what the 'environmentalists' want to happen? We posit that this is unlikely.

To make this point even more strongly, the Government of Canada attended the Paris climate convention and signed the Paris climate accords. Later that year, the Parliamentary Budget Office (an agency that provides independent cost analyses of parliamentary initiatives) issued a report that sought to bring the commitments into perspective for the average citizen [23][34][46]. The report identified that achieving Canada's commitments would require emissions reductions of a magnitude that was more than the equivalent of the elimination of all motorized transportation in Canada – no aircraft, no shipping, no busses, no cars, no motorcycles, etc.. How can a government maintain any credibility with its citizens if they make commitments that appear to be unachievable? After all, mobility of people and goods lies at the heart of the global economy and while the government's actions were strongly supported by the environmental movement, the average person's position has shifted toward disbelief, apathy and resentment. Rather than fostering support for the initiative, they have created resistance.

In contrast, sustainability initiatives in California underwent significant planning efforts, culminating in realistic implementation plans [9][36]. Even though engineering economic analyses showed that some of the goals were not cost effective, an *informed* decision was made to proceed in pursuit of those goals – unlike the public perception of the Canadian initiative.

Emotional Content: Emotionally charged content is prevalent across many of the articles, as evidenced by the author's selection of adjectives and adverbs and by the positions taken by supporters and detractors within the accompanying comment sections. From the Twitter storms of President Trump and his interactions with Kim Jong-un to people issuing threats on social media platforms toward people who oppose their position on issues of the day, how do we get past all of that negativity and unwillingness to compromise to even get to the point of being able to agree upon a goal, let alone solutions? Are these behavior patterns evident even when performing RE for software intensive systems?

Time: The time needed to introduce and pass legislation in support of policy initiatives (e.g. reduce industrial CO_2 emissions), and to see the effects of the policies (often measured in decades), is much longer than the average time a government holds power (four to six years in most democratic countries). This reality has led to two patterns: New governments try to

reverse policies set by previous governments resulting in aborted efforts and significant waste and, in anticipation, current governments try to establish policies in such a way that they cannot be easily modified. What is lost if the original policy implementation was actually going to be effective? How does a new government undo a policy that has proven deleterious?

VI. DISCUSSION

Using the MSM as a data source, rather than peer-reviewed academic papers is certainly a 'different' research experience. The prevalence of opinion, often strong opinion, without substantiating evidence converts the quality evaluation process to one of (1) how well is the article written (for me)? (2) does the article align with my personal biases and (3) what do I perceive to be the reputation of the author? When one includes the comments in the analysis, it is easy to be affected by the strength of the (often negative) positions held by the commenters. This negativity bias can easily be passed on to the analysts and this contagion is a known psychological phenomenon [42].[3] Researchers interested in performing a humanistic investigation into these materials are advised to be prepared for the potential emotional side-effects.

How does the MSM affect stakeholder perceptions, opinions, and the hardening of both? There seems to be an acceleration and hardening of positions in mainstream media – is this something that RE might have to consider or be more cognizant of moving forward? For example, do you send your (politically) left-leaning team in when you have a (politically) left-leaning client? Such a proactive effort can amplify the biases (prejudices) but has the potential to lower the risk of miscommunication. We take special note of the seeming rise in ideological bias on the part of policy makers, thought leaders and the general public. This trend toward the adherence to a position or interpretation independent of rational analysis of the underlying facts could have far-reaching and unexpected effects. While we have observed evidence of ideological bias in policy, we must ask whether this trend will have an effect on RE for software artifacts. For example, will practitioners need to be more diligent in exploring stakeholder statements of their wants, exploring whether or not these wants can be evaluated as stated (in the transition from wants to needs during prioritization) or whether the statements must be further explored to identify ideological biases? When attempting to understand the risks and threats arising from this trend we are prompted to ask: How does this knowledge inform us about how they (policy makers, their constituents, and politicians) perceive circumstances and issues; what gains, risks and threats does this offer to RE practice? In this context, miscommunication challenges can potentially be greater than anticipated.

We were somewhat surprised, if not shocked, by the number of instances of open conflict in regulations and legislation. Perhaps we were naïve in assuming that the legal structures would be more organized and better structured than they are, but we can't help but wonder what it would be like if they were as relatively error-free as well-crafted software.

[3] Associates of the lead author actually held what could (charitably) be called a mini-intervention with him in an effort to determine what had caused him to become increasingly negative over the prior six months.

VII. CONCLUSIONS AND FUTURE WORK

In this work, we investigated the use of the mainstream media as a data source for an analysis of public policy and related governmental initiatives. Our first research question asked whether we could identify challenges associated with defining, formulating and realizing public policies from this data source. We were able to identify challenges by analyzing the content, removing the commentary, then identifying the underlying "facts". We were also able to identify how people perceived the challenges, which often were biased by ideology. Furthermore, we found that the challenges do have analogs in RE for software intensive systems, so there is potential that RE can help to proactively identify possible public policy challenges.

A metaphor that we find useful is that public policy is the algorithm for governing the operation of the machine that is society. As such it is easy to answer the next research question in the affirmative: how could RE techniques help mitigate the identified public policy challenges? We saw no evidence that RE techniques could not be successfully applied in this domain. Finally, we asked whether RE techniques could be used to proactively identify possible public policy challenges during formulation and before enactment? The final research question is not as easy to answer. Certainly, validation and verification techniques could be used to identify issues and mitigate risks if the participants had sufficient domain expertise and, dare we say it, wisdom.

We see sufficient evidence for there to be a role for RE in helping people at large to understand the technology that seems to overwhelm them, possible consequences and side effects.

While this work is another piece of evidence of the universal nature of problem patterns and critical thinking, it has also delivered significant context for future work. Each of the major points in Section V could readily become a research thrust:

- Legislative contradictions
- Same old problems
- Identifying the "right" problem
- Side effects
- Magnitude of unintended consequences
- Holistic perspectives
- Affected domains
- Biases in AI and data mining
- Social perspectives
- Emotional content
- Time

Upon reflection, we must also ask whether the focus of this work is even something with which RE practitioners should be concerned. What are, and should be, the bounds of RE? Despite the fact we are pushing the bounds of RE, are we pushing too far into ethics and overreaching? Are we oblivious to the fact that there are many other people already attempting to address these issues?

Other research questions that are prompted by our experience, but farther afield from RE include:

- Do opinion article writers become thought leaders? Are they good barometers of the populous and their emotions?
- Can we use machine learning across the "wisdom of the crowd" as a means to validate what the pundits and politicians are saying?
- Can we extract the core content of each document and perform formal semantic analysis to identify the biases in the presentation and to quantify the intensity of the bias? We could attempt to identify the ideology of the policy authors, reporters and commentators, but sense that this is far out of our traditional field.
- Are things really "as bad" as the MSM would seem to want to have us believe? Is it possible to know the relative scale of the negative elements – were the reported negatives only a small proportion of the overall initiatives? Were the reported negatives only relatively rare occurrences in the greater context of society?

This work has proven to be a rich source of research questions and opportunities that provide ample pointers towards future work. First, we want to deepen our analysis using empirical methods and expand on this exploratory study with a quantitative analysis of evidence for said RE challenges. Second, we want to use that data for a scenario analysis, applying RE techniques to explore whether we can use this form of analysis to prevent some of the unintended consequences that played out in those scenarios. Third, we plan to detail a research agenda of other opportunities outside of software and systems engineering where requirements engineering techniques could have significant positive impact and improvement potential for the situations under analysis. Finally, we plan to perform an RE analysis of the goals of the GDPR, their feasibility, validation and verification techniques, and monitor for evidence of unintended consequences.

REFERENCES

[1] A. Okhaide, M. Alhaj, D. Amyot, O. Bahy Badreddin, E. Braun, N. Cartwright, G. Richards, G. Mussbacher, Creating Quantitative Goal Models: Governmental Experience, ER 2014: 466-473

[2] C. Arora, M. Sabetzadeh, L. C. Briand, F. Zimmer: Automated Checking of Conformance to Requirements Templates Using Natural Language Processing. Trans. Software Eng. 41(10), 2015, pp. 944-968.

[3] Bahill, A. Terry, and Bruce Gissing. "Re-evaluating systems engineering concepts using systems thinking." IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews) 28.4 (1998): 516-527.

[4] Boehm, Barry, and Hoh In. "Identifying quality-requirement conflicts." IEEE software 2 (1996): 25-35

[5] T. D. Breaux, D. G. Gordon. "Regulatory requirements traceability and analysis using semi-formal specifications." *International working conference on requirements engineering: Foundation for software quality*. Springer, Berlin, Heidelberg, 2013

[6] T. D. Breaux, M. W. Vail, and A. I. Anton. "Towards regulatory compliance: Extracting rights and obligations to align requirements with regulations." *Requirements Engineering, 14th IEEE International Conference*. IEEE, 2006.

[7] B. Brown, "Braving the wilderness: The quest for true belonging and the courage to stand alone". 2017. New York, NY: Random House

[8] T. A. Byrd, K. L. Cossick, and R. W. Zmud. "A synthesis of research on requirements analysis and knowledge acquisition techniques." *MIS quarterly,* 1992, pp. 117-138.

[9] California State University, Long Beach. "Strategic Energy Plan." California State University, Long Beach. July 5, 2011

[10] David Callele, Krzysztof Wnuk. More than requirements: Applying requirements engineering techniques to the challenge of setting corporate intellectual policy, an experience report. RELAW 2011: 35-42

[11] V. Cerf, "Unintended Consequences" Communications of the ACM, vol. 61, March 2018.

[12] B. Chandrasekaran, "Design problem solving: A task analysis." *AI magazine* 11.4 (1990): 59

[13] Checkland, Peter. "Systems thinking." Rethinking management information systems (1999): 45-56.

[14] N. Chomsky, "What makes mainstream media mainstream." *Z magazine* 10.10 (1997): 17-23.

[15] Results Codebook, https://drive.google.com/file/d/14ErlsNOOMj79GnXknWvOxu1UtG3ZUB1_/view?usp=sharing

[16] W. N. Dunn, Public policy analysis. Routledge, 2015.

[17] Dyer, Ezra. "That Tesla Battery Emissions Study Maming the Round? It's Bunk." Popular mechanics, June 2017. https://www.popularmechanics.com/cars/hybrid-electric/news/a27039/tesla-battery-emissions-study-fake-news/

[18] J. Entine, "The myth of social investing: A critique of its practice and consequences for corporate social performance research." *Organization & Environment* 16.3 (2003): 352-368.

[19] EUREKA "The right to be forgotten" https://eureka.eu.com/gdpr/the-right-to-be-forgotten/ Last visited February 28, 2018

[20] B. Flyvbjerg, "Five misunderstandings about case-study research." Qualitative inquiry, vol. 12, 2006, pp. 219-245.

[21] Forrester, Jay W. "System dynamics, systems thinking, and soft OR." System dynamics review 10.2 - 3 (1994): 245-256.

[22] E. Griffith, "The other tech bubble" WIRED, December 16, 2017, https://www.wired.com/story/the-other-tech-bubble/ Last visited February 28, 2018

[23] G. Lorrie "GOLDSTEIN: Trudeau breaks his promise on carbon taxing" Toronto SUN, December 14, 2017 http://torontosun.com/opinion/columnists/goldstein-trudeau-breaks-his-promise-on-carbon-pricing, Last visited February 28, 2018

[24] E. Guzman, W. Maalej. "How do users like this feature? A fine grained sentiment analysis of app reviews." Requirements Engineering Conference (RE), 2014 IEEE 22nd International. IEEE, 2014.

[25] J. M. Handelman, P. H. Cunningham, and M. A. Bourassa. "Stakeholder marketing and the organizational field: The role of institutional capital and ideological framing" *Journal of Public Policy & Marketing* 29.1 (2010): 27-37.

[26] J. Harris, "Take it from the insiders: Silicon Valley is eating your soul" The Guardian, January 1, 2018

[27] H. Dagny Hauksdottir, B. Ritsing, J. Christian Andersen, N. Henrik Mortensen: Establishing Reusable Requirements Derived from Laws and Regulations for Medical Device Development. RELAW 2016: 220-228

[28] M. G. Kirschenbaum, "The remaking of reading: Data mining and the digital humanities." The National Science Foundation Symposium on Next Generation of Data Mining and Cyber-Enabled Discovery for Innovation, Baltimore, MD. 2007.

[29] D. H. Kwak, K. Yu Kyoum Kim, and M. H. Zimmerman. "User-versus mainstream-media-generated content: Media source, message valence, and team identification and sport consumers' response." *International Journal of Sport Communication, vol.* 3, 2010, pp. 402-421.

[30] W. Maalej and N. Hadeer, "Bug report, feature request, or simply praise? On automatically classifying app reviews. "Requirements Engineering Conference (RE), 2015 IEEE 23rd International. IEEE, 2015.

[31] L. Manovich, "Trending: The promises and the challenges of big social data." *Debates in the digital humanities, vol.* 2, 2011, pp. 460-475.

[32] N. Newman, "Mainstream media and the distribution of news in the age of social discovery." *Reuters Institute for the Study of Journalism, University of Oxford* (2011).

[33] D. Pagano and W. Maalej. "User feedback in the appstore: An empirical study." Requirements Engineering Conference (RE), 2013 21st IEEE International. IEEE, 2013.

[34] Pilling, David. "Clean electric cars are built on pollution in Congo", Financial Times, July 2017

[35] Canada's Greenhouse Gas Emissions: Developments, Prospects and Reductions, http://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/2016/ClimateChange/PBO_Climate_Change_EN.pdf

[36] Ports of Long Beach and Los Angeles. "Roadmap for Moving Forward with Zero Emission Technologies at the Ports of Long Beach and Los Angeles." Roadmap for Zero Emissions – Technical Report, August, 2011.

[37] Birgit Penzenstadler and Jörg Leuser: Complying with Law for RE in the Automotive Domain. RELAW 2008: 11-15

[38] N. Sannier, M. Adedjouma, M. Sabetzadeh, L. C. Briand, "An automated framework for detection and resolution of cross references in legal texts". Requir. Eng. 22(2): 215-237 (2017)

[39] N. Sannier, M. Sabetzadeh, L. C. Briand, "From RELAW Research to Practice: Reflections on an Ongoing Technology Transfer Project". RELAW 2017: 204-208

[40] G. Lamartine da Silva Barboza, F. Cysneiros Filho, R. A. C. de Souza, "Towards Legal Compliance in IT Procurement Planning in Brazil's Federal Public Administration". RELAW 2016: 229-238

[41] G. Lamartine da Silva Barboza, F. Cysneiros Filho, R.A. C. de Souza "Towards a legal compliance verification approach on the procurement process of IT solutions for the Brazilian Federal Public Administration" RELAW 2014: 39-40

[42] P. Rozin, E. B. Royzman. "Negativity bias, negativity dominance, and contagion." Personality and social psychology review, vol. 5, 2001, pp. 296-320.

[43] D. Sculley, M. B. Pasanek. "Meaning and mining: the impact of implicit assumptions in data mining for the humanities." *Literary and Linguistic Computing* 23.4 (2008): 409-424.

[44] Sergot, Marek J., et al. "The British Nationality Act as a logic program." Communications of the ACM 29.5 (1986): 370-386.

[45] P. Shrivastava, "Is strategic management ideological?" *Journal of management* 12.3 (1986): 363-377.

[46] J. Snyder, "Canada still to fall short of Paris target", Financial Post Canada, December 29 2017, http://business.financialpost.com/commodities/energy/canada-still-on-pace-to-fall-short-of-paris-target-despite-ambitious-climate-policies-un-filings. Last visited February 28, 2018

[47] G. Soltana, M. Sabetzadeh, L. C. Briand, "Model-Based Simulation of Legal Requirements: Experience from Tax Policy Simulation" RE2016: 303-312

[48] Sommerville, Ian, and Pete Sawyer. "Viewpoints: principles, problems and a practical approach to requirements engineering." Annals of software engineering 3.1 (1997): 101-130.

[49] R. Tawhid, E. Braun, N. Cartwright, M. Alhaj, G. Mussbacher, A. Shamsaei, D. Amyot, S. B. Ahmadi, G. Richards: "Towards outcome-based regulatory compliance in aviation security", RE 2012: 267-272

[50] E. J. Uusitalo, M. Raatikainen, M.Ylikangas, T. Männistö, "Experiences from an industry-wide initiative for setting metadata for regulatory requirements in the nuclear domain", RELAW 2014, pp. 2-9.

[51] Van Lamsweerde, Axel, Robert Darimont, and Emmanuel Letier. "Managing conflicts in goal-driven requirements engineering." IEEE transactions on Software engineering24.11 (1998): 908-926.

[52] S. Waddock, "Myths and realities of social investing." *Organization & environment* 16.3 (2003): 369-380.

[53] Wikipedia "The right to be forgotten" https://en.wikipedia.org/wiki/Right_to_be_forgotten, Last visited February 28, 2018

[54] D. K. Wright, M. D. Hinson. "An updated look at the impact of social media on public relations practice." *Public relations Journal,* Volume 3, 2009, pp. 68–73.

[55] Yen, John, and W. Amos Tiao. "A systematic tradeoff analysis for conflicting imprecise requirements." Requirements Engineering, 1997., Proceedings of the Third IEEE International Symposium on. IEEE, 1997.

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