

A computational text analysis approach to investigating public discourse and participation in the case of the 2022 Arizona legislative study committee on housing

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INTRODUCTION

There is increasing interest in participatory processes as a means to deal with complexity in governance challenges. It is thought to improve decision-making and outcomes by incorporating diverse values and knowledge and generating creative solutions through dialogue and deliberation (Armitage et al., 2011; Newig et al., 2023). Who communicates, who has decision-making authority, and in what context the communication occurs shape the participants, the institutions they create, and the interactions they have within social-ecological systems (Newig et al., 2023)? We build on the growing public discourse scholarship field to demonstrate how who communicates and who has decision-making authority shapes the institutions that are created (Erbaugh et al., 2024; Newig et al., 2023). We demonstrate how computational text analysis methods may be used to investigate public discourse. Our study is the first application of these methods to public discourse of which we are aware.

Communication in environmental governance differs directionally—one-way, two-way—and by objective—informational, operational (Erbaugh et al., 2024). We focus on two-way operational—also called public participation—represents the costliest but most effective discourse (Erbaugh et al., 2024). This type of discourse is further differentiated based on whether citizens have decision-making authority or whether it is vested in a subset of the group.

Ensuring public discourse is fair and equitable demands greater attention in terms of who can engage with different types of information and who is able to participate publicly (Erbaugh et al., 2024). These questions may be analyzed through three dimensions of participation: the intensity of communication among participants and process organizers, the extent to which participants can shape decisions (“power delegation”), and the extent to which stakeholder groups are represented (Newig et al., 2023). In a meta-analysis of 305 environmental governance case studies, these three dimensions were shown statistically to impact the environmental governance outcomes with power delegation being the most stable predictor of environmental governance outcomes (Newig et al., 2023). We extend the study of these factors into urban governance and demonstrate how computational text analysis methods may be used to investigate these dimensions of participants.

Deliberative communication processes are often time intensive in both the time spent and their duration. Therefore, methods that rely on participant memory, such as self-reported methods, may be biased by social pressures, memory, and the interview(er) (i.e. hindsight bias) (Fischhoff, 2013; Roesse & Vohs, 2012; Schwarz, 1999). Ideally researchers would study the content of the discourse itself. In this study we examine public hearings, so that we can use the public recordings of those hearings as the corpus for the analysis. We introduce Latent Dirichlet Allocation (LDA)—a quantitative text analysis method—to evaluate who participates, how stakeholder groups are represented, what information they share, and what information is included in the final report and eventually legislation (Blei et al., 2003). We corroborate the quantitative data by interviewing the participants, and use the interviews and

quantitative data to discuss how the public discourse impacted the institutions that were created.

Our study builds on a robustly developing body of knowledge about public discourse and participation. We offer a quantitative approach to identifying critical dimensions of communication to study how they impact the institutions created. Lastly, we provide additional evidence of the importance of power delegation to the success of the translation of public participation to institutions in an urban governance case.

CASE DESCRIPTION

Arizona has a housing shortage. The Arizona Department of Housing estimates that the state is 270,000 units short of current demand (Arizona Department of Housing, 2022). In the Phoenix area, rents have increased 53% from 2018 to 2022, vacancy rates have dropped from 12% in 2010 to 5% in 2021, and demand is outpacing the rate of building (Common Sense Institute, 2022; Maricopa Association of Governments, 2022). Municipalities from across the state report similar shortages (Common Sense Institute, 2022).

As a step to address the housing shortage, Representative Kaiser and Representative Chávez introduced a zoning reform bill, House Bill 2674, to the Arizona House of Representatives in February 2022. The bill did not pass in its introduced form; a revised version was passed in April 2022 to establish a temporary, legislative study committee. The law specified that the bipartisan committee would consist of 11 representatives (Appendix A). The committee was chaired by an elected representative and four others were on the committee. Additionally, 4 professional stakeholders who represented realtors, for-sale builders, for-rent builders, and a state-wide non-profit advocating for housing. The remaining 2 members of the committee were one state and one local-level administrators. These representatives, named by either the President of the Senate or the Speaker of the House, convened a series of meetings where additional stakeholders participated.

The members of the committee were encouraged by the chair to ask their networks to attend and present their knowledge and experience. There were 52 stakeholders who were invited by members of the committee or self-selected to be on the agenda, including expert administrators, elected representatives, professional stakeholders, and lay stakeholders representing various interests and locales across the state of Arizona. Additionally, 42 participants who were not on the agenda made statements during open comment periods.

The committee met 12 times from July to December 2022 to “review data on the scope of housing supply and access, compile an overview of ways to address Arizona’s housing shortage and mitigate its causes, and solicit ideas and opinions of industry and subject matter experts and the community on additional recommendations.” By December 31, 2022, the committee members were to “submit a final report regarding the committee’s findings that will foster a positive housing supply in the state.” This report was provided to the Arizona State Senate president, the Arizona House of Representatives speaker, and the Arizona Department of Housing director. The full text of House Bill 2674, an act establishing the housing supply study committee, is available online.

This process was public, well-documented, and time-bound, so we could use this discrete, primary dataset to explore public discourse. The meetings were recorded and publicly archived as video and audio files by the Arizona Legislature. We transcribed the audio files using Otter.ai. The meeting in Tucson was excluded from our analysis because the recording

quality was too low to differentiate speakers. We added speaker names to the transcripts for the remaining 11 files and made no other changes after manually validating the transcription quality with the audio recording.

Table 1. 2022 Arizona Housing Supply Legislative Study Committee meeting information.

Meeting Purpose	Date (2022)	Duration (hours)	Committee Speakers	Agenda Speakers	Public Comment
Discussion on Housing Supply	Jul 12	0.9	10	0	2
Home Building Process	Jul 26	3.3	9	7	3
Housing Impacts on Arizonians	Aug 9	3.2	10	8	8
Water, Power, and Environmental Impacts on Housing Development	Aug 23	3.4	9	5	8
Flagstaff--local supply housing status	Sep 7	2.8	3	7	7
Tucson--local supply housing status	Sep 12	3.6			
Sedona--local supply housing status	Sep 26	3.2	10	3	15
Zoning & Density	Nov 15	4.0	8	10	0
Regulations Impacting Home Building, Supply and Access	Nov 17	1.4	7	1	0
Housing Shortage Impacts on Economic and Workforce Development	Dec 6	3.0	7	10	1
Housing Trends & Consultant Report	Dec 13	2.2	8	2	0
Presentation of Report	Dec 20	1.0	7	0	1

We used the mission statements from the “about” section on organizations’ websites to map the committee members, agenda speakers, and public commenters to stakeholder groups. In their testimony, each expert or public commenter stated the organization they represented. We reviewed each organization’s mission and coded the group they represented. This process yielded ten stakeholder groups: *business, consultant, developer, elected, health, low income, neighbor, planning, real estate, and special populations* (Appendix B for group description).

METHODS

This study employs a mixed methodology, first using computational text analysis—including LDA topic modeling—to explore the recordings of a public participation process and then interviewing six participants from the legislative study committee. We used these methods to estimate which stakeholder groups were communicating about what topics, and what topics ended up being addressed in the final report. They facilitated exploring if the concerns raised by the stakeholder groups are equally represented in the final report, or if issues from some

stakeholder groups get more space. We aimed to understand where these methods can relate public discourse to power dynamics. Additionally, interviews with various stakeholders were conducted to understand how the final report was created and why we see certain matches and mismatches of inputs and outputs.

Computational Text Analysis

We employ computational text analysis in our analysis. Specifically, Latent Dirichlet allocation (LDA) topic modeling, a generative probabilistic model of a corpus, where a corpus is a collection of documents that represents a sequence of words (Blei et al., 2003). Words are the basic unit of discrete data. LDA topic modeling assumes that every document is a mixture of topics and every topic is a mixture of words (Blei et al., 2003; Grün & Hornik, 2011). Unlike hierarchical clustering models, documents analyzed using LDA can be associated with multiple topics (Blei et al., 2003; Grün & Hornik, 2011). The model can be used to estimate the similarities between documents within a corpus generating topics to help quantitatively assess a large body of text (Grün & Hornik, 2011). For a description of the modeling approach and its underlying formulas see Blei, Ng, and Jordan (2003).

We used the “topicmodels” package in R generating beta, the per-topic-per-word probability, and gamma values, the per-document-per-topic probability (Grün & Hornik, 2023). The output of the model is a matrix of keywords and their probabilities of being associated with a given topic (beta value) and a matrix of documents and their probability of being associated with a given topic (gamma value). For more details on the method and its implementation in R see Grün & Hornik (2011).

We used two parameters to tune our LDA topic model—the stopword threshold and the number of topics (k). Stopword lists are lists of words that commonly appear in text and are used to remove noise from the analysis leaving behind topically significant words. Examples of stopwords are articles like “and” and “the” and verbs like “said” and “can.” We used `stop_words` from the `tidytext` package in R, which uses tidy data principles to make text mining easier. We also created a stopword list, using term frequency-inverse document frequency (TF-IDF), of words that were common across the meetings. We tried different TF-IDF cut-off values at natural breaks in the word frequency distributions (Appendix C), and the best results were provided by removing all terms that had a TF-IDF score of 0.0003 or less. See our data availability statement for a complete list of stopwords used and our code.

LDA topic models require the k -value to be set a priori and qualitatively validated (Blei et al., 2003; Grün & Hornik, 2011). Through a manual validation process, we found that $k = 12$ provided the most cohesive topics. Our iterative validation process included scrutinizing the top thirty terms by beta value per topic and reading the top fifteen documents by gamma value for each topic using different k values and stopword thresholds. The topic names were derived by the authors from the top terms and document themes. We turned off the topic size optimization parameter that creates topics of equal size so that our topics could vary in size. We did this because we anticipated that there may be topics that encompass more of the documents and others that are specific to a smaller number of documents.

Interviews

We used a deductive interview approach to complement LDA topic modeling. Deductive interview approaches draw from existing frameworks and constructs to build evidence for established relationships and theories for how the components interact (Bernard et al., 2017).

We collected data using structured interviews with thirteen questions (Appendix D). The questions examined the process and outcomes of the committee using the collective learning process framework (Heikkilä & Gerlak, 2013). We used this framework to examine the different components of public discourse—a form of collective learning. The sample frame included the 12 members of the HSSC¹. We interviewed 6 of the committee members during June and July 2023—the committee chair (an elected official), 2 more elected officials, 1 developer, 1 real estate representative, and 1 planner. The interviewees were randomly numbered 1-6 to delineate their responses in the results section. Of the 6 who were not interviewed, 4 declined to interview, and 2 were interested but unavailable. The members that were not interviewed were 1 planning, 2 low-income, 1 real estate, and 2 elected representatives.

The interviews were on Zoom and lasted between 25 and 53 minutes. We used Zoom to record the interviews and transcribed them using Otter.ai. The transcription accuracy was good (provide statistic – how do we know it was good?), and we made no changes to the AI-produced transcripts. The transcripts were loaded in MaxQDA, where we structurally coded the responses to the thirteen questions and then thematically coded the responses within them (Bernard et al., 2017). The interviews were structured deductively using the collective learning process framework to formulate the questions. The themes within each of the responses to the questions were coded inductively.

RESULTS

Who communicates, from which stakeholder groups, and with what intensity?

The 10 stakeholder groups were not equally represented by the 107 participants. We considered 4 measures of participation—the count of participants per group, the count of words spoken by group, the average count of words per speaker by group, and the count of meetings that each group spoke in (Table 2).

The first dimension of participation considered was the count of participants per group (Table 2). The *planning* and *development* stakeholder groups had 21 and 20 active participants, respectively, while the *business* and *health* stakeholder groups each had 2 active participants. The count of participants demonstrates the number of experts called and the plurality of perspectives for those groups but is limited in its ability to measure individual and group contributions to the discussion.

Second, we considered the count of words spoken by group (Table 2). The *planning* participants said 1 out of 4 words in the proceedings, more than 15 times more words than the *health* participants. The proportion of words spoken shows that the *planning*, *developer*, *elected*, and *low income* groups said over 70% of the words in the process. This measure is also limited in its ability to measure individual contributions to the discussion because it does not indicate how much each individual participant in that group contributed.

The third measure of participation we consider is the average words spoken by each stakeholder group (Table 2). While there were only four *real estate* speakers, they said about two times as many words per speaker as the more numerous *planning*, *development*, and *elected* speakers. This measure demonstrates the length of statements by the stakeholder groups. The *real estate*, *consultant*, and *planning* groups said the most words per speaker.

Lastly, we examine the number of meetings that each stakeholder group participated in (Table 2). Representatives of the *developer*, *elected*, and *low income* stakeholder groups spoke in all ten of the meetings we analyzed. *Health*, *neighbor*, *special populations*, *consultant*, and *business* representatives spoke in five or fewer of the meetings. *Planning* and *real estate* spoke in all but one of the meetings. These measures of participation describe the opportunity different interest groups had to represent their interests.

Table 2. Four measures of participation by stakeholder group.

Stakeholder Group	Total speakers (n, % of total)		Total words (n, % of total)		Avg words/ speaker	Meetings Spoken In (n, % of total)	
<i>planning</i>	21	20%	59225	24%	2820	9	90%
<i>developer</i>	20	19%	46864	19%	2343	10	100%
<i>elected</i>	16	15%	41937	17%	2621	10	100%
<i>lowincome</i>	14	13%	28710	11%	2051	10	100%
<i>realestate</i>	4	4%	21179	8%	5295	9	90%
<i>consultant</i>	6	6%	18736	7%	3123	4	40%
<i>special populations</i>	11	10%	15768	6%	1433	3	30%
<i>neighbor</i>	11	10%	10099	4%	918	5	50%
<i>business</i>	2	2%	3841	2%	1920	2	20%
<i>health</i>	2	2%	3766	2%	1883	2	20%

In summary, although there was breadth of participation represented by 10 stakeholder groups some of these groups—*planning*, *developer*, *elected*, *low income*—participated much more in the process than others—*business* and *health*.

One interviewed committee member reflected on the process' inclusivity, "You probably saw sort of the multitude of presenters, over 70 presenters, and the chairman was really intentional here, where if you wanted to make a presentation to the study committee, he allowed it. He said he didn't tell anyone no" (Interviewee 1). There were 52 invited speakers and 42 public commentators representing 10 stakeholder groups across the 11 meetings we analyzed. Multiple members commented on how open the process was. A member said, "I don't think anybody that wants to present it was turned down that I'm aware of" (Interviewee 4).

There was consensus from the committee members that the process included diverse perspectives. A committee member said, "I thought it was a very good balance of kind of industry interests, and governmental interests and housing advocates" (Interviewee 2). Another talked about the representation within the experts who testified, "Yeah, as much as they could be? I mean, it depended on who showed up and who testified. Right. So but we had a broad representation, I think of developers, of service providers, and, you know, local

jurisdiction politicians” (Interviewee 5). They explained that while it was balanced, the testimony depended on who could be there for it, supporting the theory that open, self-selected forums tend to attract participants with more time, wealth, and knowledge on the subject (Fung, 2015). Another spoke about how rare it is for a legislative committee to have meetings in different parts of the state. “The other unique thing about this thing is the fact that we travel. Usually, the study committees are always at the Capitol. I mean, I could probably count on one hand, how many times a study committee has gone across the state” (Interviewee 1). The participatory venues may be used to create boundaries of who is invited, whose interests are favored, and how participants may shape the process (Gaventa, 2006). The actor(s) designing a public participation process may use their position to limit which issues are on the agenda and who may speak, or they may use it to create an open and inclusive forum (Dahl, 1957; Ernst & Fuchs, 2022; Rydstedt Nyman, 2019). In this case, the evidence points to the latter.

To what extent can participants shape decisions?

Following the public discourse on housing, the chair of the committee introduced a bill into the 2023 legislative session. The bill introduced in 2023 represented a shift in the mental models of the committee members; however, that change did not translate to the other legislators. As one committee member recognized, “I think there was a lot of awareness, because this was probably the first or second issue on the campaign trail in 2022. So a lot of members were very aware of it, you know, homelessness, rent increasing, housing prices increasing. There was a lot of angst from voters on that, I think. So that wasn't a problem. But as it relates to the need for solutions and the value of those solutions in the legislation, the SRO [single room occupancies], the ADUs [accessory dwelling units], higher density, you know, density bonuses for LIHTC [low income housing tax credit] projects, all that kind of got fell apart” (Interviewee 4). This disconnect in understanding between the committee members and the legislature represents a change in how the committee members thought about addressing the housing shortage that did not translate to the rest of the legislature. While there may have been some degree of consensus about solutions for the housing supply challenge in the committee, other legislators used their position to block the reforms suggested by the chair of the committee. Empirical studies have concluded that collective learning is insufficient for policy change (Mukhtarov et al., 2019; Rydstedt Nyman, 2019). To be effective, learning process participants may need authority to make policy changes (Ernst & Fuchs, 2022; Mukhtarov et al., 2019). Our results support this theory indicating that when public discourse does not include all or even most of the policymakers, it may be ineffective in bringing about policy change because the votes of those who did not participate may be based on old perspectives of the problem.

The committee members reported being hopeful and determined that the bill failure in 2023 was a setback but not a defeat. They talked about reintroducing the bill in the future as multiple smaller bills and continuing to advocate for change, keeping housing supply challenges on the political agenda. One committee member reflected on the outcome of the 2023 legislative session, “I see it as having hope, that there can be some progress to be made in the future. It just hasn't happened yet. But I think that we're on a better path” (Interviewee 6). The visibility of the committee and resulting bills was perceived by the interviewees to increase the awareness of the challenge and potential solutions among the Arizona legislature broadly, paving the way for continued deliberations by legislators.

The interviewees said that they learned which topics were controversial and which were not. The committee chair and bill sponsor reflected,

But tactically, I think our huge mistake was putting all of it into one bill. And we had, this is a massively complex topic. And it's very emotional, because you're dealing with people's homes and communities, and there's a lot of fear around, is this going to change my community and where I live? And like, just leave me alone. Right. And, and, and so you're fighting all of that. And I think strategically, tactically, what we should have done is done 10 bills, each with one simple idea, run by two or three members, not just one member. And so what that would have allowed us to do is make it much more easier to digest. If there was just a bill on ADUs that would have passed no problem. If there was just a bill on SROs, no problem. housing needs assessment, no problem. Now you get into the controversial stuff. Design Review, preemption, right, the painting and coloring house and where the coach lamps are in the mailbox and all the stuff. (Interviewee 3)

While the chair's proposed legislation failed, they plan to continue working on housing. "I have a 501c4 that I started now that I'll be working on housing is one of the pillars I'm going to continue to work on. So going into next legislative session, like I'm looking right now at other states and what they did, because there's lots of other states, not lots, but there's a handful of other states that are passing this legislation that we tried, and I thought for sure we were gonna get it done" (Interviewee 3). At the end of the next section we discuss the bills that were introduced in the 2024 Arizona legislative session.

Which institutions were created?

Knowing some of the limits that the participants experienced in their decision-making authority, we now trace the topics discussed through the process to the final report which included the policy recommendations. We then look at the housing legislation that has made it out of committees to the floor in the 2023 and 2024 Arizona legislative sessions.

We consider the interests of the stakeholder groups as topics they focus on in their discussions. LDA topic modeling of the HSSC corpus yielded 12 topics related to different aspects of housing supply (Appendix E). Each document may be a combination of these topics. We analyze which topics were discussed by which groups and in which meetings. We then trace these topics to the final report published by the committee and the bills that were introduced in the 2023 and 2024 Arizona legislative session.

The 10 stakeholder groups discussed different topics (Figure 1). We described focal topics as those having a gamma score greater than or equal to 0.15. We selected this value, roughly the midpoint, for interpretability. The *developer*, *health*, *low income*, and *planning* stakeholder groups focused on 1 topic. The *business*, *consultant*, *neighbor*, and *special population* stakeholder groups focused on more than 1 topic. The *elected* and *real estate* groups did not focus on any topic.

Most topics were focused on by 1 stakeholder group (Figure 1). 7 topics were focal to 1 stakeholder group—*consultants* focused on *intersectional* and *services*, *planners* focused on *building codes*, *business* focused on *affordable housing loss*, *special populations* focused on *access to affordable housing* and *discrimination*, and *neighbors* focused on *mixed-income housing*. 4 topics were focal to 2 stakeholder groups—*business* and *health* focused on *policy mechanisms*, *consultants* and *low income* focused on *deficit impacts*, *business* and *neighbors*

focused on *water availability*, and *business* and *developer* focused on *future development*. *Housing trends* were not a focal topic for any group.

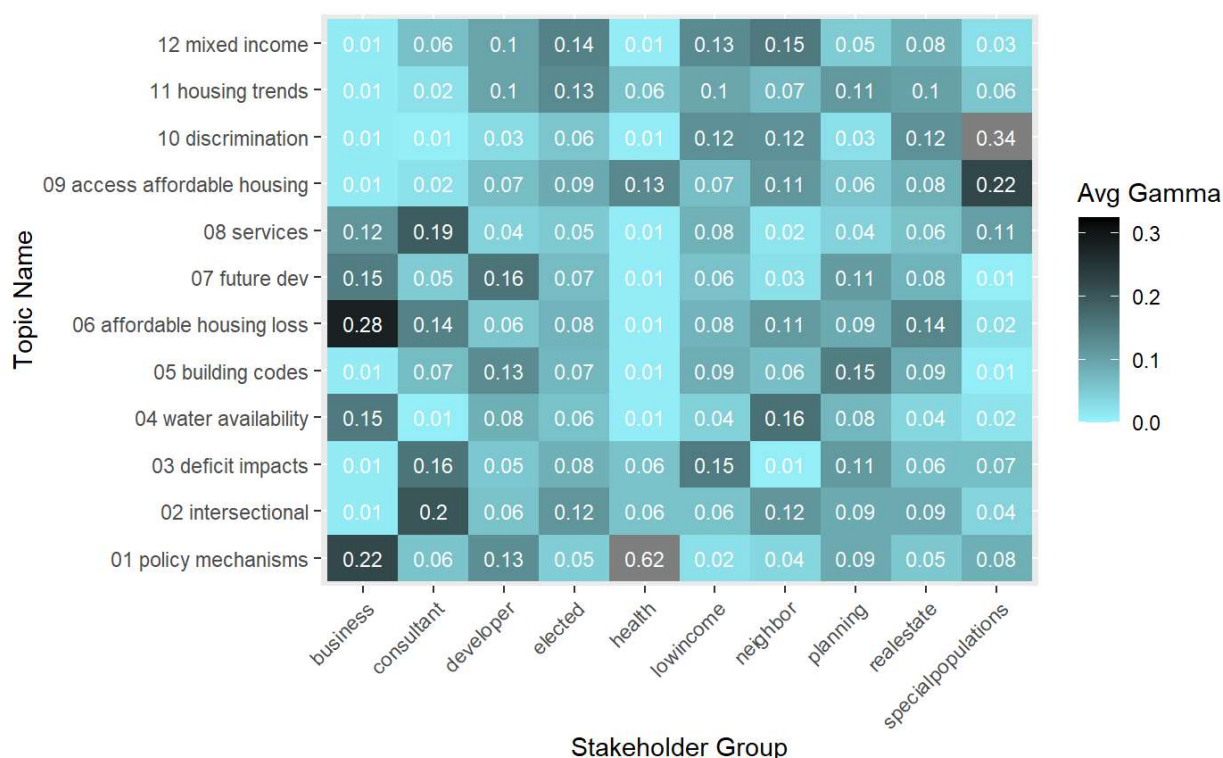


Figure 1. Gamma scores for topics by stakeholder group.

The topics discussed in the meetings differed, with most meetings focusing on 1 or 2 topics (Figure 2). All the meetings were a mix of topics; we described the focal topics of the meeting as those with a gamma score of 0.15 or higher. The housing supply discussion focused on *building codes*. The home-building process discussion focused on *building codes* and *access to affordable housing*. The impact on Arizonians discussion focused on *access to affordable housing* and *discrimination*. The water, power, and environment discussion focused on *intersectional impacts* and *water availability*. The discussion in Flagstaff focused on *policy mechanisms* and *future development*. The discussion in Sedona focused on *deficit impacts*. The zoning and density discussion focused on *building codes* and *mixed-income communities*. The regulations discussion focused on *future development* and *housing trends*. The economic and workforce discussion focused on *policy mechanisms*, *deficit impacts*, and *wrap-around services*. The housing trends consultant focused on *housing trends*.

Building codes were a focal topic in 3 meetings. 5 topics were focal in 2 meetings—*policy mechanisms*, *deficit impacts*, *future development*, *access to affordable housing*, and *housing trends*. 5 topics were focal in 1 meeting—*intersectional*, *water availability*, *services*, *discrimination*, and *mixed income*. *Affordable housing loss* was not a focal topic in any meeting.

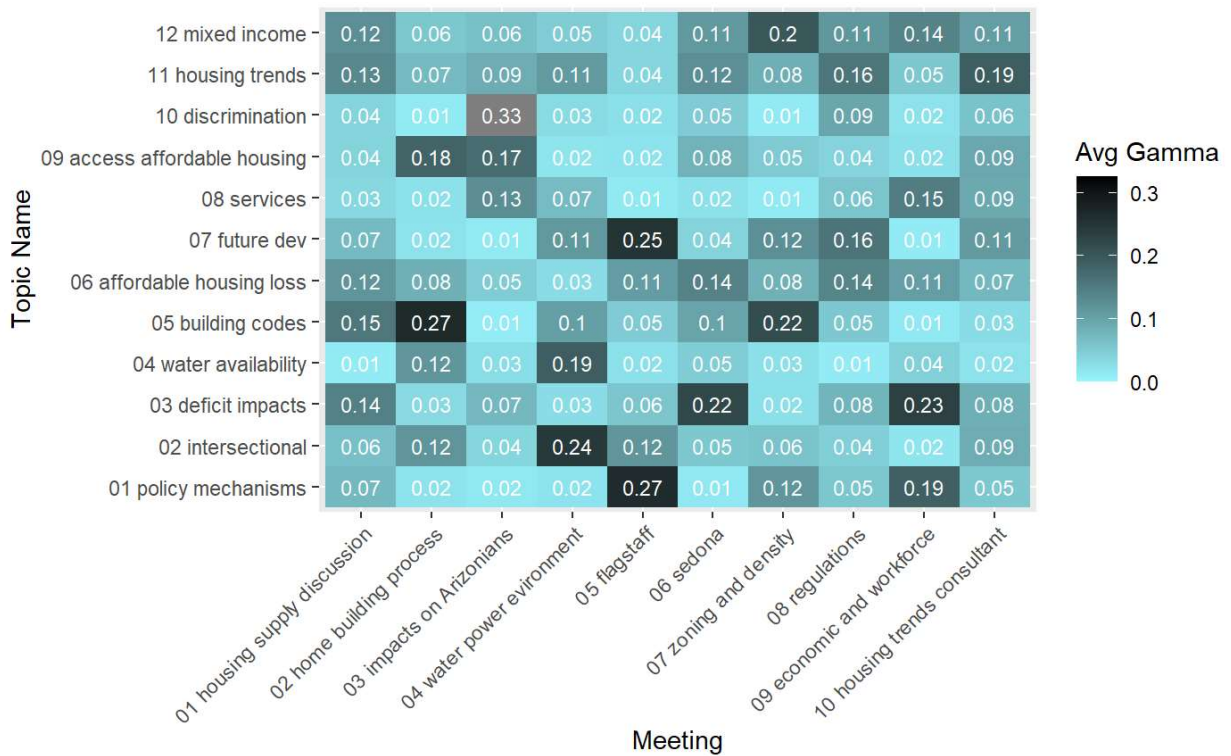


Figure 2. Gamma scores for topic by meeting.

The final report included a summary by the chair, an elected representative, and reflections from 3 committee members, 1 from the *elected* stakeholder group and 2 from the *low income* stakeholder group. The written report was read into the official record during the committee's last meeting on December 20, 2022. All committee members had the opportunity to submit a summary of their takeaways. Representatives from the *developer*, *planning*, and *real estate* stakeholder groups made verbal comments during the final meeting where the report was read. The focal topics in the final written report were *building codes*, *intersectional impacts*, and *water availability* (Appendix F). Verbal comments during the meeting included discussions of *policy mechanisms*, *intersectional impacts*, *deficit impacts*, *mixed-income communities*, *future development*, and *housing trends* (Appendix F).

3 of the 12 topics were focal to the final report— *building codes*, *intersectional impacts*, and *water availability* (Appendix F). *Building codes* were a focal topic for the *planning* stakeholder group (Figure 1), which said a quarter of the words and represented 1 in 5 participants (Table 2). *Building codes* were a focal topic in 3/10 of the meetings, more than any other topic (Figure 2). *Intersectional impacts* were a focal topic of the *consultant* stakeholder group (Figure 1), which discussed housing's relationship with heat and poverty. They were a small percentage of the speakers and words spoken but had the second-highest words per speaker (Table 2). *Water availability* was a focal topic for the *business* and *neighbor* stakeholder groups (Figure 1), which represented 6% of the words and 12% of the speakers (Table 2). *Water availability* was a focal topic of 1 meeting (Figure 2).

Table 3. Bills focused on housing introduced in the 2023 and 2024 Arizona legislative session. Adapted from (Thorington, 2024).

Number	Short Description	Year	Enacted
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SB1117	Deregulation of zoning and boost affordable housing supply	2023	NO
HB2297	Some commercial zoned properties may be reused for residential housing	2024	YES
SB1162	Rezoning requests must be completed in 180 days	2024	YES
HB2570	Arizona Starter Homes Act	2024	NO
HB2720	Cities with population >75K must allow accessory dwelling units or casitas on single-family parcels	2024	YES
HB2721	Cities with population >75K must allow the development of “middle housing” options including duplexes, triplexes, fourplexes, and townhomes	2024	YES

The bundled bill introduced in 2023, SB1117, following the Arizona Housing Supply Study committee failed; however, in 2024 five bills passed the Arizona Housing of Representatives and Senate (Table 3). Four of these were signed into law by Governor Hobbs. HB2297, HB2720, and HB 2721 all target building density and overcome the single-family zoning challenges that were frequently discussed in the hearings. Some of these bills (i.e. 2720 and 2721) were bipartisan, which may indicate that the committee process contributed to common understanding between legislators about the problem. Further, HB2297 allows for adaptive reuse of land that was formerly zoned as commercial. SB1162 addresses the long wait times for rezoning requests that developers discussed. They said these could go on for years and add costs to their projects and delay people moving in. Lastly, HB2570’s aim was to reduce restrictions on the size of homes, lots, and design requirements. Governor Hobbs vetoed this bill because it lacked provisions specifically for affordable housing and may lead to “unintended consequences” of increased density near military installations and public safety concerns. The 2024 bills are temporally distanced from the 2022 process, indicating that it took time for the ideas to take hold since the vast majority of legislators were not part of the intensive participation process.

DISCUSSION

Our paper uses a quantitative approach to evaluate who participates, how they participate, and which of the topics discussed are recommended for creating institutions. The computational text analysis methodology used in this study provides the opportunity to ask a new set of questions about public discourse and participation. It is a powerful tool to mine large bodies of text for insights. We were able to analyze over thirty hours of public discourse from over one hundred participants efficiently and effectively using a combination of summary statistics, text frequency-inverse document frequency, and LDA topic modeling methods. These methods overcome biases in self-reported data on public discourse. We examined four measures of participation and topics discussed, paving the way for future causal analysis of public discourse. These methods are possible when there are recordings or detailed notes from collective learning processes, especially when they have occurred over many hours and meetings.

Our results identify topic attrition between the public discourse process and the final report that was drafted by the committee and the legislation that was enacted. Our results indicate

that while there were 12 topics that were important to the stakeholder groups, 3 topics were focused on in the report. The topics in the report suggest that a quarter of the topics discussed were translated and shared among the committee members. The attrition of knowledge during the translation and dissemination phases may cause frustration and lack of implementation may cause disappointment among participants (Fung, 2015; Rydstedt Nyman, 2019). We suspect that there is a trade-off between a time intensive and inclusive public discourse process and the committee members' capacity to translate the information presented to recommendations. Further research should focus on how to identify quantitative measure of participatory process design that lead to greater translation of the findings.

The solutions from the 2022 legislative study committee were not implemented until 2024, and then only in part. The committee's mandate was to advise and consult on the housing challenge and potential solutions. The elected officials on the committee could introduce bills to implement these solutions. However, the bills would need to be passed by the rest of the Arizona Senate or House of Representatives, and the vast majority of these decision-makers were not involved in the process. The HSSC had moderate authority to advise on strategies to address the housing shortage and was limited in its authority to implement those changes. The limited authority of the committee and participants may hinder its effectiveness in implementing their multi-sectoral solutions (Fung, 2006, 2015). Some of the findings from the committee were adopted in the 2024 legislative session. This year gap could be indicative of a few factors: the committee members learned strategies to navigate the policy process between 2023 and 2024, there was diffusion of learnings from the legislative study committee to policy makers over that time, or some other exogenous or endogenous factors.

There are also limitations to these methods. These data provided indirect and flawed measures of learning, participation, and power. However, they do represent a viable alternative to self-report data that is biased by social pressures, memory, and the interview(er) (Fischhoff, 2013; Schwarz, 1999). Our data were limited to interactions that were recorded and did not include interactions outside of the committee meetings. Methodologically, we applied stopword lists that removed common words. As a result, the analysis focused on the topics that were unique to particular groups and meetings. We may have missed overarching topics or threads that were woven through all the meetings. We used a systematic process to categorize the participants for interpretability; however, there were many stakeholders who could have been placed in multiple categories suggesting an ecology of games (Lubell, 2013). Additionally, we had to exclude one of the meeting recordings because the audio and video quality were too poor; these methods rely on good recording and archival technologies. Lastly, the validation of topics and results from computational methods is nuanced and often manual (Grimmer & Stewart, 2013). There may have been things we missed or better interpretations of the data.

Computational text analysis methods represent a suite of tools that overcome common challenges in studying public discourse and participation through self-reported data. We demonstrate that they help researchers identify who participates, to what extent, and how do the topics they discuss lead to institutional change. Future research should build on these methods as tools for causal links between discourse and outcomes. Further additional consideration should be given to the authority of participants to implement the outcomes. These methods are powerful tools to examine public discourse and its effects on institutional design.

NOTES

¹ There were 11 positions on the committee, but 12 people filled those positions. The Director of the Arizona Department of Housing and their Deputy Director traded off meetings that they attended.

REFERENCES

- Arizona Department of Housing. (2022). *Fiscal year 2022 annual report*.
- Armitage, D., Berkes, F., Dale, A., Kocho-Schellenberg, E., & Patton, E. (2011). Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Global Environmental Change*, *21*, 995–1004.
- Bernard, H. R., Wutich, A., & Ryan, G. W. (2017). *Analyzing Qualitative Data: Systematic Approaches*. SAGE Publications, Inc.
- Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent Dirichlet Allocation. *Journal of Machine Learning Research*, *3*, 993–1022.
- Common Sense Institute. (2022). *Arizona Housing Affordability Update October 2022*. <https://commonsenseinstituteaz.org/arizona-housing-affordability-update-october-2022/>
- Dahl, R. A. (1957). The Concept of Power. *Behavioral Science*, *2*(3).
- Erbaugh, J. T., Chang, C. H., Masuda, Y. J., & Ribot, J. (2024). Communication and Deliberation for Environmental Governance. *Annual Review of Environment and Resources*. <https://doi.org/10.1146/annurev-environ-112321-082450>
- Ernst, A., & Fuchs, D. (2022). Power dynamics, shifting roles, and learning: Exploring key actors in participation processes in the German energy transformation (Energiewende). *Energy Research and Social Science*, *85*. <https://doi.org/10.1016/j.erss.2021.102420>
- Fischhoff, B. (2013). Value elicitation: Is there anything in there? *Judgment and Decision Making*, *46*(8), 207–231. <https://doi.org/10.4324/9780203141939>
- Fung, A. (2006). Varieties of participation in complex governance. *Public Administration Review*, *66*(SUPPL. 1), 66–75. <https://doi.org/10.1111/j.1540-6210.2006.00667.x>
- Fung, A. (2015). Putting the Public Back into Governance: The Challenges of Citizen Participation and Its Future. *Public Administration Review*, *75*(4), 513–522. <https://doi.org/10.1111/puar.12361>
- Gaventa, J. (2006). Finding the Spaces for Change: A Power Analysis. *IDS Bulletin*, *37*(6), 23–33.
- Grimmer, J., & Stewart, B. M. (2013). Text as data: The promise and pitfalls of automatic content analysis methods for political texts. *Political Analysis*, *21*(3), 267–297. <https://doi.org/10.1093/pan/mps028>
- Grün, B., & Hornik, K. (2011). topicmodels: An R Package for Fitting Topic Models. *JSS Journal of Statistical Software*, *40*. <http://www.jstatsoft.org/>

- Grün, B., & Hornik, K. (2023). *topicmodels: Topic Models* [Computer software].
<https://cran.r-project.org/package=topicmodels>
- Heikkila, T., & Gerlak, A. K. (2013). Building a conceptual approach to collective learning: Lessons for public policy scholars. *Policy Studies Journal*, *41*(3), 484–512.
<https://doi.org/10.1111/psj.12026>
- Lubell, M. (2013). Governing institutional complexity: The ecology of games framework. *Policy Studies Journal*, *41*(3), 537–559. <https://doi.org/10.1111/psj.12028>
- Maricopa Association of Governments. (2022). *Housing Update, December 2022*.
<https://azmag.gov/Programs/Maps-and-Data/Land-Use-and-Housing/Housing-Data-Explorer>
- Mukhtarov, F., Dieperink, C., Driessen, P., & Riley, J. (2019). Collaborative learning for policy innovations: Sustainable urban drainage systems in Leicester, England. *Journal of Environmental Policy and Planning*, *21*(3), 288–301.
<https://doi.org/10.1080/1523908X.2019.1627864>
- Newig, J., Jager, N. W., Challies, E., & Kochskämper, E. (2023). Does stakeholder participation improve environmental governance? Evidence from a meta-analysis of 305 case studies. *Global Environmental Change*, *82*, 102705.
<https://doi.org/10.1016/j.gloenvcha.2023.102705>
- Roese, N. J., & Vohs, K. D. (2012). Hindsight Bias. *Perspectives on Psychological Science*, *7*(5), 411–426. <https://doi.org/10.1177/1745691612454303>
- Rydstedt Nyman, M. (2019). Collective Learning in Organizations—Opportunities and Constraints: Case Study of an Avalanche Blocking a Railway Line. *Risk, Hazards and Crisis in Public Policy*, *10*(3), 332–359. <https://doi.org/10.1002/rhc3.12159>
- Schwarz, N. (1999). Self-Reports: How the Questions Shape the Answers. *American Psychologist*, *54*(2), 93–105.
- Thorington, J. (2024, May 21). Hobbs signs bipartisan housing bills. *Arizona Capitol Times*.
<https://azcapitoltimes.com/news/2024/05/21/hobbs-signs-bipartisan-housing-bills/>

APPENDICIES

Appendix A. COMMITTEE MEMBERS

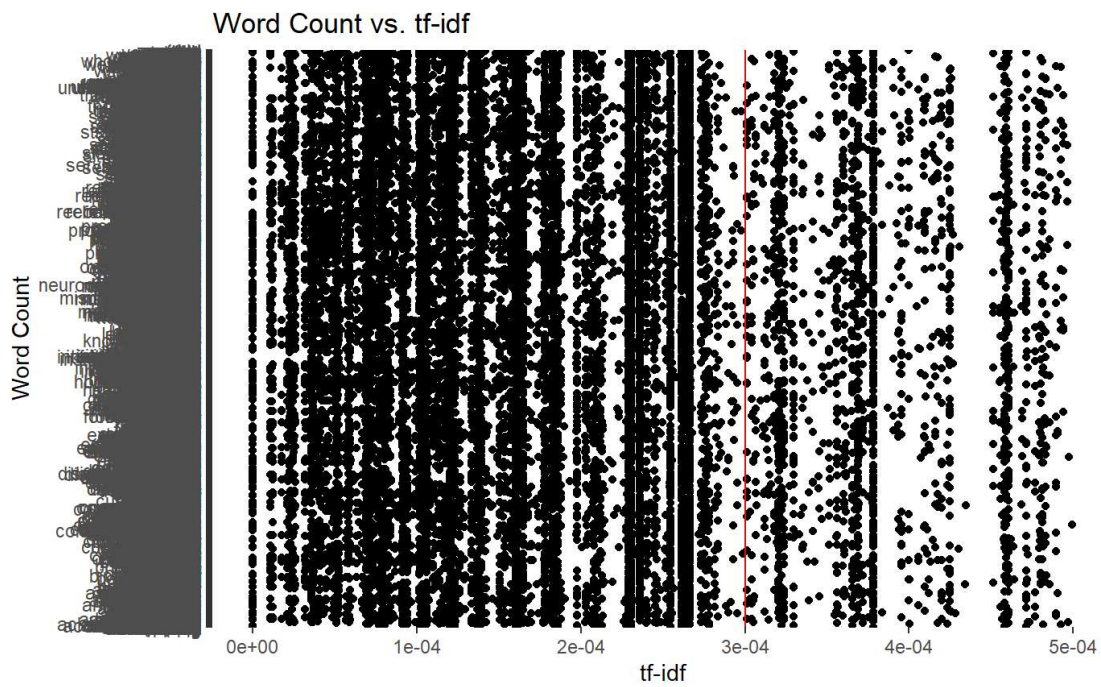
Name	Title	Description in HB2674
David Gowan Martin Quezada	AZ State Senator (R) AZ State Senator (D)	Two members of the senate who are appointed by the president of the senate and who are of different political parties.
Steve Kaiser Cesar Chavez	AZ State Representative (R) AZ State Representative (D)	Two members of the house of representatives who are appointed by the speaker of the house of representatives and who are of different political parties.
Thomas Simplot Cindy Stotler	Director Deputy Director (<i>stood in for Simplot when he was unavailable</i>)	The director of the Arizona department of housing or the director's designee.
Jake Hinman Spencer Kamps	Government Affairs Consultant, AZ Multihousing Coalition VP Legislative Affairs, Home Builders Association of Central AZ	Two representatives of the building industry, one representing rental housing and one representing for sale housing.
Corey Woods Jean Moreno	Mayor, City of Tempe Director of Community Services, City of Glendale	Two representatives from a city or town or a statewide organization that represents cities and towns.
Matthew Contorelli	Government Affairs Director, Arizona Realtors	One member who represents a trade association whose membership exceeds fifty thousand real estate licensees under title 32, chapter 20.
Joan Serviss	Executive Director, AZ Housing Coalition	One representative from a statewide non-profit housing advocacy group

Appendix B. STAKEHOLDER GROUP DEFINITIONS

These definitions were derived from the mission statements of the organizations that the 107 people who spoke in the housing supply study committee hearings represented.

Group	Group Definition	Examples
<i>business</i>	These organizations are businesses or represent business interests.	Greater Flagstaff Chamber of Commerce, Lucid Motors
<i>consultant</i>	These are attorneys, professors, and consultants who serve as expert witnesses on particular topics.	Anderson Economic Group, Mercatus Center, University of Arizona
<i>developer</i>	These are builders, developers, or professional organizations that represent them.	Dominium, Home Builders Association of Central AZ, Lennar Homes
<i>elected</i>	These are elected officials at the city, county, and state level.	Mayor, Senator, City Council Member
<i>health</i>	These are healthcare organizations.	Dignity Health, Vitalyst Health Foundation
<i>low income</i>	These are organizations serving and/or representing low to moderate income families and people experiencing homelessness.	St. Vincent de Paul, Wildfire AZ, Home Matters, Mercy Housing
<i>neighbor</i>	Individuals speaking on their or their neighbors' behalf and organizations that represent neighborhood groups.	Arizona Neighborhood Alliance, Tucson for Everyone, citizen
<i>planning</i>	These are state and city planners, community developers, and housing authorities	Planning manager, housing director
<i>real estate</i>	These organizations are involved in real estate or rental industries.	Arizona Realtors, National Rental Home Council
<i>special populations</i>	These organizations serve and/or represent populations with particular needs or challenges.	Area Agency on Aging, Human Rights Campaign, League of Veterans, Native American Connections

Appendix C. TF-IDF CUT-OFF FOR STOPWORD LIST



We removed the words with a TF-IDF score less than the value represented by the red line before running the LDA topic model.

Appendix D. INTERVIEW QUESTIONNAIRE

Welcome! Thank you for making time to discuss the 2022 Arizona Housing Supply Study Committee with me. I invited you because you were a member of the committee, and your perspective on the process and outcomes of the committee are invaluable. This interview is recorded for analysis purposes. I may use quotes to illustrate the themes that emerge from my analysis.

A little bit about myself, I am a PhD Candidate in Sustainability at Arizona State University under the supervision of Professor Marco Janssen. I study the governance of sustainability issues. Housing fits into this umbrella because of its intersections with water, natural resources, and energy. Additionally, access to housing greatly reduces people's vulnerability to heat, illness, and improves their well-being. This research is part of a working group convened by the Knowledge Exchange for Resilience, aiming to characterize and model Arizona's housing supply and allocation processes. I have analyzed the recordings of the public proceedings of the Housing Supply Study Committee, and this interview will complement that analysis. I am happy to share the findings with you when they are ready.

Today's interview has 13 questions about the background of the committee, its proceedings, the groups represented, and the outcomes. We have about an hour remaining, and I'll keep an eye on time as we proceed.

1. Why was the Arizona Housing Supply Study Committee convened?
2. What were you hoping to contribute to the process? Did you?
3. Of the topics discussed during the committee process, which were most important to you?
4. Was the committee effective in soliciting diverse ideas and opinions to describe the scope of the housing supply and access challenges across Arizona?
5. How did this process change and/or reinforce your understanding of the housing issues in AZ?
6. Which data sources or reports used by the committee do you trust most? Why?
7. How have the committee learnings been shared and used?
8. How did you decide who would contribute to the committee report and what would be included?
9. Were your interests represented in the report?
10. Have there been changes in how decisions are made about housing supply as a result of the committee or otherwise?
 - a. Would the same legislation been introduced with no committee?
11. Do you think any groups benefited more than others in the committee's process, report, and outcomes? Which?
12. Who would be critical of the committee proceedings, inputs or outputs?
13. What do you hope for the future of housing supply and affordability in Arizona?

14. Anything else you would like to say before I stop recording?

Appendix E. LDA GENERATED TOPICS

Topic names, descriptions, the top 10 words associated with the 12 topics, and example excerpts.

Topic	Description	Top 10 Words	Examples
<i>T1. Supply policy mechanisms</i>	Discussion of policy mechanisms that are perceived to cause or could alleviate the housing supply deficit.	abatement, referendum, claims, nogales, navajo, supreme, nurse, implementation, covenants, louisville, indiana, constitution, carpenter	"The impact by the way of having a protest is that you have to have now a super majority 75% of the full Council or the full Board of Supervisors in the case of the county must approve the rezoning if there is a valid protest." ts07.FC "Tax abatement legislation is something that you do have control over. And it enables you to leverage and layer all types of gap financing." ts09.AD
<i>T2. Intersectional impacts</i>	Access to affordable housing and energy intersects with heat, health, and poverty to have greater impacts on vulnerable populations.	heat, filings, goodyear, intersectional, parties, katie, deaths, thermal, temperatures, shocking, scott, extreme, correctly, cooling	"I have to make a decision between paying for air conditioning or paying for rent or not paying for air conditioning, and then my kid is going to have an asthma attack, and I'm going to have extra costs and extra medical costs." ts04.MG
<i>T3. Supply deficit impacts</i>	Relates to the impacts of the housing supply shortages on people, such as homelessness, workforce displacement, and multi-family households.	vincent, depaul, youth, shannon, campus, prevention, relaxed, licensing, chronic, automobile	"if we can figure out how to make the policies and the tax credits or the zoning or whatever it is work for not just the people that I drove past this morning in tents outside the Human Services campus, but their neighbors in houses as well. Prioritizing that everyone in Arizona can have the opportunity and the space and the resources to live a healthy life." ts09.JB
<i>T4. Water availability argument</i>	Discussion of how NIMBYs and others opposing growth use water availability at rezoning hearings and in other	conservation, casa, grande, stipulation, defer, designation, groundwater,	"The latest argument is we don't have enough water to allow anymore housing." ts04.SC

discussions to recharge, globe, prevent new drought development.

<i>T5. Building codes</i>	<p>Relates to the permits, approvals, and codes that cities have in place regulating developments, such as density, height, setback, and parking requirements. These standards vary from city to city and result in lengthy approval processes.</p>	<p>standard, apa, submittal, carports, engineers, tyler, jersey, opt, localities, reviewed</p>	<p>"Today, the vast majority of new construction is much larger, and much more expensive. And local land use regulations are a key reason for this trend. rules like minimum lot sizes mandate that each new house sits on a large and expensive piece of land." ts07.EH</p>
<i>T6. Loss of affordable housing</i>	<p>Discuss the loss of affordable housing and the impact that has on people as well as the barriers to building housing that is affordable.</p>	<p>pops, houston, actors, brian, surplus, commerce, tsmc, trickle, taryn, membership, gobble, goalposts, fled discretionary</p>	<p>"We cannot get our families out of service out of shelter quickly enough. Because we cannot access affordable housing. The current length of stay has almost doubled since 2018." ts03.LB "The number of working professionals that actually are living out of their van is unimaginable." ts06.BF</p>
<i>T7. Future development</i>	<p>Discussions about future building and housing needs, especially in the workforce and economic growth context.</p>	<p>groundwater, burdened, maintain, btr, michelle, replenishment, predictability, assured, standards, bond</p>	<p>"We have master plans that have gone through the process that are ready to go, the issue on that area really comes down to water. future growth is impacted by the larger water challenges facing the state of Arizona." ts04.JM</p>
<i>T8. Wrap-around services</i>	<p>Discussions about how some people need additional services like counseling, health, and job services. Speakers discussed</p>	<p>river, mercy, assured, angeles, institutions, substance, reclamation,</p>	<p>"Part of that is providing the residence services that we can to the folks that we serve. And a lot of the seniors have food insecurity. So we offer food banks, we do dental health fairs, benefit acquisition, helping</p>

	populations with special needs, such as neurodiverse individuals and veterans.	dense, regions, sunnyslope	seniors navigate the bureaucracy of Social Security and other veteran affairs." ts03.KB
<i>T9. Access to affordable housing</i>	Discussions about the challenges facing severe mentally ill, veteran, elderly, and chronically homeless populations in getting access to affordable housing and procedural challenges for developers to provide that housing.	clients, stairs, salvage, patrick, healthcare, dry, steel, husband, walls, illness	"There's economic reasons predominantly for seniors becoming homeless, fixed incomes, rising rents, evictions." ts03.LG "When you put it in a housing, that's also healthcare. It just makes sense...one of the most complicated populations we have are the mentally ill who are in a behavioral health facility, but also have significant medical and personal care needs." ts03.HG
<i>T10. Discrimination in accessing housing</i>	Discussion about discrimination based on identity or income source in access to housing.	vouchers, voucher, discrimination, vash, landlords, identity, gender, sexual, bostock, transgender, sex	"There's been a lot of discussion about the HUD and Vash and housing choice vouchers. All of those are sources of income that is not protected from discrimination by my renters." ts03.MJS
<i>T11. Housing trends</i>	This topic discusses the trends in the housing market and planning in aggregate at a city, county, or regional level.	luck, landlocked, seasonal, downturn, investor, completions, collect, howard, topography, gotta	"[Northern Arizona doesn't] have these broad tracts of flat land to be able to provide additional housing stock. We have to consider the unique topography." ts06.PG "there is another component of vacancy rate. And that is the seasonal homes." ts10.AB
<i>T12. Mixed-income communities</i>	Discussion of mixed-income communities where low and high income people can live as neighbors and build communities.	marina, firefighters, refugees, cassidy, subjective, ccn, strs, refugee, christian, stalls, stall, rs,	"We also know that [refugees] path to citizenship is pitted pitted with roadblocks, many of which originate in the poor housing conditions." ts03.CP "In the last six years. STRS have devoured over 60,000 housing

Short-term rentals (STRs) and the lack of affordable housing are considered a risk to this.

messaging, intentional, frank

units where Arizonans used to live." ts06.SE

Appendix F. GAMMA SCORES FOR TOPICS IN THE FINAL REPORT

Gamma scores for the topics in the final report by stakeholder group. These include the read written report by two elected and two low-income representatives and the verbal comments by developer, planning, and real estate representatives. We used the same 0.15 gamma score threshold to identify the focal topics.

