

Symbium: Using logic programming to streamline citizen-to-government interactions

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Abstract. Symbium is a US company launched in 2019. Its primary offering is a web-based service, called the Citizen’s Dashboard, that helps homeowners, architects, and contractors comply with the regulatory aspects of residential construction. A distinguishing feature of the service is its use of Logic Programming to facilitate and, in some cases, automate regulatory processes involving permits, inspections, and rebates. The Citizen’s Dashboard represents a significant improvement over traditional, manual approaches to regulatory compliance and has the potential to save individuals and governments billions of dollars per year.

Keywords: logic programming · computational law · government relationship management

1 Introduction

A recent study of home appliance replacements in the United States suggests that billions of hours are lost each year (7.5 billion hours in 2021) [5,9] due to inefficiency in permitting processes. More than 40% of available rebates for appliances go unclaimed, \$350M in 2021 [6,16], due to the complexity of regulations and the associated rebate processes. Problems in securing permits and inspections for appliance replacements frequently cause significant delays in completing projects (in many cases more than 100 days). And the numbers are much larger when one looks beyond appliances to other types of home improvement.

Citizen’s Dashboard. Symbium’s solution to this problem is a service called the *Citizen’s Dashboard* [8,14] - a web-based service that facilitates interactions between citizens (e.g., homeowners, architects, and contractors) and governmental agencies (e.g., municipalities, counties, states, and other organizations). The initial focus of the service is residential construction, with projects ranging from simple appliance replacements to the addition of accessory dwelling units (ADUs).

The Citizen’s Dashboard features a variety of interrelated sub-services. (1) It provides its users with comprehensive data about residential parcels and buildings (e.g., zoning, tax assessments, and building permit history). (2) It allows its users to describe proposed changes and automatically evaluates those changes

for compliance with applicable regulations. (3) It manages transactions with governmental agencies and other organizations (e.g., applying for building permits, scheduling inspections, and obtaining rebates).

A distinctive feature of the Citizen's Dashboard is its focus on citizens rather than governmental agencies. Other companies sell their products and services to individual government agencies, and, as a result, citizens are forced to use different systems to interact with different agencies. Symbium's customer is the citizen. The Citizen's Dashboard provides integrated interaction with multiple government agencies, making it easier for citizens to manage the various regulatory aspects of construction projects.

2 Role of Logic Programming

Technologically, the key to Symbium's deployment of the Citizen's Dashboard is its use of Logic Programming technology in codifying rules and regulations. This approach is similar to the one used in [7] to represent the British Nationality Act as a logic program.

The Symbium team formalizes planning codes and building codes as rules in Dynamic Prolog (also known as Epilog [3]); and the Symbium platform uses these rules to assess regulatory compliance of proposed projects. In this way, the system is able to provide instantaneous feedback on project plans, circumventing the manual evaluation process in common use today.

The example below is typical of rules encountered in municipal planning codes. It states that a parcel violates the city's size restriction if the parcel lies in zone R-1 and the area of any building on the parcel exceeds 2000 square feet.

```
violation(Parcel,size) :- parcel.zone(Parcel,"R-1") &
                          parcel.building(Parcel,Building) &
                          building.area(Building,Area) &
                          greater_than(Area,2000)
```

Symbium uses a similar approach to codify the rules involved in applying for permits, rebates, and tax incentives. Symbium uses both view definitions and operation definitions to manage the transactions between citizens and governmental agencies. The use of Epilog instead of Prolog to model dynamics is justified as it enables a clear separation of the formalization of dynamics from the definition of relations [2], allowing for a more organized and flexible approach to modeling complex systems.

The sample rule below describes what happens when the system receives a notice of code violation for a parcel from the city. Such a notice restricts new buildings from being built on the parcel.

```
message(City,code_violation(Parcel)) ::
  parcel.location(Parcel,City) & parcel.project(Parcel,Project) &
  project.submittable(Project)
==> ¬project.submittable(Project)
```

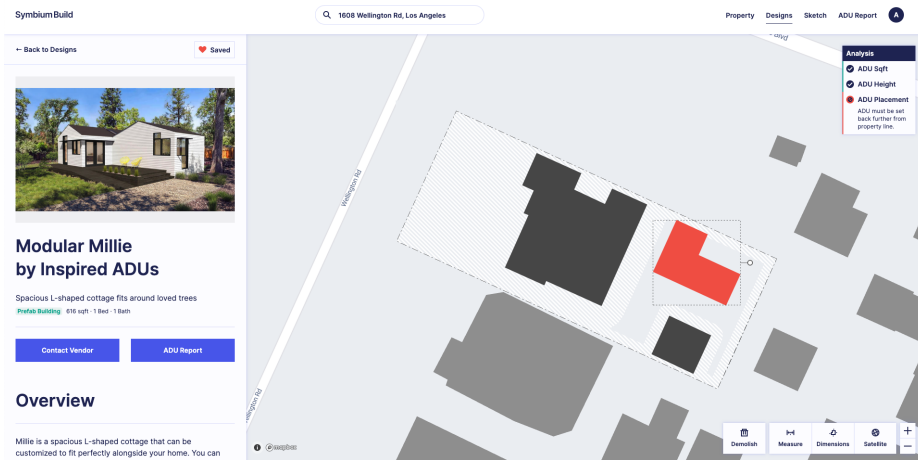


Fig. 1. Violation pinpointing in Symbium's Citizen's Dashboard

One of the main challenges in building the Citizen's Dashboard is the vast number of rules in planning codes, building codes, and procedure manuals. Symbium uses Logic Programming to solve this challenge in two ways. First, domain experts with no programming experience can be trained to write and edit rules. A second benefit stems from the simplicity and compositionality of rules, which simplifies the maintenance of large rule sets and allows for the combination of rules from overlapping sources.

3 Citizen's Dashboard: Coverage and Reception

The Citizen's Dashboard is currently available in select California cities, and Symbium is working to make the service available across the state in the coming year. Subsequently, Symbium plans to expand the service nationwide.

This service has received favorable reviews from multiple journalists, with articles appearing in Forbes [1], Government Technology [8], Builder Online [10], and so forth. The company is also the recipient of multiple awards. In 2019, Symbium was named a Hive 50 honoree [4]. In 2020, it won the prestigious Ivory Prize for Housing Affordability [11]. In 2021, it received the American Bar Association Women of Legal Tech award [12]. And in both 2021 and 2022, it was listed as a GovTech 100 company [15].

In the long term, the company aspires to apply the Citizen's Dashboard to other areas of regulatory compliance, such as property taxes, licenses, interstate commerce, and so forth. The Citizen's Dashboard is a technology that can facilitate many types of interactions between citizens and government agencies, all part of a Government Relationship Management (GRM) [13].

4 Broader Impact of Logic Programming

Symbium’s Citizen’s Dashboard represents a significant improvement over traditional, manual approaches to managing regulatory compliance, and it has the potential to save individuals and governments billions of dollars per year. The key to its success is the use of Logic Programming in codifying rules and regulations. Municipal regulations in the US are updated regularly – in some cases as frequently as 6 times per month. As such, Logic programming is a reliable approach to codify and maintain these regulations.

The discipline of codifying rules and regulations as logical statements by the Symbium team has led to the revelation of open texture issues, e.g., *what is the backyard of a building?* and the identification of inconsistencies between municipal and state codes. These issues were subsequently resolved by the municipalities in collaboration with the Symbium team. Symbium’s interactions with municipal and state governments in the US indicate that Logic Programming has begun to affect the very process of policy making itself.

References

1. Castenson, J.: Platform digitizes painful planning process to provide greater access to affordable housing. <https://www.forbes.com/sites/jennifercastenson/2022/03/21/platform-digitizes-painful-planning-process-to-provide-greater-access-to-affordable-housing/?sh=361fcaff171e> (Mar 2022)
2. Genesereth, M.R.: Dynamic Logic Programming. Tech. rep., Stanford University (2022), <http://logicprogramming.stanford.edu/miscellaneous/dlp.html>
3. Genesereth, M.R., Chaudhri, V.K.: Introduction to Logic Programming. Synthesis Lectures on Artificial Intelligence and Machine Learning, Morgan & Claypool Publishers (2020). <https://doi.org/10.2200/S00966ED1V01Y201911AIM044>, <https://doi.org/10.2200/S00966ED1V01Y201911AIM044>
4. McManus, J.: Symbium: The Permitter. https://www.builderonline.com/recognition/symbium_o (Nov 2019)
5. of Oakland, C.: Average Permit Processing Turnaround Times. <https://www.oaklandca.gov/resources/average-permit-processing-turnaround-times> (Dec 2021)
6. Rewiring-America: High-Efficiency Electric Home Rebate Act (HEEHRA). <https://www.rewiringamerica.org/policy/high-efficiency-electric-home-rebate-act> (2022)
7. Sergot, M.J., Sadri, F., Kowalski, R.A., Kriwaczek, F., Hammond, P., Cory, H.T.: The British Nationality Act as a Logic Program. *Commun. ACM* **29**(5), 370–386 (may 1986). <https://doi.org/10.1145/5689.5920>, <https://doi.org/10.1145/5689.5920>
8. Staff, N.: Symbium creates property info lookup portal for California. <https://www.govtech.com/biz/symbium-creates-property-info-lookup-portal-for-california> (Nov 2021)
9. Statista: Household Appliances - United States. <https://www.statista.com/outlook/cmo/household-appliances/united-states> (Oct 2021)

10. Strong, S.: Tech Innovator Symbium launches new property and Permit Information Portal. https://www.builderonline.com/design/technology/tech-innovator-symbium-launches-new-property-and-permit-information-portal_o (Nov 2021)
11. Symbium: Symbium wins the Ivory Prize for Housing Affordability. <https://symbium.com/press/symbium-wins-the-ivory-prize-for-housing-affordability> (Apr 2020)
12. Symbium: Symbium CEO and co-founder Leila Banijamali honored with ABA LTRC. <https://symbium.com/press/leila-banijamali-nominated-for-2021-women-of-legal-tech-award> (Feb 2021)
13. Symbium: Symbium's vision of Government Relationship Management. <https://symbium.com/blog/symbiums-vision-of-government-relationship-management> (Aug 2021)
14. Symbium: How Complaw will revolutionize the public's experience of property data for cities and counties. <https://symbium.com/blog/how-complaw-will-revolutionize-the-publics-experience-of-property-data-for-cities-and-counties> (Feb 2022)
15. Symbium: Symbium is named a GovTech 100 company for the second consecutive year. <https://symbium.com/press/symbium-is-named-a-2022-govtech-100-company-for-the-second-consecutive-year> (Jan 2022)
16. Todorova, A.: Goodbye, Mail-In Rebates. <https://www.wsj.com/articles/SB115663801471546598> (Aug 2006)