

A SYSTEMS THESIS ON AMERICAN HOUSING PRODUCTION

TWENTYTHOUSAND UNCOMPILED CODEBASES.

American housing regulation is a forked repository with no diff tool, no dependency resolver, no test suite and no upstream merge. Every project is compiled by hand, by a person, once. **This is not a metaphor — it is a structural description, and it needs both halves of a fix: legislation to grant the right, and engineering to make the right exercisable.**

Revised in Rev 3.7. Four American spellings brought into line with the rest of the document. **Revised in Rev 3.6.** A line-by-line audit against the register corrected sixteen items, including the aviation causal claim the register forbids, Tokyo's zone count, the entitlement range, the number of unmeasured rows, the Auckland rent figure, the reference ranges, the grade list and the experiment count. Recorded as correction C-008.

Where this document sits. This is the long-form research record — the diagnosis, the prior art, the four cities, the graded evidence, the adversarial review and the references, at length. The current statement of the argument, including the named solution and the scale of the problem, is carried by the narrative. Read the narrative for the argument; read this for the evidence behind it and the objections at full strength.

TOKYO HAS THE LAW AND NO COMPILER — JAPAN STILL
PERMITS BY HAND.

SINGAPORE HAS THE COMPILER AND NEEDED AN UNUSUALLY
STRONG STATE TO GET IT.
ARIZONA GRANTED THE RIGHT IN 2026 AND BUILT NO
PLUMBING TO EXERCISE IT.
NOBODY HAS BOTH HALVES.

SHEET 00 SUMMARY

THE ARGUMENT IN FIVE SENTENCES

- 1. Housing has no products, only projects.** Every unit is designed, reviewed, appraised and financed from scratch, so nothing carries forward. Four attempts to industrialise it built better factories into a system that gains nothing from identical units.
- 2. The cause is that the rules are prose.** Roughly twenty thousand jurisdictions run forked rulesets pinned to different code editions, with no diff tool, no dependency resolver and no test suite. Compliance cannot be computed, so every project is compiled by hand.
- 3. Approval, valuation and demand-signalling must become type-based together.** Every prior attempt turned one lock and was killed by another — federal preemption in 1976 produced America's cheapest housing product and then watched financing destroy it.
- 4. Three quarters of the 32-month critical path is not building.** It is information processing, waiting and risk-bearing. Duration is what excludes risk capital, because the learning cycle is longer than a fund's life.
- 5. Singapore proved compiled codes work and hand-wrote the compiler over 28 years for one jurisdiction.** That translation cost is what collapsed roughly three years ago — and it is the only reason this is now a live opportunity rather than a recurring failure.

~20,000 JURISDICTIONS, EACH WITH ITS OWN FORKED RULESET AND VERSION PIN	~28 yrs TO HAND-COMPILE ONE JURISDICTION SINGAPORE, FROM 1997
32 → 7 MONTHS OF CRITICAL PATH, TODAY VERSUS COMPILED FLOOR	9% → 47% IRR ON AN IDENTICAL MARGIN, 32 MONTHS VERSUS 7
–23–28% AUCKLAND RENTS AGAINST COUNTERFACTUAL AFTER UPZONING – THE SAVING REACHES RESIDENTS	4 REGISTER ROWS THAT RECORD THINGS NOBODY HAS MEASURED

How to read this

FIVE MINUTES

Sheet 00, then Sheet 05 (why this was arithmetic, not engineering) and Sheet 09 (why duration excludes capital). That is the investment case.

TWENTY MINUTES

Add Sheet 01 (the diagnosis), Sheet 04 (four cities, four locks) and Sheet 10 (what is proven and what is a bet).

FULL READ

Everything. Start with Sheet 11 if you are looking for the weaknesses — five objections there end in a concession rather than an answer, and that is where an informed reader should push.

Contents

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- 01** **The diagnosis** — the repository nobody can read. Fork tree, version pinning, no upstream merge.
 - 02** **Pathologies** — eight capabilities every mature software system has and housing does not.
-

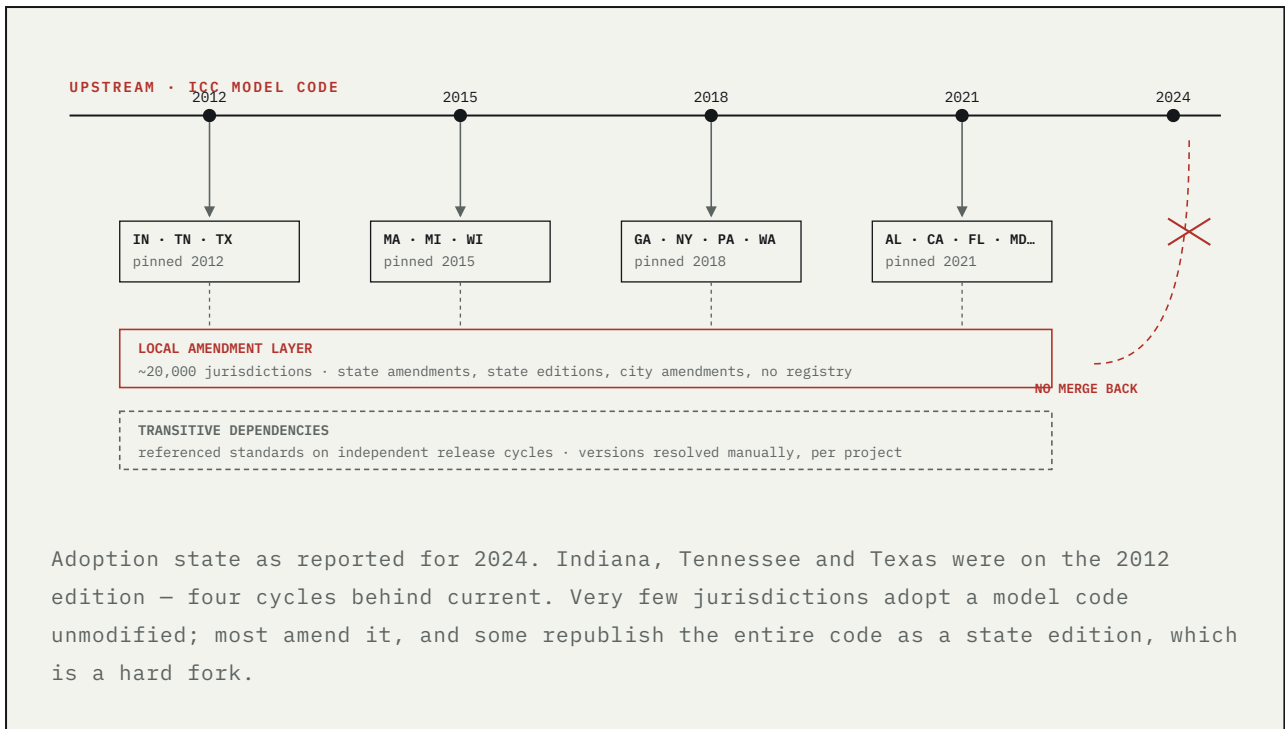
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- 03 **Prior art** — four attempts, diagnosed as engineering post-mortems.
 - 04 **Four cities** — Tokyo, Auckland, Vienna, Singapore, Arizona. Nobody has both halves.
 - 05 **The threshold** — why the market was closed by arithmetic, and what changed.
 - 06 **Donor discipline** — borrow from avionics, not web development.
 - 07 **Architecture** — seven layers, each independently falsifiable and swappable.
 - 08 **The loop** — one home, before and after, across six stages.
 - 09 **Cycle time** — three quarters of the timeline is not building. Includes the IRR case.
 - 10 **Evidence** — every claim graded Confirmed, Supported, Contested or Untested.
 - 11 **Adversarial review** — eight objections in their strongest form. Five end in a concession.
 - 12 **The experiments** — two tests, no capital required, neither yet run.
 - 13 **References** — verified sources separated from general scholarship.
-

THE POINT **Preemption grants the right; compilation makes the right exercisable. Neither delivers alone, and nobody has built both.**

SHEET 01 THE DIAGNOSIS

THE REPOSITORY NOBODY CAN READ

The International Code Council publishes model codes on a three-year cycle. States and localities adopt them on their own timelines, with their own amendments. The result is not one building code with local variations. It is a fork tree, thousands of branches wide, pinned to different upstream versions, with no tooling to compare any branch to any other.



Four properties that would be unacceptable in any codebase

Version pinning without a resolver. A design compliant in one jurisdiction can fail in another for reasons that are purely version-related rather than substantive. Nobody can compute which.

Forks with no diff. No tool exists to compare one jurisdiction's adopted code against another's, or against upstream. Regulatory divergence across America is unmeasured — not because it is unimportant, but because it is currently unmeasurable.

Transitive dependencies on independent cycles. Codes reference external standards that version on their own schedules. Resolution happens manually, per project, by a human.

No upstream merge. Twenty thousand jurisdictions accumulate local amendments that never flow back and are never reconciled. Drift is permanent and compounding.

Housing regulation is **source code**
that was never compiled — and never
version-controlled.

THE POINT

The ruleset is forked twenty thousand ways, and no tool exists to compare any branch to any other. Divergence is unmeasured because it is currently unmeasurable.

SHEET 02 PATHOLOGIES

WHAT IS MISSING, NAMED PRECISELY

Each item below is a capability every mature software system has and housing production does not. They are listed in dependency order: the earlier ones must exist before the later ones are possible.

Read this sheet as the diagnosis. Sheet 08 walks the same ground a second time, one home at a time, as the built state rather than the fault list. The repetition is deliberate — the two sheets answer different questions about the same eight failures, and the second only makes sense once these are named.

NO STATIC ANALYSIS

errors surface in production

Compliance cannot be checked before submission. Every error is discovered at review — after land is committed, capital is deployed and a team is mobilised. This is the equivalent of shipping with no compiler and no linter, and finding every bug in production.

The cost of a defect rises by roughly an order of magnitude at each stage it survives. Housing catches its defects at the most expensive stage available.

→ FIX: L1. Compile the ruleset; check at authoring time.

NO TYPE SYSTEM

invalid states are representable

Nothing prevents a non-compliant design from being drawn, priced, financed and submitted. The system relies on downstream human detection rather than upstream impossibility.

The safety-critical answer is to make invalid states unrepresentable — a configurator that cannot express a design outside the certified envelope.

→ FIX: L2. Certified type plus a site-conditions envelope.

NO SHARED STATE

every consumer rebuilds the same facts

Architect, planner, plan reviewer, utility engineer, appraiser and insurer each independently reconstruct identical parcel facts — dimensions, easements, utility access, flood status, setbacks. Six consumers, one dataset, six reconstructions, no single source of truth, no version.

Singapore solved exactly this with a national data schema shared across seven agencies.

→ FIX: L3. One authoritative parcel-and-design record.

BLOCKING SEQUENTIAL CALLS

no concurrency, no timeouts

Gates execute in series because each demands the prior gate's output as input. Planning, building, utility capacity, fire district, flood and special districts, private covenants. Any one can block indefinitely; none has a timeout; none is accountable for total latency.

Singapore's seven agencies review the same model concurrently and return a single consolidated response inside twenty working days.

→ FIX: L4. Parallel execution with statutory timeouts and a defined default.

NO REGRESSION TESTS

amendments break unknown things

When a jurisdiction amends its code, nobody can compute which in-flight designs are invalidated. There is no test suite to run, so the blast radius of any change is unknown until it is felt. One trade survey attributed 11% of new apartment cost to code changes adopted since 2012 alone.

→ FIX: L1 plus versioning. Amendments become migrations with computable impact.

NO PACKAGE REGISTRY

nothing is reusable by reference

Assemblies, details and whole designs are re-drawn per project rather than referenced by version. There is no way to declare "this wall assembly, version 3.1, certified against 2021 IBC" and have every downstream party resolve it identically.

→ FIX: L6. A registry of certified types and assemblies.

NO DEMAND SIGNAL

build first, discover market later

Production is speculative. There is no forward order book, so utilisation cannot be planned, so factory economics never close. This is the mechanism that killed both federal and venture-funded attempts at industrialisation.

→ FIX: L6. Catalogue with committed forward orders.

NO OBSERVABILITY

the system emits no telemetry

Permit volumes, approval latencies and resubmittal counts for new statutory categories are largely unpublished. States pass reforms and then have no instrumentation to determine whether they worked. You cannot optimise what was never measured, and nothing here is measured.

→ FIX: falls out of L3 for free. Instrumentation is a side effect of a shared record.

THE POINT

Every missing capability listed here has been standard in software engineering for decades. None of them is exotic, and none has ever been applied to housing production.

SHEET 03 PRIOR ART

FOUR ATTEMPTS, DIAGNOSED

Each prior effort fixed one layer of the stack and left the others manual. Read as engineering post-mortems rather than history, the pattern is unambiguous.

Operation Breakthrough

1969–74 · HUD

Launched by a HUD Secretary who had run an automobile company, explicitly on the mass-production analogy. Twenty-two housing system producers selected from over two hundred competitors. The technology half largely worked. The market-aggregation half never did, and the 1973 termination of federal production subsidies removed the demand floor participants had underwritten against.

DIAGNOSIS: built L7 and attempted L6 via subsidy. Left L1–L5 untouched. The order book was a government appropriation, and appropriations get cancelled.

The HUD Code

1976 · federal preemption

A single national construction standard for manufactured homes, displacing local codes. It produced the only consistently low-cost new-build housing product in America — and then stalled. Financing treated the homes as personal property rather than real estate, and zoning excluded them from most land.

DIAGNOSIS: shipped L2 without L5. A certified type that no one could affordably finance. Shipments fell from roughly 240,000 a year to 93,000. The clearest evidence in existence that one layer is not enough.

CORENET

1997–2026 · Singapore

The first successful automated code-compliance system anywhere. Its current generation runs seven-agency concurrent review against a shared national schema with a consolidated response, and becomes mandatory for all new projects in October 2026. But its rules were hand-encoded into a fixed object library, and users cannot author new ones — the same constraint holds across every comparable system built to date.

DIAGNOSIS: shipped L1, L3 and L4 — correctly, and in production. Roughly twenty-eight years of hand-translation bought exactly one jurisdiction. **The compiler was written by hand.**

Katerra

2015-21 · venture capital

Vertical integration of design and manufacture, funded at a scale no prior attempt enjoyed. It failed anyway, without ever facing a capital constraint.

DIAGNOSIS: optimised the build step while the pipeline around it stayed manual. A faster compiler behind a manual review queue produces no throughput. This is the natural experiment proving capital and technology were never the binding inputs.

THE POINT

Each attempt fixed one layer and left the others manual. The pattern is not bad luck — it is what happens when a stack is treated as a single problem.

SHEET 04 FOUR CITIES

FOUR CITIES, AND NOT ONE OF THEM TURNED ALL THREE LOCKS

The three-lock finding was derived from American history. It reproduces internationally, which is stronger evidence than a single national record can provide. Each city below solved a genuinely different constraint and left the others in place — and each result is measured rather than asserted.

Tokyo

1968 · National City Planning Law

Twelve standardised national land-use zones covering the entire country, in all but one of which apartments, restaurants and schools may be built. The national government sets the zones, placing a floor under how permissive any local rule must be — even the strictest zone permits multifamily, home-based business and small retail. Zones cap maximum nuisance rather than mandating exclusive use, which is why Japanese neighbourhoods mix. Compliant projects proceed as of right, without discretionary review.

The finding that actually transfers is not the zoning law. Japanese homes depreciate toward zero and are rebuilt on roughly a thirty-year cycle. A Japanese homeowner therefore has no financial stake in blocking the building next door. In the United States, home equity is the median household's dominant asset and its retirement plan, and roughly two thirds of households own.

Japan's permissive zoning is *downstream* of that asset structure, not upstream of it. It is not a policy America declined to adopt; it is a policy that presupposes a balance sheet America does not have. Import the statute and you still face an opposition Japan never had to overcome. **This is the strongest reason to doubt that Tokyo can simply be copied, and it is a financial argument rather than a political one.** Stated at the strength the evidence supports: the depreciation and rebuild cycle are well documented, but the *causal direction* — that permissive zoning follows from the asset structure rather than merely coexisting with it — is argued here, not demonstrated. It is graded Supported rather than Confirmed in the register (E-033), and establishing it properly is outstanding work rather than a settled premise.

A second observation, narrower but directly relevant: Tokyo does not need a compiler because it has only one codebase. Twelve national zones are trivially checkable. Japan still issues permits by hand — it never had to solve the problem this document addresses, because it deleted the problem legislatively instead.

SOLVED: approval (L2, L4) and the A7 relocation — local control exercised once over rules, never over instances. LEFT OPEN: land capture, finance, and the process layer entirely. CAVEAT: municipalities may set stricter limits within national ranges, so uniformity is not absolute.

Auckland

2016 · Unitary Plan

Roughly three-quarters of residential land upzoned, minimum lot sizes abolished, and legal housing capacity increased by an estimated 300%. Because the reform applied to some areas and not others, it produced the cleanest large-scale natural experiment available anywhere.

Measured outcomes: an additional 21,808 consents after five years — about 4% of the housing stock — or 43,500 within six years, about 9%, under a synthetic-control method comparing Auckland to similar New Zealand cities that did not upzone. Building permits per capita doubled against the counterfactual within five years. Eight years on, rents were 23% below counterfactual under the preferred specification; a separate study puts them 28% below at six years. Lower Hutt replicated the result: starts up 10–18%, rents down about 21%.

SOLVED: capacity — and, decisively, **demonstrated that the saving reaches the resident rather than capitalising entirely into land.** This is the strongest available answer to Red Team 01, and it is measured rather than argued. LEFT OPEN: construction cost, finance, demand aggregation.

Vienna

1920s-present · social and limited-profit housing

About 60% of Vienna residents live in publicly owned or limited-profit housing — the latter privately owned and operated under heavy rent regulation. Only around 7.4% of the stock is unrestricted for-profit rental. New limited-profit rents average roughly 27% below private market rents, and Austrian households spend about 21% of income on rent. Public land is used for social housing, with legislation aimed at holding land values down.

The mechanism is the one this document lacks: take land permanently out of the market and there is nothing left for efficiency gains to capitalise into.

SOLVED: land capture. LEFT OPEN: production cost and approval process. CRITIQUE TO ENGAGE: once Austria's 10% rent tax, utilities, repairs and heating are counted, new leases are argued to be only marginally cheaper than in major German cities; benefits are unevenly distributed, with long-term tenants paying far less than newcomers, who face a roughly 17% per-square-metre premium; minimal means-testing lets well-off households hold units indefinitely; and applicants are typically offered one to three apartments rather than choosing freely.

Singapore

HDB, 1960 · CORENET, 1997

The only case that attacked more than one lock deliberately. State land acquisition powers and the Housing and Development Board addressed land and finance together; CORENET, three decades later, addressed process. Sheet 03 covers CORENET's design and its hand-encoding limitation.

SOLVED: land, finance and process – but through an unusually strong state with land acquisition powers no American jurisdiction possesses. Transferability is the open question, and the process layer is the only part that ports.

The matrix

CITY	APPROVAL PROCESS	LAND CAPTURE	FINANCE / VALUATION	DEMAND AGGREGATION	PRODUCTION COST
Tokyo national zoning	●	○	○	○	◐
Auckland unitary plan	●	◐	○	○	○
Vienna social housing	○	●	●	◐	○
Singapore HDB + CORENET	●	●	●	◐	○
Arizona casita preemption, 2026	◐	○	○	○	○
United States current state	○	○	○	○	○

● solved · ◐ partially addressed · ○ not addressed

Arizona

2024-26 · HB 2720, HB 2928

The live American case, and the one that resolves what the others cannot. Statewide accessory-dwelling preemption for municipalities, extended to counties effective 1 January 2026, with an unusual forcing mechanism: a jurisdiction that fails to adopt compliant regulations by the deadline loses local control automatically. Meanwhile the Starter Homes Act, which would have applied to subdivisions, was vetoed and then stalled against organised municipal opposition.

The right now exists and the plumbing does not. There is no statewide certified plan library, no shared parcel record, no published permit volume, and therefore no way to determine whether throughput changed at all. A by-right entitlement that still requires bespoke design, bespoke plan review and bespoke financing in every one of a hundred-plus jurisdictions delivers a fraction of what the statute promises.

PARTIALLY SOLVED: legal right to build. LEFT OPEN: everything required to exercise it at scale. **This is the natural experiment that tests whether preemption alone produces throughput – and nobody has published the data to answer it.**

What the matrix actually shows

Nobody has both halves. Tokyo has the first-best law and no compiler; Japan still permits by hand, because it deleted the fragmentation problem legislatively rather than solving it. Singapore has the compiler and required an unusually strong state — with compulsory land acquisition powers no American jurisdiction possesses — to build it. Auckland has the law and is only now generating the measurement. Arizona has granted the right and built nothing to exercise it.

The two halves are complements, not substitutes. Preemption grants the right. Compilation makes the right exercisable. Preemption without tooling produces a statute nobody can efficiently use, which is Arizona today. Tooling without preemption produces excellent navigation of rules that still forbid the thing you want to build. Each is worth substantially more in the presence of the other, and neither delivers the industrialisation payoff alone.

One correction to how this argument is usually made. The American first-best is not national zoning. Land use is state police power delegated to localities; a national zoning act is on no agenda and would face immediate constitutional challenge. The realistic first-best is *state-level preemption* — which is Auckland's model rather than Tokyo's, and which is already moving in Montana, California, Washington and Arizona. **The first-best is not blocked. It is arriving, one state at a time — and every state that passes one increases the value of the layer this document describes.**

THE POINT

Nobody has both halves. Tokyo has the law and no compiler; Singapore has the compiler and an unusually strong state; Arizona has granted the right and built nothing to exercise it.

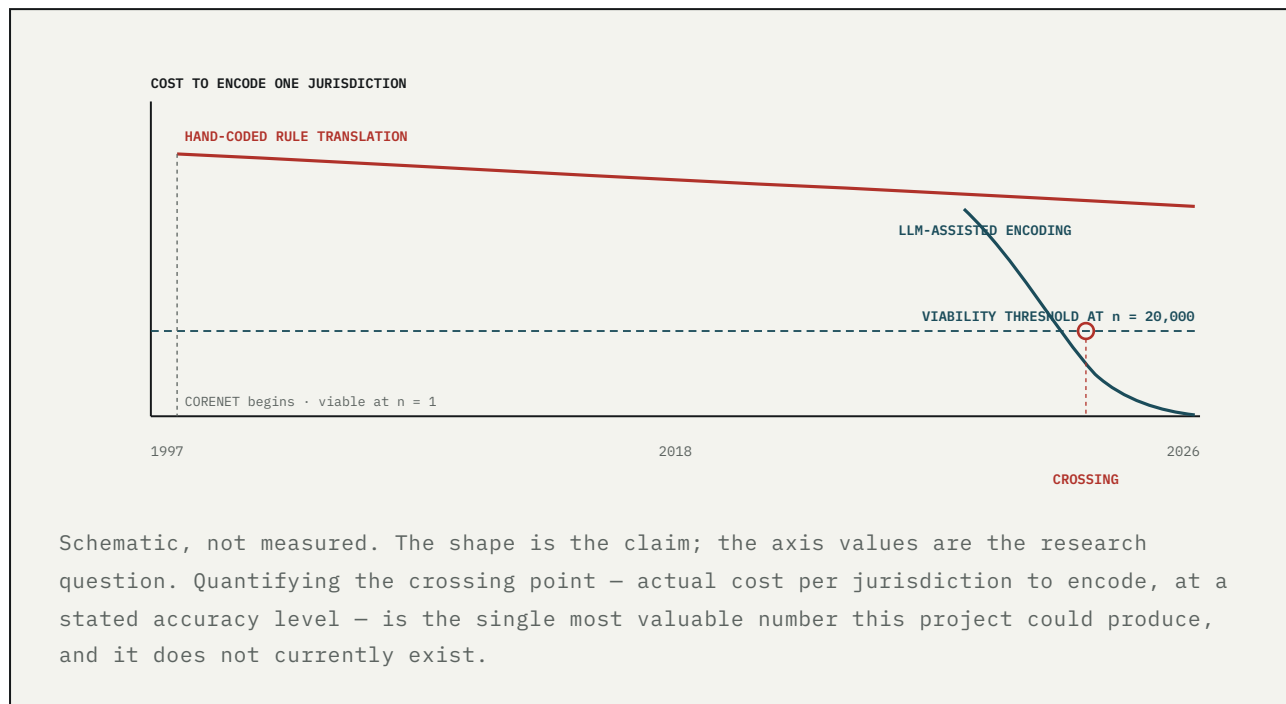
SHEET 05 THE THRESHOLD

WHY IT WAS ARITHMETIC, NOT ENGINEERING

Singapore proved compiled building codes work in production. The reason no one replicated it is not that the idea was doubted. It is that the cost of writing a compiler by hand, multiplied by twenty thousand jurisdictions, exceeded any plausible return. That product was gated by a single number, and the number moved.

The number is the cost of translating one jurisdiction's prose rules into executable logic. Until recently there was one method: a person reads the ordinance and the adopted code and writes out each binding provision as a rule by hand. Singapore did exactly that, and it is why twenty-eight years bought one city. Language models can now perform a large part of that reading and drafting, which is the first time in the history of this problem that the unit cost has moved at all. **That, and only that, is what is new here**

— the idea is old, the demonstration is old, and the arithmetic that defeated both is what changed.



The investment claim in one sentence: a market that was closed by arithmetic for twenty-eight years opened roughly three years ago — when machine translation of legal prose became good enough to attack the encoding cost — and the opening has not yet been priced, because the number that closed it has never been recomputed. It is carried as register row E-051, and it is empty.

THE POINT

This was never an engineering problem. It was a cost-per-jurisdiction problem, and the cost moved.

BORROW FROM AVIONICS, NOT FROM WEB DEVELOPMENT

The instinct to import software practice is right. The choice of which software practice is where most attempts go wrong — including, arguably, the best-funded one.

Housing cannot ship and iterate. There is no rollback, no staging environment, no canary deploy, no A/B test. A defect is not downtime; it is structural, permanent and occasionally fatal. Move fast and break things is not merely inappropriate here — it is disqualifying, and it describes a meaningful part of what went wrong at Katterra.

Safety-critical software engineering confronted precisely this constraint. Avionics and medical-device software must change quickly in a domain where failure kills, and the resolution was never velocity. It was three things:

SAFETY-CRITICAL PRACTICE	APPLIED TO HOUSING
Type systems that make invalid states unrepresentable	A configurator that cannot express a design outside the certified envelope. Non-compliance stops being something you detect and starts being something you cannot author.
Formal verification against a specification	Compiled codes as the specification; automated checking as the proof obligation. Determinism replaces reviewer judgement for objective provisions.
Certified toolchains – the tool is qualified, so its output is trusted	The load-bearing move. Do not certify each building. Certify the checker, and treat conforming output as verified by construction. This is what makes type certification legally coherent, and it is how aviation delegates verification while keeping the certification obligation intact.

Aviation is also the standing refutation of the objection that per-instance human review is required for public safety. An aircraft design is certified once; individual airframes are verified as conforming to the type; much of the

engineering verification is delegated to accredited representatives. Aviation does this in a domain where failure kills; whether the delegation improved its safety record is a separate question this document does not claim to answer.

THE POINT

Certify the checker, not each building. Housing cannot ship and iterate, so the model is qualified toolchains — not velocity.

SHEET 07 ARCHITECTURE

SEVEN LAYERS, INDEPENDENTLY SWAPPABLE

Named as a software stack because that is what it is. No layer is load-bearing for the argument as a whole: each carries its own falsification test and its own substitutable implementations, so a failed layer is replaced rather than fatal. Select a layer to inspect it.

L7	Build PLACED LAST, DELIBERATELY
L6	Registry and order book DEMAND SIGNALS BEFORE PRODUCTION
L5	Valuation adapter THE LOCK NOBODY IS WORKING ON
L4	Concurrency and timeouts CERTAINTY, NOT MERELY SPEED
L3	Single source of truth ONE RECORD, MANY READERS
L2	Type system CERTIFY THE DESIGN, NOT THE INSTANCE

Read bottom to top. Each layer depends only on those beneath it.
L7 is last – it is where all four prior attempts began.

THE POINT **No layer is load-bearing for the whole argument. Each can fail and be replaced.**

LAYER L1

PARSER AND COMPILER

FUNCTION

Compile binding zoning and building-code provisions into executable logic, so that a design and a parcel produce a deterministic compliance determination. Includes versioning against the adopted code edition.

PATHOLOGY ADDRESSED

No static analysis · no diff · no regression tests

FALSIFICATION TEST

If more than roughly half of binding provisions in a representative ordinance prove discretionary, this layer cannot be built as specified. See Experiment 01.

SUBSTITUTABLE WITH

Alternatives: probabilistic pre-check rather than deterministic ruling · jurisdiction-authored encoding · scope limited to a single by-right track

ONE HOME, BEFORE AND AFTER

The same six stages, read as a development cycle. The left column is measured or widely reported practice today; the right follows if — and only if — the pathologies in Sheet 02 are fixed. A conditional forecast, not a prediction.

This is Sheet 02 returned to, not repeated. There the eight missing capabilities were named as a diagnosis; here they are walked as one house moving through six stages. If you have read Sheet 02 closely you will recognise every fault below — that recognition is the point, and it is why the two sheets were kept separate rather than merged.

Revised in Rev 3.4. Sheet 05 now names the mechanism behind the encoding-cost claim in prose rather than only in a chart label, and the claim carries register row E-051. **Revised in Rev 3.3.** These two sheets overlap materially and roughly four pages could be cut. The overlap was retained deliberately and signposted instead, because the diagnosis and the built state are different arguments about the same failures. Recorded as correction C-002; the option to cut remains open.

01 IDEA

Opinion → determination

TODAY

- What is buildable on a parcel cannot be determined without hours of professional interpretation.
- The answer costs money to obtain and arrives as an opinion. A different reviewer may reach a different one.
- Feasibility is therefore discovered after money is committed.

COMPILED

- Any parcel returns its buildable envelope on query — deterministic, reproducible, free.
- Certified types that fit the envelope are returned with published cost and lead time.
- Feasibility precedes commitment rather than following it.

TODAY

- Value is set by nearby sales. A new type has no comparables, cannot be appraised, cannot carry a mortgage.
- The product dies financially before anyone evaluates whether it is good.
- Construction lending is priced to a worst-case timeline because the timeline is unknowable at underwriting.

COMPILED

- The certified type is the valuation unit, carrying published cost, performance and resale history.
- Location adjusts value rather than determining whether valuation is possible at all.
- A new type reaches market on demonstrated equivalence to a reference, not on the accident of having neighbours who already bought one.

TODAY

- Buy or option land, then seek permission, carrying denial and delay risk alone.
- Variance is priced into every parcel and selects for large balance sheets.
- Land banking is a rational response to unpredictability, and it withholds supply.

COMPILED

- The envelope is public and machine-readable before purchase; entitlement risk for in-envelope product approaches zero.
- Land is priced on known achievable yield rather than a bet on future permission.
- *Unresolved*: certainty raises parcel value and the seller may capture it. See Red Team 01.

TODAY

- Approval runs six to eighteen months with wide variance and repeated resubmittal cycles.
- Gates are serial, held by unrelated parties, each optimising locally, none accountable for total latency.
- Trades are scheduled stop-start against uncertain dates, so capacity is lost to waiting.

COMPILED

- In-envelope product is conformance-verified rather than re-reviewed. Days, not months.
- Gates run concurrently against one record, each under a statutory timeout with a defined default.
- The deliverable is *certainty*, not speed. Certainty underwrites, schedules and forecasts.

TODAY

- Build first, find buyers after. Production cannot be forecast, so factories cannot be utilised.
- Buyers who would purchase a specific configuration at a specific price have no way to say so.
- Price is discovered by bidding against scarcity.

COMPILED

- A visible catalogue with committed forward orders, aggregating demand across geography.
- Producers forecast against a real book, so utilisation becomes possible for the first time.
- Price is quoted before commitment, as with any other manufactured good.

TODAY

- Appraisal risk persists to closing; a low appraisal collapses transactions weeks after agreement.
- Defect recourse is litigation — slow, expensive, rarely proportionate.
- Each transaction is an isolated event that teaches the market nothing.

COMPILED

- Valuation attaches to the type, so appraisal risk at closing largely disappears.
- Recourse is product warranty against the certificate holder.
- Operating and durability data feed back into the type record. The catalogue improves with volume.

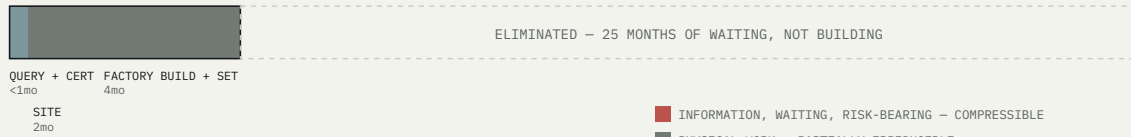
THREE QUARTERS OF THE TIMELINE IS NOT BUILDING

The reason venture capital never entered housing is not that investors failed to notice the market. It is that the learning cycle is too long to support a portfolio strategy. Software invalidates a hypothesis in twelve to eighteen months for a couple of million dollars; housing takes three to five years and tens of millions. No amount of conviction fixes that — it is arithmetic about how risk capital forms.

TODAY • CRITICAL PATH ≈ 32 MONTHS



COMPILED • CRITICAL PATH ≈ 7 MONTHS



Read the dark blocks correctly: the physical work is not the problem, it is the product. The argument is not that houses should be built faster than physically sensible — it is that the twenty-five months surrounding the build are overhead, and that four prior attempts spent their effort compressing the one segment that should be preserved.

Today's figures: Census Survey of Construction reports 9.1 months authorization-to-completion for single-family in 2024 (1.4 to start, 7.6 building); entitlement commonly runs 6-18 months, and 18-36 months acquisition-to-entitled for complex projects. California subdivision routinely runs 3-7+ years, and a UCLA Anderson study found projects requiring a full environmental impact report added 504 days on average. The compiled column is an estimate, not a measurement. Some stages overlap in practice; this is critical path, not the sum of all activity.

Why duration, not cost, is what excludes risk capital

Duration discounts returns exponentially rather than linearly. The same gross margin, realised on a different clock, is a different asset class — and the difference is large enough to change who is willing to fund it.

25% MARGIN • 32 MONTHS

≈9%

Annualised return. Below the hurdle rate of almost every risk-capital pool. This is why housing innovation is funded by patient real-estate capital demanding proven models, not by venture.

25% MARGIN • 7 MONTHS

≈47%

Identical margin, identical product, identical risk of the underlying build. Only the clock changed. This is a venture-legible return.

10% MARGIN • 7 MONTHS

≈18%

The consequential number. Double today's return at 40% of the margin. Speed converts directly into a lower price without anyone accepting a worse return — a partial answer to who captures the saving.

Illustrative calculations on stated assumptions, not measured outcomes. Gross margin on total project cost; ignores leverage, which amplifies the effect in both directions.

The iteration-rate argument, stated precisely

SOFTWARE

- Hypothesis invalidated in 12–18 months for low single-digit millions.
- Kill cost near zero at any point before launch. High optionality.
- Feedback in days; the product that ships is informed by the market it ships into.
- Portfolio strategy works: many cheap failures, funded by rare large wins.

HOUSING

- Hypothesis invalidated in 3–5 years for tens of millions.
- Capital committed at land purchase, years before revenue. Optionality near zero after that point.
- Feedback arrives after the market has moved; each experiment yields stale information.
- Portfolio strategy impossible. Only proven models get funded, so nothing new gets tried.

Housing is not underfunded because investors doubt the market. It is underfunded because the learning cycle is longer than a fund's life.

One caution

Short cycles plus abundant capital produced the dot-com misallocation, and housing has already had a capital-flood bubble of its own. The argument here is specifically about **iteration rate** — the capacity to test a hypothesis cheaply and learn from it — not about capital volume. Faster supply response is, if anything, stabilising: the standard account of housing bubbles turns on supply that cannot respond to price signals in time. But a version of this thesis that argues for more money rather than faster learning is arguing for the wrong thing.

What each layer removes

STAGE	TODAY	FLOOR	MECHANISM
Feasibility & site control	~2 months	Minutes	L1 compiled ruleset plus parcel data returns the buildable envelope on query. The question stops requiring professional interpretation.
Entitlement	6–18 months CA: 3–7+ years	Zero	L2 certified type inside a by-right envelope. Nothing to entitle. The single largest block of eliminated time, and it is entirely non-physical
Design & plan review	~5 months	Days	L6 registry supplies a certified type; L1 verifies conformance automatically; L4 runs remaining gates concurrently under a statutory timeout.

STAGE	TODAY	FLOOR	MECHANISM
Financing close	1–3 months (often parallel)	Days	L5 type-based valuation removes appraisal discovery. Underwriting against a deterministic cycle rather than a worst-case one.
Site work	~4 months	~2 months	Partially irreducible. Compressible mainly by running it concurrently with stages that are no longer blocking it.
Vertical construction	7.6 months	~4 months	L7 factory production of a certified type against a committed order. The only stage where the prior four attempts concentrated, and the least compressible on this list.
Sale & absorption	0–6 months 27% sell post-completion	Zero	L6 order book. Sold before production starts, so absorption leaves the critical path entirely.

The structural finding: every stage that compresses to near zero is an information-processing stage. Every stage that resists compression is physical. Four prior attempts to industrialise housing concentrated their effort on the one row of this table that is hardest to compress, and left the six that are easiest untouched.

THE POINT

Duration, not cost, is what excludes risk capital — and at seven months a ten percent margin still doubles today's return.

WHAT IS PROVEN AND WHAT IS A BET

Grades reflect the state of published evidence as of this revision, not the strength of the argument. The two highest-leverage claims are the two least evidenced — that is the shape of the opportunity, and it should be stated rather than obscured.

CONFIRMED	independent published evidence supports the claim
SUPPORTED	evidence consistent; mechanism contested or partial
UNTESTED	nobody has measured this – open research question

CLAIM	GRADE	EVIDENCE
Codes are compilable	UNTESTED	No published measurement of what of binding provision objective rather than discretion Singapore demonstrates compile work; no has established that Android codes compile single run load-bearing untested in this document

CLAIM	GRADE	EVIDENCE
Encoding cost has collapsed	UNTESTED	Registered E-051. The mechanism of machine translation is a prose provision of executive rules. P from first principles from general capabilities trends, cost per jurisdiction a stated accuracy has never measured Singapore twenty-years more only the method 04's crop point is hypothesized with no behind

CLAIM	GRADE	EVIDENCE
Discretion costs speed and certainty	CONFIRMED	A Los Angeles study of multifamily projects by-right projects permitted faster than discretionary ones, with lower variance in approval time. California jurisdiction spread documented median 18 months in Oakland against 24 months in San Francisco

CLAIM	GRADE	EVIDENCE
Appraisal blocks new types	CONFIRMED	Manufa home lo applicat approve under 3 the tim against 70% for built; un of chatt original were refinanc 2019 ag 44% site rate spr 5.61% a 1.20%. Shipme from ~240,00 (1977–9 93,000 i

CLAIM	GRADE	EVIDENCE
Regulation suppresses firm size and productivity	CONFIRMED	D'Amico, La Cour, & Glaeser (2013) find that in more regulated areas, firms are significantly smaller and less productive. They argue that this is due to the construction of new establishments being more costly in regulated areas, which discourages the entry of new firms and the expansion of existing ones. Glaeser and Gyourko (2005) also find that in areas with more stringent zoning regulations, the number of new homes per worker is lower, and the construction industry is less competitive. This leads to higher costs for new entrants and lower productivity. The evidence is consistent across different studies and regions, supporting the claim that regulation suppresses firm size and productivity. see Red 06.
Code fragmentation is real and severe	CONFIRMED	ICC through the cycle was staggered adoption. 2024, still spanned 2012 through 2021 editions. Very few unmodified most and some regions as state editions

CLAIM	GRADE	EVIDENCE
Parallel gates and shared schema work	CONFIRMED	COREN seven a concurr review, consolide respons twenty working shared i data sch product since Decemb 2023.
Three quarters of the timeline is non-physical	CONFIRMED	Census: months authori to-comple for sing family (of which constru Entitled alone commo months 7+ years Californ pre-per phase domina is not p work.

CLAIM	GRADE	EVIDENCE
Total idea-to-sale cycle is unmeasured end to end	UNTESTED	Census measur authori onward Entitler figures from practiti sources jurisdic specific studies. dataset a single project site identifi to closi full cycl of Ame housing never b measur

CLAIM	GRADE	EVIDENCE
Upzoning savings reach residents	CONFIRMED	Auckland rents 23% below synthetic control counterfactual at eight years. 28% below six year separate Lower Income 21%. Cost up 21,800 five year of stock 43,500 a (~9%). Per capita doubled against counterfactual. The strategy available rebuttal land capitali
National uniform zoning with as-of-right approval is achievable	CONFIRMED	Japan since 1968: two national resident permits but one nuisance ceilings than ex use, as-permitt Demon A7 relo at natio scale — achieve politica technic

CLAIM	GRADE	EVIDENCE
Every successful precedent required legislation	CONFIRMED	Tokyo, Auckland, Vienna, Singapore require legislative preemption state law acquisition jurisdiction has achieved comparable results to tooling. Implications reverse earlier revision argues that are complete not that tooling substitute law. See Team 0

CLAIM	GRADE	EVIDENCE
Preemption alone produces throughput	UNTESTED	Arizona granted statewide right of access to dwelling for municipalities and, from January 2010, countywide with an estimated loss of 10% control over missed deadlines. Permit volume does not appear to be particularly anywhere. Cleanest available natural experim... whether granted without support infrastructure change anything it is currently unmeas...

CLAIM	GRADE	EVIDENCE
Tokyo's zoning is transferable to the US	SUPPORTED	Evidence points a direct to Japanese homes depreciate near zero ~30-year rebuild so home hold no restrict interest roughly thirds of households hold the dominant in home The per zoning downst the asse structur Graded Support rather t Confirm because causal directio argued, formall establis worth a on its o

CLAIM	GRADE	EVIDENCE
Forward demand aggregation changes producer behaviour	UNTESTED	Nobody tested whether a common order book alters product planning and housing literature studies approve finance not studied demand signalling
Savings reach the buyer rather than the landowner	SUPPORTED	Contested Standard economic predicts capitalised into land Weaker supply response elastic. Unresolved see Red 01.

SHEET 11 ADVERSARIAL REVIEW

THE STRONGEST OBJECTIONS

Structured self-critique. Each objection is stated in its strongest form rather than a convenient one. Three are answered; the remaining five end in a

concession — still open, test first, unresolved, conceded, or a standing risk.

Corrected in Rev 3.5. Earlier revisions said nine objections and three conceded. There are eight — the numbering skips Red 07 — and five end in a concession rather than an answer.
Recorded as correction C-006.

RED 01 Savings capitalise into land. You are optimising a rounding error.

Land is a residual claimant. Anything that makes building faster, cheaper or more certain raises what a parcel is worth, and the seller captures it. This is the standard economic account of why permitting reform underdelivers on price.

RESPONSE

Partly correct, and it constrains where the model applies rather than whether it works. Land dominates in a small number of supply-constrained metros; across most of the country construction and soft costs dominate. The effect is also weaker where supply response is elastic — if certainty enables many more units, the gain does not simply reprice a fixed stock of parcels.

NEW EVIDENCE — AUCKLAND

This objection is now partially answered by measurement rather than argument. Auckland upzoned three-quarters of its residential land in 2016; eight years on, rents were 23% below the synthetic-control counterfactual, with a separate study putting them 28% below at six years, and Lower Hutt replicating at 21%. The saving reached residents. Capitalisation is real but it is not total.

STILL OPEN

Auckland shows savings can reach renters under large-scale upzoning. It does not show that they reach buyers of a new certified product, nor does this document specify the capture mechanism for its own model. Narrower than it was, but not closed.

Zoning is full of language like "compatible with neighbourhood character" and "appropriate scale." These are deliberate grants of discretion. Encode the objective provisions and you have automated the easy tenth while the hard nine-tenths still runs through a hearing.

RESPONSE

The sharpest attack on the thesis, and an empirical question rather than a theoretical one — measurable in a weekend by the experiment specified in Sheet 10. Two mitigations: discretionary language clusters in discretionary review tracks, while by-right tracks are usually objective by construction; and partial compilation still reduces resubmittal cycles even where it cannot produce a ruling.

TEST BEFORE PROCEEDING

If a large share of binding provisions prove non-compilable, L1 through L4 need redesign. This test costs nothing and precedes any capital commitment.

BIM-based code checking has been tried in America and went nowhere.

Automated compliance checking is not a new idea here. The International Code Council pursued machine-readable codes in the 2000s and it did not take. Vendors have sold model-checking software for two decades. If this worked, the industry would already run on it.

RESPONSE

Correct, and the reason is consistent with the thesis rather than against it. Every one of those systems required rules to be hand-encoded, which meant per-jurisdiction economics that only closed for a national regulator with one code — which is exactly why the one success is a city-state. American attempts failed on the same arithmetic Sheet 04 describes. The claim is not that the idea is new; it is that the constraint that defeated it has moved.

UNRESOLVED

Prior US attempts also failed on adoption incentives, not only cost. A jurisdiction that gains nothing from faster review has no reason to adopt. Sheet 04 does not model adoption, and it should.

Several vendors already sell permitting workflow tools to municipalities. Government software is a slow, procurement-bound, single-digit-growth business. Dressing it in systems language does not change the multiple.

RESPONSE

Correct that the category is crowded, and the earlier form of this response was wrong. It claimed existing tools leave the ruleset in prose and sell only to jurisdictions. They do not: Symbium covers California accessory-dwelling rules statewide with address-in, envelope-out determinations; Buildability claims parcel screening across 3,100+ counties; Canibuild sells site-fit and automated compliance checking directly to builders. Compiled rules are already a product, and already builder-facing.

The objection survives in a sharper and stronger form, and so does the answer. Compiling the rules is necessary and *insufficient*. The screening market has already run the information-first experiment at commercial scale and published the result: compiled information without political standing is advisory, and it moved roughly two of the thirty-two months. What separates this from that category is not who the customer is — it is whether the determination carries legal weight. A screening tool tells you what it thinks; a conformance determination is accepted in place of first-pass review, signed by a professional of record and insured. Nothing in the existing category does that, and that is the untested part rather than the crowded part.

Revised in Rev 3.2. The response above replaces the Rev 3.1 text, which drew the distinction on customer rather than on legal weight and was refuted by register rows E-040 through E-042. Recorded as correction C-001; the superseded revision is in the archive.

RED 05

Type certification means every house looks the same.

Standardisation at this scale produces monotony, erases regional building traditions, and imposes uniformity on the asset where people most want individuality.

RESPONSE

Type certification governs the envelope, not the appearance. Automotive type approval produced thousands of models within one safety and emissions framework, not one car. Historically, standardised production is associated with more variety at a given price point, because variety becomes affordable to produce.

RED 06

The real mechanism is firm size, and your fix may make it worse.

D'Amico, Glaeser, Gyourko, Kerr and Ponzetto argue that project-level regulation caps project size, which caps firm size, which destroys scale economies and innovation incentives — and they have the best causal evidence on this page. Their distinction between entry regulation, which raises equilibrium firm size, and project regulation, which lowers it, implies that type certification carries a fixed cost per design and therefore behaves as *entry* regulation.

RESPONSE

That may be good for productivity and it is directly in tension with the claim in Sheet 07 that small builders re-enter. Both cannot be the affordability mechanism. The honest position is that this document has not resolved it.

CONCEDED — OWED BEFORE FUNDRAISING

If project scale rather than approval mechanics is the binding constraint on productivity, type certification addresses something adjacent to the real problem. This reconciliation is the outstanding intellectual work.

Tokyo passed a national planning law. Auckland passed a unitary plan. Vienna acquired land and legislated. Singapore used compulsory acquisition powers and a national regulator. Sheet 04 is a catalogue of legislative victories, and it is being used to argue for a software product. If political will is what actually moves this, the correct project is advocacy, not engineering.

RESPONSE

Correct on the premise and wrong on the conclusion. The two are complements. Preemption grants the right; tooling makes the right exercisable; neither produces the industrialisation payoff alone. Arizona is the proof rather than an analogy — statewide by-right accessory-dwelling rights took effect for counties in January 2026, and there is still no statewide plan library, no shared parcel record and no published permit data. The statute passed. The throughput is unmeasured and probably small, because every unit still requires bespoke design, bespoke review and bespoke financing in every jurisdiction.

Conversely, Tokyo demonstrates the reverse asymmetry: it has the law and no compiler, and permits by hand to this day. It never had to solve this problem because it deleted it legislatively. That is a first-best America cannot copy for a reason that is financial rather than political — Japanese homes depreciate to near zero, so homeowners have no stake in blocking supply, whereas roughly two thirds of American households hold their dominant asset in home equity.

This document therefore argues for both. The first-best is state-level preemption, it is correct, it is evidenced by Auckland, and it is already arriving. The layer described here is what makes each such statute actually deliver — and it becomes more valuable, not less, with every state that passes one.

REMAINING RISK

Advocacy has no revenue model and this does, which creates a real incentive to overstate the tooling half. The discipline is to keep publishing the preemption case even where it does not

serve the business — and to treat any version of this argument that quietly drops the legislative half as having failed.

RED 09 Trade labour is the constraint, and no compiler fixes that.

Skilled construction labour is ageing and under-replaced. Faster approvals just move the queue to a bottleneck with no technological answer.

RESPONSE

Partly true and partly a measurement artefact. A meaningful share of lost trade capacity is idle time from stop-start scheduling against uncertain dates — downstream of certainty rather than independent of it. Certainty converts idle capacity into effective capacity without adding a worker. The residual shortage is real, slow-moving, and not claimed to be solved here. Organised trade opposition also contributed to the failure of the 1969 federal programme, so this is a political risk as much as a supply one.

SHEET 12 THE EXPERIMENT

THE TEST THAT COMES BEFORE EVERYTHING

Two experiments gate the entire thesis. Neither requires capital, permission or partners; the first takes about two weeks and the second about four. It should be run before this document is shown to anyone with money.

EXPERIMENT 01 — COMPILABILITY OF A MUNICIPAL RULESET

QUESTION

What share of the binding provisions governing a by-right residential project in a single jurisdiction are objective — expressible as a deterministic rule over measurable parcel and design attributes — rather than discretionary?

METHOD

Select one mid-sized jurisdiction's zoning ordinance and adopted building code. Enumerate every provision that applies to a defined project type. Classify each as objective, conditionally objective (objective once a discretionary input is fixed), or discretionary. Attempt to encode the objective set as executable rules. Record encoding hours per provision.

PRIMARY OUTPUTS

Percentage objective by count and by materiality. Encoding cost per jurisdiction, extrapolated. The first empirical point on Sheet 05's curve.

KILL CRITERION

If materially binding provisions are predominantly discretionary, the pathology in Sheet 02 line 1 is misdiagnosed and L1–L4 require redesign.

SECONDARY VALUE

Even a negative result is publishable and novel — nobody has measured this. A paper reporting the objective/discretionary split of American zoning would be cited regardless of which way it comes out.

EXPERIMENT 02 — DOES A GRANTED RIGHT WITHOUT PLUMBING PRODUCE THROUGHPUT?

QUESTION

Since Arizona's accessory-dwelling preemption took effect, has permit volume changed relative to the pre-statute trend and to comparable non-preempting jurisdictions?

METHOD

Public records requests to development services departments across Arizona municipalities and counties for accessory-dwelling permit applications and issuances, 2023–2026, with application and issuance dates and resubmittal counts. Synthetic control against comparable metros without preemption.

WHY IT MATTERS MORE THAN IT LOOKS

This is the direct test of the complement thesis. If volume rose sharply, preemption alone is largely sufficient and the tooling layer is a convenience. If the right was granted and little was built, the gap between statutory permission and practical exercisability is the whole opportunity — and it is quantified.

STATUS

These figures do not appear to be published anywhere. Confirming that absence is itself a finding: a state passed a significant housing reform and built no instrumentation to determine whether it worked.

This thesis fails if (a) binding provisions prove predominantly discretionary and therefore non-compilable; or (b) encoding cost per jurisdiction does not fall below the threshold implied by the addressable market; or (c) builders predominantly identify utility capacity or fire district sign-off, rather than approval-side gates, as the critical path on recent projects.

It is **materially weakened** if the firm-size mechanism in Red Team 06 dominates — in which case type certification addresses a problem adjacent to the real one.

Every one of these is cheap to test and none has been tested. That is the current state of this project, stated plainly.

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13. **Japan, New City Planning Law (1968) and Building Standards Law.** Twelve national land-use zones (a thirteenth added in 2018); residential development permitted in all but the exclusively

industrial zone; zones define maximum nuisance rather than exclusive use; as-of-right permitting for compliant projects. Municipalities may set stricter limits within national ranges.

14. **City of Vienna and analyses of the Viennese housing model**, including the Climate and Community Institute report and the European Investment Bank's account of limited-profit housing associations. ~60% of residents in municipal or limited-profit housing; ~7.4% of stock unrestricted for-profit rental; new limited-profit rents ~27% below private; Austrian rent burden ~21% of household income.
 15. **American Enterprise Institute**, *Vienna's "Social Housing" Model Is a Costly Illusion* (2025). Argues that once rent tax, utilities and maintenance are included, new Viennese leases are only marginally cheaper than in major German cities; documents a ~17% per-square-metre premium paid by newcomers relative to long-tenured occupants and minimal means-testing. *Cited as the strongest critique of the Vienna model; engage rather than dismiss.*
 16. **U.S. Census Bureau, Survey of Construction**. Annual length-of-time series. Single-family averaged 9.1 months authorization-to-completion in 2024 — 1.4 months to start, 7.6 months building; homes built for sale fastest at ~7.6 months, owner-built longest at 15.1. Buildings of 2+ units: 16.5 months start-to-completion in 2025. Of single-family homes built for sale and completed in 2024, 15.2% sold before construction started and 27% sold after completion.
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