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Generative AI and Formal Deductive Planning for Port-City Transformation: A Wild Scenario Methodology Applied to Cork 2050

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ABSTRACT

Port cities face planning horizons that conventional frameworks, anchored in present conditions and insufficiently imaginative, are ill-equipped to navigate. This paper develops and demonstrates the artificial intelligence (AI)-driven wild scenario planning with formal deductive implementation (AWSPFD) framework, integrating generative AI scenario generation with Horn clause-based formal planning to bridge visionary urban futures and implementable strategic plans. Drawing on Scenario Planning for Marketing Action (SPMA), service-dominant (S-D) logic, and a Gedanken thought-experiment methodology, we apply ChatGPT-4o to generate wild scenarios for Cork City and Port for 2050, formalise a composite scenario through Horn clauses, and operationalize via a Python Datalog inference engine. The methodology yields a composite scenario—'Cork 2050: Nexus of Innovation and Sustainability'—positioning Cork as a global Brainport, integrating renewable energy, AI-driven logistics, spaceport capability, and knowledge-economy institutions. Formal planning demonstrates five of seven scenario goals are logically achievable given current Cork assets, and identifies precise enabling conditions for the remaining two. AWSPFD is among the first applications of Horn clause-based formal planning to AI-generated urban futures, offering port authorities, urban planners, and policymakers a generalisable tool for translating visionary scenarios into actionable implementation pathways (In this paper, "logically achievable" denotes that the Horn clause dependency chain is satisfiable under the defined knowledge base—not that practical, political, or financial feasibility

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is guaranteed). This study presents a methodological proof-of-concept; empirical validation through primary data collection and stakeholder engagement is identified as a necessary and planned subsequent phase.

Keywords: Urban Planning; Generative AI; Scenario Planning; Brainport; Port-City Transformation; Horn Clauses; Service-Dominant Logic; Cork 2050

1. Introduction

Port cities occupy a uniquely contested position in the global economy. As gateways for trade, migration, and culture, they simultaneously anchor industrial legacy and frontiers of urban reinvention. Yet the planning frameworks available to port authorities and city governments, comprising master plans, transport impact assessments, SWOT (strength, weakness, opportunity, threat) analyses, and more, are typically ill-equipped for the complexity of transformation demanded by a 2050 horizon. The plans and frameworks tend to be incremental, constrained by present conditions, and insufficiently imaginative about futures worthy of pursuit.

This paper proposes and demonstrates a methodology that addresses this gap. We combine two capabilities rarely brought together in the planning literature: generative artificial intelligence (AI)'s capacity to produce creative, boundary-pushing scenarios, and formal logic's capacity to subject scenarios to rigorous, dependency-aware analysis. The result is a framework we term AI-driven wild scenario planning with formal deductive implementation (AWSPFD), enabling planners to envision ambitious futures and systematically work backwards from the futures to identify the conditions, investments, and sequencing required to make them a reality. The paper presents a conceptual demonstration of this combination using Cork as an illustrative case; it does not claim to provide an empirically validated planning outcome, but rather a generalisable methodology whose validation is the work of a subsequent research phase.

We apply this framework to Cork City and Port in Ireland, using the Cork 2050 plan[1], the Port of Cork Masterplan 2050[2], and the Ringaskiddy Port Redevelopment[3] as source documents. Cork is a compelling case: one of Europe's largest natural harbours, an anchor technology presence in the Apple European headquarters, strong higher-education institutions, and a port authority with a commitment to decarbonization yet official planning documents stop well short of the transformative ambition these city assets could support.

The paper makes three contributions. First, we extend the SPMA (Scenario Planning for Marketing Action)[4] framework with a Gedanken variant enabling expert-led wild scenario generation without requiring live stakeholder workshops. Second, we demonstrate ChatGPT-4o as a tool for generating wild scenarios exceeding conventional planning imagination. Third, we introduce Horn clause backward chaining as a mechanism for translating the scenarios into formal, verifiable implementation plans, a technique from logic programming applied here to strategic planning not previously documented, to the authors' knowledge, in combination with AI-generated urban scenarios.

Section 2 reviews the theoretical background. Section 3 presents the Cork context. Section 4 describes the methodology. Section 5 presents results. Section 6 discusses contributions and implications. Sections 7 and 8 address limitations and conclusions.

2. Theoretical Background

2.1. The Brainport Concept

A Brainport[5, 6] is an innovation region with knowledge-intensive industries, research institutions, and government agencies collaborating to generate economic growth and societal progress. The defining characteristic is triple-helix governance sustaining collaboration among business, academia, and government rather than simple colocation[7]. Brainport Eindhoven, home to Philips, ASML, and over 5,000 technology companies, is the paradigmatic case: a region transformed from single-company dependence to diversified innovation leadership over roughly two decades through deliberate institutional design (see **Appendix A**, **Table A1** for a comparative overview of global Brainport models).

Applied to port cities, the Brainport concept requires layering knowledge and digital infrastructure onto existing maritime and logistics operations. The article posted by IDB[8] frames this as the transition "from ports to innovation ecosystems" already well underway in Rotterdam and Singapore, with port authorities investing in innovation labs, sustainability research, and start-up incubation alongside conventional cargo operations.

2.2. Scenario Planning for Marketing Action

Scenario Planning for Marketing Action (SPMA) is a structured framework for envisioning and planning across multiple futures [4]. Developed and refined through application in executive education contexts and urban planning, eight principles (SP01–SP08) guide practitioners from environmental scanning through strategic commitment, with particular emphasis on generating divergent futures rather than extrapolating from present trends. Wild scenarios internally consistent, logically possible, but substantially beyond conventional planning assumptions are a distinctive signature and SPMA output. The scenarios surface unexamined assumptions, expand the option space, and test organisational flexibility.

2.3. Service-Dominant Logic and Storytelling

Service-dominant (S-D) logic reconceptualizes economic exchange as fundamentally a service process wherein actors co-create value through the application of knowledge and skills [9]. In planning, S-D logic reframes infrastructure development as an ongoing value-creating relationship between ports, cities, businesses, and communities rather than as discrete capital projects. Integrating storytelling with S-D logic produces scenario narratives that capture not just what a future city might look like, but how it would function as a value-creating system.

2.4. Gedanken Scenario Planning

A Gedanken experiment is a thought experiment, a mental simulation of hypothetical conditions conducted without physical execution [10]. In scenario planning, the Gedanken approach enables expert researchers to generate and evaluate scenarios using existing knowledge and documentation, without requiring live stakeholder engagement. This is methodologically significant because it allows scenario planning to proceed efficiently and iteratively, with researchers serving as both moderators and participants. This experimentation does not replace stakeholder engagement; it provides a rigorous precursor and results that can be achieved in a fraction of the time of a conventional workshop.

2.5. Horn Clauses and Formal Planning

Horn clauses are a restricted form of logical expression used in logic programming and automated reasoning [11]. A Horn clause takes the form $A \leftarrow B_1 \wedge B_2 \wedge ... \wedge B_n$, where A is a conclusion or goal and B_1 through B_n are conditions. The power of these logical expressions for planning lies in support of backward chaining. Given a desired goal, an inference engine systematically identifies the conditions required for achievability, then the conditions for those conditions, until reaching known facts or identifying gaps that represent planning requirements.

Python Datalog (pyDatalog) [12] provides a practical implementation environment for Horn clauses, enabling researchers to define facts, rules, and goals in Python and query the resulting knowledge base. This makes the logic of a strategic plan explicit, auditable, and communicable. Such properties are particularly valuable in multi-stakeholder contexts. The application of this apparatus to AI-generated urban scenarios is, to our knowledge, among the first in extending prior knowledge. Formal methods and constraint programming have been applied in computational urban planning contexts [12, 13], including answer set programming for theconstraint-based planning problems [14] but the specific combination of large language models (LLM)-generated scenarios with Horn clause backward chaining represents a distinct methodological contribution not previously documented in the urban planning literature.

3. Cork City and Port: Context and Strategic Position

3.1. The Port of Cork Today

The Port of Cork is Ireland's second-largest port by tonnage and the primary deep-water facility on the island's south coast. The natural harbor, among the largest in Europe by water area, comparable to Sydney and Halifax [15], provides a significant geographical endowment. Operations span dry and liquid bulk, containers, roll-on/roll-off, and passenger services across City Quays, Tivoli, Ringaskiddy, and Cobh terminals. The port also handles cruise traffic based on the 2024 cruise schedule [16], May–October passenger volumes total approximately 195,648, implying an estimated annual figure of around 391,000. The Cobh dedicated quayside berth, adjacent to the Cobh Heritage Centre, provides a distinctive arrival experience conventional port comparisons do not capture. High-value tourist assets of Blarney Castle, the English Market, and the Lee Valley remain an underexploited competitive advantage. (Estimation note: monthly passenger counts were aggregated from the 2024 cruise schedule [16] using a May–October operational window; this constitutes the only quantitative figure derived by the authors from direct source tabulation rather than document citation).

3.2. Planning Frameworks and Gaps

Two strategic documents frame Cork's development trajectory: Cork 2050 [1] and the Port of Cork Masterplan 2050 [2], supplemented by the Ringaskiddy Redevelopment project [3]. Cork 2050 addresses holistic city and regional development—housing, transport, culture, economic diversification, and environmental resilience—with explicit attention to community well-being. The Port Masterplan focuses on operational and capacity improvements: relocating activities from City Quays and Tivoli to Ringaskiddy, upgrading for larger vessels, achieving net-zero by 2050, and releasing central waterfront land for mixed-use redevelopment.

Both documents are credible and well-evidenced. Yet both share a characteristic limitation: they are anchored in current conditions and project relatively modest improvements from them, rather than asking what an entirely different mode of operating might make possible. **Table 1** summarizes the key dimensions of each plan and identifies the Brainport concept as a potential bridge.

3.3. Cork as an Emerging Brainport

Several existing assets position Cork credibly. Apple's European Headquarters employs over 6,000 people on 100% renewable energy [17], anchoring a broader technology cluster. University College Cork (UCC) and Munster Technological University provide research capacity and graduate talent. The Ringaskiddy transition will release substantial central waterfront land for mixed-use regeneration, mirroring the trajectories of Rotterdam, Seattle, and Los Angeles. The Atlantic Smart Ports Blue Acceleration Network [18] connects Cork with European peers in port digitalization and decarbonization. Cork's position as a node on the Atlantic maritime corridor offers potential as a gateway for tech and trade between Europe and North America.

What is missing is a sufficiently ambitious vision for what these assets, combined and extended, might produce by 2050. The following sections develop and demonstrate such a vision.

Table 1. Cork City 2050 and Port Masterplan 2050: Key Dimensions and the Brainport Bridge Synthesis.

Dimension	Cork 2050	Port Masterplan 2050	Brainport Synthesis
Primary focus	City-wide & regional development	Port operations & capacity	Knowledge-intensive ecosystem
Sustainability	Low-carbon city; green infrastructure	Net-zero 2050; green energy	Blue economy leadership; circular port
Economic model	Diversified sectors; FDI	Maritime trade; logistics	High-value services; innovation
Community engagement	Central; participatory	Limited; operational focus	Co-created; culturally embedded
Technology	Smart city; digital infrastructure	IoT, automation, blockchain	Quantum, AI, digital twins, biotech
Key assets	Apple HQ; University College Cork; cultural heritage	Deep harbour; Ringaskiddy site	Atlantic gateway + knowledge base

Note: FDI: Foreign direct investment; IoT: Internet of Things; HQ: Headquarters.

4. Methodology

4.1. The AWSPFD Framework

The AI-driven wild scenario planning with formal deductive implementation (AWSPFD) framework integrates five components: (1) expert knowledge preparation, (2) AI-driven scenario generation using ChatGPT-4o, (3) composite wild scenario development guided by SPMA and S-D logic, (4) formal implementation planning using Horn clauses and Python Datalog, and (5) expert synthesis and validation of AI outputs against researcher domain knowledge. **Figure 1** illustrates the overall workflow.

4.2. Expert Knowledge Preparation

Prior to AI engagement, the researchers review the three core planning documents to develop domain knowledge sufficient to evaluate and constrain AI outputs. This step is methodologically critical as large language models are known to hallucinate, generating confident but factually incorrect outputs[19]. Without prior domain knowledge, researchers cannot distinguish grounded from speculative content. The workflow employs three learning modes: zero-shot (no examples; testing model priors), few-shot (two to five examples to calibrate format and style), and many-shot (full document upload to maximise contextual grounding). **Table 2** summarizes the inputs, learning modes, and validation approaches for each prompt stage.

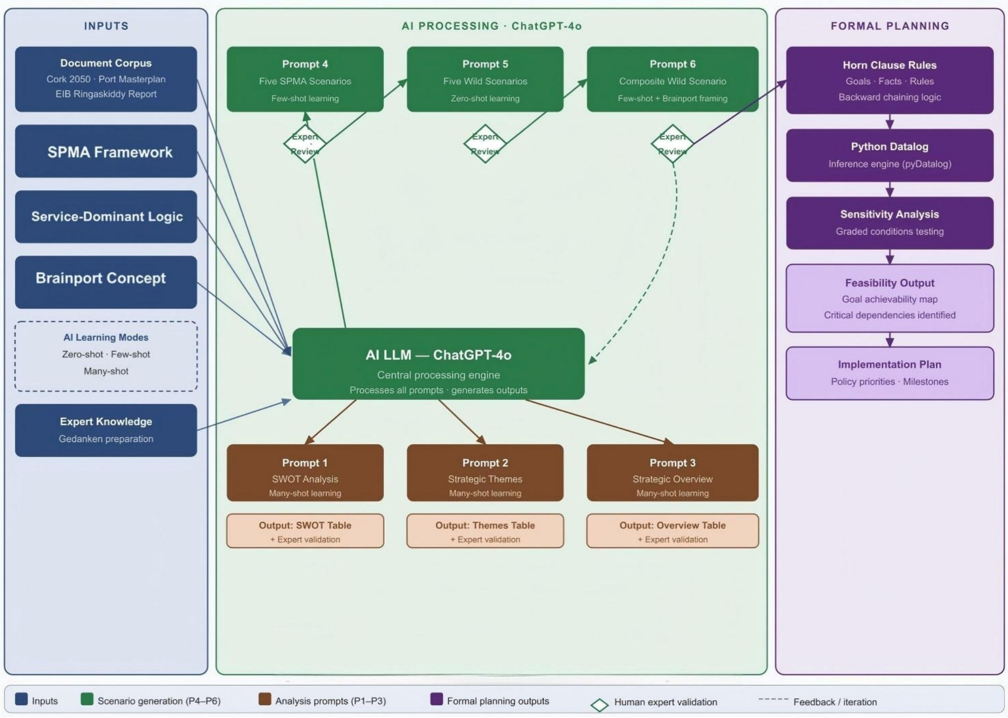

Figure 1. AWSPFD Workflow: From Planning Documents to Formal Implementation Plan.

Note: SPMA framework[4]; service-dominant logic[9]; brainport concept[5–7].

Table 2. AWSPFD Workflow: Inputs, AI Learning Modes, and Validation Approaches.

Stage/Prompt #	Prompt Objective	Learning Mode	Prompt Length (Chars/Words)	Session Date/Model Version	Validation Approach
1	SWOT analysis for Cork City and Port as of 2024	Many-shot (Cork 2050[1], Port Masterplan[2] EIB[3] uploaded in full)	301 chars 52 words	June 2024 ChatGPT-4o (OpenAI, June 2024 release)[20]	Expert cross-check against all three source documents; all SWOT elements verified to source page; hallucinated statistics removed before inclusion
2	Five to seven overarching strategic themes across documents	Many-shot (same three documents in context)	264 chars 41 words	June 2024 ChatGPT-4o (OpenAI, June 2024 release)[20]	Cross-document triangulation; researchers independently identified themes, then reconciled them; only themes supported by ≥2 documents were retained
3	Cohesive strategic overview of Cork's development trajectory to 2050	Many-shot (Stages 1–2 outputs retained in context window)	271 chars 41 words	June 2024 ChatGPT-4o (OpenAI, June 2024 release)[20]	Expert synthesis check; validated against researchers' prior Brainport knowledge[5]; unsupported generalisations removed
4	Five SPMA/S-D logic scenarios for Cork 2050	Few-shot (2 worked SPMA scenario examples provided)	336 chars 49 words	June 2024 ChatGPT-4o (OpenAI, June 2024 release)[20]	SPMA principles SP01–SP08 compliance check; each scenario evaluated for internal consistency and plausibility by both researchers independently
5	Five wild scenarios for Cork 2050	Zero-shot (boundary-pushing instruction only; no examples)	375 chars 56 words	June 2024 ChatGPT-4o (OpenAI, June 2024 release)[20]	Internal consistency review; each scenario anchored to ≥1 demonstrable Cork asset; implausible or ungrounded elements removed
6	Composite wild scenario with Brainport framing (seven pillars)	Few-shot (Stage 5 outputs as input examples)	422 chars 61 words	June 2024 ChatGPT-4o (OpenAI, June 2024 release)[20]	Brainport alignment verified against Eindhoven model[5–7]; composite sign-off required from both researchers before formalisation

Note: All six prompts were submitted in a single continuous ChatGPT-4o session to maintain context window continuity; each prompt built on prior outputs. Prompt texts are reproduced verbatim in **Appendix B**. Character counts exclude em-dash (—) rendering variants. ChatGPT-4o does not expose a session timestamp; "June 2024" reflects the cited model version[20]. Replication should specify model: gpt-4o, temperature: 1.0 (default).

The researchers collectively bring over four decades of combined experience in scenario planning, marketing strategy, and port-city development research. Sood and Pattinson developed the SPMA framework through sustained engagement with executive education and urban planning contexts [4]; Pattinson and Sood applied Brainport analysis specifically to Sydney and Kuala Lumpur [5]. This prior expertise constitutes the primary knowledge base against which all AI outputs were evaluated and represents the principal expert knowledge resource in this Gedanken approach [10].

The validation protocol required unanimous researcher consensus before any AI output was accepted for inclusion. Where AI outputs contained factual claims not traceable to the three source planning documents—the Cork 2050 plan [1], Port of Cork Masterplan 2050 [2], and Ringaskiddy project documentation [3] claims were removed or explicitly flagged as speculative. Each AI response was cross-checked against the source documents paragraph by paragraph; hallucinated statistics, misattributed facts, or unsupported causal claims were excised before incorporation. This expert-mediated filter represents the primary quality gate of the methodology and is documented stage by stage in **Table 2**.

4.3. Gedanken Scenario Planning

Our SPMA application takes the Gedanken form wherein the researchers play both moderator and participant, using existing planning documentation as the knowledge proxy rather than convening stakeholder workshops. This is justified as a methodological proof of concept; the planning documents represent the outputs of extensive community and expert consultation. Gedanken scenario planning is not a replacement for participatory engagement but a complement. It is a tool for exploring the full possibility space before narrowing it through stakeholder deliberation. The approach is further strengthened by the pre-mortem technique [21] by imagining a future state in detail and reasoning backwards exposes the assumptions and dependencies that must hold for that future to be realised or fail, which is precisely what Horn clause backward chaining formalises.

Scenario filtering followed a two-stage process applied after each AI prompt output. In Stage 1, each AI-generated scenario was assessed against four criteria: (i) internal consistency, the scenario follows logically from its own premises without contradiction; (ii) Cork asset grounding, the scenario is anchored in at least one demonstrable existing Cork asset or geographical endowment documented in the three source documents; (iii) temporal plausibility, the stated developments are conceivable within a 25-year horizon given technological trajectories visible in 2024; and (iv) non-redundancy, the scenario occupies a distinct position in the possibility space and is not substantively duplicative of another retained scenario. Scenarios failing any criterion were discarded in their entirety. In Stage 2, elements surviving from all ten prompt outputs (five SPMA and five wild scenarios) were synthesised into the composite scenario; only elements meeting the grounding criterion were carried forward. Researcher disagreements at both stages were resolved through structured discussion to consensus before any element was incorporated. This two-stage filter is the primary mechanism translating raw AI output into the validated composite scenario used for formal planning.

4.4. Formal Planning with Horn Clauses

Once a composite wild scenario is validated, translation into goals, facts, and rules is expressed as Horn clauses. Goals correspond to high-level scenario outcomes. Facts represent known present-day Cork conditions. Rules define dependencies between goals and enabling conditions. The pyDatalog [12] library executes these clauses in Python, performing backward chaining to determine whether each goal is achievable given defined facts and rules. When goals are not achievable with current facts, the system identifies missing conditions directly informing the investment and policy priorities that planners should address. This transforms the scenario from a narrative aspiration into a structured implementation roadmap with explicit dependencies.

An important boundary condition governs the formal planning exercise: the pyDatalog inference engine evaluates logical consistency and internal coherence under the stated assumptions not empirical or practical feasibility. A planning goal deemed "achievable" by the system means Horn clause dependency chain is satisfiable given the defined facts; it is not a guarantee of real-world implementation ability. Political feasibility, financial viability, institutional capacity, regulatory environments, and temporal sequencing constraints lie entirely outside the scope of the formal model. The system identifies logically coherent implementation pathways conditional on specified premises; it does not predict, confirm, or endorse any specific outcome in the actual planning environment.

5. Results

5.1. AI-Generated Scenario Analysis

Attribution note: All scenario text in Sections 5.1 and 5.2 was generated by ChatGPT-4o in response to the structured prompt sequence documented in **Table 2** and reproduced verbatim in **Appendix B**. The composite scenario in Section 5.2.3 is a researcher synthesis integrating elements across AI-generated outputs; it is not a verbatim AI output. The Horn clause rulesets in Section 5.3 were authored entirely by the researchers based on the composite scenario; they were not AI-generated. All AI outputs were subject to the expert validation protocol described in Section 4.2 before inclusion.

SWOT Analysis and Strategic Themes

The AI-generated SWOT analysis, validated by expert review, identified Cork's key strengths as its deep-water harbour, the Apple HQ presence, strong higher-education institutions, and the Ringaskiddy infrastructure investment programme by the European Union (EU). Core weaknesses include scale limitations relative to major European ports, skills gaps in emerging maritime technologies, and transition management complexity. Opportunities centre on the Irish Atlantic positioning, EU decarbonisation funding, and growing tech-sector interest in sustainable logistics infrastructure. Key threats include competition from Rotterdam and Antwerp for green energy hub status and political risk across a 25-year planning horizon.

Across the three source documents, five overarching strategic themes emerged: physical transition (relocating operations to enable urban renewal); decarbonisation (net-zero through renewable integration); digital transformation (IoT, big data, automation); community integration (mixed-use waterfront regeneration); and institutional collaboration (port authority, city government, universities, industry).

5.2. Wild Scenario Generation

5.2.1. Five SPMA Scenarios

The five SPMA-structured scenarios ranged from a conservative "Green Maritime Hub", a credible extension of the Masterplan 2050 trajectory through to an ambitious "Atlantic Knowledge Gateway" centred on Cork becoming a European headquarters city for emerging technology companies. Each scenario was validated for internal consistency and SPMA framework alignment.

5.2.2. Five Wild Scenarios

The five wild scenarios substantially exceeded conventional planning imagination, envisaging Cork as: (1) a commercial spaceport and aerospace innovation hub; (2) a floating-city laboratory for climate adaptation, deploying modular marine habitats in the harbour; (3) a global biotech capital using Cork's marine biodiversity as a pharmaceutical research resource; (4) a quantum computing centre and digital twin city; and (5) a global cultural-innovation destination blending Irish heritage with immersive technology experiences. Each scenario is internally coherent and anchors in at least one demonstrable Cork asset.

5.2.3. Composite Wild Scenario

The composite wild scenario, "Cork 2050: Nexus of Innovation and Sustainability" (tagline: "Pioneering Tomorrow: Where Technology Meets Sustainability") integrates elements from all five wild scenarios with the Brainport concept as an organising framework. Seven pillars characterise the composite vision (**Table 3**).

Table 3. Composite Wild Scenario: Cork 2050 Brainport—Seven Strategic Pillars.

Pillar	Description
Quantum Computing Capital	Europe's leading quantum computing cluster, supported by government investment, global tech partnerships, and University College Cork (UCC) research institutes.
Sustainable Urban Living	Integrated renewable energy (wind, solar, tidal) powers a smart city grid; zero-emission public transport sets new European benchmarks.
Floating City Resilience	Modular harbour habitats provide climate-adaptive living and working environments, incorporating vertical farming and AI-managed systems.
Cultural Heritage Destination	Blarney Castle, the English Market, and Cobh maritime history woven into immersive technology experiences for global cultural tourism.
Connected City	Autonomous vehicle networks and digital twin management deliver seamless connectivity; ultra-fast infrastructure supports global operations.

Table 3. *Cont.*

Pillar	Description
Commercial Spaceport	Among the first European commercial spaceports, exploiting the harbour's spatial footprint and established aerospace supply chains.
Brainport Ecosystem	A triple-helix innovation ecosystem—UCC/Munster Technological University (MTU), global tech companies, and government—drives continuous knowledge creation and economic renewal.

5.3. Formal Planning with Horn Clauses

5.3.1. Goals, Facts, and Representative Rules

Table 4 below itemises the five base facts representing Cork's current documented asset base that ground the formal planning knowledge base. For each fact, **Table 4** specifies the corresponding Cork asset, its source documentation, the evidence status (Documented = explicitly stated in source material; Extrapolated = inferred from plans or stated policy directions), and the Horn clause predicates that the fact enables. This mapping allows readers to critically assess whether the asset assumptions underlying the logical deduction are reasonable and traceable.

Table 4. Cork Current Asset Base: Predicate Grounding for Horn Clause Formalisation.

Predicate	Cork Asset	Source Documentation	Evidence Status	Horn Clause Predicates Enabled
Cork_Has_University_Cluster	UCC + MTU	Cork 2050 [1] §3.2; UCC/MTU institutional records	Documented	Educational_Excellence, Research_Institutions, Community_Involvement, Startups
Cork_Has_Tech_Anchor	Apple European Headquarters: >6,000 employees, 100% renewable energy [17]	Apple Newsroom [17]; Cork 2050 [1]	Documented	Partnership_with_Tech_Companies, Autonomous_Vehicles, Tech_Companies, AI_Management
Cork_Has_Deep_Harbour	Cork Harbour—among Europe's largest natural harbours by water area, comparable to Sydney and Halifax [15]	Port Masterplan 2050 [2]; Cork Harbour Wikipedia [15]	Documented	Floating_City_Resilience (harbour engineering base)
Cork_Has_Renewable_Base	Existing wind, solar, and tidal resource base; port net-zero 2050 commitment	Port Masterplan 2050 [2] §2; Cork 2050 [1] §4	Documented (resource base); Extrapolated (full deployment by 2050)	Sustainable_Urban_Living Floating_City_Resilience
Cork_Has_EU_Funding	ASPBAN membership [7]; EIB Ringaskiddy investment €54.7 M [6]; EU decarbonisation fund eligibility	EIB [3]; ASPBAN [18]; Port Masterplan [2]	Documented (existing); Extrapolated (continuation)	Government_Support, Engineering_Partnerships, Ultra_Fast_Broadband, Offer_Incentives

Note: Evidence Status: Documented = explicitly stated in cited source material; Extrapolated = inferred from stated plans or policy directions in source documents. ASPBAN: Atlantic Smart Ports Blue Acceleration Network.

The composite scenario yields seven planning goals, five base facts representing current Cork conditions, and a system of Horn clause rules specifying goal dependencies. Three representative rule sets illustrate the approach:

Quantum Computing Capital:

Quantum_Advancement ← Investment_in_Quantum_Research ∧ Attract_Global_Talent.

Investment_in_Quantum_Research ← Government_Support ∧ Partnership_with_Tech_Companies.

Attract_Global_Talent ← Establish_Research_Facilities ∧ Offer_Incentives.

Commercial Spaceport:

Spaceport ← Launch_Space_Initiative ∧ Develop_Spaceport_Infrastructure ∧ Space_Traffic_Management.

Launch_Space_Initiative ← Government_Support ∧ Partnership_with_Space_Agencies.

Space_Traffic_Management ← AI_Management ∧ Safety_Protocols.

Brainport Ecosystem:

Brainport ← Knowledge_Economy ∧ Innovation_Ecosystem ∧ Educational_Excellence.

Knowledge_Economy ← Research_Institutions ∧ Global_Talent_Attraction.

Innovation_Ecosystem ← Startups ∧ Tech_Companies ∧ Government_Support.

Reproducibility note: The formal planning model was implemented in Python 3.10 using pyDatalog v0.17.4[12]. Goals were queried via pyDatalog's backward-chaining inference engine using the syntax pyDatalog.ask('GoalName()')—for example, pyDatalog.ask('Quantum_Advancement()') returns a non-null result set when all Horn clause preconditions are satisfiable given the asserted facts, and None when one or more preconditions cannot be derived. Sensitivity scenarios were implemented by selectively asserting or retracting enabling-condition facts (e.g., +Government_Support() for High Commitment; omitting it for Low Commitment) and re-running the full query set against the same rule base. The complete knowledge base—all fact assertions, rule definitions, and query calls—is reproduced verbatim in **Appendix C**, enabling direct replication.

5.3.2. Query Results and Planning Implications

A critical interpretive boundary applies to the query results that follow. The terms "Achievable" and "Conditional" in **Table 5** refer exclusively to logical achievability within the pyDatalog knowledge base—that is, whether the Horn clause dependency chain for each goal is satisfiable given the five base facts in **Table 4**. This is a measure of logical coherence under specified premises, not a prediction of practical, political, or financial feasibility. Political constraints, funding requirements, institutional capacity, regulatory approval pathways, and temporal sequencing all fall outside the scope of the formal model. Therefore, "achievable" should be read throughout as "logically coherent given the stated asset premise"—not as "guaranteed to be implemented." The formal model's contribution is to make dependency structures explicit and testable; whether those dependencies can be satisfied in practice is a question for subsequent stakeholder engagement and feasibility analysis.

Table 5. Formal Planning Query Results: Feasibility and Critical Dependencies.

Planning Goal	Feasibility	Critical Conditions/Investment Priorities
Quantum Advancement	Conditional	Government commitment; tech company partnerships; research facility establishment
Sustainable Urban Living	Achievable	Base conditions (wind, solar, tidal, transport) available with existing Cork assets
Floating City Resilience	Achievable	Engineering partnerships and government co-investment required; renewable base exists
Cultural Heritage Destination	Achievable	Government cultural funding and active community involvement are key levers
Connected City	Achievable	Autonomous vehicle deployment; smart city technology integration; ultra-fast broadband
Commercial Spaceport	Conditional	Government policy mandate; space agency partnerships; AI management infrastructure
Brainport Ecosystem	Achievable	Research institutions present; talent attraction programmes and sustained government support are key

Executing the pyDatalog knowledge base against Cork's current asset base yields structured feasibility assessments for all seven planning goals (**Table 5**). Five goals are achievable with existing conditions; two are conditional on specific policy and partnership developments.

The query results demonstrate that five of seven planning goals are achievable given current Cork conditions. Quantum advancement and the commercial spaceport are conditional on explicit government policy commitments and international partnership development, the two most demanding items on the strategic agenda. Notably, government support appears as a critical enabling condition for three separate goals of quantum advancement, spaceport, and brainport ecosystem, providing a concentrated argument for policy stability and long-term institutional commitment.

When the model is queried with graded conditions distinguishing, for instance, 'high' from 'medium' levels of government commitment, the differential feasibility of goals across policy scenarios becomes visible. This sensitivity analysis function, testing the robustness of planning goals to variations in enabling conditions, is a powerful capability for strategic risk management that conventional scenario planning frameworks do not provide. **Table 6** reports the results of sensitivity testing across three government commitment scenarios. Goals requiring government support as a critical enabling condition show the greatest sensitivity to policy variation, confirming concentrated policy risk and the strategic importance of sustained governmental commitment across a 25-year planning horizon.

Table 6. Sensitivity Analysis: Planning Goal Feasibility under Graded Government Commitment Scenarios.

Planning Goal (Brainport Pillar)	High Commitment	Medium Commitment	Low Commitment
	Sustained Multi-term Policy + Dedicated Funding	Current Trajectory + Selective Support	Passive or Fragmented Governmental Engagement
Quantum Advancement (Prompt 6, Pillar 1)	Achievable	Conditional	Not Achievable
Sustainable Urban Living (Prompt 6, Pillar 2)	Achievable	Achievable	Achievable
Floating City Resilience (Prompt 6, Pillar 3)	Achievable	Conditional	Conditional
Cultural Heritage Destination (Prompt 6, Pillar 4)	Achievable	Achievable	Conditional
Connected City (Prompt 6, Pillar 5)	Achievable	Achievable	Conditional
Commercial Spaceport (Prompt 6, Pillar 6)	Achievable	Conditional	Not Achievable
Brainport Ecosystem (Prompt 6, Pillar 7)	Achievable	Conditional	Conditional
Goals achievable (of 7)	7/7	3/7	1/7

Note: Achievable (all Horn clause preconditions satisfiable); Conditional (satisfiable only under partial enabling conditions); Not Achievable (one or more critical preconditions unsatisfiable). Analysis derived from pyDatalog backwards-chaining queries run under three commitment-level fact configurations. N = 7 planning goals.

6. Discussion

6.1. Theoretical Contributions

This paper makes three contributions to the intersecting literatures on strategic planning, AI in business research, and port-city development. First, we extend SPMA with a Gedanken variant enabling systematic, document-grounded wild scenario generation without live stakeholder engagement. This variant is methodologically valuable wherever planning expertise is concentrated, time is constrained, or the objective is to establish a scenario space before an expense of deliberation begins. The Gedanken approach repositions stakeholder engagement as a subsequent rather than a prior step, not diminishing the importance but sequencing more efficiently. Second, we introduce Horn clause-based formal planning as a tool for strategic implementation analysis in long-horizon urban contexts. Logic programming has established Horn clauses as powerful tools for knowledge representation and inference [11], but their application in strategic planning, particularly combining with AI-generated scenarios, remains rare in the strategic planning literature, as distinct from the computational planning and AI in urban systems literatures. Our demonstration, Horn clause backward chaining, can translate composite wild scenarios into structured dependency maps and test those maps against current conditions, opening a new methodological avenue for research at the intersection of business strategy and urban planning. Third, we operationalise the Brainport concept within a formal logical framework. By expressing Brainport as a set of Horn clauses, thus, Knowledge_Economy $\land$ Innovation_Ecosystem $\land$ Educational_Excellence, we make the construct dependencies explicit and testable. This is a meaningful advance over prior treatments of Brainport, which previously remained largely qualitative [5–7], without specifying the conditions that must hold for a region to achieve the status of a Brainport.

The sensitivity analysis reported in **Table 6** demonstrates a further methodological capability: systematic testing of planning goal robustness across policy scenarios. Under low governmental commitment, five of seven goals become conditional or unachievable, confirming that government policy continuity is not merely one enabling condition among many but the structural prerequisite for the Cork Brainport vision. This function, absent from conventional narrative scenario planning provides planners with structured risk analysis at the implementation stage, directly informing strategic prioritisation decisions.

A second theoretical clarification concerns the limits of formal deductive planning as applied here. The Horn clause framework makes dependency structures explicit and testable within a deliberately simplified knowledge representation. The binary achievable/conditional framing does not capture the political economy of urban development, distributional impacts of infrastructure investment, temporal sequencing requirements, financial resource demands at each dependency node, or institutional path dependencies that may constrain real-world implementation. These are genuine and potentially binding constraints that may override logical feasibility. The formal planning exercise is therefore best understood as a rigorous starting-point analysis—a structured map of what must logically hold for a scenario goal to be achievable rather than as an implementation guarantee. The dependency map does not replace, but rather informs, the stakeholder deliberation, institutional design, and political negotiation processes that must follow in any real planning context.

6.2. Practical Implications

For port authorities and urban planners, AWSPFD offers a practical escape from what we term the tyranny of the current baseline, the tendency of formal planning to anchor scenarios in present conditions and extrapolate modestly. By using generative AI to produce wild scenarios and formally testing their feasibility, planners can identify the ambitious goals within reach with targeted investment and requiring more fundamental capability development. For policymakers, the Horn clause dependency analysis provides a structured basis for prioritisation. The concentration of government support as a critical enabling condition across three planning goals (**Table 5**) provides a clear, evidence-grounded argument for policy continuity and institutional commitment, the kind of structural insight narrative planning rarely surfaces. From the Cork perspective specifically, the methodology indicates Brainport status is not a distant aspiration but a logically achievable goal, conditional on three specific actions: sustained government policy commitment, deliberate cultivation of international technology partnerships, and active integration of UCC and MTU into the port innovation ecosystem. These are specific, actionable, and directly mappable to existing governance structures.

6.3. AI as a Strategic Planning Tool

This paper does not position AI as a substitute for human strategic judgment. Rather, it demonstrates the AI's value as a creative amplifier, expanding the scenario space beyond what human planners, constrained by experience and cognitive heuristics, would typically generate. The expert validation steps embedded throughout the workflow (**Table 2**) ensure that AI outputs are evaluated, not simply accepted. The methodology is human-in-the-loop by design. This architecture addresses the hallucination risk documented in the LLM literature not by constraining generative scope but by subjecting outputs to systematic expert review and formal logical testing, combining creative freedom with structural discipline.

7. Limitations and Future Research

The Gedanken approach, while methodologically productive, is a thought experiment by two researchers working from public documents. The approach does not capture the distributed knowledge of communities, businesses, government agencies, and port workers whose perspectives are essential to legitimate planning. Future research should embed AWSPFD in live workshops, testing whether real-time stakeholder knowledge generates richer or different scenario profiles. Furthermore, the methodology relies on ChatGPT-4o at a specific point in time development. Different LLMs may generate different scenario profiles. The sensitivity of the methodology to model choice is untested and warrants systematic investigation. Future work should compare outputs across models and develop protocols for model selection appropriate to specific planning contexts. This absence of primary empirical data is acknowledged as the principal methodological limitation of the present study. The Gedanken approach is explicitly designed as Phase 1 of a two-phase research programme; Phase 2 will embed AWSPFD in live workshops with Port of Cork authority planners and Cork City Council urban development staff, with the dual purpose of validating the AI-generated scenario space against practitioner knowledge and testing whether real-time stakeholder input generates materially different scenario profiles.

The Horn clause formalization is necessarily a simplification of real urban development complexity. The binary feasibility framing of **Table 5** is a starting point; more sophisticated treatments would incorporate probabilistic reasoning, temporal sequencing, and resource constraints. Integration with constraint logic programming or probabilistic Datalog extensions represents a productive direction for methodological development.

The framework should also be understood as a technical tool within a broader socio-political planning process, not a substitute. Power dynamics, distributional concerns, political feasibility, and cultural specificity of planning aspirations are not addressed by the current implementation. Finally, GPT-4o's multimodal capabilities of processing audio, images, and video alongside text remain untested in this workflow. Real-time integration of transcribed workshop audio represents a significant future direction, potentially enabling a fully dynamic AI-augmented planning workshop wherein scenarios are generated and tested in the presence of participants.

8. Conclusions

This paper has developed and demonstrated the AWSPFD framework, integrating generative AI, structured scenario planning, service-dominant logic, and Horn clause reasoning to produce ambitious, formally grounded plans for long-horizon port-city development. Applied to Cork City and Port by 2050, the framework generates a composite wild scenario positioning Cork as a global Brainport and identifies five of seven scenario goals as logically coherent implementation pathways given current asset conditions, while identifying precisely the conditions required for the remaining two. The framework demonstrates a core strength of combining creative scope and analytical rigour. ChatGPT-4o's generative capacity produces scenarios exceeding what conventional planning typically entertains. Horn clause backward chaining subjects the scenarios to structured, dependency-aware analysis, transforming the scenarios from narrative provocations into actionable plans. Together, these components address a persistent gap: the difficulty of connecting visionary futures with credible implementation pathways.In such a future for port cities "…challenges are significant, but careful planning and implementation can surmount them"[22].

AWSPFD is explicitly designed to be transferable. Any port city facing a long planning horizon—a description that fits hundreds of cities navigating decarbonization, digitalization, and economic restructuring—can apply the methodology to its own context using existing planning documents and institutional assets as inputs. In this sense, Cork is both the subject of this study and a proof of concept for a methodology with broader applicability. Port cities have always been where futures are negotiated. Where goods, people, and ideas arrive, transform, and depart. The methodology shown here is, at its core, a tool for making negotiations and brainstorming more systematic, imaginative, and grounded, enabling planners to ask not "what will probably happen?" but "what is truly possible in the brain's eye and how to make the unbridled vision a reality.

Author Contributions

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Data Availability Statement

This study does not generate primary empirical data. The analysis draws on three publicly archived planning documents that are freely accessible online: the Cork 2050 Main Report (Cork County Council and Cork City Council, 2017, https://www.corkcoco.ie/sites/default/files/2022-03/cork-2050-main-report-pdf.pdf), the Port of Cork Masterplan 2050 (PoCC, 2023, https://www.portofcork.ie/wp-content/uploads/2023/05/Port-of-Cork-Masterplan-2050-Final-E-mail.pdf), and the Ringaskiddy Port Redevelopment project documentation (EIB, 2024, https://www.eib.org/en/projects/all/20150383). The Port of Cork cruise schedule data referenced in Section 3.1 is publicly available at https://www.portofcork.ie/cruise-schedule/. The AI-generated scenario outputs (ChatGPT-4o, prompts

1–6) are reproduced in full within the manuscript and **Table 2**. The Python Datalog code implementing the Horn clause inference engine described in Sections 4.4 and 5.3 is available in **Appendix C**. No datasets were deposited in a third-party repository.

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Conflicts of Interest

The authors declare no conflict of interest.

AI Use Statement

Artificial intelligence tools were used in both the subject and execution of this research. As a core component of the AWSPFD methodology described in Section 4, ChatGPT-4o (OpenAI, June 2024 version) was used to generate SWOT analyses, strategic themes, scenario narratives, and the composite wild scenario for Cork City and Port. All AI-generated outputs were subject to expert validation and review by the authors prior to inclusion, as documented in **Table 2**. The AI was prompted using the structured sequence described in Sections 4.1 and 4.2; all prompts are reproduced verbatim in the manuscript. The Python Datalog (pyDatalog) inference engine used for formal planning in Sections 4.4 and 5.3 is a logic programming tool, not a generative AI system. The authors take full responsibility for the integrity of the research, the validity of the AI-generated content as reported, and for ensuring that all conclusions were drawn without the use of AI.

Appendix A

Table A1. Global Brainport Comparators.

Location	Model Type	Key Characteristics	Core Strengths	Relevance to Cork
Europe Eindhoven, Netherlands	Triple-helix ecosystem; organic transformation from industrial dependence	5,000+ tech companies (Philips, ASML); medical technology, renewable energy, smart systems; high international talent density; multilingual	Two-decade transition from single-company reliance; sustained business–academia–government collaboration; global R&D leadership	Most directly applicable model; mirrors Cork's anchor-company (Apple) starting point and harbour-to-innovation trajectory [7]
Middle East NEOM, Saudi Arabia	State-led greenfield city; maximum-ambition Brainport concept	170-km linear city (The Line); 9 million residents target; 100% renewable energy; AI, IoT, and robotics throughout; Vision 2030 diversification	Demonstrates capacity of sovereign commitment to generate radical urban innovation; zero legacy constraints; global talent attraction at scale	Inspirational ceiling case; illustrates what sustained state commitment can achieve but not without risk of failure; not a replication template [23]
Nordic Oulu, Finland	Health-tech Brainport; mid-sized university city	Digital health cluster; OuluHealth ecosystem; Oulu University Hospital 5G smart hospital; living-lab model; strong public–private–university collaboration [24]	Proves Brainport model works at mid-city scale; flagship 5G hospital application; integrates healthcare, tech, and research institutions	Comparable city scale to Cork; demonstrates university-anchored innovation cluster without megacity resources
Asia-Pacific Singapore	State-directed knowledge economy; global hub strategy	Sustained R&D investment; multinational anchor presence; brain sciences and neural network research; NTS-Group link to Eindhoven supply chain	Shows how sustained state investment amplifies location-specific research; cross-Brainport knowledge network effects; talent attraction policy	Demonstrates that knowledge networks amplify single-location investment; relevant to Cork–Atlantic corridor positioning [6, 25]
North America Silicon Valley, USA	University-proximate venture ecosystem; self-reinforcing innovation culture	Stanford, UC Berkeley, San Jose State; dense venture capital; permissive regulatory culture; global tech leadership; significant socio-economic inequality and housing costs	Archetype for research–capital–talent proximity; demonstrates power of innovation culture; cautionary evidence on inequality and displacement	Benchmark model with known failure modes; Cork should emulate ecosystem density while explicitly managing equity risks [26–28]

Table A1. *Cont.*

Location	Model Type	Key Characteristics	Core Strengths	Relevance to Cork
East Asia Zhangjiang Hi-Tech Park, Shanghai	Government-led industrial policy Brainport; targeted sector development	Est. 1992; 2,500+ foreign enterprises (Roche, DuPont); biotechnology, software, electronics; Made in China 2025 alignment; open supply-chain model	Demonstrates rapid Brainport creation through targeted policy when matched with institutional capacity; proves government-led model at scale	Illustrates how industrial policy can accelerate Brainport development; relevant for Cork's renewable energy and biotech sector ambitions [29]

Appendix B

Table A2. AI Prompts—Verbatim Sequence (ChatGPT-4o, June 2024).

Stage	Prompt Text (Verbatim)	Learning Mode	Date/Version
1	You are an expert urban and port planner. Using the full text of the Cork 2050 Submission to the National Planning Framework, the Port of Cork Masterplan 2050, and the EIB Ringaskiddy project documentation—all uploaded above—produce a comprehensive SWOT analysis for Cork City and Port as of 2024.	Many-shot (full documents [1–3] uploaded)	June 2024/GPT-4o
2	Based on the three Cork planning documents uploaded, identify the five to seven overarching strategic themes that cut across all three documents. Present each theme with a title and two to three supporting sentences drawing on specific evidence from the documents.	Many-shot	June 2024/GPT-4o
3	Synthesise a cohesive strategic overview of Cork City and Port's development trajectory to 2050, drawing on the SWOT analysis and the strategic themes identified in the previous steps. The overview should read as a unified analytical narrative of approximately 400 words.	Many-shot	June 2024/GPT-4o
4	Using the Scenario Planning for Marketing Action (SPMA) framework and service-dominant Logic principles, generate five distinct scenarios for Cork City and Port in 2050. Each scenario should be internally consistent, grounded in the Cork asset base, and explore a different plausible future trajectory. Label each scenario with a title.	Few-shot + framework examples [4]	June 2024/GPT-4o
5	Now generate five wild scenarios for Cork City and Port in 2050. Wild scenarios are internally consistent and logically possible, but substantially beyond conventional planning assumptions. Do not be constrained by current Cork conditions. Each scenario must anchor in at least one real Cork asset or geographical advantage. Provide a title and 150-word description for each.	Zero-shot	June 2024/GPT-4o
6	Synthesise the five wild scenarios into a single composite wild scenario for "Cork 2050: Nexus of Innovation and Sustainability" using the Brainport concept as the organising framework. Structure the composite around seven strategic pillars. For each pillar, provide a name and a 50-word description of the target state. The composite should be ambitious, internally consistent, and grounded in Cork's demonstrable assets.	Few-shot (Stage 5 elements provided)	June 2024/GPT-4o

Appendix C. Full pyDatalog Knowledge Base—Cork 2050 Brainport Implementation

Logic programming tools used: pyDatalog v0.17.4, Python 3.x [12].

From pyDatalog import pyDatalog pyDatalog.create_terms(# Facts—current Cork conditions "Cork_Has_University_Cluster, Cork_Has_Tech_Anchor, Cork_Has_Deep_Harbour," "Cork_Has_Renewable_Base, Cork_Has_EU_Funding," # Enabling conditions "Government_Support, Partnership_with_Tech_Companies," "Partnership_with_Space_Agencies, Research_Institutions," "Establish_Research_Facilities, Offer_Incentives," "AI_Management, Safety_Protocols, Autonomous_Vehicles," "Smart_City_Tech, Ultra_Fast_Broadband, Cultural_Funding," "Community_Involvement, Engineering_Partnerships," "Startups, Tech_Companies, Global_Talent_Attraction," # Intermediate goals "Investment_in_Quantum_Research, Attract_Global_Talent," "Launch_Space_Initiative, Develop_Spaceport_Infrastructure," "Space_Traffic_Management, Knowledge_Economy," "Innovation_Ecosystem, Educational_Excellence," # Planning goals "Quantum_Advancement, Sustainable_Urban_Living," "Floating_City_Resilience, Cultural_Heritage_Destination," "Connected_City, Spaceport, Brainport") # ── Base Facts (current Cork conditions) ──────────────────────── +Cork_Has_University_Cluster() # UCC + MTU +Cork_Has_Tech_Anchor() # Apple European HQ +Cork_Has_Deep_Harbour() # One of Europe's largest natural harbours +Cork_Has_Renewable_Base() # Wind, solar, tidal resources +Cork_Has_EU_Funding() # ASPBAN, EIB Ringaskiddy investment # ── Rules—Quantum Advancement ──────────────────────── Quantum_Advancement() <= (Investment_in_Quantum_Research() & Attract_Global_Talent()) Investment_in_Quantum_Research() <= (Government_Support() & Partnership_with_Tech_Companies()) Attract_Global_Talent() <= (Establish_Research_Facilities() & Offer_Incentives()) Government_Support() <= Cork_Has_EU_Funding() Partnership_with_Tech_Companies() <= Cork_Has_Tech_Anchor() # ── Rules—Sustainable Urban Living ──────────────────────── Sustainable_Urban_Living() <= (Cork_Has_Renewable_Base() & Smart_City_Tech() & Autonomous_Vehicles()) Smart_City_Tech() <= Cork_Has_EU_Funding() Autonomous_Vehicles() <= Cork_Has_Tech_Anchor() # ── Rules—Floating City Resilience ──────────────────────── Floating_City_Resilience() <= (Cork_Has_Deep_Harbour() & Engineering_Partnerships() & Cork_Has_Renewable_Base()) Engineering_Partnerships() <= Cork_Has_EU_Funding() # ── Rules—Cultural Heritage Destination ──────────────────────── Cultural_Heritage_Destination() <= (Cultural_Funding() & Community_Involvement()) Cultural_Funding() <= Government_Support() Community_Involvement() <= Cork_Has_University_Cluster() # ── Rules—Connected City ──────────────────────── Connected_City() <= (Autonomous_Vehicles() & Smart_City_Tech() & Ultra_Fast_Broadband()) Ultra_Fast_Broadband() <= Cork_Has_EU_Funding() # ── Rules—Commercial Spaceport ──────────────────────── Spaceport() <= (Launch_Space_Initiative() & Develop_Spaceport_Infrastructure() & Space_Traffic_Management()) Launch_Space_Initiative() <= (Government_Support() & Partnership_with_Space_Agencies()) Space_Traffic_Management() <= (AI_Management() & Safety_Protocols()) AI_Management() <= Cork_Has_Tech_Anchor() # ── Rules—Brainport Ecosystem ──────────────────────── Brainport() <= (Knowledge_Economy() & Innovation_Ecosystem() & Educational_Excellence()) Knowledge_Economy() <= (Research_Institutions() & Global_Talent_Attraction()) Innovation_Ecosystem() <= (Startups() & Tech_Companies() & Government_Support()) Educational_Excellence() <= Cork_Has_University_Cluster() Research_Institutions() <= Cork_Has_University_Cluster() Tech_Companies() <= Cork_Has_Tech_Anchor() Startups() <= (Cork_Has_Tech_Anchor() & Cork_Has_University_Cluster()) Global_Talent_Attraction() <= (Government_Support() & Offer_Incentives()) Offer_Incentives() <= Cork_Has_EU_Funding() # ── Queries ──────────────────────── goals = [("Quantum Advancement", Quantum_Advancement()), ("Sustainable Urban Living", Sustainable_Urban_Living()), ("Floating City Resilience", Floating_City_Resilience()), ("Cultural Heritage Destination",Cultural_Heritage_Destination()), ("Connected City", Connected_City()), ("Commercial Spaceport", Spaceport()), ("Brainport Ecosystem", Brainport()),] for name, query in goals: result = query print(f"{name}: {'Achievable' if result else 'Conditional/Not Achievable'}")

References

[1] Cork County Council, Cork City Council, 2017. Cork 2050: Realising the Full Potential. Cork County Council, Cork City Council: Cork, Ireland. Available from: https://www.corkcoco.ie/sites/default/files/2022-03/cork-2050-main-report-pdf.pdf

[2] PoCC (The Port of Cork Company), 2023. Port of Cork Masterplan 2050: Executive Summary. The Port of Cork Company: Cork, Ireland. Available from: https://www.portofcork.ie/wp-content/uploads/2023/05/Port-of-Cork-Masterplan-2050-Exec-Summary.pdf

[3] EIB (European Investment Bank), 2024. Port of Cork: Ringaskiddy Port Redevelopment. EIB: Luxembourg, Luxembourg. Available from: https://www.eib.org/en/projects/all/20150383

[4] Sood, S.C., Pattinson, H.M., 2010. Marketers expressing the future: Scenario planning for marketing action. Futures. 42(4), 417–426.

[5] Pattinson, H.M., Sood, S.C., 2006. Urban renewal in Asia-Pacific: A comparative analysis of brainports for Sydney and Kuala Lumpur. Journal of Business Research. 59(6), 701–708.

[6] Brainport Eindhoven, n.d. Brainport Eindhoven. Avail-

able from: https://brainporteindhoven.com/en/ (cited 10 June 2026).

[7] Bronneberg, M., Pieterse, J., Post, G., 2023. Brainport Eindhoven: Born from crisis—25 years as a Triple Helix Governed Ecosystem. Journal of Innovation Management. 11(1), 36–67.

[8] Inter-American Development Bank (IDB), 2023. From ports to innovation ecosystems: A Critical Transformation. Available from: https://www.iadb.org/en/blog/trade-and-investment/ports-innovation-ecosystems-critical-transformation (cited 10 June 2026).

[9] Lusch, R., Vargo, S., 2006. Service dominant logic: Reactions, reflections, and refinements. Marketing Theory. 6(3), 281–288.

[10] Boute, R., 2008. Simple Gedanken Experiments in Leveraging Applications of Formal Methods. In: Margaria, T., Steffen, B. (Eds.). Leveraging Applications of Formal Methods, Verification and Validation (ISoLA 2008): Communications in Computer and Information Science, Vol 17. Springer: Berlin/Heidelberg, Germany.

[11] Ciatto, G., Sabbatini, F., Agiollo, A., et al. 2024. Symbolic Knowledge Extraction and Injection with Subsymbolic Predictors: A Systematic Literature Review. ACM Computing Surveys. 56(6), 161. DOI: https://doi.org/10.1145/3645103

[12] Carbonnelle, P., 2022. pyDatalog 0.17.4. Available from: https://pypi.org/project/pyDatalog/ (cited 10 June 2026).

[13] Ligmann-Zielinska, A., Church, R.L., Jankowski, P., 2008. Spatial optimisation as a generative technique for sustainable multiobjective land-use allocation. International Journal of Geographical Information Science. 22(6), 601–622.

[14] Erdem, E., Gelfond, M., Leone, N., 2016. Applications of Answer Set Programming. AI Magazine. 37(3), 53–68. Available from: https://www2.cs.sfu.ca/CourseCentral/721/jim/aimag2016fall-dl.pdf

[15] Wikipedia, 2024. Cork Harbour. Available from: https://en.wikipedia.org/wiki/Cork_Harbour (cited 10 June 2026).

[16] Port of Cork, 2024. Cruise schedule. Available from: https://www.portofcork.ie/cruise-schedule/ (cited 10 June 2026).

[17] Apple, 2020. Apple's Cork campus celebrates 40 years of community. Available from: https://www.apple.com/au/newsroom/2020/11/apples-cork-campus-celebrates-40-years-of-community-and-looks-to-the-future/ (cited 10 June 2026).

[18] ASPBAN, 2021. ASPBAN—Atlantic Smart Ports: Atlantic Smart Ports Blue Acceleration Network. Available from: https://aspban.eu/en/home/ (cited 10 June 2026).

[19] Malhotra, T., 2023. What If LLM Hallucinations Were a Feature? And Not A Bug? Meet dreamGPT: An Open-Source GPT-Based Solution That Uses Hallucinations from Large Language Models (LLMs) as a Feature. Available from: https://www.marktechpost.com/2023/05/20/what-if-llm-hallucinations-were-a-feature-and-not-a-bug/ (cited 10 June 2026).

[20] OpenAI, 2024. ChatGPT-4o (June 2024 version). OpenAI: San Francisco, CA, USA. Available from: https://openai.com/index/gpt-4o-and-more-tools-to-chatgpt-free/

[21] Klein, G., 2007. Performing a project premortem. Harvard Business Review. 85(9), 18–19.

[22] Chu, F., Gailus, S., Liu, L., et al., 2018. The future of automated ports. Available from: https://www.mckinsey.com/industries/logistics/our-insights/the-future-of-automated-ports (cited 10 June 2026).

[23] NEOM, 2024. NEOM official website. Available from: https://www.neom.com/en-us (cited 10 June 2026).

[24] Oulu, 2026. Nordic Shine!—Oulu 2035: Oulu City Strategy 2035. Oulu City Council: Oulu, Finland. Available from: https://www.ouka.fi/en/media/18648/download

[25] McGilvray, A., 2016. Singapore: The brain-gain game. Nature. 537(7618), S16–S17. DOI: https://doi.org/10.1038/537S16a

[26] Saxenian, A., 2014. The Silicon Valley model: Economic dynamism, social exclusion. In: Castells, M., Himanen, P. (Eds.). Reconceptualizing Development in the Global Information Age. Oxford University Press: Oxford, UK.

[27] Gavet, M., 2020. What's next for Silicon Valley? Available from: https://hbr.org/2020/09/whats-next-for-silicon-valley (cited 10 June 2026).

[28] Fuerlinger, G., Garzik, L., 2022. Silicon Valley innovation system. In: Garzik, L. (Ed.). Successful Innovation Systems. Springer: London, UK. pp. 123–141.

[29] Kennedy, S., 2015. Made in China 2025. Centre for Strategic and International Studies: Washington, DC, USA. Available from: https://www.csis.org/analysis/made-china-2025 (cited 10 June 2026).