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Patent Genome Theory: A Dynamic Organizational Genetics Framework for Innovation Capability in Higher Education

Anchal Agarwal[1], Dr. Ashok Kumar Sharma[2]

[1]Research Scholar, Department of Law, Meerut College, Chaudhary Charan Singh University, Meerut, India

[2]Assistant Professor, Department of Law, Meerut College, Chaudhary Charan Singh University, Meerut, India

Abstract:

Innovation has become a strategic mission of higher education institutions, where patents increasingly serve as indicators of research excellence, technological advancement, and socio-economic impact. Despite operating within similar legal and policy environments, universities exhibit substantial differences in their ability to generate, protect, and commercialize intellectual property. Existing studies generally explain these differences through isolated determinants such as institutional policy, research funding, patent awareness, legal support, incentives, or industry collaboration. Although these factors are important, they provide only a fragmented understanding of institutional innovation capability because they overlook the interaction among organizational components.

This paper proposes Patent Genome Theory (PGT), a new conceptual framework that explains institutional innovation capability through an organizational genetics perspective. The theory conceptualizes every university as possessing a Patent Genome consisting of three organizational chromosomes and seven interdependent organizational genes that collectively regulate patent generation, intellectual property management, and commercialization. It further introduces four original constructs—Patent Gene Expression, Patent Mutation, Patent Fitness, and the Patent Genome Measurement Framework—to explain how organizational capability develops, evolves, and influences innovation outcomes.

Unlike existing innovation theories that primarily emphasize resources, knowledge, organizational adaptation, or external collaboration, Patent Genome Theory focuses on the internal organizational architecture responsible for sustained patent capability. The paper also proposes measurable constructs for future empirical validation and discusses theoretical as well as practical implications for universities, policymakers, and innovation managers. By integrating organizational genetics with patent management, Patent Genome Theory provides a comprehensive framework for understanding and strengthening innovation ecosystems in higher education.

Keywords: Patent Genome Theory; Organizational Genetics; Innovation Capability; Higher Education; Patent Management; Technology Transfer; Intellectual Property; Organizational Innovation.

1. Introduction

1.1 Background

Universities have evolved from institutions primarily engaged in teaching and research into key participants in national and global innovation systems. In addition to generating scientific knowledge, higher education institutions are increasingly expected to protect intellectual property, transfer technology to industry, promote entrepreneurship, and contribute directly to economic development. Consequently, patents have emerged as an important indicator of institutional innovation capability because they represent the successful transformation of research outputs into legally protected and commercially valuable assets.

Across the world, governments have introduced policies to strengthen university innovation through intellectual property protection, technology transfer offices, startup ecosystems, and research funding. In India, initiatives such as the National Intellectual Property Rights Policy, institutional Intellectual Property Rights (IPR) Cells, Technology and Innovation Support Centers (TISCs), Startup India, and the Atal Innovation Mission have significantly expanded the innovation landscape. These initiatives have encouraged universities to adopt structured mechanisms for patent facilitation, commercialization, and industry collaboration.

Despite operating under comparable legal frameworks and policy environments, however, universities continue to demonstrate substantial differences in patent generation, patent quality, licensing activity, and commercialization success. Some institutions consistently transform research into intellectual property and marketable technologies, whereas others struggle to convert comparable research capacity into innovation outcomes.

1.2 Research Problem

The persistent variation in patent performance among universities raises an important theoretical question:

Why do institutions operating under similar legal, financial, and policy environments exhibit markedly different innovation outcomes?

Existing explanations generally attribute institutional differences to factors such as research funding, patent awareness, institutional policy, legal support, incentives, or industry collaboration. Although each factor contributes to innovation capability, none adequately explains how these organizational components interact to produce sustained institutional performance.

This suggests that patent capability should be understood as the outcome of an integrated organizational system rather than the cumulative effect of independent organizational variables.

1.3 Positioning Patent Genome Theory within Existing Innovation Theories

Several organizational and innovation theories have advanced our understanding of how institutions create and sustain competitive advantage. The Resource-Based View (RBV) explains performance through valuable organizational resources, while the Knowledge-Based View (KBV) emphasizes knowledge creation as the foundation of innovation. Dynamic Capabilities Theory focuses on an organization's ability to adapt to changing environments, whereas the Triple Helix Model highlights collaboration among universities, industry, and government. Similarly, National Innovation Systems explain innovation through interactions among institutional actors operating within a country's policy environment.

Although these theories have significantly contributed to innovation research, none specifically explains how internal organizational capabilities collectively govern institutional patent performance. Existing

theories primarily focus on resources, knowledge, adaptation, or external collaboration, but they do not provide a structured organizational architecture that explains why universities with similar resources frequently produce very different patent outcomes.

Patent Genome Theory complements these established perspectives by introducing an organizational genetics framework. Rather than replacing existing theories, it explains how internal organizational capabilities are structured, coordinated, activated, and sustained to create long-term innovation capability.

Table 1. Positioning Patent Genome Theory within Existing Innovation Theories

Theory	Primary Focus	Limitation	Contribution of Patent Genome Theory
Resource-Based View	Strategic resources	Explains *what* resources matter but not how they interact	Explains interaction among organizational capabilities
Knowledge-Based View	Knowledge creation	Limited attention to patent management	Integrates knowledge creation with intellectual property capability
Dynamic Capabilities	Organizational adaptation	Generic innovation perspective	Develops a patent-specific organizational framework
Triple Helix	University–Industry–Government collaboration	Emphasizes external relationships	Integrates both internal organizational architecture and external collaboration
National Innovation Systems	National innovation environment	Limited explanation of institutional differences	Explains why universities within the same system perform differently
Patent Genome Theory	Organizational genetics	—	Explains innovation through chromosomes, genes, expression, mutations, and fitness

Table 1 demonstrates that Patent Genome Theory occupies a distinct theoretical position. Instead of focusing on a single organizational dimension, it integrates governance, innovation capability, and commercialization within a unified organizational architecture.

1.4 Research Objectives

This paper pursues four objectives.

1. To develop Patent Genome Theory as a conceptual framework for explaining institutional innovation capability.
2. To introduce the concepts of Patent Genome, Patent Gene Expression, Patent Mutation, and Patent Fitness as interconnected theoretical constructs.
3. To propose a measurable framework that enables future empirical assessment of organizational innovation capability.
4. To provide practical guidance for strengthening innovation ecosystems in higher education institutions.

1.5 Contributions of the Paper

This study makes several original contributions to innovation management and intellectual property scholarship.

First, it introduces Patent Genome Theory, a new organizational theory that conceptualizes innovation capability as the coordinated functioning of an institutional genome.

Second, it proposes a hierarchical structure comprising three organizational chromosomes, seven organizational genes, Patent Gene Expression, Patent Mutation, and Patent Fitness, thereby extending existing organizational and innovation theories.

Third, it develops a Patent Genome Measurement Framework that can support future empirical validation and institutional benchmarking.

Finally, the theory provides a practical framework that universities, policymakers, and technology transfer organizations can use to diagnose organizational strengths, identify innovation bottlenecks, and design evidence-based interventions.

2. Theoretical Foundation of Patent Genome Theory

2.1 Why an Organizational Genetics Perspective?

Organizations are complex systems composed of multiple interdependent capabilities that collectively determine their performance. Innovation, particularly within higher education institutions, is rarely the product of a single organizational factor. Instead, it emerges from the interaction of governance structures, institutional culture, financial resources, legal expertise, industry engagement, and commercialization mechanisms. Although these elements have been widely studied, they are generally examined as independent variables, resulting in fragmented explanations of institutional innovation capability.

Patent Genome Theory adopts an organizational genetics perspective to address this limitation. The theory uses genetics as a conceptual metaphor rather than a biological analogy. In biology, an organism's characteristics are determined by the coordinated interaction of genes organized within chromosomes. Likewise, Patent Genome Theory proposes that institutional innovation capability is governed by a structured system of organizational components whose collective interaction determines patent performance.

Accordingly, the theory shifts attention from individual innovation determinants to the organizational architecture that integrates them. This perspective explains why institutions possessing similar resources, operating under the same legal framework, and pursuing comparable research activities often demonstrate substantially different patent outcomes.

2.2 Defining the Patent Genome

The central construct of the theory is the Patent Genome.

Definition: The Patent Genome is the complete organizational architecture comprising interdependent organizational chromosomes and genes that collectively determine a higher education institution's capability to generate, protect, manage, transfer, and commercialize intellectual property.

Unlike conventional approaches that measure isolated organizational variables, the Patent Genome represents an integrated innovation system. Every organizational gene performs a specialized function, yet its effectiveness depends upon continuous interaction with the remaining genes. Consequently, institutional innovation capability becomes an emergent organizational property rather than the simple sum of individual organizational strengths.

The Patent Genome therefore serves as the theoretical foundation upon which all subsequent constructs—Patent Gene Expression, Patent Mutation, Patent Fitness, and institutional innovation outcomes—are built.

2.3 Hierarchical Architecture of Patent Genome Theory

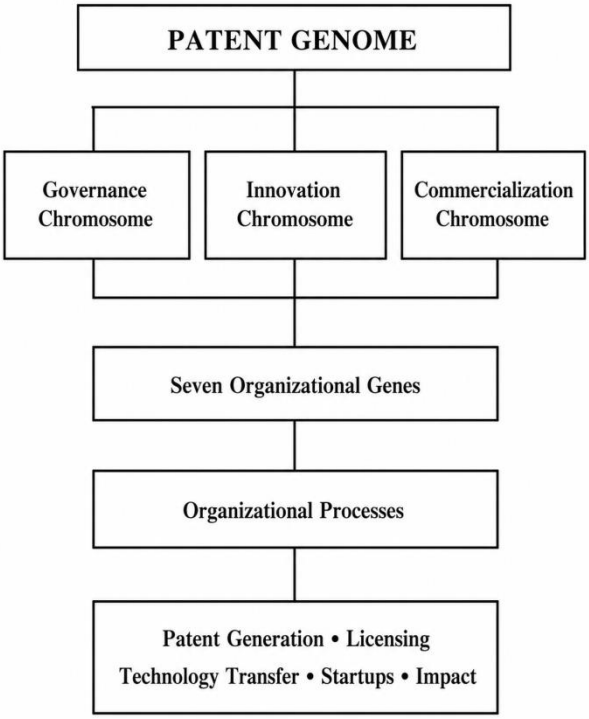
Patent Genome Theory proposes a hierarchical framework consisting of five interconnected levels (Figure 1).

1. Patent Genome – the complete organizational innovation architecture.
2. Organizational Chromosomes – broad functional domains governing innovation.
3. Organizational Genes – institutional capabilities performing specific innovation functions.
4. Organizational Processes – coordinated activities through which genes are expressed.
5. Innovation Outcomes – measurable outputs such as patents, licensing, technology transfer, startups, and societal impact.

Unlike previous organizational theories, this hierarchy explicitly links organizational structure with organizational behaviour and institutional outcomes.

Figure 1 illustrates this conceptual hierarchy.

Figure 1. Conceptual Architecture of Patent Genome Theory



As shown in Figure 1, innovation outcomes are not produced directly by organizational genes. Instead, genes influence institutional processes, which subsequently determine measurable innovation performance. This distinction forms the conceptual basis for the Patent Gene Expression Theory developed in Section 4.

2.4 Organizational Chromosomes

To provide greater conceptual clarity, Patent Genome Theory organizes the seven organizational genes into three functional organizational chromosomes. Chromosomes represent higher-order organizational domains within which related genes perform complementary functions.

(a) Governance Chromosome

The Governance Chromosome establishes the institutional framework through which intellectual property is governed and managed. It consists of:

- Policy Gene
- Legal Gene
- Incentive Gene

Together, these genes define ownership rules, administrative procedures, legal protection, reward systems, and organizational accountability.

(b) Innovation Chromosome

The Innovation Chromosome supports the creation and protection of new knowledge. It comprises:

- Awareness Gene
- Funding Gene

These genes strengthen patent literacy, invention identification, research capability, and financial support throughout the innovation lifecycle.

(c) Commercialization Chromosome

The **Commercialization Chromosome** connects institutional innovation with external stakeholders and market applications. It includes:

- Industry Gene
- Commercialization Gene

These genes facilitate collaborative research, technology transfer, licensing, startup development, and commercialization.

Together, the three chromosomes provide a comprehensive organizational architecture that integrates governance, innovation creation, and market utilization.

Table 2. Organizational Chromosomes and Their Functions

Organizational Chromosome	Constituent Organizational Genes	Primary Institutional Function
Governance Chromosome	Policy, Legal, Incentive	Intellectual property governance, legal protection, and organizational motivation
Innovation Chromosome	Awareness, Funding	Knowledge creation, invention recognition, and innovation support
Commercialization Chromosome	Industry, Commercialization	Technology transfer, industry collaboration, and market value creation

Table 2 demonstrates that each chromosome performs a distinct institutional function. However, none can independently sustain innovation capability. Effective patent performance requires balanced interaction among all three chromosomes.

2.5 Core Assumptions of Patent Genome Theory

Patent Genome Theory is built upon five foundational assumptions.

Assumption 1. Every higher education institution possesses a Patent Genome irrespective of its size, discipline, or research intensity.

Assumption 2. Organizational genes are interdependent; weakness in one gene influences the functioning of the entire Patent Genome.

Assumption 3. Innovation capability depends on the expression of organizational genes rather than their mere existence.

Assumption 4. Organizational genes evolve continuously in response to institutional leadership, technological change, government policy, and industry needs.

Assumption 5. Institutions possessing balanced organizational chromosomes exhibit greater resilience, adaptability, and long-term innovation capability.

These assumptions distinguish Patent Genome Theory from static organizational models by recognizing innovation capability as a dynamic and adaptive organizational phenomenon.

2.6 Theoretical Scope and Boundary Conditions

Patent Genome Theory is developed specifically to explain institutional patent capability within higher education. It is not intended to replace broader theories of innovation or competitive advantage; rather, it complements them by explaining how organizational capabilities are configured and coordinated to support patent generation and commercialization.

The theory is expected to be most applicable in:

- universities,
- publicly funded research institutions,
- technology transfer organizations,
- academic incubators, and
- research-intensive innovation ecosystems.

Its applicability to manufacturing firms or service organizations requires empirical validation and possible refinement.

Recognizing these boundary conditions improves the precision of the theory and provides a clear agenda for future research.

Testable Propositions

Based on the theoretical foundation developed in this section, the following propositions are advanced:

P1a: The strength of the Governance Chromosome is positively associated with Patent Gene Expression.

P1b: The strength of the Innovation Chromosome is positively associated with Patent Gene Expression.

P1c: The strength of the Commercialization Chromosome is positively associated with Patent Gene Expression.

These propositions establish the first empirical relationships within Patent Genome Theory and provide a basis for quantitative validation using institutional survey data or structural equation modelling.

3. Patent Genome Architecture

3.1 Introduction

Patent Genome Theory proposes that institutional innovation capability is governed by a structured organizational architecture composed of interdependent capabilities, referred to as organizational genes. These genes are not physical entities or administrative units; rather, they represent enduring organizational capabilities that collectively regulate how intellectual property is generated, protected, managed, and commercialized.

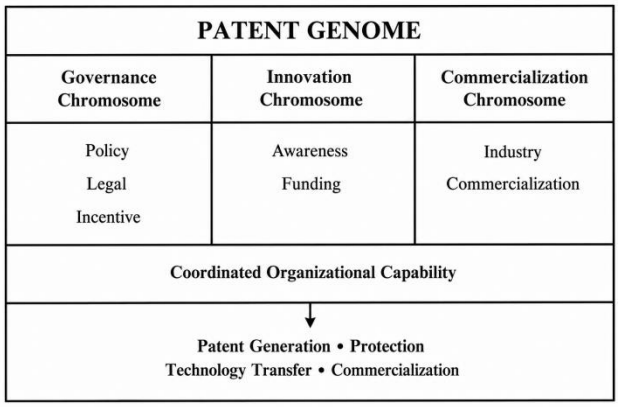
Unlike existing innovation models that examine awareness, funding, policy, legal support, or industry collaboration independently, Patent Genome Theory argues that these capabilities function as an

integrated system. No organizational gene is sufficient on its own. Sustainable innovation emerges only when all genes operate in a coordinated and balanced manner.

The seven organizational genes are grouped within three organizational chromosomes introduced in the previous section. Each gene performs a specialized function while simultaneously interacting with other genes to support institutional innovation capability.

Figure 2 illustrates the organizational architecture of the Patent Genome.

Figure 2. Organizational Architecture of the Patent Genome



As shown in Figure 2, the three organizational chromosomes function as complementary domains rather than independent organizational units. Their interaction creates the institutional capability required for sustainable innovation.

3.2 Awareness Gene (AG)

The Awareness Gene represents the institutional capability to recognize, appreciate, and promote intellectual property within the academic community. It determines whether researchers, faculty members, and students can identify patentable inventions, understand patentability requirements, and appreciate the strategic importance of intellectual property protection.

A strong Awareness Gene is reflected in regular intellectual property awareness programmes, patent literacy workshops, invention disclosure campaigns, and integration of intellectual property education into research and academic activities. Institutions with a well-developed Awareness Gene cultivate a proactive innovation culture in which researchers evaluate the commercial potential of inventions before public disclosure.

Conversely, deficiencies in patent awareness frequently result in premature publication of inventions, missed patent opportunities, and limited researcher participation in innovation activities.

The Awareness Gene therefore functions as the entry point of the Patent Genome by converting scientific knowledge into identifiable intellectual assets.

3.3 Policy Gene (PG)

The Policy Gene represents the institutional capability to govern intellectual property through clear rules, procedures, and administrative mechanisms. It establishes ownership rights, invention disclosure procedures, revenue-sharing mechanisms, conflict-resolution processes, and institutional responsibilities.

A robust Policy Gene provides organizational clarity, reduces administrative uncertainty, and enables consistent decision-making throughout the patent lifecycle. Researchers are more likely to participate in patenting when governance structures are transparent and predictable.

Weak policy frameworks, on the other hand, create ambiguity regarding ownership, delay institutional approvals, and reduce confidence in the university's innovation system.

The Policy Gene therefore provides the governance foundation upon which all subsequent innovation activities depend.

3.4 Legal Gene (LG)

The Legal Gene represents the institutional capability to protect and manage intellectual property through legal expertise and professional support. Its scope extends beyond patent filing to include prior-art searching, patentability assessment, drafting, prosecution, portfolio management, confidentiality management, licensing support, and regulatory compliance.

Institutions possessing a strong Legal Gene consistently produce higher-quality patent applications, respond effectively to examination reports, and maintain stronger intellectual property portfolios.

Weak legal capability often results in procedural errors, abandoned applications, delayed prosecution, and reduced commercial value of institutional patents.

The Legal Gene therefore safeguards the legal integrity of the Patent Genome.

3.5 Incentive Gene (IG)

Innovation requires sustained organizational motivation. The Incentive Gene represents the institutional capability to encourage researchers to participate actively in patent generation and commercialization.

Typical institutional mechanisms include financial rewards, promotion criteria recognizing patents, royalty-sharing policies, innovation awards, seed funding, reduced teaching loads, and entrepreneurial fellowships.

Effective incentive systems influence organizational behaviour by aligning individual academic goals with institutional innovation objectives. Institutions with strong incentive mechanisms generally experience higher invention disclosure rates and greater researcher engagement in commercialization activities.

The Incentive Gene therefore transforms organizational capability into sustained innovation behaviour.

Table 3. Governance Chromosome and Its Organizational Genes

Organizational Gene	Core Capability	Representative Institutional Practices	Expected Organizational Outcome
Awareness Gene	Patent literacy and invention recognition	IPR training, invention disclosure programmes	Increased identification of patentable inventions
Policy Gene	Intellectual property governance	Institutional IPR policy, ownership rules, disclosure procedures	Efficient and transparent IP administration
Legal Gene	Intellectual property protection	Patent drafting, prosecution, legal advisory services	Higher patent quality and stronger IP portfolios
Incentive Gene	Organizational motivation	Rewards, promotion criteria, royalty sharing	Increased researcher participation in patenting

Table 3 summarizes the organizational genes that collectively strengthen institutional governance and innovation readiness. Although each gene performs a distinct role, their effectiveness depends on coordinated interaction rather than isolated implementation.

3.6 Funding Gene (FG)

The Funding Gene represents the institutional capability to mobilize, allocate, and sustain financial resources across the innovation lifecycle. Funding supports research, prototype development, patent filing, prosecution, technology validation, licensing activities, and startup development.

Universities with a strong Funding Gene provide continuous financial support from invention disclosure to commercialization. Such institutions reduce financial barriers that frequently discourage researchers from seeking patent protection.

Funding sources may include institutional budgets, government grants, industrial sponsorship, venture capital, philanthropic contributions, and innovation programmes.

A weak Funding Gene interrupts innovation activities, limiting both patent generation and commercialization potential.

3.7 Industry Gene (InG)

The Industry Gene represents the institutional capability to build productive relationships with industry, startups, investors, and external innovation partners. It facilitates collaborative research, consultancy, sponsored projects, prototype validation, industrial problem identification, and joint intellectual property development.

Strong industry engagement enhances the practical relevance of academic research while creating opportunities for licensing and commercialization.

Institutions with limited industrial collaboration often generate valuable research outputs but experience difficulty translating those outputs into market-ready technologies.

The Industry Gene therefore functions as the primary interface between academic research and industrial innovation.

3.8 Commercialization Gene (CG)

The Commercialization Gene represents the institutional capability to convert protected intellectual property into economic and societal value.

Its activities include technology licensing, startup incubation, spin-off creation, entrepreneurship support, royalty management, market assessment, technology transfer, and post-licensing relationship management.

Commercialization is the ultimate expression of institutional innovation because it transforms scientific knowledge into products, services, and technologies that benefit society.

Without an effective Commercialization Gene, patents remain largely legal assets rather than drivers of economic development.

Table 4. Innovation and Commercialization Chromosomes

Organizational Gene	Core Capability	Representative Institutional Practices	Expected Organizational Outcome
Funding Gene	Financial support for innovation	Research grants, prototype funding, patent filing assistance	Sustained innovation activities
Industry Gene	External collaboration	Sponsored research, consultancy, joint R&D	Increased market relevance and technology validation
Commercialization	Technology transfer	Licensing, startups, spin-offs,	Greater societal and

Organizational Gene	Core Capability	Representative Institutional Practices	Expected Organizational Outcome
Gene	and market deployment	entrepreneurship support	economic impact

As shown in Table 4, innovation capability extends beyond patent generation. Sustainable institutional performance requires adequate financial support, productive external collaboration, and effective commercialization mechanisms.

3.9 Interaction among Organizational Genes

Patent Genome Theory proposes that organizational genes function as an interconnected network rather than as isolated capabilities. Improvements in one gene frequently strengthen others, while deficiencies may propagate throughout the organizational system.

For example, enhanced patent awareness increases invention disclosures, thereby improving the effectiveness of legal support. Strong governance promotes confidence in institutional policies, encouraging greater researcher participation. Successful commercialization generates financial returns that can be reinvested into research, awareness programmes, and innovation infrastructure, reinforcing the entire Patent Genome.

Accordingly, institutional innovation capability is determined by the quality of interactions among organizational genes, rather than by the strength of any single organizational capability.

Testable Propositions

Based on the Patent Genome Architecture, the following propositions are advanced:

P2a: The strength of the Awareness Gene is positively associated with invention disclosure activity.

P2b: The strength of the Policy Gene is positively associated with institutional efficiency in intellectual property management.

P2c: The strength of the Legal Gene is positively associated with patent quality and successful prosecution.

P2d: The strength of the Incentive Gene is positively associated with researcher participation in patenting activities.

P2e: The strength of the Funding Gene is positively associated with institutional patent generation.

P2f: The strength of the Industry Gene is positively associated with technology transfer and collaborative innovation.

P2g: The strength of the Commercialization Gene is positively associated with licensing, startup creation, and commercialization outcomes.

4. Patent Gene Expression Theory

4.1 Introduction

The Patent Genome represents the structural foundation of institutional innovation capability. However, organizational structures alone do not produce patents, technology transfer, or commercialization. Universities may possess well-documented intellectual property policies, dedicated innovation centres, legal support mechanisms, and research funding, yet still demonstrate poor patent performance. Such differences indicate that innovation capability depends not only on the existence of organizational capabilities but also on how effectively they are activated and translated into organizational action.

Patent Genome Theory addresses this issue through the concept of Patent Gene Expression (PGE). Borrowing the principle of gene expression from genetics, the theory proposes that organizational genes influence institutional performance only when they become operational through coordinated organizational processes. Accordingly, Patent Gene Expression explains how organizational capabilities are transformed into measurable innovation outcomes.

Patent Gene Expression therefore acts as the dynamic mechanism connecting the Patent Genome with institutional innovation performance.

4.2 Defining Patent Gene Expression

Patent Genome Theory defines Patent Gene Expression as follows:

Patent Gene Expression is the coordinated activation of organizational genes through institutional processes that transform organizational capability into measurable patent and innovation outcomes.

The concept emphasizes that organizational capabilities possess potential value only when they are effectively implemented. For example, the existence of an institutional intellectual property policy does not automatically improve patent performance. The policy must be understood, implemented, supported by leadership, and integrated into institutional decision-making before it can influence innovation outcomes.

4.3 The Patent Gene Expression Process

Patent Gene Expression is not a single event but a continuous organizational process involving multiple interconnected activities. Innovation capability develops progressively as organizational genes are activated throughout the patent lifecycle.

Figure 3. Patent Gene Expression Cycle

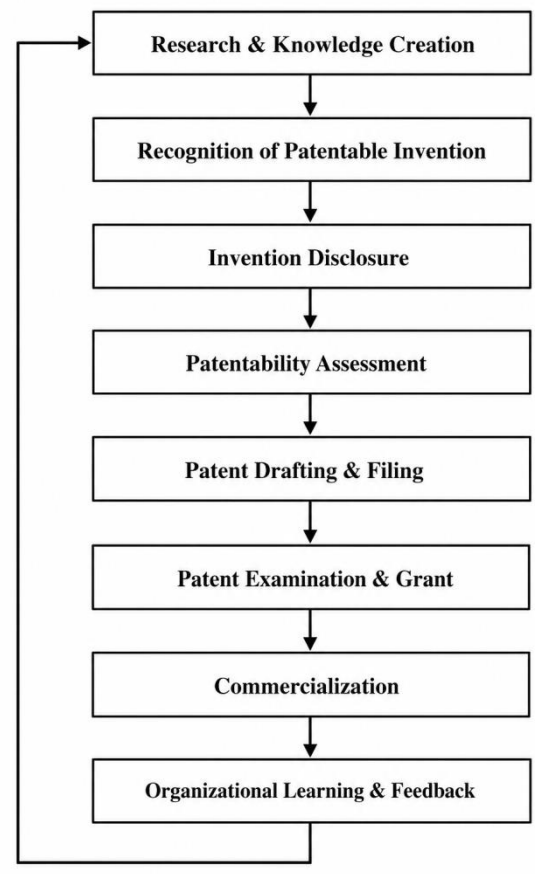


Figure 3 illustrates that Patent Gene Expression functions as a continuous organizational learning cycle rather than a one-time administrative process. Each completed innovation cycle strengthens organizational capability and contributes to the long-term evolution of the Patent Genome.

The process begins with research and knowledge creation, where new scientific or technological ideas emerge. Through the Awareness Gene, researchers identify inventions with commercial potential and submit formal invention disclosures. The Legal Gene supports patentability assessment, prior-art searching, drafting, and filing, while the Policy Gene governs administrative procedures and ownership arrangements. The Funding Gene provides financial resources required for patent protection and prototype development, whereas the Industry Gene facilitates external validation and collaborative development. Finally, the Commercialization Gene enables licensing, startup creation, and technology transfer.

The process is cyclical rather than linear. Revenue, organizational learning, industrial experience, and institutional knowledge generated through commercialization strengthen the Patent Genome, thereby improving future innovation capability.

4.4 Levels of Patent Gene Expression

Patent Genome Theory proposes that universities differ in the degree to which their organizational genes are expressed. Four levels of Patent Gene Expression are identified.

Level I: Dormant Expression

Organizational genes formally exist but remain largely inactive. Innovation activities depend on individual researchers rather than institutional systems. Patent applications are infrequent and organizational learning is limited.

Level II: Emerging Expression

Some organizational genes begin functioning effectively, particularly awareness programmes, basic institutional policies, and limited legal support. Patent filings increase but remain inconsistent because organizational coordination is incomplete.

Level III: Coordinated Expression

Organizational genes operate in an integrated manner. Policies are effectively implemented, invention disclosures increase, funding mechanisms are stable, legal support is readily available, and commercialization activities become systematic. Patent generation becomes an institutional capability rather than an individual achievement.

Level IV: Adaptive Expression

Adaptive Expression represents the highest level of organizational maturity. Universities continuously evaluate and improve their Patent Genome in response to technological change, industrial demand, policy reforms, and global innovation trends. Organizational learning becomes embedded within institutional culture, enabling sustained innovation performance.

Table 5. Levels of Patent Gene Expression

Level	Characteristics	Institutional Behaviour	Expected Innovation Outcome
Dormant	Organizational genes largely inactive	Innovation depends on individuals	Low patent output
Emerging	Partial organizational activation	Increasing awareness and patent activity	Moderate patent growth

Level	Characteristics	Institutional Behaviour	Expected Innovation Outcome
Coordinated	Integrated organizational processes	Institution-wide innovation culture	Consistent patent generation
Adaptive	Continuous organizational learning	Dynamic improvement and strategic adaptation	Sustainable innovation leadership

As shown in Table 5, Patent Gene Expression reflects organizational maturity rather than simply the number of patents produced. Institutions may exhibit similar patent counts while operating at different levels of organizational capability.

4.5 Drivers of Patent Gene Expression

Patent Gene Expression is influenced by several organizational conditions that determine whether institutional capabilities remain dormant or become fully operational.

Strategic Leadership aligns innovation with institutional priorities and ensures long-term commitment to intellectual property management.

Innovation Culture encourages researchers to recognize patentable inventions, disclose research outcomes, and participate in commercialization activities.

Administrative Efficiency reduces procedural delays associated with invention disclosures, patent filing, and technology transfer.

Interdisciplinary Collaboration promotes knowledge exchange across departments and increases the likelihood of developing commercially valuable technologies.

External Networks, including industry partnerships, incubators, government agencies, and investors, provide technical expertise, financial resources, and commercialization opportunities that strengthen gene expression.

These drivers collectively determine the effectiveness with which organizational capabilities are translated into innovation outcomes.

4.6 Inhibitors of Patent Gene Expression

Patent Genome Theory also recognizes that organizational capabilities may remain underutilized because of institutional inhibitors. Common inhibitors include:

- inadequate leadership commitment;
- weak innovation culture;
- poor communication among stakeholders;
- bureaucratic administrative procedures;
- insufficient patent expertise;
- fragmented industry collaboration;
- lack of commercialization support; and
- inconsistent institutional incentives.

These inhibitors suppress organizational gene expression even when the underlying organizational genes formally exist.

Understanding such inhibitors enables institutions to distinguish between **structural weaknesses** (addressed later through Patent Mutation Theory) and **operational inefficiencies** that reduce organizational performance.

4.7 Theoretical Significance of Patent Gene Expression

Patent Gene Expression extends Patent Genome Theory beyond structural analysis by introducing a dynamic explanation of organizational innovation capability. It demonstrates that institutional performance is determined not merely by the presence of organizational capabilities but by the effectiveness with which those capabilities are activated, coordinated, and continuously improved.

This distinction also differentiates Patent Genome Theory from the Resource-Based View and Dynamic Capabilities Theory. While those theories explain the importance of organizational resources and adaptation, Patent Gene Expression specifies the internal organizational mechanism through which capabilities are converted into patent generation, technology transfer, and commercialization.

Testable Propositions

The following propositions arise from Patent Gene Expression Theory.

P3a: Patent Gene Expression mediates the relationship between Patent Genome strength and institutional patent performance.

P3b: Higher levels of Patent Gene Expression are positively associated with patent generation.

P3c: Higher levels of Patent Gene Expression are positively associated with technology transfer performance.

P3d: Higher levels of Patent Gene Expression are positively associated with commercialization success.

P3e: Organizational learning positively moderates the relationship between Patent Gene Expression and Patent Fitness.

5. Patent Mutation Theory and Innovation Disorders

5.1 Introduction

Organizations seldom fail because they lack innovation potential; they more often underperform because critical organizational capabilities become weakened, fragmented, or poorly coordinated. Universities may possess intellectual property policies, dedicated IPR cells, research funding, and experienced researchers, yet continue to demonstrate unsatisfactory patent performance. Such situations indicate that organizational capabilities exist but do not function as intended. Patent Genome Theory explains this phenomenon through the concept of Patent Mutation.

Borrowing the mutation metaphor from genetics, Patent Mutation refers to persistent deficiencies that impair the normal functioning of organizational genes. Unlike temporary operational problems, mutations represent structural or functional weaknesses that reduce the effectiveness of the Patent Genome and diminish institutional innovation capability. Because organizational genes are interdependent, a mutation affecting one gene may influence several others, creating cascading effects across the institutional innovation ecosystem.

Patent Mutation Theory therefore complements Patent Gene Expression Theory by explaining why organizational capability sometimes fails despite the presence of apparently adequate institutional resources.

5.2 Defining Patent Mutation

Patent Genome Theory defines Patent Mutation as follows:

Patent Mutation is a persistent structural or functional deficiency within one or more organizational genes that disrupts the coordinated functioning of the Patent Genome and reduces institutional innovation capability.

Patent Mutations differ from routine administrative challenges. Occasional delays in patent filing or temporary reductions in research funding do not necessarily constitute mutations. A mutation exists only when deficiencies become systematic, recurring, and sufficiently significant to impair organizational performance over time.

For example, an institution may possess an intellectual property policy, but if the policy is outdated, poorly implemented, or rarely understood by researchers, the Policy Gene becomes functionally impaired. Similarly, the absence of qualified patent professionals weakens the Legal Gene even though an IPR Cell formally exists.

Patent Mutation Theory therefore emphasizes organizational effectiveness rather than organizational existence.

5.3 Classification of Patent Mutations

Each organizational gene may develop its own characteristic mutation. These mutations correspond directly to the seven organizational genes introduced in Section 3.

Awareness Mutation (AM)

Awareness Mutation occurs when researchers possess inadequate knowledge of patentability, prior-art searching, invention disclosure procedures, or intellectual property rights. As a result, valuable inventions are often published before protection or remain undisclosed.

Policy Mutation (PM)

Policy Mutation arises when institutional intellectual property policies are absent, outdated, ambiguous, or inconsistently implemented. Such deficiencies create uncertainty regarding ownership, benefit sharing, confidentiality, and administrative responsibilities.

Legal Mutation (LM)

Legal Mutation reflects inadequate institutional legal capability. Poor patent drafting, delayed prosecution, ineffective portfolio management, and insufficient intellectual property expertise reduce the quality and enforceability of patents.

Incentive Mutation (IM)

Incentive Mutation occurs when institutions fail to reward innovation adequately. Promotion systems that recognize publications but ignore patents frequently discourage researchers from pursuing intellectual property protection.

Funding Mutation (FM)

Funding Mutation represents persistent financial constraints affecting research commercialization, patent filing, prototype development, licensing, or startup creation. Limited financial support interrupts the innovation lifecycle.

Industry Mutation (InM)

Industry Mutation reflects weak collaboration between universities and external stakeholders. Limited industrial engagement reduces opportunities for collaborative research, market validation, sponsored projects, and technology transfer.

Commercialization Mutation (CM)

Commercialization Mutation occurs when institutions successfully generate patents but fail to convert them into practical, social, or economic value through licensing, startup creation, or technology transfer.

Table 6. Classification of Patent Mutations

Patent Mutation	Organizational Gene Affected	Typical Indicators	Organizational Consequences
Awareness Mutation	Awareness	Low patent literacy, poor invention disclosure	Missed patent opportunities
Policy Mutation	Policy	Weak or outdated IP policy	Administrative uncertainty
Legal Mutation	Legal	Poor patent drafting, delayed prosecution	Weak patent portfolio
Incentive Mutation	Incentive	Limited rewards and recognition	Reduced researcher participation
Funding Mutation	Funding	Insufficient innovation funding	Lower patent generation
Industry Mutation	Industry	Weak university–industry collaboration	Reduced technology relevance
Commercialization Mutation	Commercialization	Poor licensing and startup support	Limited economic and societal impact

Table 6 demonstrates that Patent Mutations are not isolated administrative problems. Each mutation affects a specific organizational capability while simultaneously influencing the overall effectiveness of the Patent Genome.

5.4 Interaction Among Patent Mutations

Figure 4. Organizational Mutation Framework

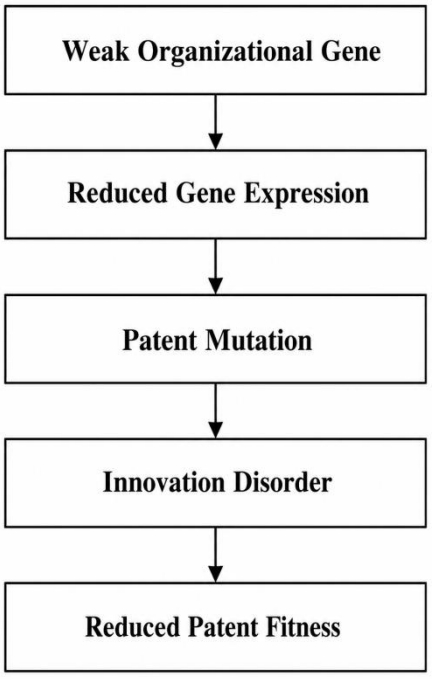


Figure 4 illustrates the progression from localized organizational weakness to institution-wide innovation decline. Early identification of mutations can therefore prevent long-term deterioration in institutional innovation capability.

Patent Mutations rarely occur independently. Because organizational genes operate as an integrated system, deficiencies in one gene frequently generate secondary weaknesses elsewhere in the Patent Genome.

For example, weak patent awareness reduces invention disclosures, limiting the effectiveness of legal support and decreasing commercialization opportunities. Similarly, inadequate funding may restrict prototype development, discourage industry collaboration, and ultimately reduce licensing potential. Inconsistent institutional policies may undermine incentive programmes by creating uncertainty regarding ownership and revenue sharing.

Patent Genome Theory therefore proposes that organizational mutations should be analysed as interacting deficiencies rather than isolated institutional problems. Corrective interventions should likewise address underlying organizational relationships instead of focusing exclusively on individual symptoms.

5.5 Innovation Disorders

When multiple Patent Mutations persist over time, they may collectively produce broader organizational conditions referred to as **Innovation Disorders**. These disorders represent systemic failures of the Patent Genome rather than isolated administrative deficiencies.

Patent Genome Theory identifies three principal Innovation Disorders.

Innovation Deficiency Disorder (IDD)

Innovation Deficiency Disorder is characterized by chronically low patent activity resulting from widespread weakness across multiple organizational genes. Institutions typically exhibit poor invention disclosure rates, few patent applications, and minimal commercialization.

Innovation Imbalance Disorder (IID)

Innovation Imbalance Disorder occurs when some organizational genes are highly developed while others remain substantially underdeveloped. For example, an institution may possess excellent research capability but weak commercialization systems. Although patents are generated, their broader societal and economic impact remains limited.

Innovation Stagnation Disorder (ISD)

Innovation Stagnation Disorder reflects the inability of an institution to adapt its Patent Genome to changing technological, industrial, or policy environments. These institutions often rely on outdated organizational practices and gradually lose innovation competitiveness.

5.6 Organizational Diagnosis and Corrective Strategies

Patent Mutation Theory provides a practical diagnostic framework for institutional leaders. Rather than evaluating innovation solely through patent statistics, universities should periodically assess:

- the strength of each organizational gene;
- interactions among organizational genes;
- the prevalence and severity of Patent Mutations;
- emerging Innovation Disorders; and
- organizational interventions required to restore balanced innovation capability.

Such assessments enable institutions to move from reactive problem-solving to proactive innovation management.

5.7 Theoretical Significance

Patent Mutation Theory extends organizational innovation research by introducing the concept of organizational pathology into patent management. Existing innovation theories generally explain why organizations succeed but devote relatively little attention to how organizational weaknesses evolve and spread across innovation systems.

By identifying recurring organizational deficiencies, Patent Mutation Theory provides a structured framework for diagnosing institutional innovation failures and designing targeted corrective strategies. It therefore strengthens the explanatory power of Patent Genome Theory while providing a bridge between organizational capability and long-term innovation performance.

Testable Propositions

The following propositions arise from Patent Mutation Theory.

P4a: Patent Mutations are negatively associated with Patent Gene Expression.

P4b: Patent Mutations are negatively associated with institutional patent generation.

P4c: Patent Mutations are negatively associated with technology transfer performance.

P4d: Patent Mutations are negatively associated with Patent Fitness.

P4e: The cumulative effect of multiple Patent Mutations is greater than the effect of any individual mutation on institutional innovation capability.

6. Patent Fitness Theory and the Patent Genome Measurement Framework

6.1 Introduction

The preceding sections established that the Patent Genome provides the structural foundation of institutional innovation capability, Patent Gene Expression explains how organizational capabilities are activated, and Patent Mutation Theory identifies the deficiencies that weaken organizational performance. However, an important question remains unanswered:

How can the overall health and effectiveness of an institution's Patent Genome be evaluated?

Existing measures of university innovation commonly rely on isolated performance indicators such as the number of patent applications, patents granted, research publications, licensing revenue, startup creation, or industry-sponsored projects. While these indicators provide valuable information, they primarily measure innovation outputs rather than the organizational capability responsible for producing those outputs.

Patent Genome Theory addresses this limitation by introducing Patent Fitness Theory, which shifts the focus from measuring innovation results alone to assessing the underlying organizational condition that enables sustainable innovation. Patent Fitness represents the overall effectiveness, adaptability, and resilience of the Patent Genome.

6.2 Defining Patent Fitness

Patent Genome Theory defines Patent Fitness as follows:

Patent Fitness is the overall ability of an institution's Patent Genome to sustain coordinated organizational capability that consistently generates, protects, commercializes, and continuously improves intellectual property outcomes over time.

Patent Fitness extends beyond patent quantity. A university producing a large number of patent applications may still exhibit low Patent Fitness if those patents are of poor quality, rarely commercialized, or generated through unsustainable organizational practices. Conversely, an institution

with fewer but strategically valuable patents supported by effective governance, strong commercialization, and continuous organizational learning may demonstrate higher Patent Fitness.

Accordingly, Patent Fitness reflects the long-term health of the organizational innovation system, rather than short-term innovation output.

6.3 Dimensions of Patent Fitness

Patent Genome Theory proposes that Patent Fitness is a multidimensional construct consisting of five complementary dimensions.

(a) Structural Fitness

Structural Fitness evaluates the completeness and balance of the Patent Genome. It examines whether all organizational genes exist and whether the three organizational chromosomes are adequately developed.

(b) Functional Fitness

Functional Fitness measures the effectiveness with which organizational genes are expressed through institutional processes. It reflects the degree of coordination among awareness, governance, legal support, funding, industry collaboration, and commercialization.

(c) Adaptive Fitness

Adaptive Fitness reflects the institution's ability to modify its Patent Genome in response to technological advances, policy reforms, industrial requirements, and emerging innovation opportunities.

(d) Collaborative Fitness

Collaborative Fitness evaluates the strength of relationships with industry, government agencies, investors, startups, and other innovation partners. Effective external collaboration strengthens both organizational learning and commercialization capability.

(e) Sustainable Fitness

Sustainable Fitness measures the institution's ability to maintain innovation capability over extended periods through organizational learning, leadership commitment, financial stability, and continuous improvement.

Together, these dimensions provide a comprehensive assessment of institutional innovation capability.

6.4 Patent Genome Measurement Framework (PGMF)

One of the principal contributions of Patent Genome Theory is the development of the Patent Genome Measurement Framework (PGMF). Unlike conventional innovation metrics that focus primarily on outputs, the PGMF evaluates both organizational capabilities and innovation outcomes.

The framework consists of four complementary indices.

Patent Genome Index (PGI)

The Patent Genome Index measures the strength of the seven organizational genes and the overall balance of the three organizational chromosomes. It reflects the structural quality of the Patent Genome.

Patent Gene Expression Index (PGEI)

The Patent Gene Expression Index measures the extent to which organizational genes are effectively activated through institutional processes. Higher values indicate greater organizational coordination and innovation maturity.

Patent Mutation Index (PMI)

The Patent Mutation Index measures the prevalence and severity of organizational deficiencies affecting the Patent Genome. Higher values indicate greater organizational vulnerability and lower institutional effectiveness.

Patent Fitness Index (PFI)

The Patent Fitness Index provides an integrated assessment of institutional innovation capability by combining information from the Patent Genome, Gene Expression, and Mutation indices.

Patent Genome Theory proposes that institutions with high PGI and PGEI together with low PMI will generally demonstrate high Patent Fitness.

Table 7. Patent Genome Measurement Framework

Index	Purpose	Primary Assessment Focus	Interpretation
Patent Genome Index (PGI)	Measures organizational structure	Strength of chromosomes and organizational genes	Higher values indicate stronger organizational capability
Patent Gene Expression Index (PGEI)	Measures organizational activation	Coordination and implementation of organizational processes	Higher values indicate stronger organizational maturity
Patent Mutation Index (PMI)	Measures organizational weaknesses	Severity of structural and functional deficiencies	Higher values indicate greater organizational risk
Patent Fitness Index (PFI)	Measures overall innovation capability	Integrated assessment of organizational health	Higher values indicate greater long-term innovation capability

Table 7 illustrates that the four indices evaluate complementary dimensions of institutional innovation rather than duplicating one another. Together they provide a balanced assessment of both organizational capability and innovation performance.

6.5 Assessing Patent Fitness

Patent Fitness should be evaluated using a balanced combination of organizational indicators and innovation outcomes. Potential assessment criteria include:

- strength of institutional IPR policies;
- effectiveness of patent awareness programmes;
- quality of legal and patent drafting support;
- adequacy of research and patent funding;
- depth of industry collaboration;
- effectiveness of commercialization mechanisms;
- patent application and grant performance;
- licensing and technology transfer activities;
- startup and spin-off creation; and
- organizational learning and continuous improvement.

Patent Genome Theory does not prescribe fixed numerical weights for these indicators. Instead, the framework is intentionally flexible so that future empirical research can develop validated measurement scales suited to different institutional contexts.

6.6 Practical Applications of Patent Fitness Theory

Figure 5. Patent Genome Dashboard

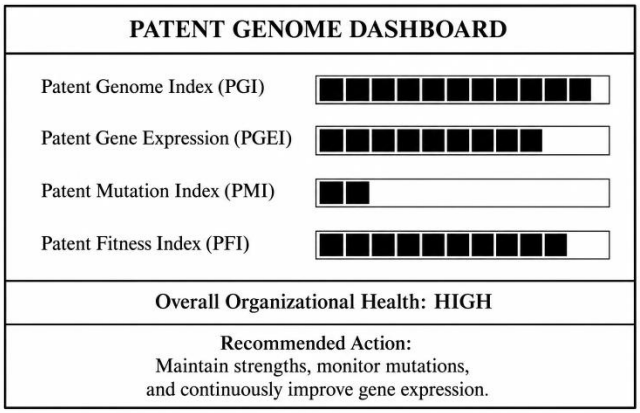


Figure 5 presents a conceptual dashboard that illustrates how institutional leaders may visualize the condition of their Patent Genome. The dashboard is intended as a decision-support tool rather than a fixed scoring model and can be adapted for future empirical applications.

Patent Fitness Theory provides several practical applications for institutional leaders and policymakers.

First, universities can use the framework to diagnose organizational strengths and weaknesses before they become significant barriers to innovation.

Second, institutional benchmarking becomes possible by comparing Patent Fitness across universities with similar missions or research profiles.

Third, policymakers may use Patent Fitness assessments to identify institutions requiring targeted capacity-building initiatives rather than relying solely on patent statistics.

Finally, repeated assessment of Patent Fitness enables universities to monitor organizational improvement over time and evaluate the effectiveness of innovation policies and strategic interventions.

Thus, Patent Fitness functions not only as a theoretical construct but also as a practical management tool for strengthening institutional innovation ecosystems.

6.7 Theoretical Significance

Patent Fitness Theory completes the conceptual architecture of Patent Genome Theory by introducing a mechanism for evaluating institutional innovation capability in a holistic manner. Existing innovation research frequently measures outputs such as patent counts, licensing income, or startup formation. In contrast, Patent Fitness emphasizes the organizational conditions that make these outcomes sustainable.

By integrating organizational structure (Patent Genome), organizational processes (Patent Gene Expression), organizational weaknesses (Patent Mutation), and organizational health (Patent Fitness), the theory offers a comprehensive framework for understanding how universities develop and sustain innovation capability over time.

Testable Propositions

The following propositions arise from Patent Fitness Theory.

P5a: Patent Gene Expression is positively associated with Patent Fitness.

P5b: Patent Mutation is negatively associated with Patent Fitness.

P5c: Patent Fitness is positively associated with institutional patent generation.

P5d: Patent Fitness is positively associated with technology transfer and commercialization outcomes.

P5e: Patent Fitness mediates the relationship between Patent Gene Expression and long-term institutional innovation performance.

7. Theoretical Contributions, Practical Implications, Boundary Conditions, and Future Research

7.1 Theoretical Contributions

Patent Genome Theory makes several original contributions to innovation management, intellectual property research, and organizational theory by introducing a comprehensive framework that explains how universities develop and sustain patent capability. Rather than examining isolated organizational variables, the theory conceptualizes institutional innovation as an integrated organizational system whose effectiveness depends on the coordinated functioning of multiple organizational capabilities.

Contribution 1: A New Organizational Theory for Patent Management

The principal contribution of this paper is the development of Patent Genome Theory (PGT) as a new conceptual theory explaining institutional patent capability. Existing theories such as the Resource-Based View, Knowledge-Based View, Dynamic Capabilities Theory, Triple Helix Model, and National Innovation Systems explain important dimensions of innovation, but none specifically describes the internal organizational architecture governing patent generation and commercialization.

Patent Genome Theory fills this gap by proposing that institutional innovation capability is determined by the interaction of organizational chromosomes, organizational genes, Patent Gene Expression, Patent Mutation, and Patent Fitness.

Contribution 2: Organizational Genetics as a Conceptual Lens

This study introduces organizational genetics as a novel theoretical perspective for innovation research. Rather than treating awareness, policy, legal support, funding, industry collaboration, and commercialization as independent organizational variables, Patent Genome Theory conceptualizes them as interdependent organizational genes.

This perspective provides a more holistic explanation of organizational capability because it emphasizes relationships, coordination, and interaction among institutional capabilities rather than isolated organizational resources.

Contribution 3: Integration of Structure, Process, and Performance

Existing innovation theories frequently emphasize either organizational resources or organizational outcomes. Patent Genome Theory integrates three complementary dimensions into a single conceptual framework.

- Structure is represented by the Patent Genome and organizational chromosomes.
- Process is represented by Patent Gene Expression.
- Performance is represented by Patent Fitness and long-term innovation outcomes.

This integration provides a clearer explanation of how organizational capability develops and influences institutional performance.

Contribution 4: Introducing Organizational Pathology

Patent Mutation Theory extends innovation research by introducing the concept of organizational pathology. Rather than focusing exclusively on organizational strengths, the theory explains how recurring deficiencies weaken institutional innovation capability and reduce long-term competitiveness.

This contribution provides researchers with a systematic vocabulary for analysing institutional weaknesses instead of merely describing innovation failures.

Contribution 5: A Measurable Conceptual Framework

Patent Genome Theory is intentionally designed to support empirical research. The introduction of the Patent Genome Index (PGI), Patent Gene Expression Index (PGEI), Patent Mutation Index (PMI), and Patent Fitness Index (PFI) provides future researchers with measurable constructs that can be operationalized through validated survey instruments and organizational assessment tools.

Consequently, Patent Genome Theory functions not only as a conceptual explanation but also as a foundation for future empirical investigation.

7.2 Practical Implications

Although Patent Genome Theory is conceptual, it also offers significant practical value for universities, policymakers, technology transfer organizations, and research administrators.

Universities

Universities can use Patent Genome Theory as an organizational diagnostic framework to evaluate the strength of their innovation ecosystem. Rather than relying solely on patent counts, institutional leaders can identify which organizational genes require strengthening and design targeted interventions accordingly.

The framework also encourages universities to view innovation capability as a coordinated institutional responsibility rather than an activity confined to individual researchers or intellectual property offices.

Policymakers

Government agencies responsible for research and innovation policy may use Patent Genome Theory to design institutional capacity-building programmes.

Instead of allocating resources solely on the basis of patent statistics, policymakers can assess organizational capability and provide support in areas such as awareness generation, legal expertise, commercialization infrastructure, or industry collaboration.

Such an approach promotes sustainable innovation rather than short-term increases in patent numbers.

Technology Transfer Offices (TTOs)

Technology Transfer Offices can use the Patent Genome framework to monitor institutional innovation capability across different stages of the patent lifecycle.

Periodic evaluation of Patent Gene Expression and Patent Mutations enables TTOs to identify organizational bottlenecks before they significantly affect patent generation or commercialization performance.

Funding Agencies

Funding organizations may employ Patent Genome Theory when evaluating institutional readiness for innovation grants.

Assessing Patent Fitness alongside research excellence provides a more comprehensive understanding of an institution's capacity to convert research into societal and economic impact.

Researchers

For academic researchers, Patent Genome Theory offers a new conceptual framework for studying organizational innovation. The theory creates opportunities for interdisciplinary research involving innovation management, intellectual property, organizational behaviour, public policy, and higher education management.

Table 8. Practical Applications of Patent Genome Theory

Stakeholder	Application	Expected Benefit
Universities	Organizational diagnosis and strategic planning	Stronger institutional innovation capability
Policymakers	Capacity-building and policy design	Improved national innovation performance
Technology Transfer Offices	Monitoring Patent Gene Expression and Patent Mutations	More efficient IP management
Funding Agencies	Evaluation of institutional innovation readiness	Better allocation of research funding
Researchers	Theory development and empirical validation	Expansion of organizational innovation research

Table 8 demonstrates that Patent Genome Theory has practical relevance beyond academic discussion. Its concepts can support strategic decision-making at multiple levels of the innovation ecosystem.

7.3 Boundary Conditions

Every theory has limits to its applicability, and clearly identifying those limits strengthens theoretical precision.

First, Patent Genome Theory has been developed specifically to explain institutional patent capability within higher education institutions. Although several concepts may be transferable to research organizations or technology-intensive firms, such applications require empirical validation.

Second, the theory focuses on organizational capability rather than individual creativity or technological excellence. Highly creative researchers may produce valuable inventions even within weak organizational systems; however, Patent Genome Theory explains the institutional conditions that enable such innovation to be sustained over time.

Third, the theory does not attempt to explain macro-level national innovation performance. National policies, economic conditions, and legal systems undoubtedly influence institutional innovation, but these external factors remain outside the immediate scope of the Patent Genome.

Finally, Patent Genome Theory assumes that institutions possess a minimum level of research activity. Its explanatory power may therefore be limited in organizations with negligible research capacity or without formal innovation objectives.

Recognizing these boundary conditions enhances the clarity and credibility of the theory while defining appropriate contexts for future application.

7.4 Future Research Directions

Patent Genome Theory opens several promising avenues for future research.

First, the conceptual constructs proposed in this paper should be operationalized into validated measurement scales for the Patent Genome Index, Patent Gene Expression Index, Patent Mutation Index, and Patent Fitness Index.

Second, future studies should empirically test the propositions advanced throughout this paper using quantitative methods such as structural equation modelling, multilevel modelling, or longitudinal analysis.

Third, comparative studies may investigate differences in Patent Fitness among universities with varying research intensity, disciplinary specialization, or institutional governance structures.

Fourth, cross-national research may evaluate the applicability of Patent Genome Theory across different legal and innovation systems, thereby assessing its international generalizability.

Fifth, future studies may examine how digital transformation, artificial intelligence, open innovation, and interdisciplinary collaboration influence the evolution of organizational genes.

Finally, researchers may explore whether the organizational genetics perspective can be extended beyond patents to other forms of intellectual property, including industrial designs, copyrights, trademarks, plant varieties, and technology licensing systems.

These research opportunities demonstrate that Patent Genome Theory is intended as a platform for continued theoretical development rather than a closed conceptual model.

7.5 Overall Theoretical Model

The complete theoretical logic of Patent Genome Theory can now be summarized as follows:

Patent Genome→ defines the institutional organizational architecture.
Organizational Chromosomes→ organize complementary innovation capabilities.
Organizational Genes→ provide specialized institutional functions.
Patent Gene Expression→ activates organizational capabilities.
Patent Mutation→ weakens organizational functioning.
Patent Fitness→ reflects the long-term health of the innovation system.
Innovation Outcomes→ include patent generation, technology transfer, commercialization, entrepreneurship, and societal impact.

This sequential logic demonstrates that sustainable innovation results not from isolated organizational factors but from the coordinated functioning of the entire Patent Genome.

8. Conclusion

Innovation has become a defining responsibility of higher education institutions, extending beyond the traditional missions of teaching and research. Universities are increasingly expected to generate intellectual property, facilitate technology transfer, support entrepreneurship, and contribute to economic and societal development. Despite operating under similar legal, financial, and policy environments, however, institutions continue to demonstrate considerable variation in patent generation and commercialization performance. Existing innovation theories explain many aspects of organizational capability, yet they provide only a partial understanding of the internal organizational architecture that governs institutional patent capability.

This paper proposed Patent Genome Theory (PGT) as a new conceptual framework for explaining how universities develop, sustain, and enhance organizational innovation capability. Drawing upon an organizational genetics perspective, the theory conceptualizes institutional innovation as an integrated system consisting of three organizational chromosomes, seven organizational genes, Patent Gene Expression, Patent Mutation, and Patent Fitness. Collectively, these constructs explain how organizational capabilities are organized, activated, weakened, and continuously improved to produce sustainable innovation outcomes.

A central contribution of Patent Genome Theory is its distinction between organizational structure and organizational functioning. The Patent Genome represents the structural architecture of institutional innovation capability, whereas Patent Gene Expression explains how these organizational capabilities are transformed into coordinated institutional processes. Patent Mutation Theory complements this

perspective by identifying recurring organizational deficiencies that weaken innovation performance, while Patent Fitness Theory provides a holistic assessment of the long-term health, adaptability, and resilience of the institutional innovation system.

Unlike conventional approaches that primarily evaluate innovation through patent counts or commercialization statistics, Patent Genome Theory emphasizes the organizational conditions responsible for generating those outcomes. This shift from output-oriented evaluation to capability-oriented assessment enables a more comprehensive understanding of institutional innovation performance. Universities with similar patent outputs may differ substantially in their underlying organizational capability, making Patent Fitness a more meaningful indicator of sustainable innovation than patent quantity alone.

Another important contribution of this study is the introduction of four original conceptual indices: the Patent Genome Index (PGI), Patent Gene Expression Index (PGEI), Patent Mutation Index (PMI), and Patent Fitness Index (PFI). These constructs provide a foundation for future empirical measurement and institutional benchmarking. Rather than prescribing fixed numerical models, the paper establishes a conceptual framework that future researchers can operationalize through validated measurement instruments suited to different institutional and national contexts.

Patent Genome Theory also contributes to organizational theory by introducing the concept of organizational genetics into innovation management. Existing theories have traditionally emphasized resources, knowledge, organizational adaptation, or external collaboration. Patent Genome Theory complements these perspectives by focusing on the internal organizational architecture that coordinates these capabilities. In doing so, it offers a coherent explanation for why institutions operating under similar external conditions often achieve markedly different innovation outcomes.

The theory further extends innovation research by introducing the concept of organizational pathology through Patent Mutation Theory. By identifying recurring structural and functional deficiencies that impair institutional innovation capability, the framework provides a systematic approach for diagnosing organizational weaknesses and designing targeted interventions. This diagnostic perspective has significant practical relevance for university administrators, technology transfer offices, policymakers, and funding agencies seeking to strengthen institutional innovation ecosystems.

Although Patent Genome Theory has been developed specifically for higher education institutions, its conceptual foundations may have broader applicability to other research-intensive organizations. Nevertheless, empirical validation across different institutional contexts remains an important priority. Future research should develop reliable measurement scales for the proposed indices, test the theoretical propositions advanced in this paper, compare Patent Fitness across institutions and countries, and examine how emerging technologies such as artificial intelligence, digital transformation, and open innovation influence the evolution of organizational genes.

In conclusion, Patent Genome Theory offers a comprehensive and integrative explanation of institutional patent capability by combining organizational structure, organizational processes, organizational weaknesses, and organizational performance within a unified theoretical framework. Rather than viewing patent generation as the outcome of isolated organizational factors, the theory demonstrates that sustainable innovation emerges from the coordinated interaction of multiple organizational capabilities operating as an integrated Patent Genome. By providing a coherent conceptual foundation together with measurable constructs for future empirical investigation, Patent Genome Theory contributes to the

advancement of innovation management scholarship and offers a practical framework for strengthening innovation ecosystems within higher education institutions.

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