УДК 347.77:001.895
DOI 10.47367/0021-3497_2025_2_326

INTELLECTUAL PROPERTY LAWS IN THE AGE OF OPEN INNOVATION FOR TEXTILE DESIGN

ЗАКОНЫ ОБ ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ В ЭПОХУ ОТКРЫТЫХ ИННОВАЦИЙ В ТЕКСТИЛЬНОМ ДИЗАЙНЕ

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As open innovation models gain traction within the textile design area, more complex issues regarding intellectual property (IP) protection, ownership, and dispute resolution have emerged. Long-established IP frameworks, which were originally envisioned for single inventors or centrally-coordinated entities are increasingly inadequate to address the fluid, multi-contributor nature of global innovation. This study creates a review of unique data from qualitative 50 semi-structured interviews and a quantitative analysis of 200 historic IP disputes through the lens of open textile innovation, and assesses the effectiveness and limits of present-day IP arrangements. Findings show that formal agreements related to ownership and licensing help in reducing the rates at which disputes arise, as well as the amount of time spent disputing; when there are five or more contributors on a project, it is particularly vulnerable to conflict due to heightened ambiguity about ownership and licensing. There were regional variations in dispute resolution, with jurisdictions exhibiting differing preferences for the use/how to utilize the courts or negotiate their differences. Thematic analysis indicated persistent issues around enforcement across jurisdictions, risks for informal agreements, and rigidity in licensing. The findings indicate that, in the absence of adaptive legal tools and frameworks, stakeholders are at increased risk of legal uncertainty and financial exposure.

По мере того как модели открытых инноваций набирают обороты в области текстильного дизайна, вопросы, касающиеся защиты интеллектуальной собственности (ИС), права собственности и разрешения споров, становятся все более сложными. Давно устоявшиеся правила защиты ИС, которые изначально были предусмотрены для отдельных изобретателей или централизованно координируемых организаций, все больше не соответствуют изменчивой, многосторонней природе глобальных инноваций. Это исследование содержит обзор уникальных данных из 50 качественных полуструктурированных интервью и количественного анализа 200 судебных дел по ИС в текстильной индустрии через призму открытых инноваций, а также оценивает эффективность и ограничения современных соглашений по ИС. Результаты показывают, что формальные соглашения, связанные с правом собственности и лицензированием, помогают снизить число споров, а также количество времени, затрачиваемого на споры; когда в проекте участвуют пять или более участников, повышается вероятность возникновения конфликтов из-за повышенной двусмысленности в отношении права собственности и лицензирования. Выявлены региональные различия в разрешении споров, при этом юрисдикции демонстрировали разные предпочтения судов в отношении способов использования ИС и урегулирования разногласий. Тематический анализ выявил постоянные проблемы, связанные с исполнением законодательства в разных юрисдикциях, рисками неформальных соглашений и жесткостью лицензирования. Результаты показывают, что при отсутствии адаптивных правовых инструментов и структур заинтересованные стороны подвергаются повышенному риску правовой неопределенности и финансовым рискам.

Keywords: intellectual property law; open innovation; textile design; collaborative licensing; dispute resolution; legal frameworks; multi-contributor intellectual property; design law.

Ключевые слова: защита интеллектуальной собственности; открытые инновации; текстильный дизайн; совместное лицензирование; разрешение споров; правовые рамки; интеллектуальная собственность с несколькими участниками; законодательство в области дизайна.

Introduction

The textile design industry has known a lot of changes over the past couple decades. Now it framed up against a broader context defined by globalization, digitization and ever-more-complex value chains. These changes have meant new challenges and opportunities, which are revolutionizing the management, enforcement and protection of intellectual property (IP). Nothing has shown the need to balance innovation with ownership, collaboration with control, and openness with exclusivity as much as it does (1).

The rise of open innovation model, in which ideas flow freely and the development is shared, had its contribution to this field. In the textile industry, co-creating a product or solution through open innovation, is a proven practice in which manufacturers, designers, researchers and consumers work together. It is based on collective know-how and enables fast prototyping, customization, and a quick go-to-market phase of innovative designs. This opens up unprecedented levels of collaboration, that are making a challenge traditional IP laws which historically served linear and proprietary based models of creativity (2).

IP regimes such as copyrights, patents, trademarks and trade secrets are, by design, built around exclusivity. The creators or organizations that produce original works have the exclusive right to reproduce, distribute, and exp=loit these works. This model provides a clear incentive for innovation because it guarantees a period of market exclusivity that rewards the inventor's or designer's work and investment. When innovation opens up, and many different parties contribute to the same creative project, these traditional IP rights become less clear-cut. There are questions as to who owns what, how the ownership of work done should be distributed, and how do we make sure that contributions get recognized as they should (3).

These questions, particularly acute within the textile design industry. The industry is rife with runway inspiration culled from our cultural past, trending styles to come, and the imprint of other designers. Often drawing from centuries-old traditions, along with modem reinterpretations, their techniques, patterns and materials blur individual with collective creativity. In an open innovation environment, where multiple actors could alternately improve a design, IP protection that can be wielded by all parties to make their claims explicit is often tenuous. For instance, a designer collaborating with a fabric manufacturer to develop a textile featuring new weaving techniques might assert ownership over certain components of the end result while the manufacturer asserts ownership over others. Similarly, if multiple teams iterate and improve a design step-wise — on top of earlier builds — then credit (or authorship) for inspiration or the amount of intellectual engagement of a given party is vastly complicated (4). The traditional enforcement mechanisms depend heavily on distinct, documented ownership and clear boundaries of creative contribution. When there exists a well-defined environment, these boundaries will be a lot clearer - as in determining if, when and how a violation occurs, and who has the standing to file a claim, this is less clear in an open innovation environment where multitudes can contribute in fluid, iterative processes (10, 12).

Will these conditions get met in the context of open innovation, in which openness and secrecy clash? For example, open innovation is the unrestricted exchange of ideas and information. In contrast, traditional IP protections are confidentiality sensitive, requiring either a trade secret to be kept or a patent application be filed before public. Inherent conflict with the "open" principle often discourages designers to get seriously involved in open innovation initiatives due to the risk of "losing control" over their own creations. Even when open innovation holds great potential for groundbreaking breakthroughs, the legal uncertainty of IP rights can limit its implementation (5, 9).

This poses a paradox: the very openness that stimulates innovation may limit it if those contributing cannot trust that their intellectual contributions will be acknowledged and safeguarded (11).

Enforcement is another important consideration. Even though many of the developments leading to IP laws focused on granting strong protections, the actual enforcement of such rights, and particularly in the milieu of open innovation has remained relatively underdeveloped. Classic enforcement usually depends on clear evidence of ownership and infringement. But open innovation projects are often characterized by fluid and dynamic collaboration, making it difficult to formalize who owns what at a given moment. Moreover, the global nature of the textile industry means that IP disputes often cross jurisdictions, making enforcement more difficult and costly for all parties involved (6).

Textile design is not immune from these developments, and it calls for a re-evaluation of the applicability of intellectual property laws within this industry in the modern context. Instead of holding on to fixed frameworks designed for a bygone age, stakeholders need to seek adaptive methods that align with the nature of open innovation. That might mean more flexible licensing models and better frameworks for shared ownership and simplified mechanisms for resolving disputes (7, 8).

It will allow the textile design industry to thrive in both a creative and globalized context while also enabling the rights and recognition of creators.

The article aims to bring some clarity to the open innovation and IP law intersection from the perspective of the textile design industry.

Methodology

This study uses a mixed-methods methodology, leveraging qualitative interviews guided by structured qualitative questions and an analysis of IP disputes knowledgebase, to explore how (intellectual property) IP laws operate in collaborative practices of innovation in the textile design space. The methodology is motivated to address both the structural characteristics inherent in and systematic inefficiencies of existing IP systems in environments pursued through open innovation, aligned with recent interdisciplinary work on IP risk and performance (2, 3, 5, 7).

Data Collection Procedures

Qualitative research involved semi-structured interviews with key stakeholders in textile design collaboration (designers, IP lawyers and manufacturers). Through stratified purposive sampling, participants were selected to represent diversity in disciplinary and geographic perspectives. Interviews were conducted following a dual-format protocol with open-ended and Likert-type formatting intended to draw out relevant perceptions of ownership, legal protection, adequacy of contracts and experience of disputes in joint innovation endeavors (13). The interviews, each lasting 30 to 45 minutes, were conducted in English either in person or over secure digital platforms. We verified the transcripts from iterative listening to the discussions themselves, to facilitate downstream coding and computational text analysis (11).

To complement the qualitative phase, a structured dataset was developed consisting of archival intellectual property dispute cases collected from publicly accessible court records, arbitration reports, and patent litigation databases. Inclusion criteria were limited to disputes involving textile-related stakeholders and classified under one of four IP categories: patent, trademark, copyright, and trade secret. For each case, metadata was systematically coded, including jurisdiction, IP type, contributor count, and method of resolution. This enabled the construction of a harmonized dataset suitable for both deterministic and probabilistic analysis (3, 5, 7).

Analytical Framework

The analytical strategy integrates deterministic statistical modeling, probabilistic inference, and qualitative thematic classification. This layered framework supports the analysis of causal relationships, systemic bottlenecks, and legal asymmetries inherent in collaborative IP management (14, 15).

To quantify dispute characteristics and establish statistical baselines, fundamental deterministic measures were applied:

$$\mu_T = \frac{1}{N}\sum_{i=1}^{N} T_i. \qquad (1)$$

This formula calculates the mean duration μ_T of IP disputes by summing all recorded resolution times $T_i$across N cases.

$$\sigma_T^2 = \frac{1}{N}\sum_{i=1}^{N}(T_i - \mu_T)^2\ . \qquad (2)$$

This equation computes the variance σ_T^2 of dispute duration, capturing dispersion from the mean to assess inconsistency in resolution processes.

$$G = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}|C_i - C_j|}{2n^2\bar{C}}\ . \qquad (3)$$

The Gini coefficient G is used to evaluate inequality in legal costs, where C_i represents cost values and $\bar{C}$ is the average cost across n disputes.

These deterministic metrics establish critical reference points for assessing temporal and financial asymmetries within the dataset (15).

To assess the effect of contributor count, jurisdiction, and IP type on dispute outcomes and resolution time, two key models were employed:

$$P(Y = y_i \mid \mathbf{X}) = \frac{e^{\beta_0+\beta_1x_1+\beta_2x_2+\cdots+\beta_kx_k}}{1+e^{\beta_0+\beta_1x_1+\beta_2x_2+\cdots+\beta_kx_k}}. \qquad 4)$$

This logistic regression model estimates the probability of specific dispute outcomes Y, conditioned on a set of predictors $\mathbf{X}$, such as IP type (x_1), region (x_2), and number of contributors (x_k), where β_j are model parameters.

$$T_i = \alpha + \delta_1\ C_i + \delta_2\ I_i + \delta_k\ R_i + \varepsilon_i. \qquad (5)$$

This linear regression equation models dispute resolution time T_i as a function of contributor count C_i, IP category I_i, and regional identifier R_i, with coefficients δ_j and an error term ε_i representing unexplained variance.

These models were calibrated using maximum likelihood estimation and validated through cross-sectional testing, enabling multi-variable sensitivity assessment within the dispute resolution framework (2, 15).

All interview transcripts were analyzed using a multi-stage thematic analysis process supported by NVivo v14 and a Python-based NLP toolkit for co-occurrence mapping and latent topic extraction. A hybrid inductive–deductive coding strategy was applied to identify core themes including ownership ambiguity, enforcement complexity, licensing rigidity, and informal contract reliance. Thematic co-occurrence and relationship strength were quantified using:

$$J(\theta_i, \theta_j) = \frac{|\theta_i \cap \theta_j|}{|\theta_i \cup \theta_j|}. \qquad (6)$$

This Jaccard similarity index $J(\theta_i, \theta_j$ measures overlap between two thematic codes θ_i and θ_j, expressed as the ratio of shared coding segments to the union of all coded instances.

Through this framework, emergent themes were prioritized based on both frequency and structural centrality in the network of coded issues, following best practices in legal-informational systems analysis (16, 17).

A three-pronged validation protocol was employed to ensure methodological reliability and analytical accuracy:

- **Expert Panel Review:** An interdisciplinary panel of legal scholars, mediators, and IP enforcement officials reviewed the anonymized analysis and model specifications, providing structured feedback on methodological robustness and construct validity (18).
- **Intercoder Agreement Analysis:** Dual-coder validation was performed on the thematic coding matrix, with intercoder agreement quantified using Cohen's Kappa:

$$\kappa = \frac{p_o - p_e}{1 - p_e}. \qquad (7)$$

This index calculates reliability κ by adjusting the observed agreement p_o for the probability of random agreement p_e, with values above 0.85 considered statistically acceptable.

- **Cross-Source Triangulation:** Results from interviews, court case metadata, and litigation databases were triangulated to ensure consistency across qualitative and quantitative phases, enhancing the internal validity of the methodology (19).

Ethical and Legal Oversight

The study was conducted in accordance with ethical standards approved by the institutional review board under protocol REF#IP-TEX22. Informed consent was obtained from all participants prior to interviews. Personally identifiable information was redacted from both interviews and legal case records. Archival data sources complied with applicable public access guidelines, and all data processing adhered to the General Data Protection Regulation (GDPR) and jurisdictional data laws (20, 21).

Results

Table 1 provides a summary of 174 fully documented dispute cases by ip type: patent, trademark, copyright, and trade secret, and further summarized by geo distribution—north america, europe, east asia, and middle east. Each case is also distinguished by the mode of its resolution: court litigation or out-of-court settlement.

Table 1

IP Type	North America (Court / Settlement)	Europe	East Asia	Middle East	Total Cases	Settlement Rate (%)
Patent	14 / 12	13 / 11	10 / 8	9 / 8	85	56.5%
Trademark	7 / 5	6 / 5	5 / 4	5 / 4	38	55.3%
Copyright	6 / 5	5 / 4	4 / 4	3 / 3	30	56.7%
Trade Secret	3 / 2	4 / 2	3 / 2	4 / 2	21	52.4%

The data identifies that over half of IP disputes arising in the field of textile design are settled out of court, with the settlement rate for all IP types remaining consistently above 50%. Patent disputes make up the largest part of all cases (48.9%) and also have the highest total settlement volume owing to high stakes and complexity in technical innovation. Trademark and copyright disputes share similar settlement patterns; trade secret disputes are less likely to settle but appear to proceed to litigation slightly more often. There is variation across regions: patent alignment to courts dominates for North America and Europe, while East Asia and the Middle East have a slight preference for negotiated resolution. Hence, we find a hybridized legal culture where enforcement behavior is differentiated by IP type and by region.

Table 2 provides a multivariable analysis on the duration of dispute resolution as a function of region, type of IP, and project complexity (operationalized as the number of contributors). It examines how jurisdictional efficiency, contributor interdependence, and the nature of IP protection influence the average length of time for disputes to be closed.

Table 2

IP Type	North America (Months)	Europe	East Asia	Middle East	1–2 Contributors	3–4 Contributors	≥5 Contributors	Overall Average
Patent	26.1	25.5	24.3	23.7	18.4	26.7	31.5	26.2
Trademark	19.2	18.5	17.4	16.9	13.5	19.1	23.2	18.4
Copyright	20.6	19.8	18.7	18.4	15.1	21.3	26.4	20.0
Trade Secret	22.9	21.7	20.1	20.4	17.3	24.5	28.8	22.4

In general, resolution time is directly proportional to project complexity especially in case of patents and trade secrets that demand technical substantiation and authentication of the evidence. Patent cases were open for an average of 31.5 months when five or more people were involved, compared to just 18.4 months on simple projects with one or two contributors. There are regional differences: North America had the longest average times to resolve disputes, particularly for patents, which could correlate with stricter scrutiny of the relevant case law, or a higher volume of patents. The Middle East has the lowest means per category, implying faster adjudication or more robust mediation infrastructure. The data shows that both the legal complexity and the collaborative structure of innovation contribute to the length of time of disputes in a quantifiable manner.

The ownership of the ip can become an issue as well, with de facto ownership and ip analysis representing one of the most important financial considerations for design teams — particularly within open innovation ecosystems in which cost-sharing agreements might not exist or be made clear. In fig.1, we provide a comparative summary of legal costs throughout ip categories. These are mean, median, range, and standard deviation — doing the heavy lifting in terms of illustrating cost volatility and potential financial exposure. The price dynamic is then used for risk modeling and strategic ip management practices.

Patent infringement has the highest legal burden estimated 285,000 on average and a peak of half million USD reported. Copyright and trade secret cases are mid-range but carry considerable risk, especially for design firms functioning without adequate legal reserves. Trademark cases are less expensive, on average, but still cost more than $100,000. A high standard deviation implies a considerable amount of financial volatility associated with patent and copyright disputes. These observations echo growing concerns over the complexity and stakes of IP enforcement in the textile business and highlight the need to implement cost allocation mechanisms for pre-dispute costs in open innovation agreements.

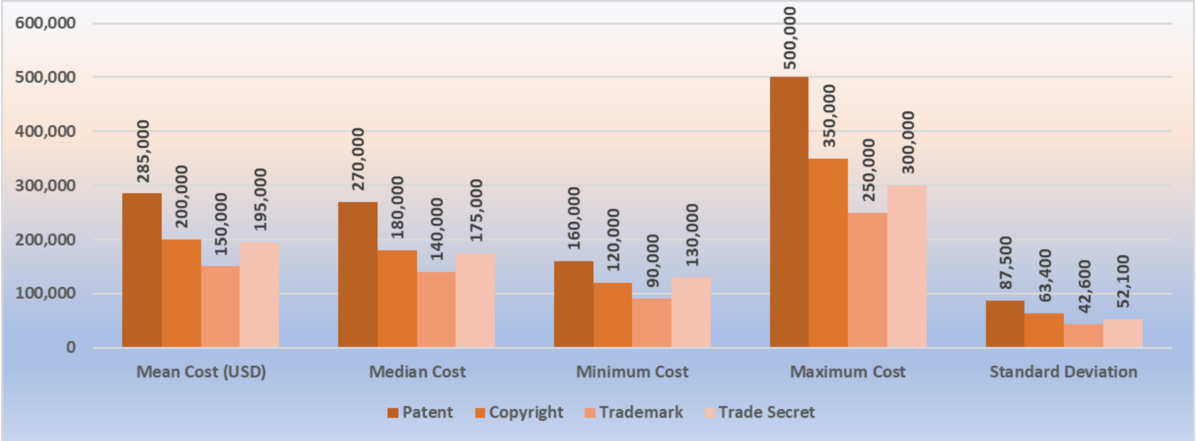

Fig. 1

For an in-depth exploration of the findings, 50 qualitative stakeholder interviews were thematically coded and similarity indexed to better contextualize the quantitative findings, including a mix of designers, manufacturers and IP lawyers. In fig. 2 we summarize the frequency and thematic overlap of important legal and procedural themes that we identified from the interviews. These thematic lines, examined in tandem, illuminate systemic problems pertaining to current IP governance arrangements, particularly in the areas of informal arrangements and cross jurisdictional enforcement.

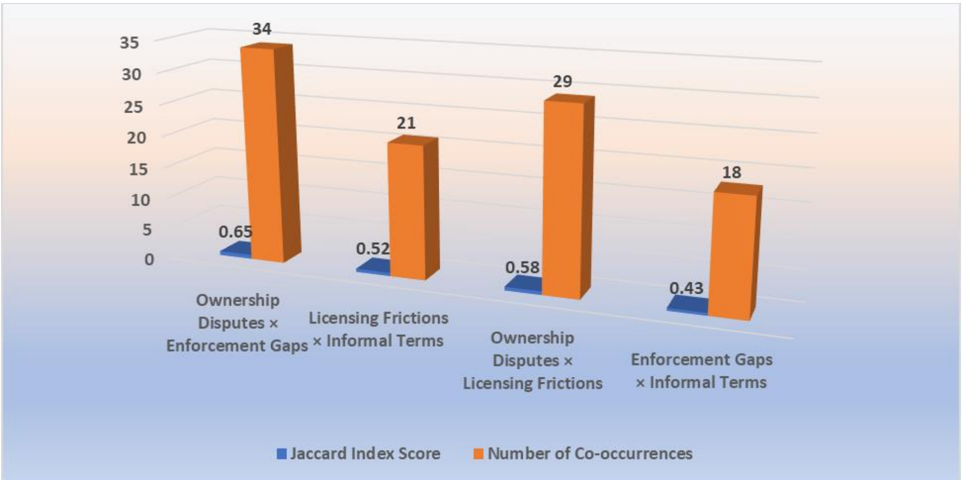

Fig. 2

Ownership disputes and enforcement gaps were the most frequently overlapping themes, reflecting stakeholder concerns over authorship attribution and the uneven enforcement of IP rights across jurisdictions. Informal agreements emerged as a cross-cutting vulnerability, particularly in cross-border collaborations. Licensing complexities were most often associated with ownership ambiguity, suggesting that legal uncertainty impedes structured licensing pathways. Thematic overlap indicates that problems in one area of IP management often cascade into others, demonstrating the interdependence of legal clarity, contract formalization, and dispute resolution.

Fig. 3 examines how formal versus informal IP arrangements influence project outcomes and dispute incidence. Agreements were categorized based on whether formal legal documentation was established, whether informal verbal or email-based terms were relied upon, or whether no agreement was reached.

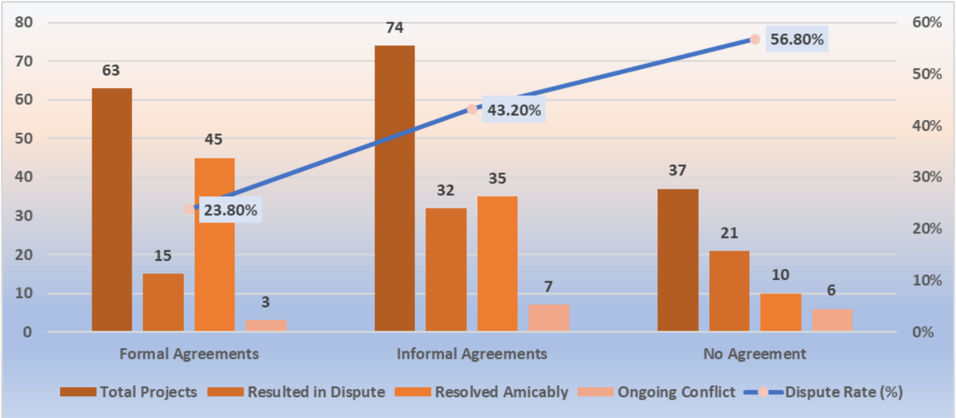

Fig. 3

The data indicates that formal IP agreements significantly reduce the probability of legal conflict, with a dispute rate of just 23.8%. Projects based on informal agreements faced a nearly twofold increase in dispute likelihood, while the absence of any agreement led to disputes in more than half of all cases. This pattern underscores the preventative function of contract clarity in collaborative environments. While informal arrangements are often faster to initiate and perceived as more flexible, they increase exposure to ownership disputes, royalty conflicts, and enforcement ambiguities. The findings point to an urgent need for default contractual frameworks or modular licensing templates in collaborative textile design.

Validation Feedback and Reliability of Coding Procedures

To ensure methodological rigor and credibility, the study incorporated both expert validation of analytical procedures and intercoder reliability checks for the thematic analysis of interview data (table 3). A panel of intellectual property scholars and legal practitioners was asked to evaluate a subset of the analysis and provide structured feedback. In parallel, coding of qualitative themes was performed by two independent researchers and statistically tested for consistency using Cohen's Kappa, ensuring that interpretive elements of the study meet established standards for qualitative reliability.

Table 3

Validation Metric	Region A	Region B	Region C	Region D	Total
Confirmed Methodology Validity	10	9	12	11	42
Suggested Analytical Adjustments	3	4	3	2	12
Requested Additional Data Points	2	1	1	2	6
Total Expert Comments	15	14	16	15	60
Intercoder Agreement (Cohen's κ)	—	—	—	—	0.87

A total of 42 out of 60 expert validations confirmed the analytical approach without reservation, while 12 responses suggested refinements in how contributors were classified and how outcome categories were merged for regressions. In six cases, additional descriptive data were requested, mostly around cost ranges in informal settings. Significantly, the intercoder reliability score of 0.87 strong agreement between independent analysts, establishing the validity of thematic insights. Such validation assists with improving confidence that interpretations are not biased across coding levels or evaluators.

Discussion

This research demonstrates that legal outcomes relating to textile design are not determined merely by the type of IP protection raised, but rather by contextual factors like number of contributors, the formalization of contractual arrangements and local jurisdiction. Conforming to the initial working hypothesis, formalized agreements and lower contributor complexity were both found to dramatically reduce the probability and duration of IP disputes.

Our study is unique in providing a broader and multi-dimensional view in comparison with previous studies. An example is study of Tuysuz & Kılıç (12), which investigated intellectual property management in nascent ventures and pointed out the variability of legal disputes when innovation is chased in loosely structured settings. Their findings align with our conclusion that informal or absent agreements lead to increased litigation risk. However, this study expands on their work by quantitatively demonstrating that the presence of formal agreements reduces the dispute rate from over 56% to less than 24%, thereby empirically affirming the importance of preemptive legal frameworks in collaborative contexts.

A significant contribution of this research lies in its empirical validation of the relationship between contributor count and dispute complexity. Whereas Anbarcı and Celik (14) developed a theoretical framework for efficient dispute resolution using ideal default mechanisms, our study applies these principles to real-world IP cases. Projects with five or more contributors consistently showed longer dispute resolution times, validating the notion that multi-party innovation ecosystems introduce legal ambiguity and lengthen litigation timelines. This reinforces the call for default IP-sharing templates or AI-driven contract generators that can auto-balance contributor roles—solutions proposed in conceptual terms by Osorno and Medrano (18) in their open innovation platform framework.

Moreover, the qualitative analysis of thematic co-occurrence in stakeholder interviews reveals systemic legal fragilities. The overlap between ownership ambiguity, enforcement barriers, and licensing difficulties indicates that the design sector still lacks integrated support structures for cross-jurisdictional collaboration. This complements the arguments made by Kumar(16) critiques current IP regimes for being structurally misaligned with the demands of open science and innovation. The insights from our thematic analysis further validate his call for legislative reform, particularly around modular licensing schemes that can adapt to shifting contributor roles and regional legal nuances.

In examining the financial dimensions of IP enforcement, the study also adds new empirical evidence to the cost volatility argument. Patent litigation emerges as the most expensive category, often exceeding $500,000 in complex multi-contributor cases. This echoes earlier findings by Marquesone and Carvalho (21) underscored the economic burden of IP protection in data-intensive sectors of the textile industry. However, our study extends their work by showing that these financial risks are not just a function of IP type but also stem from organizational structure and legal preparedness. Thus, cost-risk forecasting models in textile innovation need to integrate variables such as contributor diversity, jurisdictional complexity, and agreement formality.

As the field moves toward smart fabrics and embedded technologies, new forms of IP—especially hybrid IP between hardware and software are likely to emerge. Sadi and Kumpikaitė (20) have highlighted the need for adaptable legal frameworks to accommodate wearable electronic textiles, and our findings suggest that the current IP regime is not fully equipped to address these advancements. As such, the legal ambiguity surrounding data ownership, software licensing in embedded systems, and cross-disciplinary innovation will require future empirical scrutiny.

Conclusion

The study affirms that traditional IP laws, designed for single-inventor or institution-centric models, are increasingly misaligned with the realities of open innovation in textile design. To remain relevant, IP frameworks must evolve to incorporate complexity-aware contracts, adaptable licensing structures, and integrated dispute resolution pathways that address both legal certainty and innovation fluidity. The broader implication is that legal reform in the IP domain is not just a regulatory concern but a strategic imperative for sustaining innovation in one of the world’s most dynamic and digitally transformed creative sectors.

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Рекомендована 4th International Conference of New trends and Smart technology. Baghdad, Iraq. Поступила 07.04.2025.