



## **DETERMINATION OF A SPECIFIC RISK- ADJUSTMENT RATE FOR INTELLECTUAL PROPERTY VALUATION ACCORDING TO TECHNOLOGY READINESS LEVEL**

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### **Abstract**

Intellectual property (IP) valuation is recognized as one of the knowledge that valuers need to explore as a new opportunity in diversifying valuation services. However, IP's intangible nature, unfamiliarity with specific risk allocations, unique IP characteristics and future uncertainty of IP growth make it challenging to allocate specific risks to ensure valuation reflects true economic fair value as IP risks differ by IP category and technology readiness level (TRL) level. Therefore, through relief from the royalty method, the study of the specific risk-adjustment rate (SRAR) framework to build a rubric that facilitates appraisers. The aim of the research is to determine the approach for establishing the element of potential and risk associated with the classification of IP. Through content analysis, this study successfully assesses associated risks by mapping methodology towards the assessment of the potential risk associated with the classification of IP and risk assessment according to the TRL level. Introducing this SRAR rubric will familiarize valuing IP among member firms and allow valuers to diversify their valuation service. IP is evaluated as a future backup collateral value for corporate financing.

**Keywords:** Intellectual Properties, Technology Readiness Level, Specific Risk-Adjustment Rate, Weighted Average Cost of Capital

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## INTRODUCTION

Since 2010, business models have become increasingly technology-driven, as reflected in online banking, e-commerce, and platform-based firms such as Airbnb and Grab, where intellectual property (IP) protection underpins competitive advantage (Schiavi et al., 2018; Miguez et al., 2018; Lindsay & Hopkin, 2010). Consequently, IP valuation has become critical for licensing, franchising, and mergers and acquisitions (M&A), influencing royalty determination, firm value, and financial performance. This is evident in major acquisitions and accounting practices that require intangible assets to be recognized separately from goodwill. Nevertheless, IP valuation remains challenging due to uncertainty in future economic benefits, limited asset life, and sensitivity to market and technological changes, a concern also reflected in Malaysian studies highlighting asset-specific risks beyond conventional tangible measures (Ramli et al., 2023; Mustaffa et al., 2023; Rohaizad et al., 2021).

To address these challenges, IP valuation commonly applies the income approach using discounted cash flows and the firm's Weighted Average Cost of Capital (WACC), although this often inadequately captures innovation-related risks (Wasserman, 2015). Technology Readiness Levels (TRLs) provide a structured framework for assessing technological maturity and associated risks across development stages. As risks vary by IP type and TRL, the formulation of a Specific Risk Adjustment Rate (SRAR) aligned with TRLs is essential to enhance valuation accuracy and reduce the risk of IP mispricing.

## LITERATURE REVIEW

### *Associates Risk of Intellectual Property Valuation*

University–industry collaboration plays a critical role in facilitating intellectual property (IP) commercialization and knowledge transfer; however, limitations in absorptive capacity, technology transfer office (TTO) capabilities, and market alignment continue to constrain effective valuation and commercialization outcomes, particularly in developing economies such as Malaysia. As intangible assets increasingly drive value creation, accurate IP valuation has become essential, although prior studies show that not all university-generated knowledge translates into improved firm innovation performance (Bekkers & Freitas, 2008; International Chamber of Commerce, 2019).

IP valuation is further complicated by uncertainties in forecasting future income and the frequent underestimation and underutilization of IP assets, particularly patents and trademarks (King, 2003; OECD, 2017). In Malaysia, many firms, especially SMEs, tend to undervalue their IP, reflecting weak absorptive capacity and limited ability to leverage external knowledge from universities (Chandran et al., 2014; The Star, 2008). Market misalignment further

constrains commercialization, as innovations often fail to meet market needs due to insufficient demand-driven research (Raja, 2011; Bakar et al., 2022).

Moreover, structural constraints within TTOs—such as shortages of skilled personnel and financial resources—limit effective innovation management and commercialization support (Raja, 2011). Firms also face technological capability gaps that hinder the translation of research outputs into high-impact innovations (George et al., 2008). As firm value increasingly depends on the effective management of IP assets, strengthening absorptive capacity and improving IP evaluation mechanisms remain critical to overcoming commercialization challenges in Malaysia (Sandner & Block, 2011; Ramli et al., 2023; Mustaffa et al., 2023).

### ***Uncertainty in Intellectual Properties Commercialization***

The literature on commercialization support organizations—such as technology transfer offices (TTOs), science parks, and incubators—highlights the importance of efficient organizational practices in facilitating the transfer of knowledge from universities to industry (Bekkers & Freitas, 2008; Thursby & Thursby, 2001). Efficient IP commercialization generates economic value for universities and firms; however, valuation uncertainty arises when commercialization outcomes and future revenues are difficult to predict (Sharif et al., 2018). Empirical evidence from developed economies demonstrates the economic significance of IP commercialization, although such outcomes remain uncertain in valuation contexts. TTOs play a critical role in protecting and transferring IP through mechanisms such as patenting, licensing, spin-offs, and joint ventures, with licensing being the most common commercialization mechanism, while spin-offs may generate higher but more uncertain returns (Arundel & Geuna, 2004; Sveiby & Simons, 2002; Cohen & Munis, 2002; Ovortrup, 2006; Enache & Srivastava, 2018).

Despite these mechanisms, commercialization remains challenging due to the tacit nature of technological knowledge, which complicates effective transfer (Chew & Yun, 2007; Lee & Yun, 2007). Successful IP transfer therefore requires coordinated efforts among universities, industries, and students to support knowledge transmission (Nystén-Haarala et al., 2010). Trust further plays a crucial role in managing potential misunderstandings and protecting IP through contractual arrangements; however, inadequate valuation of IP may undermine the realization of its full economic potential (Bose & Thomas, 2007; Bishop, 2003; Smith & Parr, 2000).

### ***The Complexity of Intellectual Property Commercialization Process***

Commercialization of university IP starts with the disclosure of innovations by researchers to the TTO for an assessment of market potential and patentability (Sharif et al., 2018). When viable, TTO moves to arrange protection globally,

exploring further options for commercialization, including licensing or a spin-off. However, most researchers are not entrepreneurial, and that makes TTOs very significant in the knowledge transfer process (Brantnell & Baraldi, 2022).

Governments and industries also continue to play key roles in providing funding for university research and implementing supportive policies, such as faculty training and enhancing research markets. In Malaysia, the Centre for Research and Innovation Management helps professors seek funding and also monitors innovation progress. After an innovation is ready, the Technology Transfer Office-which commercializes the innovation through TTO-negotiates contracts and does all legal documentation (Debackere & Veugeler, 2005; Marshall, 2005; Kneller, 1999). Commercialization is faced with challenges such as bureaucratic delays, aversion to risk, and the difficulties inherent in the transfer of technology from academic to industry (Siegel & Wright, 2015; Mirowski & Nik-Khah, 2007). More often than not, inefficiencies and time-consuming approval processes discourage researchers from commercializing their work and hence limit the impacts of innovations (Chandran et al., 2014; Raja, 2011).

#### ***Poor Demand from Local Industrial in Commercializing Intellectual Property***

Malaysia is transitioning into a technology-driven economy, inspired by Asia's Newly Industrializing Economies (NIEs). As the global shift towards a knowledge economy grows, businesses increasingly rely on intellectual property (IP) for competitive advantage (Chen et al., 2019). Malaysia's industry has expanded due to rising disposable incomes and consumer confidence, driving demand for top brands and IP licensing (IBISWorld, 2020). Ranked 37th in the Global Innovation Index (Cornell University et al., 2017), Malaysia is well-positioned to capitalize on Industry 4.0 advancements (WEF & A.T. Kearney, 2018).

Malaysia faces challenges in its innovation landscape, including low absorptive capacity for subcontracting commercialization (Motohashi & Yun, 2007) and poor IP management (King, 2003). Inexperienced companies struggle with pricing, marketing, and licensing decisions, hindering commercialization (Kodama, 2019; George et al., 2008). The country lags in innovation due to limited knowledge sharing and failure to capitalize on local expertise (Shah & Tripsas, 2016). To bridge this "commercialization gap," Malaysia needs to foster a culture of science, technology, and innovation, transforming scientific knowledge into socio-economic advancements (Akoum, 2016; Aman, 2020; Dyer & Hatch, 2006).

#### ***Intellectual Properties Protection Issued Does Not Meet Market Readiness***

Technological and market readiness are critical factors in the adoption of new technologies; however, no standardized model fully captures market readiness. The Technology Readiness Level (TRL) framework, introduced by NASA,

evaluates technological maturity but places greater emphasis on innovation push than market demand (Kirchberger & Pohl, 2016; Dent & Pettit, 2011). To address this limitation, complementary models such as innovation readiness and demand readiness have been developed to incorporate market-oriented considerations (Tao et al., 2009; Paun, 2012).

Despite achieving technological maturity and regulatory approval, market adoption remains a key challenge, as adoption depends on a technology's relative value, utility, and competitive positioning. As technologies transition from early adopters to broader markets, constraints related to market consensus, innovation support, and knowledge transfer often emerge. These uncertainties directly affect revenue forecasts and discount rate determination, requiring consideration of market, industry, and IP-specific risks. Consequently, successful IP commercialization relies on strong market demand, while weak market alignment and limited commitment to technology transfer continue to hinder the commercialization of local IP (Bakar et al., 2022; Trimi et al., 2012; Dent & Pettit, 2011; Sandner & Block, 2011).

#### ***Risk Associated with Intellectual Property Patents Valuation***

IP valuation involves estimating intangible assets such as patents, trademarks, copyrights, and trade secrets while accounting for both diversifiable (unsystematic) and non-diversifiable (systematic) risks. Diversifiable risks include patent infringement, reputation risk arising from inaccurate valuation, and ownership risk related to legal ambiguities over IP rights, all of which can reduce asset value but may be mitigated through diversification strategies (Damodaran, 2020).

Non-diversifiable risks, including market, regulatory, geopolitical, and technology risks, stem from broader macroeconomic and industry-wide factors and directly influence discount rates used in valuation. Higher market volatility increases discount rates and lowers IP value, while technology obsolescence, regulatory uncertainty, market saturation, and litigation risks further shape valuation outcomes (Smith & Parr, 2000; Cockburn & MacGarvie, 2009; Dhingra, 2020). Accordingly, robust IP valuation frameworks must explicitly incorporate both diversifiable and non-diversifiable risks to ensure accurate valuation (Smith & Parr, 2000; Helfer & Austin, 2011).

#### ***Conceptual Idea on the Relationship of Patent Valuation According to Technology Readiness Level***

Key risks include patent infringement, which may lead to costly litigation, reputation risk from inaccurate valuations that damage brand or investor trust, and ownership risk, involving legal disputes over IP rights that can reduce asset value. (Damodaran, 2020).

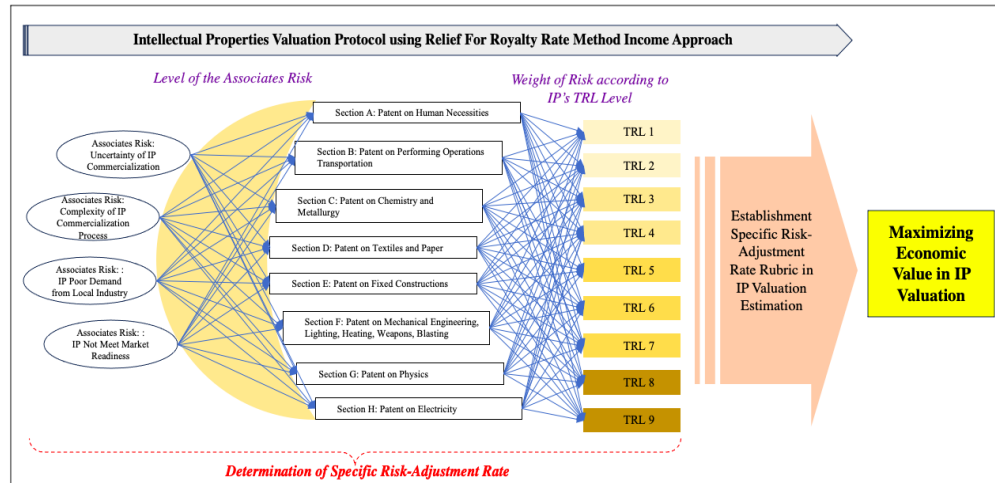


**Figure 1:** Conceptual framework illustrating the relationship between patent-specific risk-adjustment rate and Technology Readiness Level (TRL), incorporating diversifiable and non-diversifiable risk components.

As depicted in Figure 1, explain that non-diversifiable risks, such as market, geopolitical, regulatory, and technology risks, affect entire industries and influence IP valuations. Increased market volatility leads to higher discount rates and lower valuations. Technology risks include potential obsolescence due to innovation or competition, while geopolitical risks, like political instability or changes in IP laws, also impact IP value. Additional risks, such as market saturation and litigation, are critical considerations. Accurate IP valuation requires adjusting for both diversifiable and non-diversifiable risks to ensure reliable results (Smith & Parr, 2000; Damodaran, 2020; Cockburn & MacGarvie, 2009).

## RESEARCH METHODOLOGY

The data collection was conducted through content analysis of prior literature to establish intellectual property (IP) valuation in relation to Technology Readiness Levels (TRLs). This analysis was further aligned with the intellectual property categorization framework outlined by the Intellectual Property Corporation of Malaysia (MyIPO), enabling systematic classification of IP types for subsequent risk and valuation assessment.

**Table 1:** Intellectual Property Categorization Based on Patent Sections

|            |                                                                        |
|------------|------------------------------------------------------------------------|
| Section A: | Patent on Human Necessities                                            |
| Section B: | Patent on Performing Operations Transportation                         |
| Section C: | Patent on Chemistry and Metallurgy                                     |
| Section D: | Patent on Textiles and Paper                                           |
| Section E: | Patent on Fixed Construction                                           |
| Section F: | Patent on Mechanical Engineering, Lighting, Heating, Weapons, Blasting |
| Section G: | Patent on Physics                                                      |
| Section H: | Patent on Electricity                                                  |

Data collection involves content analysis of prior literature to establish the IP's Technological Readiness Level (TRL) and associated risk valuation based on IP categorization. A survey instrument is then developed to interview ITMA members, testing the reliability of this research. The data collection focuses on validating the related elements with ITMA members, following the rationale of the literature to establish IP valuation according to the TRL level. The elements of potential and risk associated with IP classification are identified through content analysis and tabulated.

## ANALYSIS AND DISCUSSION

Table 2, materializes through Step 1 of Procedure 1 design in research methodology, which is the data collection from content analysis in Chapter 2 of the prior literature on potential and risk associated with IP commercialization. These risks have been considered in the estimation of specific risk-adjustment rates in IP valuation according to IP categorization.

**Table 2:** Associated risk in commercialization

| Associated Risk in IP Commercialization                         |       |                                                                                                                     | Authors                                                                      |
|-----------------------------------------------------------------|-------|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| <b>Uncertainty in Intellectual Properties Commercialization</b> | (i)   | Time speeding up the realization of knowledge transfer and commercialization                                        | Arundel and Geuna (2004)<br>Sveiby and Simons (2002)<br>Cohen et al., (2002) |
|                                                                 | (ii)  | Innovation performance of the firm                                                                                  | Bekkers and Freitas (2008)                                                   |
|                                                                 | (iii) | Innovation products have lower take-up rates for commercialization                                                  | Thursby and Thursby (2001);<br>Sharif et al., (2018)                         |
|                                                                 | (iv)  | It is more complicated to transfer the technology or innovation when there are implicit elements in the innovation. | Teece (2010); Reily (2022)                                                   |
|                                                                 | (v)   | Immaturity of IP in developing innovative products reliable for the market                                          | Paasi et al., (2010)                                                         |

| Associated Risk in IP Commercialization                                           |        |                                                                                                                   | Authors                                                                                          |
|-----------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
|                                                                                   | (vi)   | Risk on commercialization collaboration engagement                                                                | Pisano and Teece (2007)                                                                          |
|                                                                                   | (vii)  | Capability of parties conducting commercialization                                                                | Enkel et al., (2018);<br>Lee (2019)<br>Blomqvist et al., (2008)<br>Nystén-Haarala et al., (2010) |
|                                                                                   | (viii) | Future income is predicted, unreliable, and does not represent intellectual property assets' whole or fair value. | Smith and Parr, (2000)<br>Bose & Thomas, (2007)<br>Bishop, (2003)                                |
| <b>The Complexity of Intellectual Property Commercialization Process</b>          | (i)    | IP commercialization negotiation is difficult                                                                     | Ellonen et al., (2008)<br>Olander et al., (2010)                                                 |
|                                                                                   | (ii)   | The long process of commercialization                                                                             | Sharif et al., (2018)                                                                            |
|                                                                                   | (iii)  | Inexperience of TTO where it can help in assisting the knowledge transfer from creation to commercialization      | Debackere and Veugeler (2005)<br>Kneller (1999)<br>Marshall (2005)                               |
|                                                                                   | (iv)   | Require funding to adopt commercialization                                                                        | Rasmussen (2008)                                                                                 |
|                                                                                   | (v)    | Rigid procedure of commercialization                                                                              | Mirowski and Nik-Khah (2007); Siegel et al., (2004); and Siegel & Wright (2015)                  |
|                                                                                   | (vi)   | Inefficiency of exploitation in R&D by the university and linkages                                                | Chandran et al., (2014); Raja (2011)                                                             |
| <b>Poor Demand from Local Industrial in Commercializing Intellectual Property</b> | (i)    | Inexperience for commercialization                                                                                | Kodama (2019);<br>George et al., (2008)                                                          |
|                                                                                   | (ii)   | Lowly managed or not fully utilised                                                                               | King (2003)                                                                                      |
|                                                                                   | (iii)  | Subcontract the commercialization to <sup>third</sup> parties and poor absorptive rate.                           | Motohashi and Yun (2007)                                                                         |
|                                                                                   | (iv)   | Less response on innovation commercialization                                                                     | Rappert et al., (1999)                                                                           |
|                                                                                   | (v)    | Industry depends on financial assistance for commercialization                                                    | Shah and Tripsas (2016)                                                                          |
|                                                                                   | (vi)   | Deficiency in knowledge shared, interaction, and failure to adopt innovative knowledge and skill formation        | Dyer and Hatch (2006)<br>Riege (2005)                                                            |
|                                                                                   | (vii)  | Industry requires an effective model to form a science-literate society                                           | Akoum (2016)                                                                                     |
|                                                                                   | (viii) | Industry unaware of the capability of local IP creation                                                           | Aman (2020)                                                                                      |
| <b>Intellectual Properties Protection Issued Does Not Meet Market Readiness</b>   | (i)    | Enter the market at the right time                                                                                | Bakar et al., (2022)<br>Trimi et al., (2012)                                                     |
|                                                                                   | (ii)   | Immaturity of IP entering the market                                                                              | Mankins (1995)                                                                                   |

| Associated Risk in IP Commercialization |                                                                                    | Authors                                                   |
|-----------------------------------------|------------------------------------------------------------------------------------|-----------------------------------------------------------|
| (iii)                                   | The local market lacks funds to commercialize IP                                   | Dreyfuss (2010)<br>Roessner et al., (2013)<br>Paun (2012) |
| (iv)                                    | Lack of consensus between the market and IP creator                                | Dent and Pettit (2011)                                    |
| (v)                                     | IP introduction requires a higher degree of market penetration                     | Kim et al., (2012);<br>Lemley (2019)                      |
| (vi)                                    | Lack of transforming the R&D into a valuable innovation product in the marketplace | Bakar et al., (2022)<br>George et al., (2008)             |
| (vii)                                   | Inadequate for high-impact invention                                               | Sandner and Block (2011)                                  |

### ***Mapping of Associate Risk according to IP Categorization***

These risks have been considered in estimating specific risk-adjustment rates in IP valuation according to IP categorization.

- (i) Patent on Human Necessities
- (ii) Patent on Performing Operations Transportation
- (iii) Patent on Chemistry and Metallurgy
- (iv) Patent on Textiles and Paper
- (v) Patent on Fixed Construction
- (vi) Patent on Mechanical Engineering, Lighting, Heating, Weapons, Blasting
- (vii) Patent on Physics
- (viii) Patent on Electricity

Evaluation of IP patents regards risks associated with the potential for commercialization and can be broken down based on the IP category. These risks associated with each category are evaluated using the Technology Readiness Level (TRL) and span from category 1 (where basic principles are observed) to category 9 (where the system has already been proven) (Lestari et al., 2022; Khan & Wu, 2020). Uniquely different risks associated with the different categories of IP (such as medical devices and industrialized building systems) pose differing threats to their prospects in terms of commercialization (Sharif et al., 2018).

Patent classifications influence risk exposure, with healthcare-related patents facing higher regulatory and approval risks, while engineering- and electricity-based patents encounter different commercialization challenges. As TRL increases, associated risks decline, reflecting greater technological maturity and market readiness.

From a broader planning and asset valuation perspective, prior studies in the Malaysian context emphasize that valuation accuracy improves when non-tangible risk attributes are systematically incorporated into assessment frameworks rather than treated implicitly. This aligns with findings in Planning Malaysia that highlight the importance of structured valuation approaches for

assets with complex, intangible, and technology-driven characteristics, particularly where future economic benefits are uncertain (Rohaizad et al., 2021; Jalil, 2023)

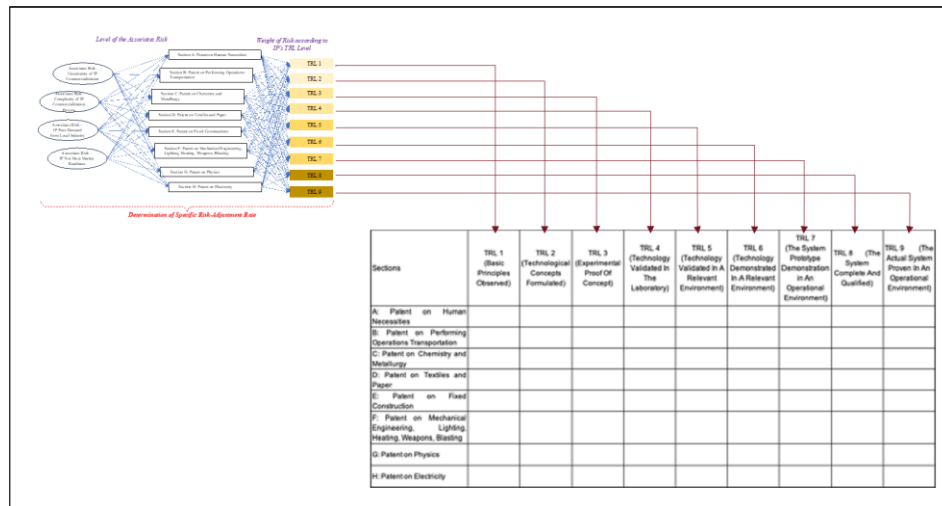


**Figure 2:** Mapping of associated commercialization risks across IP categories and corresponding Technology Readiness Levels (TRL), illustrating declining risk intensity as TRL increases.

## CONCLUSION

This study maps the risks associated with IP categorization and its Technology Readiness Level (TRL), identifying four key risk sub-categories: (i) uncertainty in commercialization, (ii) commercialization complexity, (iii) poor demand from local industry, and (iv) market readiness. Risk levels vary across IP categories and are influenced by the patent lifecycle and TRL. Higher TRLs generally reduce risks, as mature technologies are easier to commercialize. The study introduces a Risk-Adjustment Rate (SRAR) to guide patent valuation, improving accuracy by incorporating both IP categorization and TRL level in the risk assessment.

## ACKNOWLEDGEMENT

This is part of the research of the National Real Estate Research Coordinator (NAPREC), under the Allocation RMK-12 (Phase 2A), (INSPEN), Valuation and Property Services Department (JPPH), Ministry of Finance Malaysia

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Received: 9<sup>th</sup> March 2025. Accepted: 15<sup>th</sup> November 2025