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Heikkilä Jussi T.S.

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Jussi T.S. Heikkilä [a,b,*]

[a] Jyväskylä University School of Business and Economics, P.O. Box 35, FI-40014, Jyväskylä, Finland
[b] School of Engineering Science, Lappeenranta-Lahti University of Technology LUT, Lahti, Finland

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ABSTRACT

We suggest key performance indicators (KPIs) that provide a systematic framework to analyse the functioning of utility model (UM) systems. The KPIs are based on a literature review and a content analysis of the webpages of IP offices in countries offering UM protection in 2021. Generally, the IP offices highlight UMs to be shorter, simpler, faster, and cheaper protection methods compared to patents but there are differences how these features are highlighted. The differences between UMs and patents lead to multidimensional sorting as economic agents choose within the IP menu which determine the observed differences in characteristics and outcomes of patents and UMs. National differences call for separate context-dependent KPIs for UM systems.

1. Introduction

While the functioning of patent systems has been extensively studied, utility model (UM) and two-tiered patent systems have received much less attention until recently [1–11]. UM systems have a history of more than 130 years, with the first still-functioning UM system introduced in Germany in 1891 [1,3,4,12].[1] Initially, the German UM system had a lower standard of inventiveness, a non-examination system, a short period of protection and—most notably—rather than being a supplemental patent regime, it supplemented German legislation from 1876 protecting copyrights and designs and was thus originally conceived as a form of design protection [1,3].

According to the WIPO IP Statistics Data Center, in 2020, 69 IP offices altogether received slightly less than 3 million UM filings. Fig. 1 shows the major trends in UM filings for the past decades. UM filings are an exception compared to patents, trademarks and design rights, since their filing is much more concentrated in specific countries.[2] For each of the past 40 years, UM filings at the patent offices of China, Japan, the Republic of Korea and Germany have accounted for about 90% or more of all global UM filings. Consequently, the contribution of UMs to the stock of patent information (i.e. knowledge codification and technical information) is mainly in the official languages of these countries.

WIPO has noted that UMs are not easy to define because the systems vary across countries, but UMs are in general considered to be particularly well suited for protecting inventions that make small improvements to, and adaptations of, existing products or products that have a short commercial life, and UMs are often used by local inventors.[3] Radauer et al. (2019) [8] questioned the narrative of UM being a 'small patent for small inventors'. It should be highlighted that in some countries, second-tier patent systems are called short-term patents, innovation patents, utility certificates or petty patents. The general term 'second-tier patent system' [1,2] captures all of these, and a patent system offering UMs can be referred to as a two-tiered patent system [8,10]. In 2022, from a regional perspective, of 38 EPO member states, 22 (58%) had a UM system or some sort of two-tiered patent system in place; of eight EAPO members, the number was seven (88%), of 17 OAPI

* Jyväskylä University School of Business and Economics, P.O. Box 35, FI-40014, Jyväskylä, Finland.
E-mail address: jussi.heikkila@jyu.fi.

[1] The German utility model system established in 1891 is the oldest still functioning UM system [12], while Suthersanen (2019) [4] noted that the first known second-tier patent system was introduced in the UK in 1838 in response to 'criticism of the Victorian British patent system as being administratively complex and causing insuperable costs'. See Dickens's 1850 essay 'Poor man's tale of a patent' for a fictional illustration of the challenges.

[2] According to WIPO (2022) [64], 37 IP offices received more than 100 UM filings in 2020, 16 received more than 1000 UM filings, two received more than 10,000 UM filings and one (the Chinese IP office) received more than 100,000 UM filings. In comparison, there were 98 IP offices receiving more than 100 patent filings, 51 receiving more than 1000 filings, 18 receiving more than 10,000 filings and five receiving more than 100,000 filings.

[3] https://www.wipo.int/patents/en/topics/utility_models.html (Accessed 20 Sep 2022).

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members, there were none (0%)[4] and of 22 ARIPO members, there were 10 (45%). Also, of the 10 members of the ASEAN Framework Agreement on Intellectual Property Cooperation, six (60%) had UM systems in place in 2022. Hence, there are significant and differing fragmentations of IPR systems across regions.

Fig. 1 shows the steep increase in UM filings mainly driven by filings in China (cf. [13,14]). Fig. A.1 in the appendix illustrates how, in recent years, less than 1% of UM filings have been by non-residents, indicating how UM systems are very localised phenomena [4]. Thus, UM systems are much more locally orientated than patents, since UM applicants have domicile in the market in which they file UMs. UM filing activity is currently extremely concentrated in China, with about 98% of UM filings globally being filed at the China National Intellectual Property Administration (CNIPA, see Ref. [15]).

Despite the long history of UM systems, surprisingly little empirical evidence exists about their functioning and impacts (see e.g. Refs. [8, 10]). UM systems can be said to be a 'backwater' of intellectual property rights (IPRs) (Janis 1999 [1], p.152). This is a clear research gap that hinders future development of UM systems and two-tiered patent systems as part of global IPR systems (including in the European Single Market) and innovation policy instruments.

The contribution of this article is to develop a simple and systematic framework to analyse the functioning of national UM systems. Thus, the underlying research question is *What are the key performance indicators of UM systems?* In relation to this, we ask *How do these KPIs relate to the justification and goals of patent and UM systems?* We base the analysis, identification and selection of key performance indicators for UM systems on the following steps:

1) A review of prior research on UM systems and the use of UMs
2) A review of the information that patent offices provide about local UM systems
3) A reasoned selection of the key performance indicators for UM systems

Clearly, national UM systems are heterogenous, which is reflected by the characteristics emphasised on IP offices' webpages, and the UM systems' goals may differ depending on whether the country is a developing or a developed nation. Therefore, it is also suggested that KPIs are context-dependent and vary from one national UM system to another. In this article, we refrain from analysing UM legislation, which is in constant flux (cf. [6–9]). However, we acknowledge that an understanding of the national UM legislation and its interactions with other IPR legislations and context-specific innovation policy instruments is necessary when conducting case studies of specific UM systems.

The paper is structured as follows. Section 2 provides a concise bibliometric overview and a literature review. Section 3 reviews the webpages of IP offices on what information they provide about UMs. Section 4 introduces the key performance indicators. Section 5 concludes.

2. Literature review

To systematically collect information on how UM systems have been evaluated in the existing literature, we began by conducting a simple bibliometric analysis. Based on this landscaping, we proceeded to conduct a literature review, which is divided into multiple sections by UM topics.

2.1. Bibliometric landscape

We searched for relevant documents in the Web of Science database using the search query "'utility model*" AND "patent*"' in the titles, abstracts or keywords. This resulted in 136 documents (see Table A.1 in the Appendix). The black bars in Fig. 2 illustrate the increasing trend in the number of these articles, some of which discuss or analyse UM systems or utilise UM data as part of their analyses. The grey bars show the number of articles found using the keyword search query '"utility model*" AND "patent*" AND chin*"', where the idea was to identify articles in which China, the country with the most used UM system, had been mentioned. Clearly, an increasing number and share of UM-related articles also mentioned China, but we have not analysed here the actual context and content of the articles in detail.

Next, we searched for relevant documents in selected journals using a similar query. We searched articles in which the titles, abstracts or keywords contained '"utility model*" AND "patent*"'. The reported journals were ones in the field of IPR (e.g. *IIC, Journal of Intellectual Property Law and Practice*) and innovation and technology studies (e.g. *World Patent Information, Research Policy, Scientometrics, Technological Forecasting and Social Change*) that often published articles analysing patent systems or utilising patent statistics, as shown in Table A.1 in the Appendix.

Generally, it seems that only a very limited set of journals has

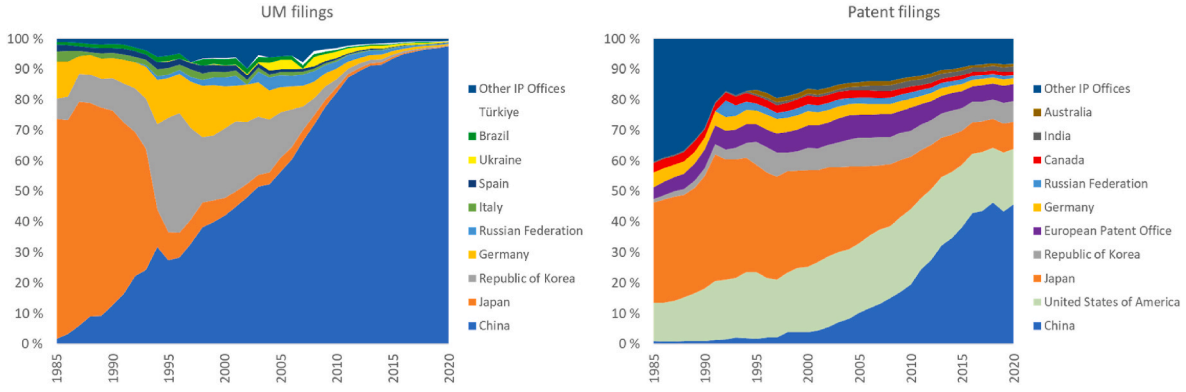

Fig. 1. IP offices receiving most utility model and patent filings, trends in shares.
Notes: The data source is the WIPO IP Statistics Database, showing Total patent and UM applications, total count by filing office (direct and PCT national phase entries). Accessed 8 October 2022. The figures only illustrate trends and are less accurate for the more distant past due to missing data. The "Top 10 IP offices" chosen are the ones that received most UM and patent filings between 2000 and 2020. Unfortunately, the WIPO IP Statistics Database does not include information on UM registrations in force by country.

[4] However, OAPI grants utility models that are in force in its member states. According to the WIPO IP Statistics Database, OAPI altogether granted 67 utility models between 1985 and 2020 (see also [13]).

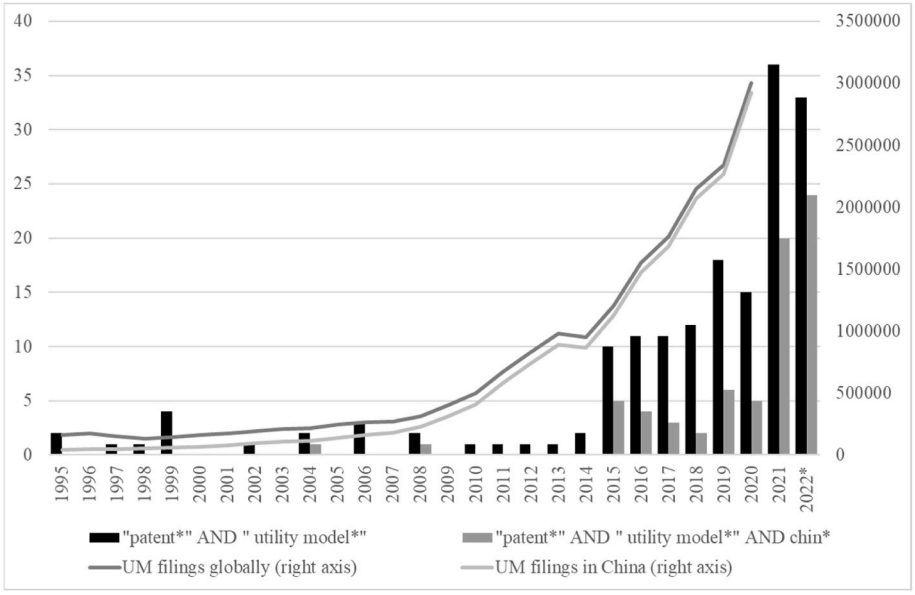

Fig. 2. Trend in UM-related scholarly articles.
Notes: Based on the topic search "'patent*" AND "utility model*"' in the Web of Science Core Collection on 29 Sep 2022. *Year 2022, as of 29 Sep. The UM filing data are from the WIPO IP Statistics Database. A similar search query in the Scopus database retrieved qualitatively similar trends, although with more articles.

published articles focusing on UM systems. Among them, *World Patent Information* (WPI) is a leading international academic peer-reviewed journal in the field of patent information.[5] Interestingly, in their bibliometric review of research published in WPI during its first 40 years (1979–2019), Sick et al. (2021) [16] did not mention UMs. Hence, we may conclude that UM systems really remain a backwater in IPR research, using the notion of Janis (1999) [1].

There are several potential reasons why UM systems have received limited attention in academic research. First, not all countries have UM systems in place, Second, UM systems differ across countries and are not internationally harmonised [3,4,6–9,17,18]. Third, prior research has focused on the US patent system and conducted empirical analyses using US patent data, but the US does not have a UM system.

2.2. Justification of UM systems

Janis (1999) [1], Suthersanen (2006) [3], Boztosun (2010) [19] and Grosse Ruse-Khan (2012) [17], among others, have pointed out that there is a significant amount of flexibility to design UM systems, since international treaties (TRIPS) do not specify or limit their details very little. WIPO has a dedicated Database on Flexibilities in the Intellectual Property System,[6] where UMs are considered one type of flexibility [20]. In September 2022, one retrieves 73 records – that is countries with UM legislation when one searches for utility model related flexibilities.[7] Hence, adding flexibility to the patent systems or ameliorating its defects are the traditional reasons for establishing UM systems [4,8].

An increasing number of articles have summarised the motives for having UM systems. For instance, Suthersanen (2019) [4] discussed the following three rationales for UM systems: 1) ameliorating the defects of the national patent system; 2) preventing free-riding copying and encouraging innovation, especially in relation to SMEs; and 3) improving the legal environments of developing countries.

The third rationale emphasises the role of UMs in technological catch-up [6,21,22]. Hence, it is important to make the distinction between developed and developing countries, since the impact of UM systems and the corresponding rationales may vary accordingly. Maskus and McDaniel (1999) [21] reported that technology diffusion through UM applications had a positive impact on Japan's post-war productivity growth. Bielig (2015) [23] reported a negative association between UM applications and GDP in Germany between 1999 and 2009.

Kim et al. (2012) [22] found patent protection to be an important determinant of innovation and that patentable innovations contribute to economic growth in developed countries, whereas in developing economies, UMs are conducive to innovation and growth. Thus, the justification for UM systems in developing countries seems stronger than in developed countries, based on scant empirical evidence [10].

It should be emphasised that one must be cautious towards the generalisability of the findings, as there have been significant changes in UM systems across countries. For instance, South Korea and Japan made such changes in the late 1980s and 1990s, respectively, which led to sharp drops in UM filings. Among others, Heikkilä (2018, [10] p.18) summarised how, over time, countries have introduced UM systems and international IPR systems have integrated in the European context. A description of the details of these UM system reforms is beyond the scope of this paper, but, for instance, Suthersanen (2006, 2019) [3,4], Prud'homme (2014, 2017) [6,7] and Radauer et al. (2015, 2019) [8,9] provided overviews of selected UM systems and their recent reforms.

The development of UM systems has stalled in the European Union [8–11,24–27]. Radauer et al. (2015, 2019) [8,9] analysed the economic impact of UM legislation in nine EU member states with UM systems, four without a UM system and five countries outside the EU with a UM system. They found there to be little evidence about the use and impact of UM systems and that UM systems differ greatly. Whereas Hall and Helmers (2019) [28] showed that the European patent convention (EPC) accession led to a decrease in national filings in new member states, particularly due to non-resident applicants' shift to filing European patents instead of national ones (e.g. Ref. [28]), there has been little research on the impact of EPC on UM filings. Currently, a European unitary UM system does not seem realistic, although the UK's exit from the EU means that it will no longer oppose such a move within the EU (cf. [8]).

[5] Sick et al. (2021) [16] reported *Research Policy, Scientometrics and Technological Forecasting and Social Change* to be among the most cited journals in articles published in the WPI.

[6] https://www.wipo.int/ip-development/en/agenda/flexibilities/database.html (accessed 22 Sep 2022).

[7] https://www.wipo.int/ip-development/en/agenda/flexibilities/search.jsp?field_id=2343&type_id=2357 (accessed 22 Sep 2022).

While modern patent systems have not been abolished, in the context of second-tier patent systems, it is possible to analyse the abolition of two-tiered patent systems [29]. For instance, the Netherlands, Belgium and Australia have abolished their two-tiered patent systems during the 2000s. According to Heikkilä (2017) [29], the abolition of the short-term patent institution in the Netherlands was associated with a temporary decrease in the total level of patent applications, indicating a shift from short-term patents to regular ones. Recently, the abolition of the Australian innovation patent in 2021 was motivated by the reasoning that the innovation patent system had not achieved its intended objective because, according to IP Australia, 'innovation patents were being used by large firms as a strategic tool' and 'unexamined innovation patents created uncertainty around where SMEs have freedom to operate', among other things.[8]

2.3. Choices and motives to use UMs

There exists an extensive propensity to patent literature [30,31]. In countries in which there is a two-tiered patent system, it is crucial to analyse the interaction between the propensity to patent and the propensity to use UMs. Heikkilä and Verba (2017) [32] noted that two-tiered patent systems – that is, systems with both patents and UMs in the menu of options for the protection of technical inventions are *de facto* sorting mechanisms in which the sorting between patents and UMs can occur along several dimensions. Atal and Bar (2014) [5] analysed the functioning of a two-tiered patent system where the modelling focused on the impacts of patent fees and examination intensity on sorting and related outcomes.

National IP laws may differentiate patents and UMs, among other things, with respect to 1) novelty and inventive step (obviousness) requirements, 2) examination intensity of patentability requirements, 3) the length of protection, 4) grant lags (speed of protection) and 5) patenting fees. Radauer et al. (2015, 2019) [8,9] highlighted six key parameters as the main building blocks of UM or second-tier patent systems that may have a major impact on the innovation activities of users; these concerned a reduction of protection standard thresholds with respect to 1) novelty and 2) inventive step; 3) reduction of examination standards at the IP office; 4) restriction/variation of the scope of protectable subject matter (as compared to first-tier patents); 5) legal safeguards (i.e. procedural aspects concerning enforceability of UMs) and 6), lowering the maximum term of protection. Also, Prud'homme (2014) [7] provides a comprehensive overview of the flexibilities related to selected UM systems. The self-selection or sorting of applicants between patents and UMs depends on the design of these UM system characteristics relative to patents.

Johnson (2002) [33] reported using Brazilian licensing data that large firms rely more on patents and less on UMs. Heikkilä and Lorenz (2018) [11] found that larger firms are more likely to combine patent protection with UM protection in Germany. Beneito (2006) [34]) analysed how patents and UMs are associated with internal and external R&D. She assumed that patents and UMs approximate significant and incremental innovations, respectively, and found using panel data of Spanish manufacturing firms that significant innovations (patents) are mainly developed in-house, whereas contracted R&D is more orientated towards incremental innovations (UMs). Torres-Barreto et al. (2016) [35] analysed the association between R&D grants and UMs in Spain and reported that regional and national R&D grants do not have a significant direct effect on obtaining UMs. Based on Korean firm-level data, Kim et al. (2012) [22] reported that UM innovations contribute to firm growth and innovation when firms are technologically lagging, but they contribute insignificantly when firms are technologically more advanced.

UM systems are considered to be 'desirable' in the widely used patent rights index of Ginarte and Park (1997) [36], which was developed further by Park (2008) [37] so that it assigns higher index values on the strength of protection to countries that provide UM protection. As a consequence, a country cannot reach the maximum value of the index unless it offers UM protection. According to Ginarte and Park (1997) [36], assigning additional points for providing a UM system 'helps to distinguish which of developing countries provide relatively stronger protection', but there is no explicit motivation given in the case of advanced economies.

Recently, Prud'homme (2017) [6] developed the first indexes of utility model patent regime 'strength', which comprises 'strictness' and 'appropriability' indexes. He then analysed the calibration of regime strength in 'East Asian latecomers' from 1905 to 2016. He documented that initially, during earlier stages of economic catch-up, these countries instituted UM regimes that were less strict and offered less appropriability, likely in order to facilitate technological learning, and subsequently, the strictness was increased as knowledge accumulation and technological capabilities increased and, in mainland China's case especially, as patent quality problems were experienced.

While there has been extensive research on the motives to use patents [30,38,39], we know less about applicants' motives for filing UMs [8,9,40]. In principle, most of the motives for filing and using UMs do not differ from those of patents but rather complement patenting strategies. Like patents, UMs can be used to prevent imitation and copying, in licensing, to gain freedom to operate and increase bargaining power in negotiations, in marketing, to attract funding and obtain public subsidies, among other things. Björkwall (2009) [40] reported in her survey of Finnish UM applicants that the three most important reasons to file UM applications were strengthening competitiveness, exploitation of the exclusive UM right and using the UM as a means of negotiation.

According to Radauer et al. (2015) [9], the main reason to use UMs is speed, making the UM particularly attractive for industries with short product lifecycles and for enforcing pending patents using branched-off UMs. Heikkilä and Lorenz (2018) [11] focused on the speed dimension and documented that among German firms, the short lifecycles of products and services are associated with the increased use of UMs. If an applicant engages in defensive publishing—that is, aims to hinder other players' opportunities to patent specific inventions—then UMs might sometimes be preferrable or at least a cheaper option [8].

Some studies have focused on the use of UMs as part of international patent families. Cao et al. (2014) [41] examined the subsequent choices of applicants with US priority filings between Chinese UMs and patents and related renewal payments. They found that such applicants differ in their preferences for time delay and the length of patent protection and reported that applicants valuing quick granting more than duration opt to protect valuable inventions with the fast and short UMs. Heikkilä & Verba (2018) [42] analysed the role of UMs in patent filing strategies in selected European countries and documented that UMs are typically used for solely national protection—that is, they are not members of large patent families but rather form singleton patent families.

Recently, building upon Cao et al. (2014) [41] and Heikkilä and Verba (2018) [42], Cahoy and Oswald (2021) [18] made the counter-case for the harmonisation of national intellectual property laws' arguments and argued that the full harmonisation of IPRs may do more harm than good. They used unstandardised national UM systems as evidence to support this argument. They documented, consistent with Radauer et al. (2015, 2019) [8,9], Cao et al. (2014) [41] and Heikkilä and Verba (2018) [42], using PATSTAT data and focusing on US-priority patents, that a firm may choose standard patent protection in one region and UM protection in another even though first-tier patent protection is available in both settings.

Heikkilä (2021) [43] reported that Finnish applicants of UM filings are less likely to use professional representatives (patent attorneys) than those applying for patents. However, more systematic empirical evidence is needed for the role of patent attorneys' recommendations on

[8] https://www.ipaustralia.gov.au/patents/applying-patent/innovation-patent-application-process/phase-out-innovation-patent (accessed 30 Sep 2022).

the choice between patents and UMs. For instance, Radauer et al. (2015, [9], p.169) noted that 'know-how on the utility model is pooled with IP professionals in the respective countries, be it IP professionals in large firm patent departments or independent patent attorney practices' and, interestingly, added that 'patent attorneys seldom know about UM legislation in other countries, which is one indication that UMs issues are more of a national than an international issue'. Königer (2017, [12], p.75) warned that 'the idea that a utility model application needs less care and competence than a patent application can have fatal consequences especially for sole inventors'.

Heikkilä (2019) [44] showed that the gender gap is larger in the case of UMs compared to patents and design rights in Finland and showed no improvement over time. This suggests that there can be even stronger gendered patterns in the use of UMs compared to patents.

2.4. Patent quality and UM quality

UM systems may have a variety of impacts, and the literature on patents provides a natural framework to analyse the functioning of UM systems. There exists a burgeoning literature on the quality indicators of patents [45–48] that play a focal role when we formulate the key performance indicator framework for UM systems in Section 4.

Trappey et al. (2012) [45] considered application length, number of IPC and UPC classes, forward citations, foreign citations, backward citations, number of claims, independent claims, patent family size, technology cycle time, science linkage and the length of specification. Squicciarini et al. (2013) [47] discussed the following patent quality indicators for the technological and economic value of patents: patent scope, patent family size, grant lag, backward citations, citations to non-patent literature (NPL), claims, forward citations, breakthrough inventions, generality index, originality index, radicalness index, patent renewal and data dissemination. Recently, Higham et al. [48] concluded that the measurement of patent quality is highly sensitive both to the observable outcome selected and to the technology type.

UM systems may have an impact on each of these patent quality measures, but the size of the impact depends naturally on the intensity of UM use and whether UMs substitute or complement patent protection. Furthermore, since the use of patents varies across industries and technology fields [47,49–51], so too does the use of UMs [9,44], and therefore the impact of UMs on patent quality is presumably industry- and technology field–specific. As method and process inventions are often excluded from UM protection, UMs should have less impact on them [32].

Since in several countries, there has been no similar substantive examination for UMs as there has been for patents, UMs are instead registered, and the presumption is that, on average, their quality is lower. Rutenberg and Makanga (2016) [52] found that in Kenya, the examination of UM certificates being ceased in 2014 resulted in an immediate and dramatic increase in the number of granted UMs and a decline in the quality of granted UMs.

2.5. Time dimensions: Lags and lengths

A specific stream of the literature has focused on patent grant lags and the analysis of other 'time dimensions' of patent systems (e.g. Ref. [53]). Moreover, some researchers have analysed how the length of patent protection impacts the direction of technological change—that is, to which projects firms allocate their R&D [54].

In several countries, obtaining a UM involves a simple registration process, and the relative speed compared to the patenting process is emphasised by several IP offices (see Section 3) and has been documented by several authors [8,9,11,41,55]. In essence, since they are generally a faster protection method than patents, UMs extend the *de facto* patent protection from the front-end. According to Radauer et al. (2019) [8], IP professionals consider this to be the most important characteristic of UM systems.

In several countries, the justification of UM systems is specifically that it provides fast protection (e.g. Germany: [8,9,11]; China: [41]). If there is substitution from patents to UMs in cases in which the applicant needs rapid protection, then this reduction in the number of patent filings could lead to a decreased backlog of pending patents and decreased grant lag. On the other hand, the average grant lag of patents could even increase if applicants in search of fast patent protection shifted to file UMs.

Also, the average duration of patents and UMs that depend on owners' choices of renewal payment can be impacted by the design of two-tiered patent systems. The average duration of patents could increase if those applicants that need only short protection change to applying for UMs instead of patents. The possibility (or not) for double-filing may have an impact on the average time lag and renewals between patents and UMs.[9] Radauer et al. (2019, [8], p.8) noted that 'branched-off utility models' (BOUM) are available in Germany, Austria, Finland, the Czech Republic and Denmark, and this instrument remedies 'the situation typically found in patent law that pending patents are, before grant, not enforceable'; they also emphasised that 'for IP professionals, the existence of BOUMs—particularly in Germany—is one of the most important rationales for the existence of a UM system'. While Germany allows for double-filing, "double-patenting" is not allowed: once a branched-off UM is registered and the parallel patent gets granted, the applicant must choose between them.[10] Wolter and Pfaffenzeller (2016, [14], p. 28) noted that China and Japan ban double protection by patent and UM.

Chen et al. (2014) [55] reported that in their randomly selected sample of 960 UMs granted in Taiwan between 2003 and 2012, the expired UMs (453 of the sample) were kept in force (renewal fees paid) on average for slightly more than three years (ranging between 3.07 for the IPC main Section A Human Necessities and D Textile Paper and 3.39 for C Chemistry, Metallurgy), while the maximum duration of UMs in Taiwan is limited to 10 years.

3. Shorter, simpler, faster, cheaper? UM features highlighted by IP offices

Lack of awareness is often cited as a challenge, particularly for SMEs and individual inventors, in the IPR context (e.g. Refs. [56,57]). Radauer et al. (2015) [9] noted the overall awareness of UMs outside IP professionals to be low. Therefore, it is important to analyse what kind of information is provided about IPRs in official information sources, such as the webpages of IP offices, and, on the other hand, how professional IPR service firms and patent attorneys describe and market UM-related services. Here, we focus on the former and leave the latter for future analysis.

WIPO describes UMs as a method of protection for 'minor inventions' that is 'designed primarily to respond to the needs of local innovators' and notes that in general, 'compared with patents, utility model systems require compliance with less stringent requirements (for example, lower level of inventive step), have simpler procedures and offer shorter term of protection'.[11]

As a UM is often argued to be a protection method that is particularly appropriate for small inventions, it is especially necessary to analyse how, in practice, SMEs and individual inventors can learn and build their understanding of this IPR institution. In this section, we briefly review what kind of information IP offices provide about UMs in their web pages. At the same time, this information sheds light on how UM

[9] See WIPO on the possibility of having both patents and UMs in the context of PCT filings: https://www.wipo.int/export/sites/www/pct/en/texts/pdf/typesprotection.pdf.

[10] We thank an anonymous reviewer for noting this.

[11] https://www.wipo.int/patents/en/topics/utility_models.html (accessed 20 April 2022).

systems are officially portrayed to potential users. As noted, there are around 70 national UM systems around the world. We reviewed the webpages of each of these patent offices, and Table 1 reports what characteristics IP offices relate to UMs, and particularly how they are described compared to patents. The shorter protection period is emphasised by a majority of IP Offices, and the lower inventive step requirement is highlighted by more than one third.

While we focus here only on the information provided by IP offices, in practice, patent attorneys may play a crucial role in an applicant's choice between a patent and a UM when choosing a strategy to protect a technical invention (cf. [8,9,43]). For instance, Heikkilä and Peltoniemi (2022) [58] described the evolution of the Finnish IPR service sector and patent attorney firms and showed how the use of named representatives in UM filings has decreased over time. Therefore, an interesting complementing extension to Table 1 would be to review the information provided about UMs on patent attorney firms' web pages.

Finally, it should be noted that UM systems in several countries are undergoing or have relatively recently been subject to significant reforms (see e.g. Refs. [8,9]), which also may change the underlying motivations and justifications for their existence and also their relative benefits and weaknesses compared to patents.

4. Key performance indicators for UM systems

The set of key performance indicators for UM systems introduced here provides a simple systematic framework to analyse the functioning of UM systems. It should be noted that we discuss here KPIs at a general level. In essence, the performance of UM systems could be analysed at a firm/applicant, inventor, industry or national level. Moreover, the international impacts of UM systems could also be analysed. These international impacts consist of knowledge diffusion and spillovers that can be traced using patent and UM citations.

There are about 70 IP Offices that provide UM protection or some other form of two-tiered patent system, and we may categorise them by the intensity of their UM filings. Naturally, in only those countries where UMs are actively utilised by economic agents, UM systems can have observable systematic impacts. If we use the simple cut-off of 100 UM filings per year, then there were 38 'UM-intensive' IP offices with more than 100 UM filings in 2021, and the rest would then be classified as 'non-UM-intensive'.[12]

Table 2 presents high-level figures of the most intensive UM countries. The ratios between patent and UM filings and the related changes during the past 20 years vary significantly across countries. Clearly, the relative changes in global UM and patent filing numbers and in the global UM/Patent ratio are primarily driven by increased applications in China. It is notable that there are probably various underlying explanatory factors for the changes, but no clear systematic patterns are visible in Table 2. Of the 15 countries with the most UM filings in 2020, only three (Ukraine, Indonesia and the Philippines) are classified as lower-middle-income countries, whereas the rest are either high-income or upper-middle-income countries. Between 2000 and 2020, seven countries increased their position with respect to income group; these were Ukraine and the Philippines from the low to the lower-middle-income group; China, Russia and Thailand from the lower-middle to upper-middle-income group; and the Republic of Korea and the Czech Republic from the upper-middle to the high-income group.

Fig. 3 presents a conceptual framework for the analysis of the potential impacts of a UM system. It helps the analysis to distinguish between the direct and indirect impacts of UM systems. Indirect impacts are those that a UM system has on outcome variables via interaction between other innovation policy instruments, naturally and most notably as a complement to or substitute for the national patent system (cf. [5]). As noted, patent systems are globally harmonised to some extent, whereas UM systems are not. Therefore, presumably the interaction between patent and UM systems differs by country. It should be also noted that a national design right system may also have a significant impact on the functioning and demand for UMs, depending on its features.

Table 1
UM characteristics compared to patents, based on IP office webpages.

Faster (simpler to obtain)*	Cheaper	Shorter	Lower (or no) inventive step (for minor inventions)	Field restrictions
19	17	39	24	12
29.7%	26.6%	60.9%	37.5%	18.8%

Notes: The information was collected from the webpages of 64 IP offices in autumn 2022. See WIPO's Directory of Intellectual Property Offices, available at: https://www.wipo.int/directory/en/urls.jsp (accessed 7 September 2022). The interpretations are necessarily based on subjective interpretations of the information provided by the patent offices. It should be noted that when IP offices' webpages are updated, the observations could also be impacted. Thus, the observations should be interpreted with caution.

[12] See 'Total utility model applications (direct and PCT national phase entries), total count by filing office' in the WIPO IP Statistics Data Center (accessed 8 October 2022).

4.1. Intermediate impacts: Functioning of the UM system

As shown in Fig. 3, a UM system has an impact on and coexists with a national patent system. Clearly, the differences between UMs and patents may induce sorting by applicants and invention types [5,32]. Since UMs are typically 'shorter, simpler, faster and cheaper' methods of protection compared to patents, in aggregate, the self-selection may have more or less impact on the quantity and average quality of patents, which is discussed next.

4.1.1. Quantity: Choice between patents and utility models, sorting

An intuitive and simple approach to analysing the importance of utility model systems quantitatively is to compare the absolute numbers of UM filings to the patent filings in each country. Heikkilä and Verba (2017) [32] argued that patent offices provide applicants with a menu of options when they offer both patent and UM protection (or their combination) and applicants reveal their preferences by choosing between the options of the menu. At the country level, we can then observe the aggregate preferences of applicants between patent and UM protection, which provides information about the importance of UM systems compared to patent systems. The analysis can also be done at industry, technology or patent classification code (e.g. international patent classification, IPC) level to reveal differences in the speed of adoption and intensity of use across them. Presumably, companies try to make their best responses to their competitors' strategic patent and UM filing choices so that the adoption of UMs in specific sectors is an equilibrium phenomenon.

Since UMs, unlike patents, are often registered without substantive examination, it is important to distinguish between those patents and UMs that are in force and those that are rejected, pending, withdrawn or lapsed. Information on the payment of renewal fees [41] enables comparisons to be made between the duration of the actual patent and that of the UM—that is, the time windows in which owners may have potentially tried to enforce their right to exclude others from using their protected inventions commercially. It should be noted that litigated patents are often over 10 years old (counted from filing date, [59]), which is the maximum duration of a UM in multiple countries. Finally, it should be noted that the evolving features of design rights systems, aside from the evolving features of patent systems, may have an impact on the quality of both patents and UMs.

Table 2
Patent and UM filings in the top 15 UM-intensive countries.

			2000				2020			Relative change between 2000 and 2020		
Country	Region (Regional IP Office)	Income group	UM	Patent	UM/Patent ratio	Income group	UM	Patent	UM/Patent ratio	UM	Patent	UM/Patent ratio
1 China	Asia	Lower middle	68815	51906	1.326	Upper middle	2926633	1497159	1.955	4152.9 %	2784.4 %	47.4 %
2 Germany	Europe (EPO)	High	22310	62142	0.359	High	12318	62105	0.198	-44.8 %	-0.1 %	-44.8 %
3 Russian Federation	Europe (EAPO)	Lower middle	4631	32337	0.143	Upper middle	9195	34984	0.263	98.6 %	8.2 %	83.5 %
4 Japan	Asia	High	9587	436865	0.022	High	6018	288472	0.021	-37.2 %	-34.0 %	-4.9 %
5 Ukraine	Europe	Low	376	7224	0.052	Lower middle	5281	3183	1.659	1304.5 %	-55.9 %	3087.6 %
6 Republic of Korea	Asia	Upper middle	37163	102010	0.364	High	4981	226759	0.022	-86.6 %	122.3 %	-94.0 %
7 Australia	Oceania	High	654	22001	0.030	High	4412	29294	0.151	574.6 %	33.1 %	406.7 %
8 Turkey	Europe (EPO)	Upper middle	460	3433	0.134	Upper middle	3627	8158	0.445	688.5 %	137.6 %	231.8 %
9 Thailand	Asia	Lower middle	616	5049	0.122	Upper middle	3455	7525	0.459	460.9 %	49.0 %	276.3 %
10 Spain	Europe (EPO)	High	3212	3194	1.006	High	3448	1555	2.217	7.3 %	-51.3 %	120.5 %
11 Brazil	Latin America	Upper middle	3278	17283	0.190	Upper middle	2662	24338	0.109	-18.8 %	40.8 %	-42.3 %
12 Italy	Europe (EPO)	High	3085	9273	0.333	High	2397	11008	0.218	-22.3 %	18.7 %	-34.5 %
13 Indonesia	Asia	Low	251	3890	0.065	Lower middle	2311	8160	0.283	820.7 %	109.8 %	338.9 %
14 Philippines	Asia	Lower middle	572	3636	0.157	Lower middle	1490	3993	0.373	160.5 %	9.8 %	137.2 %
15 Czech Republic	Europe (EPO)	Upper middle	1288	4939	0.261	High	1324	729	1.816	2.8 %	-85.2 %	596.4 %
World total			163400	1377500	0.119		3000110	3276700	0.916	1736.1 %	137.9 %	671.9 %
Other countries excl. China			94585	1325594	0.071		73477	1779541	0.041	-22.3 %	34.2 %	-42.1 %

Notes: The information source is WIPO IP Statistics (https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html). Notably, the filings for the Australian equivalent of a UM, innovation patents, were discontinued in 2021 (https://www.ipaustralia.gov.au/patents/understanding-patents/types-patents). Region and income information: World Bank, The World by Income and Region (https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html, accessed 7 Sep 2022).

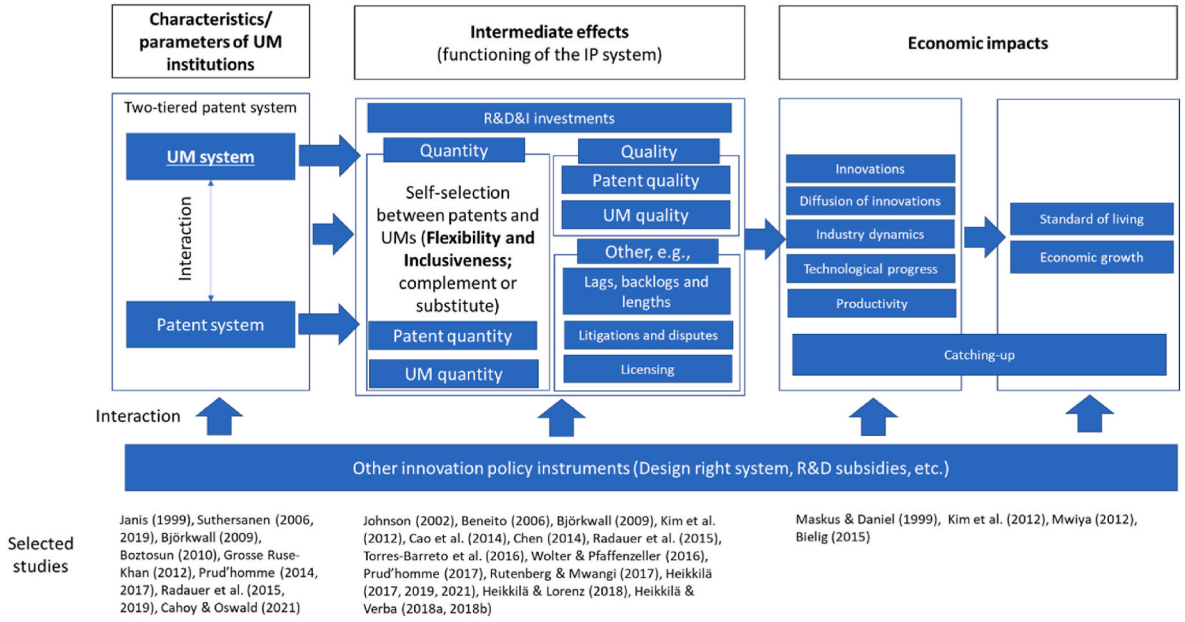

Fig. 3. A Framework for the multidimensional analysis of UM systems' performance.
Note: Authors' illustration.

4.1.2. Quality: UMs compared to patents and impact on the patent system

Several studies have provided extensive overviews of patent quality indicators [46–48]. Most of the patent quality indicators are also applicable to UMs, but there are a few exceptions (cf. Heikkilä 2018, [10], p.23). For instance, in several countries, UMs are registered without substantive examination, so there are no comparable 'grant rates'—that is, how a large share of patent applications become granted patents. Moreover, there can be, and have been, stricter limitations for the number of claims in UM filings compared to patents (e.g. one claim per UM filing in Japan and South Korea in the past, [6]). In addition, the literature on motives to patent [38] applies relatively well to motives to use UMs. Rigorous analysis of the motives to use UMs requires survey methods that have been applied, for instance, by Björkwall (2009) [40] and Radauer et al. (2015, 2019) [8,9].

4.1.3. Flexibility and inclusiveness

4.1.3.1. Quicker protection. Since the process of obtaining UMs is typically simpler and quicker than that of patents, an appropriate KPI in this context is the time lag in obtaining registered/granted protection from filing. In addition, the registration and grant lag difference between UMs and patents is of interest because in some countries, the quick protection of UMs makes them a particularly lucrative option [9].

4.1.3.2. Inclusive institution. In economics jargon, inclusiveness boils down to the following question: do UMs substitute or complement patent protection? As noted, it has been argued that UM systems are particularly appropriate protection methods for small inventions and small inventors, but this justification has also been criticised [8,9]. Therefore, an interesting question is whether the UM system is, in practice, an inclusive institution—that is, to what extent do we have more registered inventions and inventors in our databases in the presence of UM systems. The inclusiveness of institutions can be examined by analysing the extend of overlap—or the level of substitution and complementarity—between patents and UMs with respect to different dimensions, including the following:

1) **Inventions:** Are there more technical inventions—particularly incremental ones—for which patent or UM protection is filed and more technical inventions documented in patent databases in the presence of a UM system? What is the level of substitution with respect to inventions? To what extent are UMs a fallback option for failed patent applications? To what extent do applicants aim to protect the same technical inventions with both patents and UMs? What is the role and share of double-filings or 'branched-off' UMs?
2) **Applicants:** Are there more applicants that protect technical inventions in the presence of a UM system, or are UM applicants the same as patent applicants? Are there more SMEs and individual inventors ('small innovators') in the presence of a UM systems? Is a UM system a 'learning device and thus a steppingstone for developing more patentable inventions later on', as noted by Kim et al. (2012) [22].
3) **Inventors:** Does the total number of registered inventors in a society increase in the presence of a UM system, or are UM inventors the same as patent inventors? Relatedly, as women inventors have recently received increasing attention (e.g. Ref. [15]), the gender gap in UM is as important as it is in the case of patents. Thus, it is also important to ask whether the share of women inventors increases in the presence of UM systems.

As noted by Radauer et al. (2015, 2019) [8,9], SMEs are often highlighted as potential users of UMs. However, large incumbents have typically more resources and existing IPR know-how to utilise UMs as a complementary instrument (cf. [11,60]). Thus, the ratio between new and small firms, compared to old and large firms, is a relevant measure. That UMs have somewhat lower administrative fees may not be so important, since patent attorneys' cost for drafting UM specifications do not differ much from drafting patent specifications and patent attorney costs are often a much larger cost factor [8,9]. Patent attorney fees can be many times larger than application and examination fees [61], and Königer (2009) [27] noted that, for instance, the German UM application is as difficult to handle as a patent application.

Finally, the inclusiveness of the UM system depends both on the characteristics of the patent system and the UM system and ultimately on their mutual interaction and interaction with other innovation policy instruments and rules of the game. Therefore, differences in patent systems across countries should always be considered when evaluating the inclusiveness of UM systems.

4.1.3.3. International UM filings. WIPO lists how UMs can be used in the context of the PCT system.[13] There are significant country differences, but it generally seems that UMs are only moderately used as part of international protection, although exceptions exist [9,18,41,42]. Therefore, the most common structures of patent families, including UMs, are an important performance indicator.

4.2. Economic impacts

4.2.1. Innovation incentives and diffusion of innovations

The traditional approach to and traditional welfare criteria for impact assessment that have been applied to patent systems can also be applied to UM systems. The literature on the impacts of patent systems can be roughly divided into a strand that focuses on innovation incentives (e.g. the association between patents and R&D&I investments) and a strand that focuses on the diffusion of innovations utilising patent citations. An important aspect that is related to the former is the role of patents in acquiring finance [62]. At an even more general level, there are studies on the association between patent utilisation and company survival. These suggest associations between R&D investments and UM filings but fail to illuminate the underlying mechanisms. All these approaches are also applicable to the impact assessment of UM systems, but it should always be taken into account that the aggregate impact of UM systems depends on the interplay between the patent system, the design right system and other innovation policy instruments.

4.2.2. Technological catching up

As pointed out by multiple authors (e.g., Refs. [4,6,21,22]), UM systems can be particularly beneficial for countries in a catching-up or developing phase. Different organisations have their own classifications of developed and developing countries, and there are also some boundary cases—that is, some countries are sometimes categorised as developed and sometimes as developing.[14]

As noted, there is no clear cut-off for UM intensive and non-intensive countries, but one ad hoc categorisation is to consider countries with more than 100 UM filings per year as UM intensive, and UM non-intensive otherwise. Presumably, in countries where the intensity of UM usage is very low, their UM systems can have only a limited impact on innovation activity in aggregate. For instance, Rutenberg and Mwangi (2017) [63] concluded that granted patents and UMCs have not been a significant factor in driving innovation in Kenya, since between 1993 and August 2016, 725 patents and 108 UM certificates were granted.

National UM systems can be simply categorised by the development level of the country and by the aggregate intensity of UM filings. Relying on the International Monetary Fund (IMF)'s definition of developing country, for instance, China, Russia and Ukraine would be considered as UM-intensive developing countries; Germany, Japan and the Republic of Korea as UM-intensive developed countries; Kenya, Azerbaijan and Ecuador as non-UM-intensive developing countries; and France and Greece as non-UM-intensive developed countries.

4.2.3. Direction of technological change

As noted in Section 2, some IP laws differ across countries with respect to technology field restrictions. In some countries, UMs cannot protect, for example, processes and chemical inventions. This means that the incentives created by UMs are not technology neutral. UMs should particularly incentivise device-related innovations, since process inventions are excluded in several countries from UM protection. The impact of UM systems on the rate and direction of technological progress can be evaluated by analysing the patent classes to which UMs are assigned at IP offices and by focusing on the industries that utilise UMs intensively.

The impact of patent systems on the direction of technological change has been studied increasingly [51,64]. Patents incentivise more innovation and promote the diffusion of innovations in some industries and technology fields more than in others. Similarly, UM systems are non-neutral with respect to industry- and technology field–specific incentives. In particular, UMs may attract more economic agents in specific industries, such as in industries where product life cycles are short [11] or where innovations are of a more incremental nature.

4.3. Other performance indicators and limitations

The presented KPI framework is naturally not exhaustive. For

[13] WIPO provides information about the use of UMs as part of international patent filings (PCT); WIPO: Types of Protection Available via the PCT in PCT Contracting States (status on 25 November 2019) https://www.wipo.int/export/sites/www/pct/en/texts/pdf/typesprotection.pdf; WIPO Newsletter 05/2018: Practical Advice, https://www.wipo.int/pct/en/newslett/practical_advice/pa_052018.html (accessed 28 Sep 2022).

[14] There are alternative categorisations for developed and developing countries (e.g. by the United Nations, the International Monetary Fund and the World Bank). Categorisation for UM intensity is ad hoc, and one cut-off is to consider countries with more than 100 UM filings as UM intensive and non-UM-intensive otherwise.

instance, the use of UMs in litigation and the invalidation processes of UMs were not included. There are no comprehensive publicly available data and understanding them in detail would require a nuanced understanding of the institutional contexts and evolving national UM and patent legislations. The WIPOLex database gathers such information, but it seems that there are currently very few cases available.

Second, we did not consider here the administrative costs of maintaining a UM system. For instance, the time allocated to the substantive examination of UMs may require significant resources. The calculation of the 'return on investment' and total net benefits of UM systems would require taking this cost into account. Presumably, the fees related to obtaining UM protection compared to patents also have an impact on how applicants choose between them.

Thus far, UM systems have existed for over a century, but their impact remains a puzzle. We may speculate about the future trajectories of these systems by discussing positive, neutral and negative scenario options. The positive option would include further adoption of UM systems across countries and increase in the intensity of UM use. The neutral scenario suggests the 'same old', which currently seems to be a gradual decrease and atrophy in the use of UMs. The negative scenario is the active abolition of UM and two-tiered patent systems, which we witnessed in the Netherlands, Belgium and Australia during the 2000s. Currently, the neutral scenario seems to be the most probable one, unless there are new initiatives to revitalise UM systems.

This analysis is not without limitations. For instance, law preparation documents underlying the development of UM systems were not considered, even though they would have probably revealed more explicitly the original motives for the establishment of UM systems. Second, the presumably important role of patent attorneys in recommending UM filings for applicants was not discussed in detail. In particular, the small number of non-resident UM applicants suggests that UMs may not be a lucrative business for patent attorneys, since if they were, we would see more UM filings by non-residents that use—and sometimes have been and still are obliged to rely on—a local patent attorney.

Currently, as shown in Fig. 1, there are a few UM-intensive countries in which UM reforms will have the largest impact on the IPR environment. Other countries should learn from these experiences and adopt the evidence-based development of UM systems.

4.4. Selection of context-specific key performance indicators

Table 1 presented the key differences and advantages of UMs compared to patents. These multidimensional differences between UMs and patents—and related across country variations—lead to self-selection by applicants between patents and UMs, which may lead to

Table 3
KPIs for the functioning of utility model systems.

KPIs	"Traditional" welfare criteria				Flexibility to national patent system			Impact on patent system	
	Innovation incentives	Diffusion of innovations	Rate and direction of technological change	Catching up	Quicker protection	Inclusiveness	International protection	Quantity of patents	Quality of patents
Number of UM filings	X								
Number of UM applicants	X								
Number of UM inventors	X								
Performance of firms using UMs	X								
R&D investments by firms using UMs	X								
Commercialization of UM-protected inventions	X								
Number of published UM filings with descriptions of inventions		X							
Citations to UMs		X							
Licensing of UM-protected inventions		X							
Patent filings by IPC classes			X						
UM filings by IPC classes			X						
Resident UM filings				X					
Resident patent filings				X					
National R&D investments				X					
Registration/Grant lags for inventions					X				
Backlog of pending patents					X				
Patent and UM inventions overlap						X			
Patent and UM applicants overlap						X			
Patent and UM inventors overlap						X			
Number of UM filings by SMEs						X			
Priority and non-priority UM filings							X		
Number of patent filings								X	
Share and absolute number of rejected patents									X
Share and absolute number of granted patents									X
Patent quality indicators									X

Notes: Each of the 'goals' could be measured on different levels of aggregation, such as national, regional, industry or technology field (e.g. International Patent Classification, IPC codes), among others. Innovation-based competition occurs at the industry level, the use (including substitution and complementarity) of UMs and patents differs across industries, and the field restrictions of UMs have an impact on industries differently.

there being an impact on the quantity and quality of patents. Based on the literature review and analysis, we suggest the performance indicators on the functioning of UM systems in Table 3. The key message is that KPIs are context-dependent and UM systems should be evaluated given the institutional framework. Thus, KPIs for each UM system are to be selected from this set of indicators depending on the context. We intentionally refrain from explicitly determining the positive and negative impacts of UM systems (cf. [8]).

5. Conclusions

The evidence-based development of UM systems requires systematic and rigorous analysis of the functioning of existing UM systems. We reviewed the characteristics and benefits of UM systems as described by the national IP offices and provided an analysis of the literature that analyses the performance of UM systems. Based on this review, we introduced a systematic framework to analyse the functioning of UM systems. The suggested KPIs related to multiple justifications and goals associated with UM systems. Given that non-standardised UM systems always interact with more standardised national patent systems, the functioning and impacts of UM systems are the outcome of this interaction, and the peculiarities of national patent (and design right) systems should be taken into account.[15] This simple framework can be developed further and applied in the future empirical analyses of national UM systems.

CRediT author statement

Jussi Heikkilä: Conceptualization, Methodology, Data collection, Investigation, Writing, Visualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A.1
Articles mentioning utility models

	Query	
Topic[1] search in Web of Science Core Collection	"patent*"	"patent*" AND "utility model*"[2]
Articles	83633	136
Journal		
IIC International Review of Industrial Property and Copyright Law	341	4
Research Policy	729	3
Scientometrics	668	3
IIC International Review of Intellectual Property and Competition Law	268	3
Journal of Intellectual Property Law and Practice	190	2
Technological Forecasting and Social Change	413	1
World Patent Information	272	1
Journal of Intellectual Property Rights	109	1
Economics of Innovation and New Technology	87	1
Technology Analysis and Strategic Management	220	0
Journal of Technology Transfer	217	0
Technovation	164	0
International Journal of Technology Management	126	0
Industrial and Corporate Change	118	0
International Journal of Industrial Organization	115	0
R&D Management	102	0
Industry and Innovation	89	0
Journal of Informetrics	76	0
RAND Journal of Economics	64	0
Nature	521	0
Science	370	0

Notes: [1]As of 26 April 2022. "Topic search" searches title, abstract and keywords. [2]Simpler keyword query "utility model" is too broad retrieving papers where, e.g., "expected utility model" or "random utility model" are mentioned.

[15] Radauer et al. (2019) [8] emphasised that patent systems are not as homogenenous as is sometimes assumed, and the characteristics of patent systems moderate the impacts of UM systems (see Fig. 1, 'Impact model', p.5).

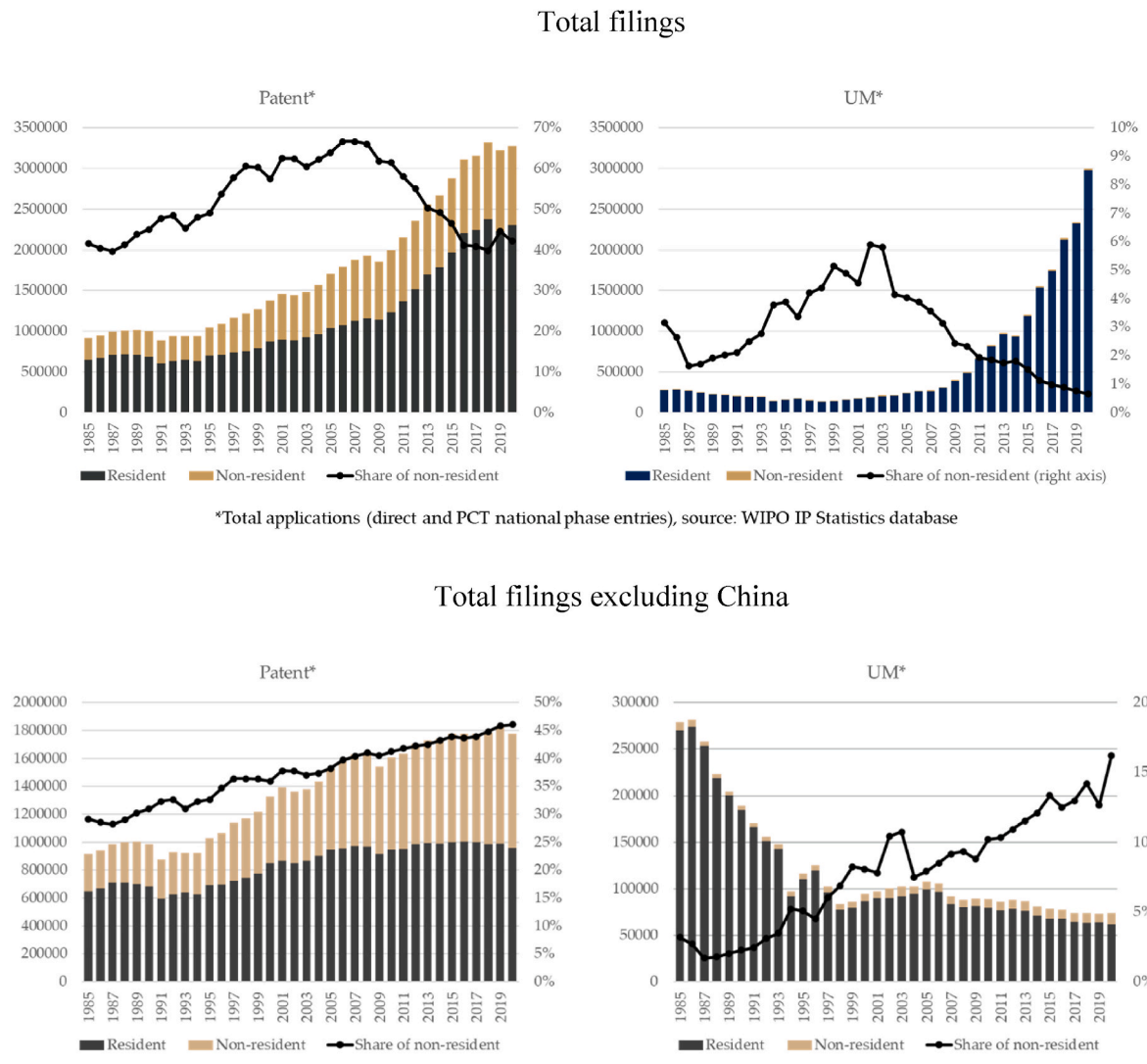

Fig. A.1. Resident and non-resident filings of patent and UM filings.
Notes: Data source is WIPO IP Statistics Database. It should be noted that company structures (parents and subsidiaries) have an impact on the statistics on "foreign" and "domestic" applicants.

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D.Sc. (Econ) Jussi Heikkilä is Research Fellow in Economics at Jyväskylä University School of Business and Economics and Adjunct Professor in Industrial Engineering and Innovation Management at Lappeenranta-Lahti University of Technology, School of Engineering Science.