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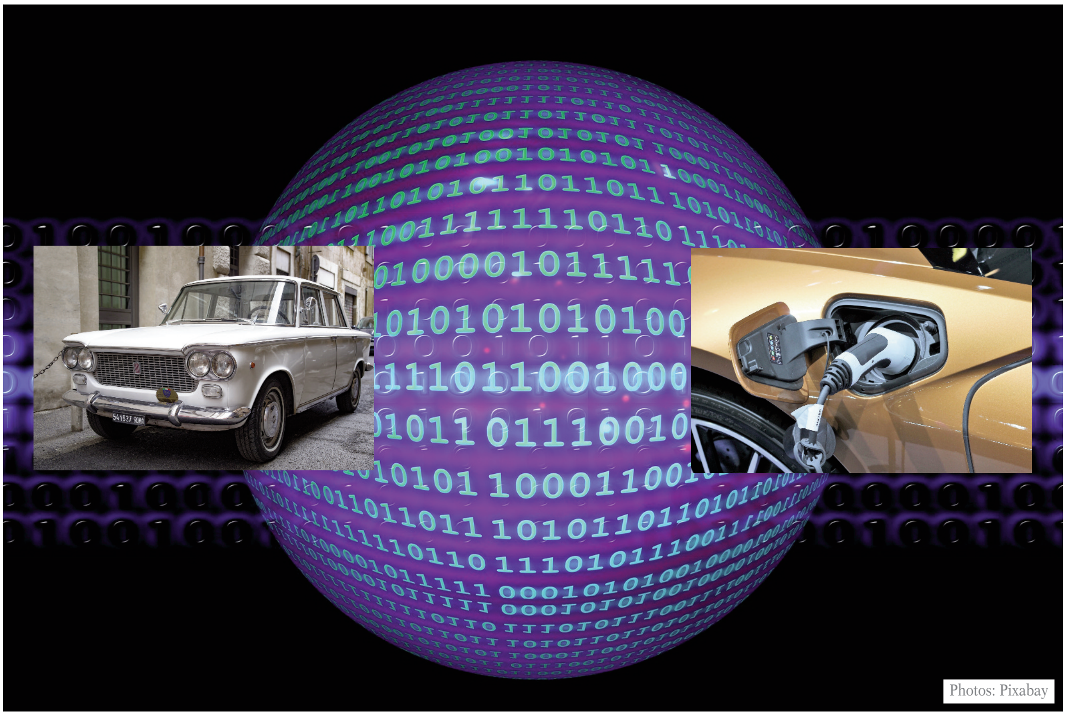

Developing metrology systems: Adapting to change

BULLETIN

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The OIML Bulletin is the journal of the Organisation Internationale de Métrologie Légale

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■ Editorial

M. Peter Mason

Président du Groupe Consultatif
des CEEMS (CEEMS AG)

Évolution des activités de l'OIML en faveur des CEEMS

Parmi tous les changements qui ont eu lieu dans notre Organisation au cours des quinze années qui se sont écoulées depuis que j'ai commencé à m'impliquer activement au niveau du CIML, je pense que le plus frappant a été la manière dont nos activités ont été réorientées pour mieux répondre aux besoins de tous nos membres, y compris ceux dont les économies sont moins développées.

À mon sens, le moment clé de ce changement a été l'initiative proposée en 2013 lors de la 48ème Réunion du CIML à Ho Chi Minh Ville, qui a conduit à la création du groupe consultatif des CEEMS.

Rétrospectivement, de nombreux éléments de la résolution du CIML adoptée lors de la réunion de 2013 ont été au cœur de la manière dont les activités de l'OIML se sont développées.

C'était, par exemple, la première fois que l'expression « Countries and Economies with Emerging Metrology Systems » (CEEMS) était utilisée dans un contexte officiel de l'OIML. Le fait de ne plus parler de « pays en développement » ou de termes similaires a été, à mon avis, très utile. Tout d'abord, il reconnaît qu'il ne s'agit pas seulement d'une question de PIB. Il existe indubitablement des pays qui ont connu une croissance significative de leur PIB mais dont les systèmes de métrologie sont encore relativement sous-développés. Deuxièmement, comme il n'y a pas de définition claire, cela permet aux pays de s'identifier comme faisant partie de la communauté CEEMS. En effet, tout pays qui souhaite apporter des changements significatifs à son système de métrologie peut être considéré comme faisant partie de la communauté CEEMS.

Parler de systèmes de métrologie émergents nous amène également à dépasser les accords de métrologie légale. Dès le début, nous avons reconnu la nécessité de prendre en compte les capacités de métrologie industrielle et scientifique de ces économies. Cette nécessité a été soulignée par le nouveau D 1, qui est désormais une publication conjointe OIML/BIPM.

D'autres aspects de la résolution de 2013 ont également été cruciaux : l'établissement de liens avec les projets et initiatives des différents États Membres et d'autres organismes impliqués dans la promotion du développement économique au sein des CEEMS ; la collaboration avec les organisations régionales de métrologie légale ; la concentration sur les besoins *identifiés* au sein des CEEMS et la réalisation de vastes consultations. Dès le début, nous avons demandé à la communauté CEEMS, par le biais d'enquêtes et d'ateliers, ce qu'elle considérait comme les priorités de son économie.

Le résultat de tout ceci est que nous pouvons maintenant clairement voir les activités CEEMS de l'OIML comme formant un troisième pilier de l'OIML à côté de notre travail technique et du Système de Certification OIML. Et en effet, le travail au sein de ces deux autres piliers est également plus ouvert à la communauté CEEMS.

En ce qui concerne l'avenir, j'ai le sentiment que notre plus grand défi est d'aider nos collègues des CEEMS à faire face aux exigences de la transformation numérique, qui offre un large éventail de possibilités pour améliorer l'efficacité des autorités de métrologie légale dans le monde entier. Elle peut également faciliter l'accès des entreprises et du public aux informations et aux services. Mais dans le même temps, les autorités des CEEMS doivent relever d'énormes défis pour superviser et réglementer les systèmes de mesure qui sont de plus en plus numérisés et se déploient de plus en plus rapidement dans le monde entier. Une collaboration étroite entre le groupe consultatif des CEEMS et le nouveau Groupe de Travail sur la Numérisation (DTG) de l'OIML sera essentielle pour aider à relever ces défis. ■

Mr Peter Mason

CEEMS Advisory Group
(CEEMS AG) Chairperson

Evolution of OIML activities in favour of CEEMS

Of all the changes that have taken place in our Organisation in the fifteen years since I started to be actively involved at the CIML level, I think the most striking has been the way in which our activities have been re-oriented to be more relevant to the needs of all of our membership, including those with less developed economies.

To my mind, the key moment in this change was the initiative proposed in 2013 at the 48th CIML Meeting in Ho Chi Minh City, which led to the creation of the CEEMS Advisory Group.

Looking back, there are many elements in the CIML Resolution adopted in 2013 meeting that have been central to the way the OIML's activities have developed.

It was, for instance, the first time that the phrase "Countries and Economies with Emerging Metrology Systems" (CEEMS) was used in an official OIML context. This move away from talking about "developing countries" or similar terms has, in my opinion, been very helpful. Firstly, it recognises that this is not just a question of GDP. There are undoubtedly some countries which have seen significant growth in GDP but whose metrology systems are still relatively under-developed. Second, because there is not a clear definition, it makes it possible for countries to self-identify as part of the CEEMS community. In effect, any country which wishes to make significant changes to its metrology system can be regarded as part of the CEEMS community.

Talking of emerging metrology systems also takes us beyond legal metrology arrangements. From a very early stage, we have recognised the need to take into account the industrial and scientific metrology capabilities of these economies. This has been further emphasised by the new D 1 which is now a joint OIML/BIPM publication.

Other aspects of the 2013 Resolution have also been crucial: linking with projects and initiatives from individual Member States and other bodies involved in promoting economic development within CEEMS; working with the Regional Legal Metrology Organisations; and concentrating on the *identified* needs within CEEMS and carrying out wide-ranging consultations. From the start we have sought input from the CEEMS community, both through surveys and through workshops, about what they see as the priorities in their economies.

The result of all this is that we can now clearly see the OIML's CEEMS activities as forming a third pillar of the OIML alongside our technical work and the OIML Certification System. And indeed, work within those two other pillars is also more open to the CEEMS community.

Looking to the future, my feeling is that our biggest challenge is how to help to our CEEMS colleagues cope with the demands of digital transformation, which provides a wide range of opportunities to improve efficiency in legal metrology authorities all over the world. It can also make it much easier for businesses and the public to access information and services. But at the same time there are enormous challenges for CEEMS authorities in supervising and regulating measuring systems which are increasingly digitised and are being rolled out with increasing rapidity across the world. Close working between the CEEMS Advisory Group and the OIML's newly established Digitalisation Task Group will be central to helping meet these challenges. ■

CEEMS

The development of the OIML's CEEMS activities

PETER MASON
CEEMS Advisory Group (CEEMS AG) Chairperson

Introduction and background

There is a long history of efforts within the OIML aimed at making its work more relevant to the needs of less developed economies. For many years, there was a Permanent Working Group on Developing Countries, which met at the same time as the CIML. In 2008 the Conference dissolved that Permanent Working Group and established the position of "Facilitator on developing country matters". In 2009, on the Facilitator's recommendation, the CIML established an Award for "Excellent achievements in legal metrology in developing countries" (now the OIML CEEMS Award). In 2012 the Conference dissolved the position of Facilitator following the resignation of the post holder, but the OIML budget drawn up that year included a special fund to support OIML activities aimed specifically at developing countries.

There has also been a well-established history of the OIML and the BIPM working together within the previous DCMAS Network (now INetQI) and on World Metrology Day. However, none of these initiatives succeeded in attracting significant support from OIML Member States, nor did they lead to any measures which were judged to have a real impact in the countries they were intended to help.

That situation changed significantly following the initiative proposed in 2013 at the 48th CIML Meeting in Ho Chi Minh City by the then CIML Member for the People's Republic of China, Mr Pu Changcheng, which led to the creation of what is now the *Advisory Group on matters concerning Countries and Economies with Emerging Metrology Systems* – the "CEEMS AG".

The 2013 Resolution introduced the phrase "Countries and Economies with Emerging Metrology Systems" (CEEMS). It also saw the beginning of an intensive process of identifying the actual needs of the CEEMS community through wide-ranging consultations. The initial work of the ad hoc group set up in response to the Resolution concentrated on conducting surveys and organising workshops in order to gather ideas which would feed into a work programme of activities. This culminated in the Resolution adopted in 2015 at the 50th CIML Meeting in Arcachon (Resolution 2015/10), which set out the direction of the OIML's CEEMS activities.

The Arcachon Resolution had three main components:

- Instructions to the BIML and CIML officeholders on steps they could take to further the CEEMS agenda. Initially this was focussed on using the OIML website to give more prominence to matters of interest to CEEMS and to draw up a database of "experts" who were available to work on CEEMS projects. However, it also endorsed the continued involvement of BIML staff and CIML officeholders in activities such as training courses organised by others.
- Directions that the OIML's "technical work" – that is, the development of Recommendations, Documents and Guides – should take more account of their use in CEEMS. Projects being undertaken on pre-market surveillance and certification systems for prepackages were identified as areas of particular interest. There was a similar expectation that the revision of the Directives for OIML Technical Work (OIML B 6) and the development of a new Certification System (OIML-CS) should also take explicit account of the needs of CEEMS.
- Recommendations to OIML Member States and other organisations on steps that they could take, facilitated where necessary by the OIML, to further the CEEMS agenda. An early example of this was the concept of "OIML Training Centres" – in effect facilities in Member States approved by the OIML – which could meet training needs within the CEEMS community. A pilot initiative in P.R. China was already planned, and the Resolution both expressed its support for this and encouraged other Member States to consider similar initiatives. In addition, Member States were asked to consider other initiatives, including secondments, which would develop talent within CEEMS.

The Arcachon Resolution, followed by an updated Resolution adopted at the 53rd CIML Meeting in Hamburg in 2018, continued to provide the framework within which the Advisory Group has organised its work programme and has reported progress annually to the CIML. A key feature was the recognition that projects and initiatives promoted by the OIML had to complement, rather than compete with, the activities of individual Member States and other bodies with an interest in promoting the economic development of countries and economies with emerging metrology systems. So too was the need to work with the Regional

Legal Metrology Organisations (RLMOs). This theme of partnership with the programmes of others has been central to the way the OIML's CEEMS activities have developed.

The Advisory Group, which had begun as an ad hoc task group, was made permanent at the 51st CIML Meeting in Strasbourg in 2016, with its objectives, functions and composition set out in a new Basic Publication (B 19:2017). Its composition is unique, membership being a mix of:

- Ex officio members – The CIML President and Vice-Presidents and the Directors of the BIML and the BIPM;
- Individual CIML Members – any CIML Member who wishes can volunteer for membership;
- RLMO representatives – any RLMO recognised by the OIML can nominate a representative of their choosing; and
- Individual experts – the Advisory Group is able to co-opt any suitable individuals who are experts in CEEMS matters, who then become full members of the Advisory Group.

This ensures that there is a wide pool of talent to call upon when we are carrying out different projects.

Since the Advisory Group became permanent there has been a lot more emphasis on specific projects, led by various individuals within the AG, set out in the rolling Work Plan that we maintain. The most significant of these projects are presented below.

OIML website

From the beginning, it was recognised that a well-designed website is an essential part of explaining the OIML's CEEMS activities and making available the information which will be of greatest use within the CEEMS community. At an early stage, we decided that this should be a prominent section within the OIML website rather than something completely separate. The progressive development of the OIML website over recent years has given us the opportunity to take a fresh look at its structure so that the most important information is now clear and readily available. For instance, one of our first projects – the creation of an **"Experts Database"** – features prominently on the OIML's CEEMS pages.

e-Learning

Also prominent on the website are certain e-Learning packages, and the further development of this material is certain to be an important focus of future activity. An early source of our material was the result of a project carried out by the ACP EU TBT Programme – another example of the benefits of working with other organisations. Since then, this area has been given additional impetus by the Workshop held in Bratislava alongside the 54th CIML Meeting in 2019 and more material has been offered by both individual Member States and RLMOs.

OIML Pilot Training Center: First OIML OPTC NAWI training course
17–21 July 2016 - Beijing, P.R. China

OIML Training Centres and OIML Training Events

The pilot in P.R. China mentioned above proved to be very successful. The model provided an inspiration for events in Kenya and Cuba in 2018, in addition to further events in P.R. China. There were a number of other proposals put forward in other parts of the world before the COVID-19 pandemic intervened.

Although the original idea was of training centred on dedicated facilities, most other proposals involved various forms of one-off events, supported in different ways by Member States and other organisations. A common feature was the OIML's role in identifying suitable experts and in promoting the events. As a result, the Advisory Group produced a framework which could be used for future centres and events – this is now available in OIML Basic Publication B 21:2019.

Unfortunately, almost as soon as this framework was available the COVID-19 pandemic made it extremely difficult to organise similar events. It is also very possible that future events will have a much more significant online element to them (see below). Nevertheless, as the world emerges from the worst effects of the pandemic we can look forward to more use being made of this framework. We have been notified of at least one event (in Germany) planned for 2023.

Assisting future leaders in CEEMS

Another casualty of the pandemic has been a proposal which was worked up in 2019 to promote a scheme for encouraging various forms of secondments and placements. We are still at an early stage of planning what we can do in this area, but the success of similar initiatives sponsored by the BIPM suggests that we should return to looking at this. The BIML itself benefitted from having a secondee working on CEEMS matters prior to the pandemic.

Documents and guidance for CEEMS

One of the most interesting developments in the Advisory Group's functions since it was set up has been a direct role in supervising the production of OIML publications. The first, and most significant so far, was the revision of OIML International Document D 1 (see insert), which originated as a "Model Law" which countries could adopt or modify when modernising their legislation. It subsequently developed into a tool for countries to use in improving all aspects of their

OIML International Document D 1:2020

National metrology systems – Developing the institutional and legislative framework

The structure of OIML D 1 covers sections on the importance of metrology; the design of national metrology systems and their place within a wider Quality Infrastructure; international co-operation; policy options for Governments; advice on legislating for metrology; and the challenge of keeping metrology systems up-to-date. There are annexes containing a checklist of legal framework elements and a Model Law.

General themes in the Document include:

- there is no single ideal blueprint for a national metrology system;
- metrology systems need to cover a country's needs for legal, industrial **and** scientific metrology;
- it is very desirable that a metrology system fits with the country's wider Quality Infrastructure, but that "fit" is quite a complex one;
- international engagement will save time, money and effort;
- it is important that all groups of users have a say in how the system develops;
- the legislative framework needs to cover all the aspects of the metrology system and both the system and the framework will need regular updating;
- metrology needs are changing all the time – national systems and legal frameworks need to be capable of adapting in terms of:
    - reviewing national policies;
    - developing institutions;
    - modernising legislation;
    - updating capabilities of metrologists and legal metrology officials; and
    - engaging with business and the public.

OIML Pilot Training Center: Prepackaged goods. Group discussion during the training course, 10–13 April 2018 - Nanning, P.R. China

**OIML Pilot Training Center: First OIML OPTC OIML Metrology Management System Seminar
9–11 August 2016, Guangzhou, P.R. China**

metrology systems. The 2020 revision involved a complete restructuring and expansion of its contents, along with a new title. It is now published as a joint OIML/BIPM Document.

The success of the D 1 project has also led to the AG identifying certain other publications where it can perform a similar role – in effect acting in the same way as a TC or SC would in forming the Project Groups which undertake the actual revision within the framework of OIML B 6:2019. This is particularly appropriate in the case of publications with a wide application but of particular interest to the CEEMS community – documents such as D 14 *Training and qualification of legal metrology personnel*, D 19 *Pattern evaluation and pattern approval* and D 20 *Initial and subsequent verification of measuring instruments and processes*. Work has already started on the first two of these revisions.

Use of online technology for CEEMS activities

With the COVID-19 pandemic disrupting planned progress on most of the AG's Work Plan, the major focus of recent work has been to provide guidance on how CEEMS activities can best be carried out while international travel remains severely restricted. Even with the worst of the pandemic hopefully behind us, there is a widespread assumption that there will be less international travel, along with more home-working, reductions in availability of legal metrology staff, and reduced funding. All of this is likely to result in much more use of online technology such as video-conferencing across the whole range of CEEMS activities. The Advisory Group's recent work has therefore been largely devoted to looking at how legal metrology authorities in CEEMS can make the best use of online technology to function in a world where there are fewer and less experienced staff, with a particular focus on how online technology can be used to conduct CEEMS support activities.

Arising from this work, the Group expects to publish shortly a document (probably as an OIML Guide) which will provide guidance on how online technology can be applied to a wide range of different activities – the development of documents and materials of interest to CEEMS; e-learning; interactive training courses; consultancy and advisory services; informal contacts between legal metrologists; and engagement with development agencies and government decision-makers.

At the same time, the new document will also contain a number of recommendations to the BIML, the CEEMS Advisory Group and other OIML bodies on actions they can take. The most significant of the recommendations have been added to the Advisory Group's Work Plan.

The Advisory Group's work on the online technology project has also highlighted the wider CEEMS interest in various aspects of digital transformation. This notably includes the different issues and opportunities arising from:

- the regulatory and enforcement challenges posed by the increased use of digital technology in measuring instruments;
- changed expectations on how the legal metrology community carries out its dealings with business and the general public; and
- increased use of digital technology within legal metrology authorities and the organisations that support them.

I am sure that ensuring the CEEMS interest is covered by the work of the OIML's newly established Digitalisation Task Group (OIML DTG) will be an important part of the Advisory Group's work going forward.

Developments beyond the work of the Advisory Group

As mentioned at the beginning of this article, it is a measure of the success of the Advisory Group that the OIML's CEEMS activities are now seen as a third pillar of the OIML alongside the technical work of producing Recommendations, Documents and Guides, and the OIML Certification System. Work within those two other pillars is, however, also of crucial importance to the CEEMS community.

As a result of successive revisions of B 6 and the greater use of modern online technology for the development and approval of OIML publications, it is now a lot easier for Member States and Corresponding Members in CEEMS to participate in this work, and I am pleased to see that there are increasing signs of them doing so.

This is even more apparent in the way the OIML Certification System is perceived as operating. I do not think it is an exaggeration to say that in the past OIML certificates were seen as mainly of interest to Issuing Authorities in the most developed countries and to manufacturers in those countries. Under the revised arrangements there is much more emphasis on users, notably CEEMS authorities operating type approval systems. There has been a continued demand within the CEEMS community for presentations of the new system and explanations of how it can be used effectively in their jurisdictions.

The future

Looking forward to the next few years, there is still much to be done in taking further many of the initiatives already mentioned. And there is certainly scope, as the COVID-19 pandemic recedes, to do more to ensure that full use is made of the revised D 1.

In addition to this, as noted above, there is a pressing need to make sure that the CEEMS community is able to cope with the challenges of digital transformation. The use of digital technology in CEEMS activities has preoccupied us for the last two years. But this is only part of the wider range of opportunities which digitalisation offers for the improved efficiency of legal metrology authorities all over the world. Businesses and the public also have increased expectations of better access to information and services. In addition to that, there are the technical demands of supervising and regulating measuring systems which will be increasingly digitised. Globalisation means that these new generations of measuring systems will be deployed in CEEMS areas with increasing rapidity, posing new challenges to their legal metrology authorities.

Close collaboration between the Advisory Group and the OIML DTG will thus be essential. Applying our experience when the Advisory Group was being set up, an early task will be to seek input from the CEEMS community themselves about the priorities they see in meeting these challenges.

At the end of this year, I will be stepping down as Chairperson of the CEEMS Advisory Group. Having been closely involved in its work from the very beginning, first as CIML President and later as Vice-Chairperson and then Chairperson, it has given me great satisfaction to see its work develop and for the CEEMS agenda to have become so prominent within the wider work of the OIML. I am confident that I will be leaving the CEEMS AG in competent hands and that its development will continue for many years to come. And lastly, may I express my sincere thanks to all those who have been – and who will continue to be – involved in this development. I have very much enjoyed working with everyone and wish you every success in the future. ■

OIML D 14

What does it take to start a career in legal metrology?

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Often, articles with a question mark in their title tend not to answer the question raised. This note is an exception to that rule, however, because the answer has been known for quite some time already: In its International Document D 14:2004 *Training and qualification of legal metrology personnel*, the OIML provides a comprehensive overview of what knowledge and competence a legal metrology officer should have and what training modules are appropriate to get there.

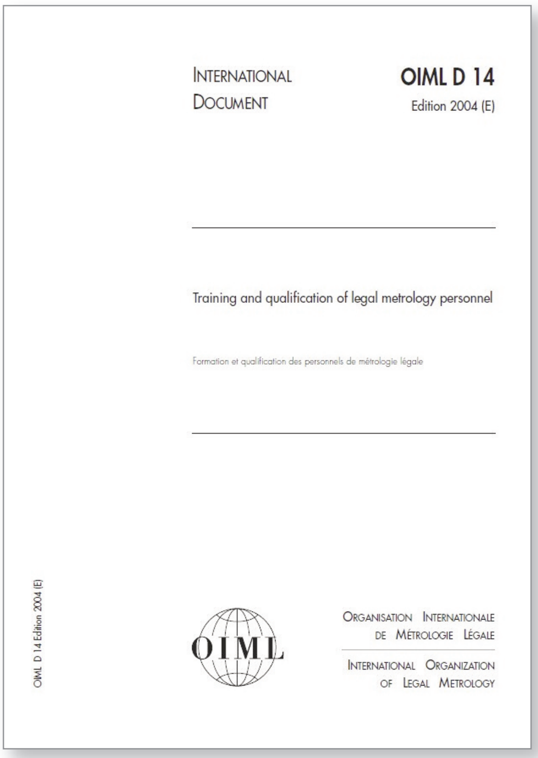
It can be argued that the difficulty of a training course on legal metrology is not the metrology part, namely, that its practitioners worry about the technical accuracy of their measurements and scientific conclusions from their data. This is a qualification that most candidates have absorbed during their higher education while becoming a qualified technician, engineer or scientist. Rather, these technical competences have to be complemented by all sorts of legal aspects. These legal aspects can be rather confusing for the technically minded – for instance when a road tanker fuel meter just inside the maximum permissible error has to be accepted as conforming, although it is clearly and systematically adjusted to the end customer's detriment, purely because the metrological rules in place fail to clearly define a measurable threshold to prevent such a practice (cf. clause 2.8 in Annex VII of the European Measuring Instruments Directive 2014/32/EU: "The measuring system shall not exploit the MPEs or systematically favour any party.").

In the end, of course, the legal and technical content of a training course should be complementary, so that the professional legal metrologist knows how to apply the laws of nature as well as the laws and regulations of their country with the same certainty and ease.

While OIML D 14:2004 offers quite substantial information on *what* should be taught (by suggesting several modules that span, if followed completely, several weeks to months of full-time training) the Document hardly hints at *how* such teaching can be most effective. In 2004, few people foresaw saw the advent of e-Learning on a large scale, exemplified by massive open online courses (MOOCs) that became popular in the following decade. Traditional classroom teaching has not become obsolete since then, on the contrary, but it certainly was the panoply of modern e-Learning formats such as webinars and asynchronous online courses that kept many teaching activities alive during the COVID-19 pandemic.

Under the revolutionising impact of digitalisation, we now face the twofold task of keeping up with the technological progress of measuring instruments and of finding the best blend of digital and analogue methods for the training of legal metrology officers. Ideally, our methods of teaching should evolve at the same rate of digitalisation that also drives the metrology infrastructure. What should be taught then, today, and tomorrow, and how?

A revised D 14 should be of interest to most members of the OIML and to the greater metrological community, no matter whether they enjoy a highly developed quality infrastructure at the forefront of technological innovation or wish to boost their emerging metrology system. The D 14 revision project is now open, and we welcome constructive participation so that, in the end, we can answer the question raised, anew and perhaps even better. ■


International Document

OIML D 14
Edition 2004 (E)

Training and qualification of legal metrology personnel

Formation et qualification des personnels de métrologie légale

OIML D 14 Edition 2004 (E)

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Organisation Internationale de Métrologie Légale

International Organization of Legal Metrology

UNIDO

The Quality Infrastructure for Sustainable Development Index – A standardised tool for measuring and tracking the performance of national QI in achieving the SDGs

William Becker, Juan Pablo Davila Sanchez, Hedvig Norlén and David Tomlinson

United Nations Industrial Development Organization (UNIDO)

Introduction

On 25th September 2015, the Member States of the United Nations adopted the *2030 Agenda for Sustainable Development* which was a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. At the core of the 2030 Agenda are 17 Sustainable Development Goals (SDGs) that outline the globally unified plan to achieve a more sustainable future for all. These SDGs make up the internationally agreed upon minimum expectations in order to fulfil the 2030 Agenda, and achieving them will require a radical and harmonised change in business practices and human behaviour. The SDGs are built on five pillars also called the 5 P's – people, planet, prosperity, peace and partnership.

Quality Infrastructure (QI) is one of the systems currently being developed in support of achieving the SDGs. While many people expect that systems exist to prevent fraud in economic transactions and protect human life and safety, very few are aware that there is an internationally harmonised system called QI that achieves this purpose and more. The International Network of Quality Infrastructure (INetQI) defines QI as *"the system comprising the organizations (public and private) together with the policies, relevant legal and regulatory framework, and practices needed to support and enhance the quality, safety and environmental soundness of goods, services and processes"*.

QI has been primarily linked to manufacturing and international trade (Prosperity) but also has significant direct and indirect links to safeguarding human life and health (People) and the responsible use of the earth and its resources (Planet). Through a harmonised consensus driven process, minimum specifications called standards are developed by National Standards Bodies (NSBs). The measurements required in these standards are defined and realised by National Metrology Institutes (NMIs) who cooperate to ensure that all measurements used internationally are accurate and internationally traceable to the International System of Units (SI). Conformity Assessment Bodies (CABs) then in turn measure the compliance of these goods, services and processes in relation to the applicable standards and provide results of their assessment. In order to ensure the CABs possess the required competence to produce high quality results, Accreditation Bodies (ABs) evaluate their competence and compliance with the applicable standards.

Within developed economies, it has long been established that a robust QI is required to support innovation, trade and a high quality of life for citizens. This recognition of the link between sustainable development and QI in these countries can be seen in terms of the high level of support provided to QI institutions by governments and industry. Conversely, many developing economies do not have this level of national support and must rely on international donors to provide funding and on international organisations such as the United Nations Industrial Development Organization (UNIDO) to build technical capacity.

Since resources are limited and the needs of developing economies vary, the interventions developed must be focused in order to achieve the most sustainable outcome. UNIDO, recognising that there was not yet a way to quantify and present the state of QI in relation to supporting countries in achieving the SDGs, set about creating a new tool. This tool would be beneficial especially within international technical cooperation as it would allow governments and organisations to prioritise interventions, compare development between similar countries and regions as well as track progress over time.

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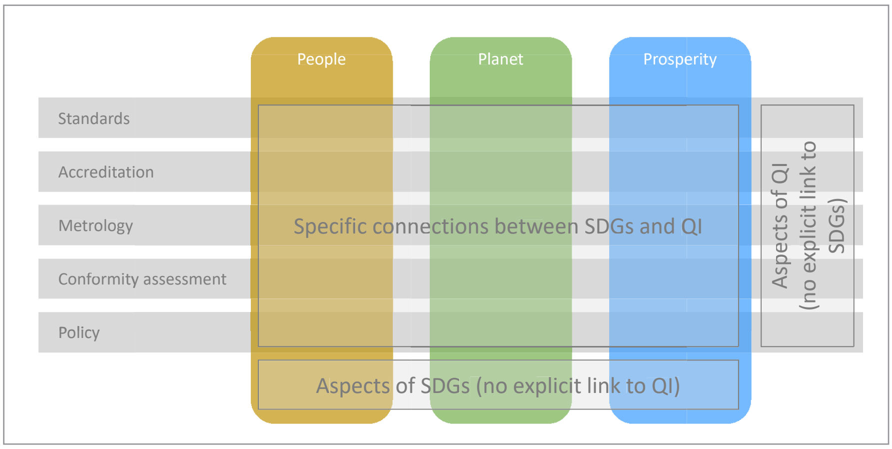

Figure 1: Proposed conceptual framework/matrix of the QI4SD Index

Conceptualisation of the QI4SD Index

Recognising this opportunity, UNIDO set about assembling an expert team to create the **Quality Infrastructure for Sustainable Development (QI4SD) Index**. In addition to experts on the development of Indexes, UNIDO collaborated with experts from the partner organisations of the INetQI. Along with funding provided by the State Secretariat for Economic Affairs (SECO) of Switzerland, the team set about designing the conceptual framework for the Index. This meant taking the main dimensions of QI and understanding their correlation to the SDG pillars. The team started out with the main QI dimensions and after discussions with INetQI organisations came up with a list of the six QI dimensions relevant for the Index. The six dimensions that were identified are:

1. Standards (also including technical regulations);
2. Accreditation;
3. Metrology (scientific, legal and industrial);
4. Conformity Assessment (Management System, Product and Personnel Certification Bodies, Test and Calibration Laboratories and Inspection Bodies);
5. Market Surveillance (for technical regulations only); and
6. Policy.

After further consultations with the INetQI organisations, it was however decided that while the dimension of Market Surveillance was relevant, it would be removed from the Index at this time because there was no feasible way to collect data within the project timeline. The remaining five dimensions were analysed in relation to the 3 Ps of sustainable development (Prosperity, People and Planet) and illustrated in the matrix provided in Figure 1.

This analysis revealed that there are at least three distinct types of indicators. These are:

1. **Indicators which measure specific intersections between QI dimensions and the SDGs.** An example would be adopted environmental standards: this maps a QI dimension (standardisation), to an SDG dimension (Planet). These are the most desirable indicators but are hard to obtain. They require two main components:

   a. A detailed data set, e.g. in the example given, we would need to know which specific standards have been adopted by each country.

   b. A mapping which tells us which dimension of the SDGs the QI indicator is contributing to. In the example given, we would need to know which P each standard is contributing to.

   Clearly, this kind of data is not always possible to obtain, although it is available in some cases.

2. **Indicators which measure aspects of QI, but have no explicit link to SDGs.** For example, this could be the number of accredited laboratories in a country, or the membership of international QI organisations. Such indicators are very relevant to QI, and these activities no doubt contribute to SDGs, but there is way to decompose or link them to specific dimensions of sustainable development.

3. **Indicators which measure sustainable development but have no particular link to QI.** These are generic indicators linked to SDGs, which can be found in various indexes. They are likely to be the least relevant indicators since we are interested in measuring the contribution of QI to SDGs and not the SDG outcomes themselves.

The “matrix” framework developed for the QI4SD Index is somewhat unconventional in composite indicators, in that it attempts to merge two multi-dimensional concepts (QI and Sustainable Development). This will present challenges in data collection and processing, as well as how the index is eventually presented and communicated. In particular, each country would have (potentially) three scores at the index level – one for People, one for Planet, and one for Prosperity. This is also true at the level of each dimension.

Indicator formulation

With the conceptual framework developed, the next step was a literature review and the creation of a first list of indicators. This list of indicators was then used as the basis for several discussions with INetQI organisations to elicit their opinions and to see whether they could help with data acquisition. INetQI organisations work primarily within one dimension of QI and therefore provided expert guidance on their respective dimension, but in many cases, they can also offer valuable input on other dimensions.

To help further refine the indicators, experts from each INetQI organisation were asked questions on the following issues, among others:

1. Whether the proposed indicators are relevant in measuring/monitoring the relevant dimension, in particular with relation to SDGs.
2. Whether they have any data relevant to these indicators that we could use in the QI4SD Index, or could suggest data sources.
3. Whether they would propose any additional indicators.
4. Whether any indicators on our list are not suitable.
5. Whether they have any general thoughts, suggestions, or criticisms about our approach to measuring quality infrastructure.

Following these meetings, potential indicators were considered against a set (initially qualitative) of selection criteria. Essentially, the objective was to screen out any indicators where it was impossible or impractical to collect data, or which represented obvious overlaps or duplicates, so as to focus on data collection of relevant indicators. These questions, and further discussions, helped to refine the indicator list and identify a number of data sources. In some cases, INetQI organisations were prepared to share non-public data, and this has helped enormously to enrich the QI4SD Index data set.

Data was collected for this reduced and focused set of indicators, and this was analysed using the R statistical programming language. The statistical analysis, which examined correlations, missing data and unique values, led to a further screening of indicators. The outcome of this was a set of indicators which could be used to build preliminary results.

Finally, the preliminary results were presented to QI experts as a first quality check. The methodology and indicators were then refined based on the feedback received from the experts. This process was necessarily iterative, and involved feedback from the experts at each step in the index construction in order to ensure the best outcome and keep the index on track. The process of selecting the indicators is shown in Figure 2.

Indicator selection

The literature review and the expert consultations resulted in a set of candidate indicators, which were then subjected to a set of indicator criteria, beginning with qualitative considerations. After data was collected for the remaining indicators, it was possible to also

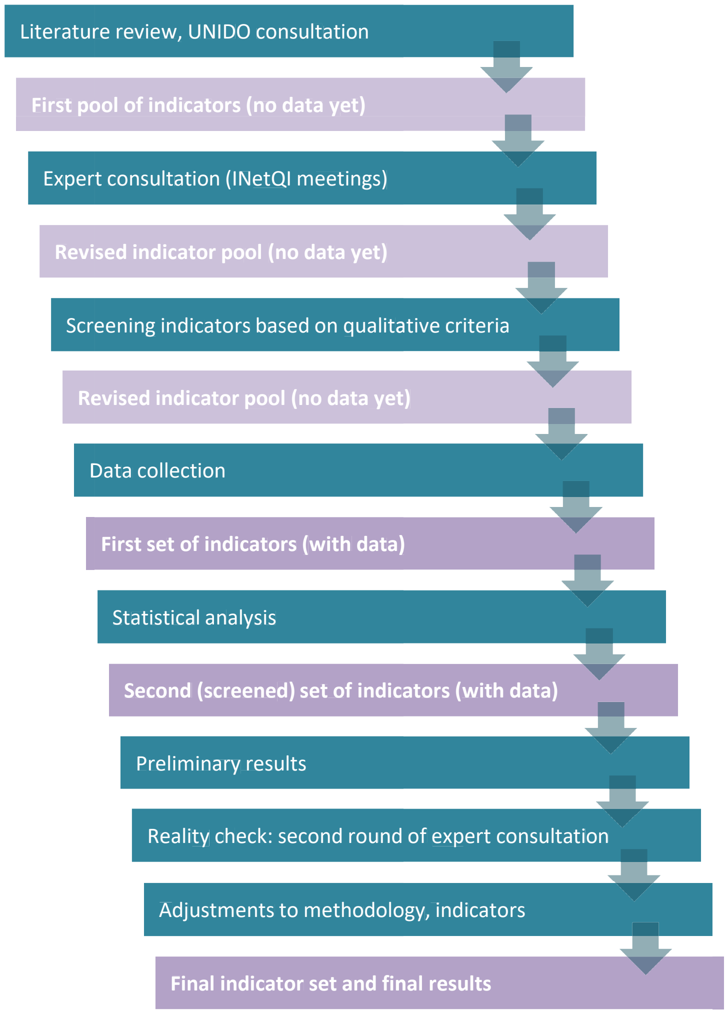

Figure 2: The indicator selection process

apply quantitative criteria, such as checking data availability – this is discussed in the next section.

Indicator selection criteria were as follows:

- Relevance to the framework, and in particular to the intersection of the P and QI component in question (note that, although ideally indicators should address a particular intersection of a P and QI, indicators that generally address a QI contribution to sustainable development, or specific dimensions of QI can also be considered).
- Availability of data, in terms of:
  - Cross-country coverage
  - Time coverage (i.e. time series data is an advantage, and suggests that the indicator would be regularly updated).
- Cost/ease of data acquisition (if not already available), since some indicator data might be acquired through a survey.
- Reliability of data: is the data from a trusted source and representative of the reality?
- Value added: indicators should each contribute unique information to the framework, and overlaps minimised.
- Interpretability: it should be clear what the indicator is measuring, so that it is useful to end users on its own, as well as part of a framework.
- Differentiation: indicators should show a range of values between countries. If the indicator has the same or very similar values for all or most countries, it is not very useful in making comparisons.

It is worth noting that although repetitions and overlaps should be avoided in the context of a composite indicator and a coherent scoreboard, some indicators can have a standalone value. Indicators that repeat similar information could still be included in a separate pool of auxiliary indicators which could still be useful to stakeholders interested in particular quantities, rather than the overall index/scoreboard.

In general, these criteria were used as guidance for selection, but compromises sometimes have to be made between relevance, data availability, and sometimes data reliability.

Index construction

With the final set of indicators, the index was constructed following the statistical methodology found in the JRC and OECD Handbook on Constructing Composite Indicators, which is the main reference for composite indicator construction (JRC and OECD, 2008). This consists of the following main steps:

1. Outlier treatment (treating any outlying/extreme values that may have negative effects on the aggregation).
2. Normalisation (bringing indicators onto a common scale).
3. Weighting and aggregation.

Outlier treatment consisted of a standard procedure based on Winsorisation which is used to adjust values solely for the purposes of aggregation.

Normalisation is the operation of bringing indicators onto a common scale. This is done so that indicators with very different units and scales can be aggregated and bring relatively equal contributions.

The QI4SD Index adopts a standard approach called the min-max method. This scales each indicator so that it lies inside the [1, 100] interval, as follows:

$$\tilde{x}_i = 1 + \frac{x_i - min(x_i)}{max(x_i) - min(x_i)} \times 99$$

Data collection

Data quality and availability can be inconsistent between different countries. As a result, some previous efforts to quantify QI focus only on countries which are embedded in the international QI and trade system, aiming to improve comparability (Harmes-Liedtke and Oteiza Di Matteo, 2011). In practice, this means belonging to international accreditation, certification, standardisation, metrology or other institutions (e.g. BIPM, IAF, IEC, IIOC, ILAC, IQNET, ISO, ITC, ITU, OIML, UNECE, UNIDO, WBG, WTO). The QI4SD Index is more ambitious and leverages UNIDO's connections in the INetQI community to obtain data that may not otherwise be available or immediately obvious.

Overwhelmingly, the data collected has been through INetQI organisations, since no centralised statistics exist on quality infrastructure (e.g. through the World Bank, OECD, or other typical sources of indicators). Data is obtained from the following sources:

1. Publicly available lists and databases provided by INetQI organisations or associates.
2. Non-public data provided by INetQI organisations.
3. UNIDO survey data where no existing data can be found.

The final category was used only for key indicators for which no other source is available. UNIDO has the ability to send a survey to a number of countries but had to strike a balance between collecting as much data as possible, and minimising the administrative burden on those who fill it in.

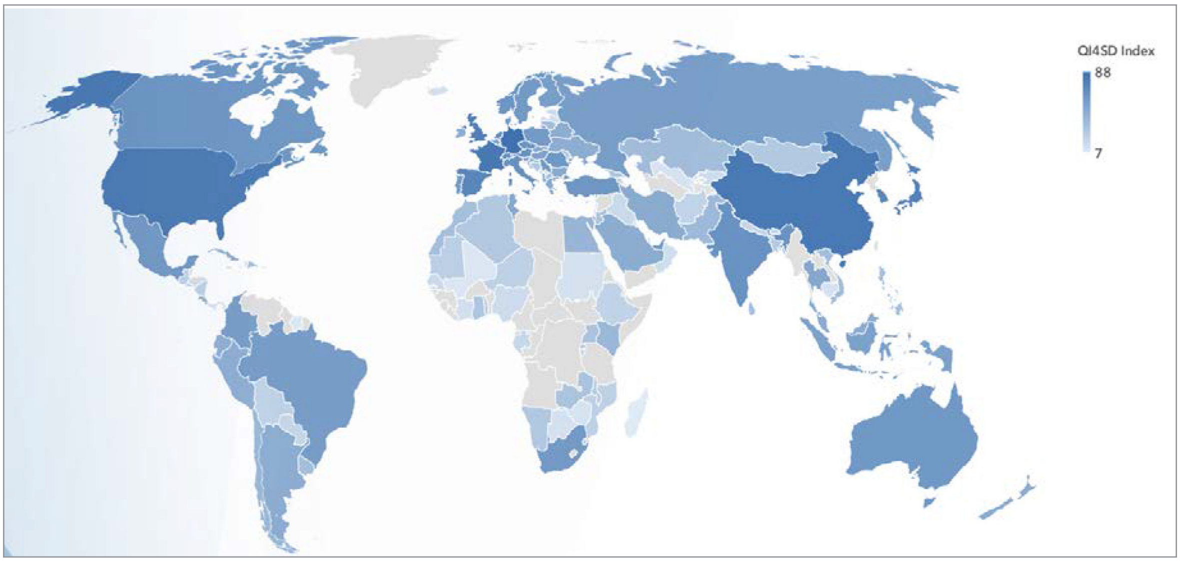

Figure 3: QI4SD Index scores

Results

The QI4SD Index is a rich data set aggregated into four composite indicators, each of which can be used to look at specific dimensions of QI. This section begins to unpack the data, in order to bring out some initial messages from the study.

- QI, as measured here, is strongly linked to the economic size of a country: bigger economies have higher QI scores. This is true for all dimensions of QI, except Policy.
- High QI4SD Index scores mainly occur in countries that enjoy high GDP and there is a reciprocal relationship between economic prosperity and QI.
- Germany has the strongest QI in the world, both in the main QI4SD Index and in the "3P"-indexes (People, Planet and Prosperity).

QI is inextricably linked with economic development in the first place because QI boosts economic output. But equally, QI costs money, so larger economies are able to have a more extensive QI. This is intuitively clear from Figure 3, which shows the largest economies scoring highest on QI: Germany, P.R. China and the USA, among others.

It is more relevant to present scores that gather together countries into peer groups. Four GDP groups are identified based on 2020 GDP values:

S Below USD 10 Bn

M Between USD 10–100 Bn

L Between USD 100 Bn–1 Tn

XL Above USD 1 Tn

The results for the XL group are presented in Table 1 (see next page). According to the QI4SD Index, Germany is ranked as having the highest level of QI in the world, followed by P.R. China, France, the USA and the UK. Five of the top ten countries are European (Germany, France, UK, Spain and Italy), with three from the East Asia and Pacific region (P.R. China, Japan and the Republic of Korea), one from South Asia (India), and the USA from the North America region.

Germany has the highest scores in the world in metrology and conformity assessment. This is due, among other things, to having some of highest numbers of certified management certificates, a wide network of certification bodies, heavy involvement in both the BIPM (including the largest number of key and supplementary comparisons of any country, however this is partly due to active engagement in two Regional Metrology Organisations) and the OIML (highest involvement in OIML Project Groups).

P.R. China closely follows, with broadly similar scores, but with a slightly lower value in metrology due to a slightly lesser involvement in OIML Project Groups, and a slightly lower involvement in key and supplementary comparisons. Nevertheless, P.R. China still scores very highly in all five dimensions of QI.

Some countries shown have missing data values in the Policy dimension. The Policy score is only calculated when at least 60 % of its indicators have data available, and since the Policy dimension was based on the UNIDO/ISO survey, missing data occurs for countries that did not respond to the survey, or did not respond to the Policy questions in the survey. The index-level ranks of these countries should be treated with a little caution since they are based on scores of four dimensions rather

Table 1: QI4SD scores for countries in the XL group (grey boxes indicate missing data)

Country	Region	Rank	Index	Standards	Conformity	Metrology	Accreditation	Policy
Germany	Europe & Central Asia	1	88	83	77	92	97	90
China	East Asia & Pacific	2	83	84	74	83	92	82
France	Europe & Central Asia	3	83	82	66	83	91	91
United States of America	North America	4	80	84	51	84	100	
United Kingdom	Europe & Central Asia	5	78	89	41	86	95	
Japan	East Asia & Pacific	6	76	79	56	83	87	
Spain	Europe & Central Asia	7	73	67	57	62	95	84
South Korea	East Asia & Pacific	8	73	75	59	77	73	82
India	South Asia	9	67	79	42	52	93	
Italy	Europe & Central Asia	10	67	80	52	61	98	41
Australia	East Asia & Pacific	11	62	61	25	68	93	
Canada	North America	12	62	60	17	64	74	93
Mexico	Latin America & Caribbean	13	59	55	16	53	89	80
Brazil	Latin America & Caribbean	14	58	51	40	63	79	
Russian Federation	Europe & Central Asia	15	58	73	33	82	42	
Indonesia	East Asia & Pacific	16	56	54	13	35	83	95

than five. This includes countries such as the UK, the USA, India, and Australia. Still, these countries score highly on the other four dimensions.

In the L group of countries (GDP USD 100 Bn–1 Tn), Table 2 shows the scores of the top twenty countries (with the remaining countries not shown for reasons of space). This group includes many medium-sized European countries, with countries such as the Netherlands and Switzerland ranking at the top, although the Netherlands has no score in the Policy dimension due to lack of data.

Let us take Switzerland as an example of a high-QI country in the L group. In Standards, Switzerland has full membership of ISO and IEC and has strong involvement in both of these organisations' technical committees (which are responsible for defining standards, among other things), having the 12th and 14th rank worldwide, which is the third highest score in both cases within the L group. According to the ISO/UNIDO survey, it has a fully-fledged Quality Policy in place covering all dimensions of QI, and with political/government support and monitoring/evaluation facilities. In Metrology, it is a full member of nine of ten CIPM Consultative Committees (the highest score in the L group) and is a full member of both the BIPM and the OIML. In Conformity Assessment it has the 13th and 20th highest number of recognised certificates according to the International Certification Network (IQNet) and ISO databases respectively. Finally, in Accreditation it is a signatory to both the IAF Multilateral Recognition Arrangement (MLA) and the ILAC MRA, and its accreditation body scores highly in terms of the overall scope. Overall, this shows that for its size, Switzerland has a high level of QI.

Other countries in the L group include South Africa, which is the highest-ranking African country, and the United Arab Emirates, which is the highest ranking Middle Eastern country.

The scores for the M group are shown in Table 3. While the scores are generally lower than in the L and XL groups, the Policy scores are similar and, in some cases, rather high, with Slovenia, Zambia, Uganda and Georgia having a top score of 100. In practice, this means that they received the highest value in all Policy indicators.

The higher-ranking countries in this group include many Eastern European countries such as Serbia, Slovenia and Bulgaria. These countries are typically full members of many QI organisations such as IAF, ILAC, BIPM, and OIML, but have slightly lower scores on indicators such as the number of recognised certificates – perhaps simply because they are smaller countries. Serbia, however, has a large proportion of ISO standards adopted (18 of the 22 standards surveyed), and is also rather deeply integrated in the IQNet network of conformity assessment bodies, having a head office and four hosted offices within its borders. Indeed, this higher score in conformity assessment distinguishes five Eastern European countries in this group: Serbia, Slovenia, Bulgaria, Belarus and Croatia. Further down in the rankings in this group we find that the conformity assessment scores become lower. Typically, this seems to be due to a lack of involvement in the IEC's conformity assessment systems, among other reasons.

Finally, the scores in the S group (GDP below USD 10 Bn) are shown in Table 4. As expected, the overall scores are lower, with the exception of the Policy dimension. Here Mauritania has the highest score.

Table 2: QI4SD Scores for countries in the L group (grey boxes indicate missing data; truncated to the top 20)

Country	Region	Rank	Index	Standards	Conformity	Metrology	Accreditation	Policy
Netherlands	Europe & Central Asia	1	69	71	31	79	97	
Switzerland	Europe & Central Asia	2	68	67	31	65	85	90
Austria	Europe & Central Asia	3	66	69	36	54	87	84
Norway	Europe & Central Asia	4	63	65	19	39	91	100
Czechia	Europe & Central Asia	5	63	66	26	64	95	
Turkey	Europe & Central Asia	6	62	56	36	62	95	
Romania	Europe & Central Asia	7	62	64	28	44	88	84
South Africa	Sub-Saharan Africa	8	60	63	19	70	88	
Sweden	Europe & Central Asia	9	60	74	18	54	91	64
Poland	Europe & Central Asia	10	60	64	27	56	91	
United Arab Emirates	Middle East & North Africa	11	60	53	52	23	79	91
Portugal	Europe & Central Asia	12	59	59	27	42	85	82
Singapore	East Asia & Pacific	13	59	48	22	44	86	93
Finland	Europe & Central Asia	14	58	70	21	52	88	
Denmark	Europe & Central Asia	15	57	65	22	52	89	
Colombia	Latin America & Caribbean	16	57	50	32	39	80	84
Hungary	Europe & Central Asia	17	53	58	23	44	88	
Slovakia	Europe & Central Asia	18	53	53	10	60	88	
Belgium	Europe & Central Asia	19	53	71	10	43	86	
Thailand	East Asia & Pacific	20	52	52	15	43	84	69
Greece	Europe & Central Asia	21	50	50	22	35	91	
New Zealand	East Asia & Pacific	22	50	47	14	45	93	
Malaysia	East Asia & Pacific	23	49	54	39	29	79	46
Iran	Middle East & North Africa	24	49	68	6	39	32	98
Saudi Arabia	Middle East & North Africa	25	47	55	46	32	1	100
Ireland	Europe & Central Asia	26	47	57	6	36	88	
Argentina	Latin America & Caribbean	27	46	51	23	35	77	
Ukraine	Europe & Central Asia	28	46	50	18	36	82	
Peru	Latin America & Caribbean	29	45	43	6	20	62	95
Israel	Middle East & North Africa	30	45	53	41	30	56	
Cuba	Latin America & Caribbean	31	44	35	1	40	51	96
Hong Kong	East Asia & Pacific	32	44	11	3	28	87	93
Egypt	Middle East & North Africa	33	42	51	4	37	75	
Pakistan	South Asia	34	39	50	9	31	68	
Chile	Latin America & Caribbean	35	39	44	23	18	72	
Viet Nam	East Asia & Pacific	36	37	36	11	25	77	
Kazakhstan	Europe & Central Asia	37	37	38	4	34	71	
Philippines	East Asia & Pacific	38	35	46	5	16	72	
Morocco	Middle East & North Africa	39	34	44	3	30	1	94
Bangladesh	South Asia	40	28	38	2	15	56	
Algeria	Middle East & North Africa	41	28	43	2	15	51	
Ethiopia	Sub-Saharan Africa	42	21	36	2	8	38	
Iraq	Middle East & North Africa	43	17	42	2	22	1	
Qatar	Middle East & North Africa	44	16	43	3	15	1	
Nigeria	Sub-Saharan Africa	45	15	41	8	9	1	
Kuwait	Middle East & North Africa	46	15	42	1	15	1	

Table 3: QI4SD scores for countries in the M group, (grey boxes indicate missing data, truncated to the top 20)

Country	Region	Rank	Index	Standards	Conformity	Metrology	Accreditation	Policy
Serbia	Europe & Central Asia	1	60	61	25	41	80	93
Slovenia	Europe & Central Asia	2	59	51	18	43	82	100
Tunisia	Middle East & North Africa	3	50	43	4	35	75	93
Bulgaria	Europe & Central Asia	4	48	58	16	40	80	
Belarus	Europe & Central Asia	5	46	48	13	38	86	
Ecuador	Latin America & Caribbean	6	44	39	4	23	68	88
Albania	Europe & Central Asia	7	43	35	2	23	70	87
Costa Rica	Latin America & Caribbean	8	42	35	3	18	69	82
Croatia	Europe & Central Asia	9	41	51	18	37	56	
Kenya	Sub-Saharan Africa	10	39	40	8	38	72	
Lithuania	Europe & Central Asia	11	37	40	2	26	79	
Dominican Republic	Latin America & Caribbean	12	35	25	2	8	51	89
Sri Lanka	South Asia	13	34	38	2	23	75	
Uruguay	Latin America & Caribbean	14	34	35	2	29	70	35
Luxembourg	Europe & Central Asia	15	34	44	1	16	75	
North Macedonia	Europe & Central Asia	16	33	35	2	23	74	
Jordan	Middle East & North Africa	17	32	31	1	8	51	69
Zambia	Sub-Saharan Africa	18	31	28	1	27	1	100
Uganda	Sub-Saharan Africa	19	31	44	2	9	1	100
Georgia	Europe & Central Asia	20	31	31	4	18	1	100
Ghana	Sub-Saharan Africa	21	30	44	2	15	1	88
Moldova	Europe & Central Asia	22	30	29	1	17	72	
Rwanda	Sub-Saharan Africa	23	29	41	1	14	1	89
Mongolia	East Asia & Pacific	24	29	30	1	16	69	
Namibia	Sub-Saharan Africa	25	28	25	3	22	1	91
Bosnia and Herzegovina	Europe & Central Asia	26	28	42	3	18	51	
Malta	Middle East & North Africa	27	28	36	1	15	1	88
Mauritius	Sub-Saharan Africa	28	28	32	2	15	62	
Trinidad and Tobago	Latin America & Caribbean	29	27	27	2	16	1	89
Cyprus	Europe & Central Asia	30	26	36	7	15	45	
Malawi	Sub-Saharan Africa	31	26	34	1	8	1	84
Palestine, State of	Middle East & North Africa	32	24	25	1	1	1	93
Mozambique	Sub-Saharan Africa	33	23	21	2	8	1	82
Niger	Sub-Saharan Africa	34	23	18	1	1	1	92
Bolivia	Latin America & Caribbean	35	22	31	2	17	1	60
Armenia	Europe & Central Asia	36	22	29	1	1	1	78
Nicaragua	Latin America & Caribbean	37	22	21	1	1	45	42
Afghanistan	South Asia	38	22	30	1	1	1	75
Jamaica	Latin America & Caribbean	39	21	25	1	9	51	
Tanzania, the United Republic c	Sub-Saharan Africa	40	21	32	1	24	1	47
Nepal	South Asia	41	21	28	1	8	45	
El Salvador	Latin America & Caribbean	42	20	28	3	1	51	
Guatemala	Latin America & Caribbean	43	20	15	2	8	56	
Paraguay	Latin America & Caribbean	44	19	18	1	16	40	
Gabon	Sub-Saharan Africa	45	18	42	1	1	1	44
Senegal	Sub-Saharan Africa	46	17	24	2	1	1	55
Estonia	Europe & Central Asia	47	16	36	2	24	1	
Oman	Middle East & North Africa	48	15	44	1	15	1	

Table 4: QI4SD scores for countries in the S group (grey boxes indicate missing data)

Country	Region	Rank	Index	Standards	Conformity	Metrology	Accreditation	Policy
Togo	Sub-Saharan Africa	1	26	40	1	1	1	85
Mauritania	Sub-Saharan Africa	2	24	15	1	1	1	100
Eswatini	Sub-Saharan Africa	3	23	22	2	1	1	92
Seychelles	Sub-Saharan Africa	4	21	21	1	16	1	68
Bhutan	South Asia	5	20	19	1	1	1	75
Burundi	Sub-Saharan Africa	6	18	22	1	1	1	66
Barbados	Latin America & Caribbean	7	17	24	1	15	1	42
Antigua and Barbuda	Latin America & Caribbean	8	17	6	1	8	1	67
Kyrgyzstan	Europe & Central Asia	9	16	15	1	8	40	
Montenegro	Europe & Central Asia	10	13	25	2	23	1	
Suriname	Latin America & Caribbean	11	8	21	1	8	1	

Otherwise, conformity assessment scores are generally low, as are metrology scores, with a few exceptions including Montenegro. Montenegro is a small country but is in the upper middle-income group, and has a high breadth and number of calibration and measurement capacities – in both cases mid-ranked worldwide which is quite high given its size.

In the Accreditation dimension, Kyrgyzstan stands out as having a much higher score than the other countries in the group. This is because, unlike many of its peers, it is a signatory to the ILAC MRA. We recall that having a score of 1 in accreditation does not mean that the country has no capacity in accreditation. Indeed, some of these countries have other membership types with ILAC or IAF but are not signatories to the MRA or MLA.

Challenges

A number of challenges were faced along the way. In the first place, data is not readily available and indicators had to generally be created from scratch, sometimes using data downloaded from websites, and in other cases extracted from documents and tables. This is in contrast to many composite indicators for which data is taken from central statistical sources, such as the OECD, World Bank, and the UN. As a consequence, indicators were created using the best interpretations of the data by the authors, with the methodology cross-checked by INetQI experts. A positive implication of this is that the QI4SD data set represents a unique centralised resource which can be used to examine the state of QI and its relations to SDGs, for individual countries, and to investigate global trends.

A further challenge was the incorporation of sustainable development into the index. As mentioned in Section 2.1, this results in a "matrix" framework which is quite unusual in composite indicator construction, and four separate indexes. This again adds value, but care is needed in interpreting the resulting rankings and scores. In this respect, the Country Profiles (available in an accompanying document and in the online data portal) help to zoom in a little on the individual scores of each country.

Conclusion

This paper has outlined the methodology and results for a Quality Infrastructure for Sustainable Development Index. The objective (among others) was to quantify and compare the extent to which QI in each country is able to contribute to SDGs. The framework is composed of four indexes: the general QI4SD Index and three "P-indexes" (People, Planet and Prosperity). The "P-indexes" measure specific intersections between QI dimensions and the SDGs.

The work has yielded a number of conclusions, including:

- QI is linked with economic development, in the first place because QI boosts economic output. But equally, QI costs money, so larger economies are able to implement a more extensive QI. The largest economies scoring highest on QI are Germany, P.R. China and the USA, among others.

- As a result, high QI4SD Index scores mainly occur in countries that enjoy high GDP, but the economic output is not the only enabler for an advanced QI system of the country. There seems to be a reciprocal relationship between economic prosperity and Quality Infrastructure in a country.
- Some countries score higher regarding QI in respect to their GDP and these QI over performers are mainly found in Europe. At the other end, countries with higher GDP levels compared to their QI are the so-called QI underperformers and they are mostly situated in the Middle East, Central Asia and Africa.
- Countries have similar ranks/scores in each of the three “P-indexes”. If a country is doing well in the People index, for example, it is likely to do well in the other two “P-indexes”, Planet and Prosperity.
- Of the 17 SDGs, the People, Planet and Prosperity indexes correlate the most with SDG 9, the goal that promotes socially inclusive and environmentally sustainable economic development by enhancing infrastructure, industry and innovation. The QI institutions and services have an important role in industry and infrastructure, as they are needed to embed sustainability requirements within projects and are required to support the sustainable management of organisations, global supply chains, and associated environmental and social responsibility aspects.
- All the dimensions apart from the Policy dimension are highly correlated with the general QI4SD Index. Further, all dimensions of QI except Policy are positively correlated with one another. This means that higher scores in one dimension generally imply higher scores in the other.
- For the first time (to our knowledge) Quality Policy (QP), i.e. a policy for developing and sustaining effective QI, was assessed in a worldwide survey. The majority of the ranked countries (55 %) have a national or regional QP and 30 % of the countries have regulations or directives that define functions and responsibilities of the different areas of QI. The survey also evidenced that smaller economies may have high QP scores.

In conclusion, the QI4SD Index represents a first iteration of an index for measuring the intersection of QI and SDGs, and could probably be improved using further feedback after use by stakeholders. This is a natural process for any analytical tool – though experts and stakeholders were closely involved at every step of its construction. At the heart of this work is the aim for transparency and reproducibility. As such, the methodology is described in considerable detail in the accompanying Methodological Annex which may be downloaded from the UNIDO Knowledge Hub, and data is publicly available online at the QI4SD Index website, https://hub.unido.org/qi4sd/data.

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INFRASTRUCTURE

Evaluation of the infrastructure and performance of the local government Legal Metrology Unit in Indonesia

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Abstract

This paper explores the capability and performance of 121 local verification offices across the Java Region in Indonesia. The key findings of this study were:

- first, that the legal and institutional framework pillar has a better mean score across the local verification offices, followed by service delivery pillars and technical competency;
- second, the most significant legal and institutional framework pillar score was in the western region, while the highest scores of the internal monitoring and evaluation pillars are distributed among the local verification offices in the center of the Java Region;
- third, the capability of a local verification office in the Java Region is likely not to influence the development of other local verification offices;
- fourth, the influence of the management capabilities of the local verification offices in the West Region is stronger than in the East Region in terms of their contribution to increasing the Legal Metrological Infrastructure (LMI) index. Meanwhile, the influence of technical aspects in the local verification offices is moving from east to west where they are likely to have a strong positive impact on increasing the LMI index; and
- fifth, most of the Local Verification Offices across the Java Region are at Level III and Level II.

The outcome of this paper can be used for both central government and local government to formulate the strategies and policy based on the status of capability and performance of each institution.

Keywords: *Legal Metrology, Legal Metrological Infrastructure Index, Organizational Evaluation, Local Government*

1 Introduction

It is expected that any legal metrological infrastructure needs to be fully geared towards not only protecting society from measurement fraud but also enforcing trust in measurements. Much of the existing published research [2], [9], [33] has determined that legal metrological infrastructures benefit society and the economy when legal metrology can increase confidence in measuring instruments. The role of the legal metrological infrastructure in measurement control systems is irreplaceable [20], [26], [37]. Furthermore, the legal metrological infrastructure must be developed, maintained, and operated to provide better metrological services to consumers at the community, national, and international levels [4]. Therefore, assessing the capability and performance of the legal metrological infrastructure at national level is crucial in ensuring fair trade and protecting the consumer.

In Indonesia, the legal metrology system is adapted to the new autonomy law of 2014 – *The Law of Local Government No. 23* of 2014. The changing administration function in performing public service duties in legal metrology has impacted the legal metrological structure across the Regions in Indonesia [3]. After 2002 and again in 2014, legal metrological services such as verification and inspection are performed by City/ Regency Government. Currently, 432 local verification offices perform verification and inspection activities at the city/regency level. The increasing number of regional verification offices across the various Regions in Indonesia provides positive energy for legal metrology activities such as providing direct access for business to legal metrological service providers, since they are faced with a geographical condition, i.e. that Indonesia is an archipelago country, reducing costs (e.g., transportation) for business and other entities.

The establishment of local verification offices across Indonesia has a new challenge in maintaining and monitoring the capability and performance in a certain period. Many seminal [1], [6], [10], [15], [22], [27], [28], [36] had studied the assessment and evaluation of an organization by using various tools. One specific evaluation tool used to assess the quality infrastructure, particularly for legal metrology performance, is the Quality Infrastructure (QI) diagnostic and reform toolkit, developed by The World Bank Group and the Physikalisch-Technische Bundesanstalt (PTB), the National Metrology Institute of Germany. Kellermann [25] states that the comprehensive diagnostics tools developed by the World Bank and the PTB can be used to map and evaluate the maturity of Quality Infrastructure in certain countries, such that it can help the government to identify the strengths and weaknesses and to assess the progress of the development of the related infrastructures.

The Indonesian Government, through the Ministry of Trade, has also developed the evaluation tools to evaluate the infrastructure and performance of local verification offices. The evaluation uses the LMI Index, which consists of a legal and institutional framework, internal monitoring and evaluation, human resources management, service delivery, technical competency, and standard operational procedure aspects.

This paper aims to explore the capability and performance of local verification offices in Indonesia using the LMI Index developed by the Indonesian Government. The Geographical Weighted Regression is also applied to analyze the spatial interaction between the variables that influenced the LMI Index. The outcome of this paper can be used for both central and local government, and also the OIML to formulate the strategies and policy based on the status of capability and performance of each institution.

This paper is split into three parts: First, it will present the literature review on legal metrological performance in Indonesia, particularly the local verification offices and authority delegation. Second, it describes the data and methodology used in the analysis. The discussion is drawn in the third part, concluding the paper.

2 Literature review

The mechanism for implementing national development in Indonesia has been regulated in the applicable laws and regulations. There are two relevant legal products, namely:

1) Law No. 2 of 1981 concerning Legal Metrology; and
2) Law No. 23 of 2014 concerning Regional Government.

This study shows that the implementation of legal metrology activities in Indonesia has been in place since 1923 based on the Ijk-ordonnantie 1923. Over time, the implementation of legal metrology activities continued to develop, and changes in legislation occurred dynamically by way of the Ijk-ordonnantie 1923, the Ijk-ordonnantie 1928, and the Ijk-ordonnantie 1949 in the colonial era. Law No. 2 of 1981 concerning legal metrology is now applicable, which has been promulgated since April 1, 1981.

In general, the purpose of regulation related to measurement, dosing, and weighing within the legal metrology framework is to protect the public and create responsible business actors both in producing, carrying out import activities, packaging, trading, distributing, and using measuring instruments. Accurate weighing is in the public interest. Law No. 2 of 1981 concerning legal metrology provides legal certainty in Indonesia regarding the correctness of measurements.

Along with the development of the governance system in Indonesia, the implementation of national responsibility for metrology activities has also changed. The implementation of legal metrology activities was initially regulated by Law No. 5 of 1974 concerning the principles of government in the Regions, where the implementation of metrological activities was the duty and responsibility of the Central Government. Legal metrology activities are centralized activities that sole the Central Government carries out. In 1999, the Indonesian government system entered the era of decentralization. The issuance of Law No. 22 of 1999 concerning regional government was an early marker for implementing legal metrology activities carried out in a decentralized manner by assigning duties and responsibilities to the Provincial Government. With Law No. 22 of 1999, 52 legal metrology service offices are owned by the provincial government.

In 2004, Law No. 32 of 2004 was issued concerning regional government, which stipulated that legal metrology services are carried out by central government strata, provincial government, and district/city governments. However, since the administration of legal metrology is a matter of choice for the Provincial Government and the Regency/City Government, the principle of implementing autonomy as widely as possible is still based on the potential and priorities of each Region. Government Regulation No. 38 of 2007 concerning the Division of Government Affairs between the Central Government, Provincial Government, and Regency/City Governments was issued to detail the division of affairs among the three government strata.

In 2014, Law No. 23 of 2014 concerning regional government was issued. Although it is still within the framework of regional autonomy, the implementation of metrological services is no longer carried out by the three strata of government. Still, it is only carried out by the Central and District/City regional governments. The Provincial Government providing metrological services is only the DKI Jakarta Provincial Government. The Central Government has the authority to administer, control, and evaluate legal metrology nationally and to administer legal metrology in the context of special handling. The Provincial Government of DKI Jakarta and the Regency/Municipal Governments conduct metrological services such as verification and inspection. To assess the performance of the local verification offices, Central Government conducts monitoring and evaluation. Regular evaluation is important to identify and investigate the problems, performance and status of each local verification office.

Legal metrology infrastructure development is similar to PDCA, an iterative design and management tool used for control and continuous improvement of processes and product. The development process can be carried out in a circle, starting from planning,

Table 1 Some benefits of evaluating an organization

Benefits	Studies
Reduced bureaucracy	[7], [21], [35], [39]
Improved service execution	[14], [30], [32]
Creation of more innovation	[5], [8]
Increased reaction speed to stakeholder needs	[8], [32]
Cost-saving	[11], [19], [29], [38]
Creation of better relationships with stakeholders	[8], [38]
Improved quality of systems	[14], [30], [32], [38]
Greater stakeholder satisfaction	[8], [32]

implementing, monitoring, and evaluating. The result of the monitoring process is to obtain further improvement and development to obtain better results. To do this, it is necessary to have comprehensive tools to assess the system. This is necessary in order to gain a wider picture of the legal metrological performance to guide both central and local government in making plans and regulations.

There are many assessment tools for evaluating the capability and performance of such an infrastructure One such tool is the Quality Infrastructure (QI) diagnostic and reform toolkit, developed by The World Bank Group and the PTB. The toolkit is designed to assess the QI infrastructure such that government and its development partners can formulate a coherent strategy to underpin QI capacity development [25]. If necessary, they can learn more about the QI or parts thereof from the toolkit, and reform it.

One of the components of the toolkit is legal metrology. There are four pillars to assess legal metrology infrastructure in the toolkit:

- the first pillar is a legal and institutional framework that consists of four elements: legal metrology strategy, legal entity, governance, and financial sustainability;
- the second pillar is administration and infrastructure, consisting of the director, organizational structure, management and personnel, equipment, quality management system, and premises element;
- the third pillar of service delivery and technical competency covers five elements: legal metrology technical staff, calibration and verification services, market surveillance, training system, and type approval of measuring instruments; and
- the fourth pillar is external relations and recognition. This pillar consists of liaison with regional and international organizations, coordination within the Quality Infrastructure stakeholders, designated organization, and consultative forum. Finding a formula to solve major problems and ensure that the government meets the goal.

Other tools to assess the performance and infrastructure of the organization, in general, have been developed, such as ISO 9001 based-assessment [1], [6], [1], [36], ISO17025 based-assessment [15], [22], business organization [13], [27], [28], [34], and others.

The benefits of evaluating an organization related to both performance and infrastructure are also felt by the government itself, and by the stakeholders in improving the services to be delivered. For example, various studies have identified the benefit of organization evaluation such as reduced bureaucracy [7], [21], [35], [39], improved service execution [14], [30], [32], created more innovation [5], [8], increased speed to stakeholder needs [8], [32], saved cost [11], [19], [29], [38], created a better relationship with stakeholders [8], [38], improved quality of systems [14], [30], [32], [38], and made greater stakeholders' satisfaction [8], [32].

Table 1 shows a summary of the benefits of evaluating an organization.

3 Research method

3.1 Data

Java has an area of 138,793.6 km^2, with a population of 150 million [23], [24]. Java is an island that is home to nearly 60 per cent of Indonesia's population, with a density of 1,317 inhabitants/km^2 [23], [24]. The island is also one of the most densely populated islands globally. Java is also the most developed island in Indonesia. Industry, business and trade, and services are developing in big cities in Java, such as Jakarta, Surabaya, Semarang, and Bandung. Java Island was chosen as a study area because most local governments across Java Island had established local verification offices (91 out of 121 local verification offices). The other reason is a wide range of characteristics of local verification offices across Java Island, such as various measuring instruments used for verification, the various capacities of local government (e.g. financial, human resources), and geographical characteristics.

The analysis of the LMI Index described in Section 3 is fitted to the dataset on 121 local verification offices across the Java Island Region. The data was gathered by using an online questionnaire to each local verification office during 2020. The LMI Index is a tool based on a survey carried out by the Directorate of Metrology to evaluate the status capability of local verification offices in performing legal metrological services such as verification and inspection.

3.2 Legal Metrological Infrastructure (LMI) Index

To assess the capability and performance of the legal metrological infrastructure at the district level, Indonesia has developed a Legal Metrological Infrastructure Index (LMI Index) tool. The LMI Index was created by the Ministry of Trade's Directorate of Metrology as a composite index based on six pillars: Legal and Institutional Framework, Internal Monitoring and Evaluation, Human Resources Management, Service Delivery, Technical Competency, and Standard Operational Procedure. The components of the LMI Index are extracted from ISO 17025 *General requirements for the competence of testing and calibration laboratories*. The ISO standard is used to establish whether or not testing and calibration laboratories are technically competent [15], [22].

The LMI Index tool is based on the idea that to establish a legal metrological infrastructure, a sustainable development framework is required in which the legal and institutional framework, internal monitoring and evaluation, human resource management, service delivery, technical competency, and standard operational procedural aspects become a complementary force and maintain the potential and ability of local governments as legal metrologists. In this context, these components are considered to be dimensions that strengthen the motion of the process and the empowerment of the legal metrological infrastructure of a Region to achieve the goal of producing fair measurements and protecting consumers from fraudulent measurements. Therefore, the development and empowerment of the legal metrological infrastructure must align with this goal.

In all areas for which governments are responsible, such as trade facilitation, confidence building, and national level harmonization, the LMI Index maps the development of the legal metrology infrastructure at both regional and national levels. The LMI Index may influence the accuracy of interventions in the policy with the appropriate correlation of development interventions from Central and Local Government.

There are two main components regarding the LMI Index, namely the Management component and the Technical component:

- the Management component consists of three pillars such as Legal and Institutional Framework (P1), Internal Monitoring and Evaluation (P2), and Human Resources Management (P3);
- the Technical component consists of Service Delivery (P4), Technical Competency (P5), and Standard Operational Procedure (P6).

Therefore, the LMI Index is made up of six pillars. The Legal and Institutional Framework is the first pillar that gives details of the organization's legal entity, which is responsible for performing legal metrological services and how the organization is structured. It includes a structure of the organization (C1), the hierarchy of management (C2), and the Responsibility line (C3). The second pillar Internal Monitoring and Evaluation is the pillar which details the organization's performance and aims to monitor and evaluate the service delivery to the public. This pillar includes document records and control (C4), Internal Audit (C5), Partnership and cooperation (C6), Annual Evaluation scheme (C7), and Feedback Response (C8). The third pillar, Human Resources Management, is the pillar which details how organizations manage human resources. It includes Working Weighting Analysis (C9), verification officer needs (C10), Competency of verification officers (C11), inspector needs (C12), Competency of inspectors (C13), and Law enforcement officer needs (C14).

The Service Delivery pillar defines how organizations perform their service to the public. It includes control of human resources and the environment prior to, during, and post delivering service (C15), service delivering (C16), and reporting test results (C17). The Technical Competency pillar is the pillar that details how the organization is well-equipped with the appropriate standards and other supporting equipment. This pillar includes working standard availability (C18), traceability of standards (C19), and verification seal management (C20). The final pillar is the Standard Operational Procedure, which details the organization's standards for performing metrological services. This pillar includes the availability of standard operational procedures (C21).

It is important to differentiate between the capability of local verification offices across the national legal metrology authorities in Indonesia. Establishing local verification offices in Indonesia as one of the fundamental organizations of the designated legal metrological infrastructure is critical because of the national Act on Government Administration System. In addition, the local community requires the local verification offices to operate to balance resources. Therefore, any evaluation of the legal metrological services' performance done by local verification offices, such as verification and inspection, are heavily dependent on its capability to perform those services. The differentiation of the level of the capability of local verification offices based on the LMI Index can be expressed as shown in Table 2.

Table 2 The maturity level of Local Verification Offices

Characteristics	Basic	Developing	Defined	Managed
Legal and institutional framework	Responsibility line directly from the head of technical unit/laboratory	Responsibility line directly from the head of technical unit/laboratory	Strong responsibility line directly from the head of the department	Strong responsibility line directly from the head of the department
Internal monitoring and evaluation	Have regular audit but not frequent	Regular audit activities	Regular audit activities Demand survey	Regular audit activities Demand survey
Human resources management	Minimum number of human resources	The number of human resources meets the requirement	- The number of human resources meets the requirement - Regular training plan	- The number of human resources meets the requirement - Regular training plan - Training on the job - Verification and inspector as a professional profile
Service delivery	Basic services Level I (Market and fuel station)	Level II service's scope	Level III service's scope	Level III service's scope
Technical competency	Traceability of standard	Traceability of standard	- Traceability of standard - Intercomparisons - Proficiency test	- Traceability of standard - Intercomparisons Proficiency tests - Metrological consultancy
Standard operational procedure	Availability of standard operational procedure	Availability of standard operational procedure	Certification/ accreditation	Certification/ accreditation

3.3 Geographical Weighted Regression (GWR)

The Geographically Weighted Regression (GWR) is an extended ordinary least square which is an addressed locality effect of the relationship between dependent and independent variables [18].

The GWR has the advantage that it captures variations at the local level due to the fact that this method produces a set of parameters for each location across the study area, see [12], [16], [17], [18].

In general, the GWR can be formulated as follows:

$$y(s) = \beta_0(s) + \sum_{i=1}^{k} \beta_i(s) x_i(s) + \varepsilon(s) \ldots (1)$$

where $y(s)$ is LMI Index at location s, $x_i(s)$ represents the value of the ith parameter at location s. The parameters of β_i, can thus be mapped to obtain a map of spatial variations in the relationship between the dependent and independent variables across the study area. Mapping the parameters of β_i, helps to understand the spatial association between the dependent and independent variables.

4 Result

Each local verification office was assessed using the questionnaire based on the six pillars and the 21 components described in Table 2. The result is shown in Table 2, which presents the mean of the LMI Index of 91 local verification offices in the Java region. The legal and institutional framework pillar has a greater mean score across the local verification offices (3.800). This is due to the main requirement in establishing and performing legal metrological services such as verification and inspection under national regulations. The second-

Table 3 LMI Index and average scoring of each element of the LMI Index in the Java region in 2020

Pillar/Component	Variable	Score			
		Min	Max	Mean	Standard deviation
Legal and institutional framework	P1	2.700	6.000	3.800	2.270
Organization	C1	1.800	3.600	2.224	1.360
Hierarchy of management	C2	0.900	1.200	0.808	0.481
Responsibility line	C3	0.000	1.200	0.767	0.525
Internal monitoring and evaluation	P2	0.110	2.500	1.324	0.901
Document record and control	C4	0.050	0.500	0.270	0.186
Internal audit	C5	0.000	0.500	0.257	0.225
Partnership and cooperation	C6	0.000	0.500	0.238	0.170
Annual evaluation scheme	C7	0.000	0.500	0.277	0.202
Feedback response	C8	0.000	0.500	0.280	0.190
Human resources management	P3	0.110	1.300	0.437	0.336
Working weight analysis	C9	0.000	0.150	0.093	0.072
Verification officer needs	C10	0.110	0.230	0.129	0.091
Competency of verifications officer	C11	0.000	0.230	0.066	0.089
Inspector needs	C12	0.000	0.190	0.049	0.056
Competency of inspector	C13	0.000	0.190	0.015	0.037
Law enforcement officer needs	C14	0.000	0.150	0.022	0.052
Service delivery	P4	1.190	3.510	2.057	1.263
Control of human resource and environment at prior, during, and post delivering service	C15	0.000	1.580	0.883	0.589
Service delivering	C16	0.090	1.230	0.728	0.453
Reporting test result	C17	0.350	0.700	0.446	0.269
Technical competency	P5	1.040	3.400	1.893	1.169
Working standard availability	C18	0.520	1.400	0.869	0.539
Traceability of standard	C19	0.000	1.050	0.533	0.369
Verification seal management	C20	0.000	0.950	0.491	0.339
Standard operational procedure	P6	0.320	3.000	1.329	0.954
Availability of standard operational procedure	C21	0.080	0.750	0.332	0.239
LMI Index		2.780	6.650	3.786	2.262

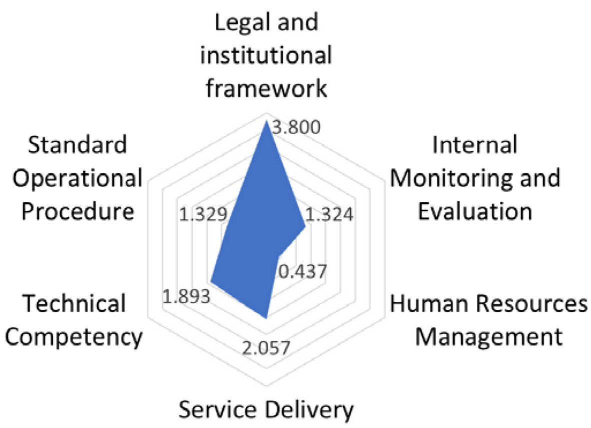

Figure 1 Radar chart of the six pillars of the legal metrological infrastructures of the 91 local verification offices across the Java Island region in 2020

largest mean score is the service delivery pillar of 2.057, followed by technical competency (1.893).

In contrast, the lowest mean score is human resources management (0.437). Most local verification offices have similar issues about human resources, such as lack of several inspectors, a quick mutation or rotation period of verification officers, and others. Figure 1 shows the radar chart of the six pillars in the mean score of the legal metrological infrastructure. The average strengths and weakness of the infrastructure are shown.

Figure 2 (page 29) shows the map of the distribution of the scores of the six pillars across the Java Island Region. By using the natural breaks (Jenks) classification method, it can be seen that the local verification offices with the largest source of legal and institutional framework pillar are spatially distributed. The largest score was in the western Region, while the middle scores are distributed across the center of the Java Region. In contrast, for the internal monitoring and evaluation pillars, the highest scores are distributed among the local verification offices in the center of the Java Region.

Figure 2 also shows a similar pattern for the service delivery pillar scores, the second-largest mean score, distributed among the local verification offices established in the center of Java Island. The scores are spatially distributed for the technical competency and standard operational procedure pillars. Local verification offices across the Java Island Region are likely to have a similar score. Interestingly, as explained above, the scores of the human resources management pillar are low for most of the local verification offices, most of which have this problem in common.

Figure 3 shows the value of the LMI Index of the local verification offices across the Java Region. Lower values of the LMI Index are indicated in light colors and higher values in dark colors. Mapping of the LMI Index shows a homogeneous pattern which is distributed as shown in Figure 3.

To test the assumption of the spatial independence of the LMI Index across the Java region, Moran's I index was calculated. The calculated value of Moran's I is –0.031158 with a z-score of –0865764. The results indicate that the spatial distribution of the LMI Index values is random with a significant level of 5 %. This indicates that there is no interaction among the local verification offices. Therefore, the capability of a local verification office in the Java region is likely not to influence the development of the other local verification offices.

The GWR, as mention in equation 1, is then used to investigate the magnitude and direction of the impact of each aspect: technical capability and management capability to the LMI Index. The R-square of the GWR is at 99.99 %, with the standard residual of the GWR model shown in Figure 4. The map of whether the LMI

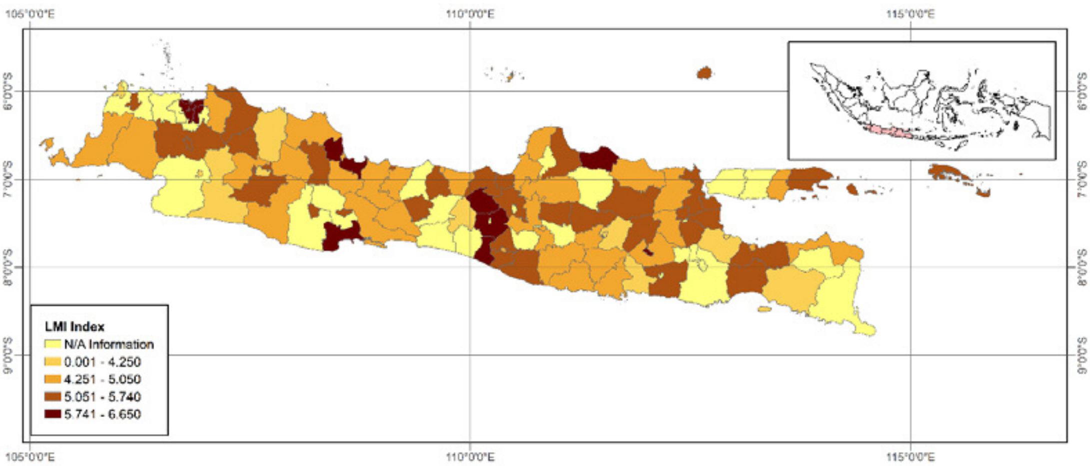

Figure 3 Map of the LMI index across the study area

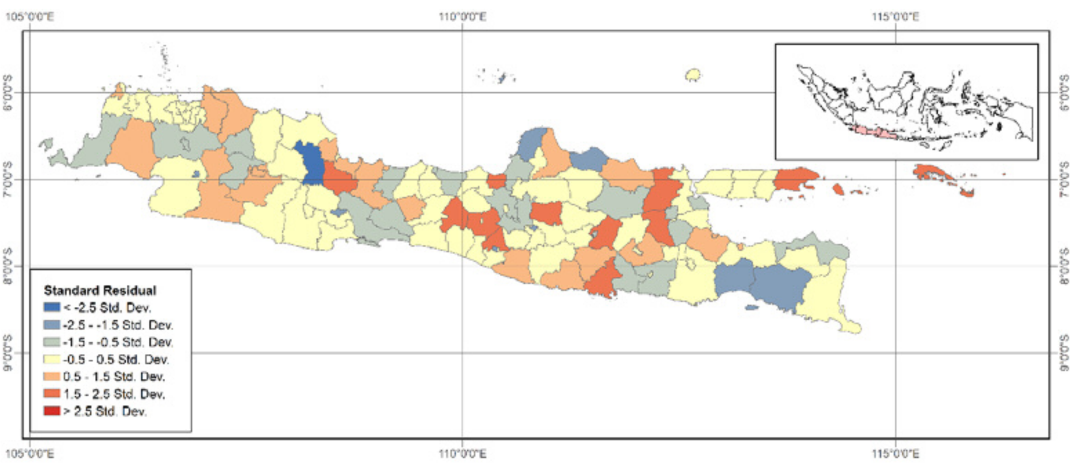

Figure 4 The standard residual of the GWR model in the LMI index

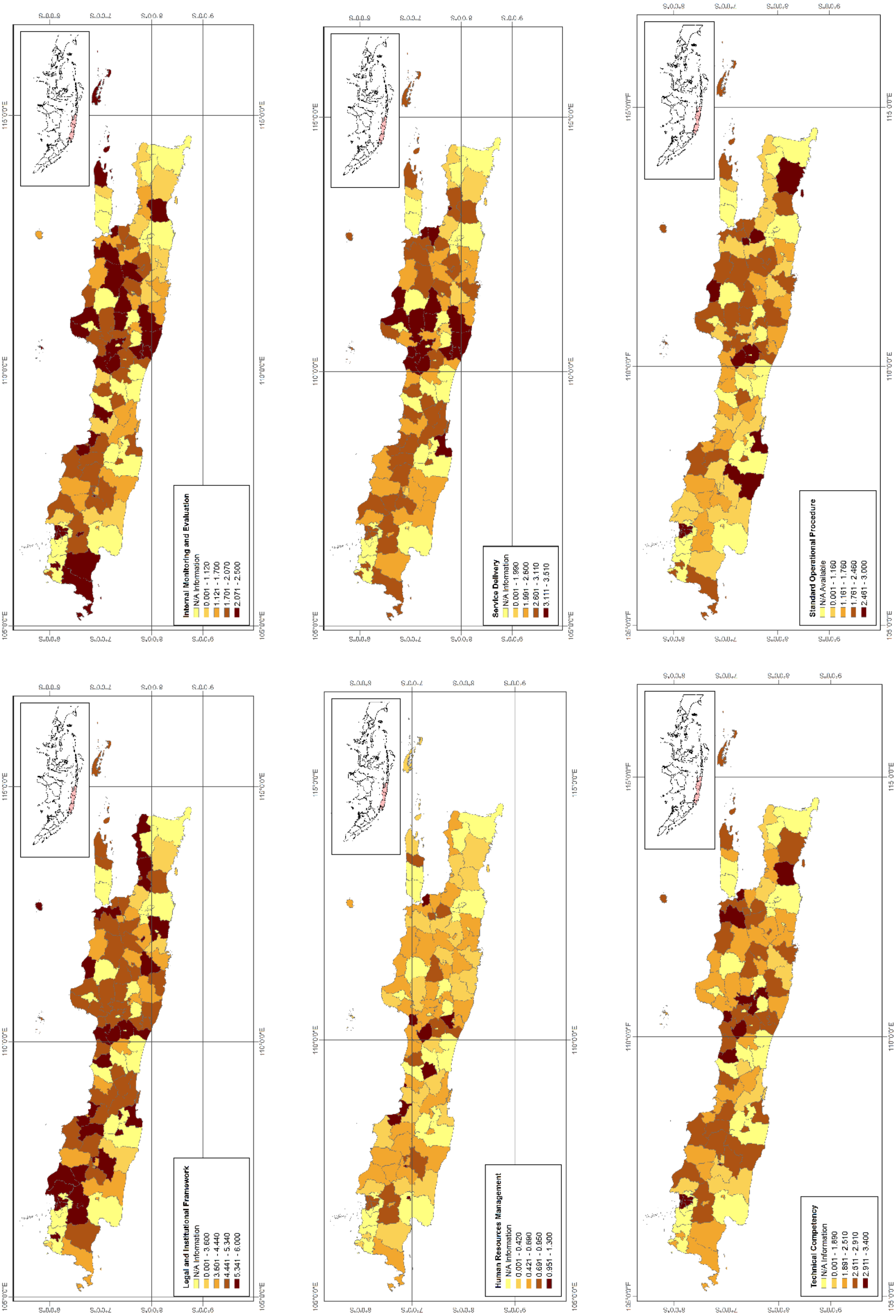

Figure 2 Maps of the six pillars of the local verification offices legal metrological infrastructure across the Java Island Region

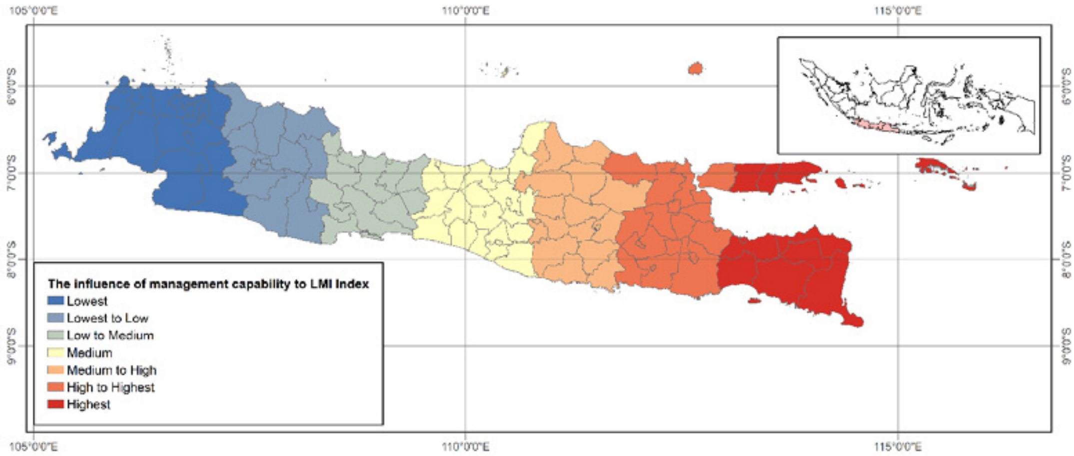

Figure 5 The magnitude and direction of the influence of management capability to the LMI Index

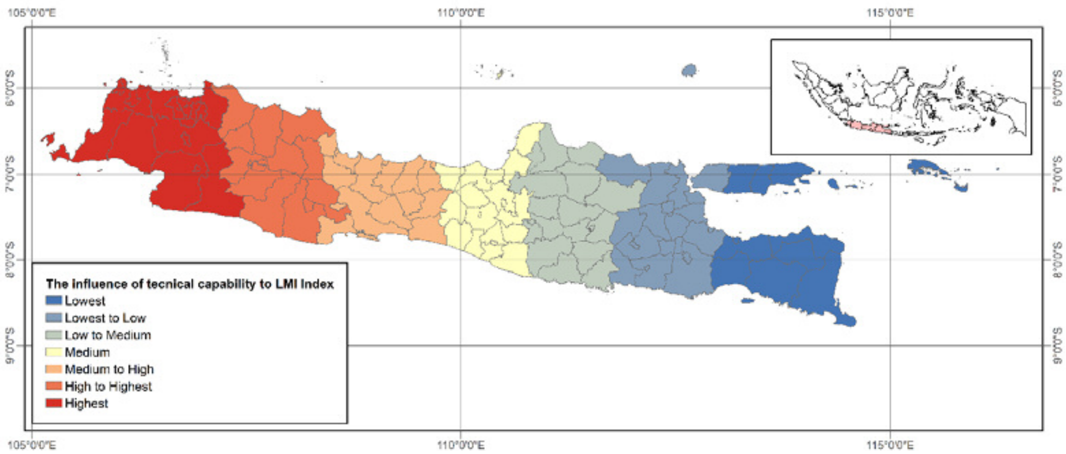

Figure 6 The magnitude and direction of the influence of technical capability to the LMI Index

Index is well predicted, under-predicted, or over-predicted is shown. Most LMI Index values are well predicted with a standard deviation of between –0.5 to 0.5 times the standard deviation, which is very low. Only a few areas are over-predicted with greater than the 2.5 standard deviations of the mean.

Figure 5 and Figure 6 show further discussion using local analysis to assess the magnitude and direction of the influence of specific explanatory variables such as management and technical aspects. In the management aspect, Figure 5 shows the influence of management in the local verification offices in conducting legal metrological services. The positive influence is shown for all the local verification offices across Java Island. The direction of the influence of management capability of the local verification offices to the LMI Index is from east to west. The influence of the management capability of the local verification offices in the West Region is stronger than in the East Region to contribute to increasing the LMI Index. It can be inferred that if management capability in the local verification offices in the East Region increases, it can significantly increase the LMI Index, while in the West Region, the management capability is likely to have a weaker influence on the LMI Index.

Figure 6 shows the influence of technical aspects in the local verification offices in conducting legal metrological services. The magnitude of the influence of the technical aspect is positive to the LMI Index of the local verification offices across Java Island. The influence moves from east to west, where the technical aspect in the local verification offices is likely to have a strong positive influence on increasing the LMI Index. While in the East Region, the influence is weaker than in the West Region, which is in contrast to management capability. The technical capability of the local verification offices in the West Region can increase their LMI Index and vice versa. From Figure 5 and Figure 6, it can be seen that there are two different strategies to increase the performance of the local verification offices across Java Island. Local verification offices in the West Region can focus on management capability, and on technical capability in the East Region.

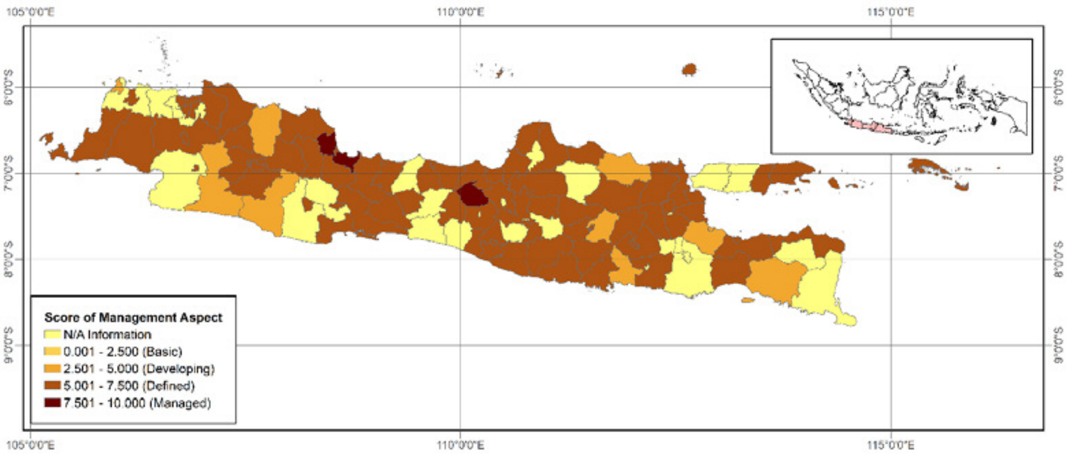

Figure 7 The score of management capability of the local verification officers across the Java Region

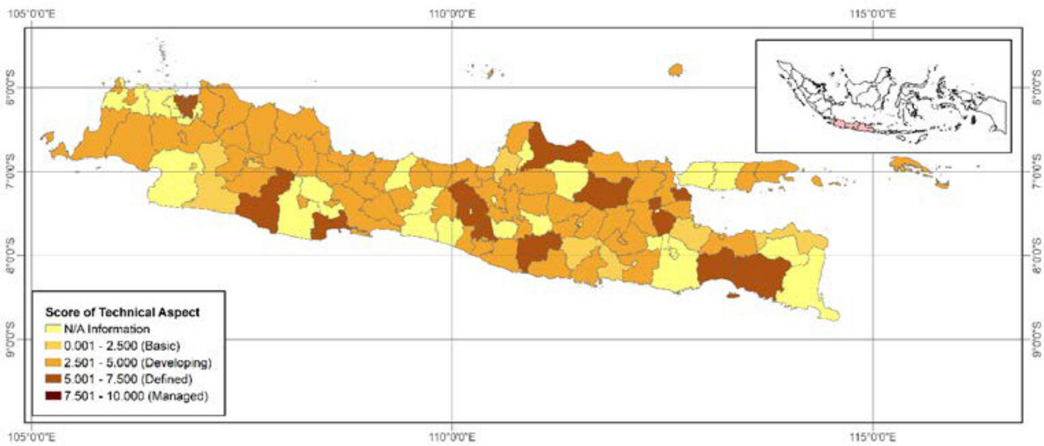

Figure 8 The score of technical capability of the local verification officers across the Java Region

Hence, referring to the classification discussed in the previous section, the local verification offices across the Java Region are grouped into four classes, namely Basic, Developing, Defined, and Managed. Figures 7 and 8 show the mapping of the clusters based on management capability and technical capability. In management capability, only two local verification offices (1.65 %) are classified into managed infrastructures. This is because they have proven their capability in managing legal metrology activities in advance. 65.29 % of local verification offices have defined the management level and carry out their activities in line with the associated regulations. Only a few local verification offices (33.06 %) develop their management system to ensure better performance (see Figure 7).

Unlike the management capability aspects, most local verification offices are still developing their technical capability (Figure 8). 61.16 % are developing their capability underpinning better service performance, and 33.06 % are still at a basic level in their technical aspect. Most local verification offices across the Java Region were only established in the last two years.

Overall, Figure 9 shows the map of the LMI Index of local verification officers across Java. There are 46 local verification offices (38.02 %) at level III (Defined) and 45 37.19 % at level II (Developing). The remaining 24.79 % have basic metrological infrastructures, including management and technical capability to support their metrological service performance such as verification and inspection.

5 Discussion

Overall, there are two considerations. First, the LMI Index will allow individual local legal metrology authorities to determine and input their data, measure and compare their performance, and analyze the most effective allocation of resources specific to their situation in developing the appropriate infrastructure for the legal metrological services. Second, the benefit of the LMI Index in this context is that in addition to an overall LMI Index, the performance of each local

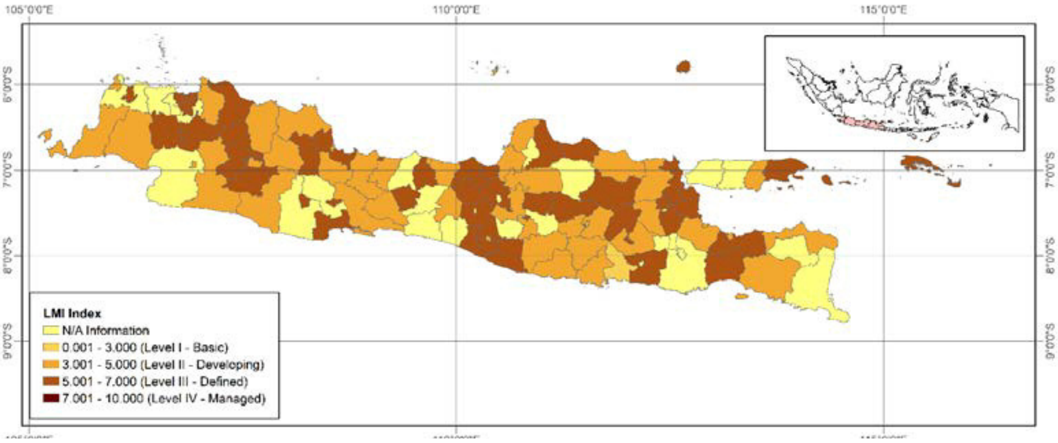

Figure 9 The LMI index of the local verification officers across the Java Region

verification office can be benchmarked in more specific infrastructure management. Benchmarking specific factors and indexes would enable central government, local government, and other key stakeholders to measure the individual balance of resource allocation, overall priorities, and the effectiveness of alternative resourcing strategies. Such measures could then provide information about related considerations, including maintenance, capacity building needs, funding priorities, and others. As a result, some recommendations can be written to ensure the sustainability of local verification offices, such as identifying the most vulnerable local verification offices in a specific region so that their performance and capabilities can be evaluated, implementing proactive management measures as needed so that prioritization is required to ensure that the budget is used wisely to achieve optimum results, and recognizing the correct actions for specific local governments to take.

An effective LMI Index might identify the indicator factors that best represent the proactive and reactive local verification office activities across Indonesia. The LMI Index can be further classified as a capability index, providing an individual index for each local verification office. However, the LMI Index is only a tool to assess organizational capability. Other measures are also used to complement the LMI Index, which measures the outcome of the performance of the local verification offices.

6 Conclusion

This paper has explored a tool that can be used to monitor the capability and performance of local verification offices in Indonesia through the Legal Metrological Infrastructure (LMI) Index. There are several key findings from the study.

First, the legal and institutional framework pillar has a greater mean score across local verification offices, followed by the service delivery and technical competency pillars. The lowest mean score is human resources management. Most local verification offices have similar issues concerning human resources, such as a lack of several inspectors and a quick mutation or rotation period of verification officers.

Second, the largest legal and institutional framework pillar score was in the Western Region, while the middle scores are distributed across the center of the Java Region. Conversely, the highest scores of the internal monitoring and evaluation pillars are distributed among the local verification offices in the center of the Java Region.

Third, the capability of a local verification office in the Java Region is likely not to influence the development of other local verification offices.

Fourth, the influence of the management capability of the local verification offices in the West Region is stronger than in the East Region to increase the LMI Index. Meanwhile, the direction of the influence of the technical aspect in local verification offices is moving from east to west where it is likely to have a strong positive influence on the increasing of LMI Index.

Fifth, most of the local verification offices across the Java Region are at Level III and Level II. Only a few still have basic metrological infrastructures, including management and technical capability to support their metrological service performance, such as verification and inspection.

7 Recommendation

This paper has explored a recent study that specifically prioritizes legal metrology's approaches to a sustainability infrastructure in a broader metrological performance context. The most substantive outcome of this research is explicit confirmation that legal metrology authorities believe that developing an appropriate infrastructure for strengthening services is the main critical factor for successfully sustaining the infrastructure. Such regulatory measures have proven ineffective in the infrastructure, and this is the primary concern for the government, especially local governments engaged in legal metrology planning. Therefore, future research should seek to improve the effectiveness and efficiency of evaluating the implementation of legal metrological regulations underpinning the development of local government in legal metrology.

A further benefit of the results of this study is that the different levels of infrastructure on local verification offices can be used to initiate and formulate different strategies to improve and develop the infrastructure. Funding agencies can utilize the value of the LMI Index in prioritizing the allocation of resources to local government. The result of this study will provide information to legal metrology authorities, planners, engineers, architectures, and economists as they develop more quantitative indicators and standards for the development of legal metrology infrastructure, set targets, and make improvements over time. ■

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MetTalk

OIML MetTalk webinar

Electric Vehicle Supply Equipment (EVSE)

7 October 2022

Ian Dunmill, BIML

Following the publication on 15 September 2022 of a new OIML Guide, G 22:2022 *Electric vehicle supply equipment*, it was decided to run the second in the series of OIML MetTalks webinars on this subject. Around 400 people registered for the webinar, and the event itself generated an extremely interesting and interactive discussion on many technical and regulatory aspects of the new Guide.

Background and OIML technical work on EVSE

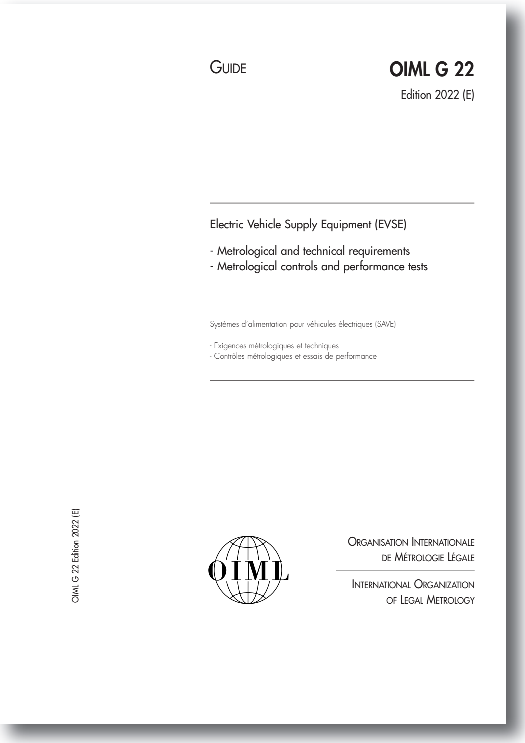
As a result of the transition from fossil fuels to sustainable forms of energy, worldwide developments in the area of charging electrical vehicles (EVs) are proceeding at a rapid pace. In this newly developing market, it is important that trading parties have confidence that the amount of energy transferred is measured fairly and accurately. Regulators in various individual economies have started, or are starting, initiatives to develop national or regional metrology regulations for Electrical Vehicle Supply Equipment (EVSE), for which the requirements are not always mutually exchangeable.

The need for international guidance on metrology for EVSE was already agreed upon by the CIML at its 51st meeting in 2016 in Strasbourg, where the Committee decided on the mandate to revise OIML R 46:2012 *Active energy electricity meters*. Recommendations for EVSE metrology were initially foreseen to be included in the next version of R 46. By 2021, however, it had become apparent that the needs of the EVSE market, and of regulators, were more urgent than could be met by the timeline expected for the publication of the revised R 46. Initial work on international harmonisation of EVSE requirements and test procedures was carried out as part of the revision process for R 46. This effort was subsequently split off into a separate Project Group, established following CIML approval of the relevant project proposal in October 2021. The existence of the new Project Group allowed the development of a self-contained OIML publication for EVSE, separate from R 46, and which could be published on a faster timeline than that foreseen for this ongoing revision. While there are obvious similarities between "traditional" (utility type) electricity metering and charging EVs, there are also profound differences. This separate OIML publication for EVSE allows for clear treatment of the unique aspects of EV charging, such as the direct sales nature of transactions, means of conveying the measurement result, and typical progressions of current levels over time.

Initially the new Project Group determined that the most expedient way of introducing guidance on EVSE would be to develop a Guide based on many aspects of OIML R 46. The resulting OIML Guide, G 22 *Electric vehicle supply equipment*, was published on 15 September 2022. While it is based on OIML R 46, it is not a generally applicable metering document, but rather a purpose-specific application with different use and application. The intention of this Guide is to provide a blueprint for requirements and procedures for type testing, to be used by national regulators and approval authorities to set up their own legislation. In this Guide, the EVSE is considered as a unique, built-for-purpose system, which incorporates AC or DC energy metrology. Whether the metrology in the EVSE is accomplished using a separately type approved meter, or integrated into the electronics of the EVSE, does not affect the requirements for testing, or the performance of the EVSE.

Practical technical experience in testing and approving DC charging is lacking in some respects. However, DC charging applications constitute an important, growing portion of the EV charging market, and fair trade of electrical energy in DC is deemed at least as important as in AC. Measuring DC energy by EVSE is therefore explicitly covered in this Guide, albeit in a rudimentary way.

Immediately following the development of this Guide, the same OIML Project Group will continue working to produce a full Recommendation on EVSE. The major parts of this Guide are already styled as "Part 1" (Metrological and technical requirements) and "Part 2" (Test procedures) of an OIML Recommendation. The Recommendation will be a fine-tuned, more elaborate version of the text of G 22:2022, and will contain all the mandatory parts. Once the Recommendation on EVSE is published, the OIML intends to withdraw G 22:2022.



OIML G 22:2022 *Electric vehicle supply equipment* was published on 15 September 2022

▶ Definition in G 22:

Electric Vehicle Supply Equipment (EVSE)

device intended to supply or receive electrical energy to or from an electric vehicle and to measure that energy, store and report the measurement result to the customer, and if necessary, transmit the information to a billing system

Summary of the MetTalk webinar on EVSE

- Introduction and history
- Part 1: Requirements in OIML G 22
- Part 2: Test procedures in OIML G 22
- Future and conclusion

Introduction and history

The introduction to the webinar explained that there was a broad sense of urgency to facilitate energy transition as a result of pressure from governments on the rollout of EV charging infrastructure to support the increased sales of electric vehicles.

The speakers then highlighted the importance of reliable metrology in EV charging, and explained that there was generally an absence of international guidance and harmonisation, which resulted in a risk of diverging regulation in this area between countries.

They then ran through the history of the project, from its roots in the project to revise OIML R 46, which started in 2016, to the 2021 decision to allocate the work on EV charging to a dedicated Project Group, to the delivery of the first phase in this new project in September 2021.

Part 1: Metrological and functional requirements in OIML G 22

The speakers then explained that the requirements in G 22 covered measurements at publicly accessible EVSE, and included both AC and DC implementations, as well as bidirectional charging (grid to vehicle and vehicle to grid). G 22 also covered EVSE with integrated measuring components, as well as those with a separately type approved meter.

The metrological requirements were detailed, and the speakers explained that G 22 includes three MPE classes: A (2 %), B (1 %), C (0.5 %). The Guide also includes requirements for influence quantities, disturbances, durability, and markings, as well as many other technical details.

Part 2: Metrological control and performance tests in OIML G 22

The test programme for type approval is based on the same transactional process as is used in normal operation, and enables the use of real or phantom loads, covers AC and DC measurements, and allows for the use or a car simulator. Several details of the test procedures were explained, such as the reference conditions, determination of the intrinsic error, the relationship between the applicable MPE for different classes and the EVSE starting current, and the use of statistical verification.

Standardisation and future developments

The webinar then gave an overview of related developments in standardisation by other bodies such as the IEC and CENELEC. The speakers also gave some details of the German Application Rule, and mentioned the MET4EVCS research programme.

They concluded by explaining that the OIML TC 12/p 3 Project Group would now continue its work to develop a full OIML Recommendation on EVSE, which would include all the necessary parts. This work will be based on the experience and insights gained during the work on this OIML Guide by members of the Project Group, as well as information from the networks they have established.

The recording and presentation from the webinar can be found on the OIML website at the following link:

www.oiml.org/en/structure/ceems/online-learning-from-the-oiml

OIML G 22:2022 *Electric Vehicle Supply Equipment (EVSE)* may be downloaded free of charge from the OIML website at www.oiml.org.

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OIML MetTalks webinars

The OIML intends to make MetTalks webinars a regular feature of the OIML's work. Each one consists of a short, live presentation on a single topic, followed by a question and answer session. So far, two events have been held:

- Medical devices in legal metrology
- Electric Vehicle Supply Equipment (EVSE)

If you have ideas or suggestions for topics which might be covered in future events, please email Ian Dunmill at the BIML.

OIML Certification System (OIML-CS)

Introduction

The OIML-CS is a system for issuing, registering and using OIML Certificates and their associated OIML type evaluation reports for types of measuring instruments (including families of measuring instruments, modules, or families of modules), based on the requirements of OIML Recommendations.

The OIML-CS comprises two Schemes: Scheme A and Scheme B. Competence of the OIML Issuing Authorities and their Test Laboratories is demonstrated through self-declaration under Scheme B and accreditation or peer assessment under Scheme A.

The aim of the OIML-CS is to facilitate, accelerate and harmonize the work of national and regional bodies that are responsible for type evaluation and approval of measuring instruments subject to legal metrological control. In the same way, instrument manufacturers, who are required to obtain type approval in some countries in which they wish to sell their products, should benefit from the OIML-CS as it will provide evidence that their instrument type complies with the requirements of the relevant OIML Recommendation(s).

It is a voluntary system and OIML Member States and Corresponding Members are free to participate. Participating in the OIML-CS commits, in principle, the signatories to abide by the rules of the OIML-CS that are established in OIML B 18:2018 *Framework for the OIML Certification System (OIML-CS)*. Signatories voluntarily accept and utilize OIML type evaluation and test reports, when associated with an OIML Certificate issued by an OIML Issuing Authority, for type approval or recognition in their national or regional metrological controls.

The OIML-CS was launched on 1 January 2018 and has replaced the former OIML Basic Certificate System and the OIML Mutual Acceptance Arrangement (MAA).

OIML certificates

OIML certificates issued under Scheme A and Scheme B can be downloaded from the database on the OIML website at https://www.oiml.org/en/oiml-cs/certificat_view.

The database also includes certificates issued under the former OIML Basic Certificate System and the MAA. Although these two systems are no longer in operation, the certificates remain valid.

OIML Issuing Authorities, Utilizers and Associates

A summary of the approved OIML Issuing Authorities is published on the next page, followed by a summary of those Utilizers and Associates that have declared that they will accept OIML certificates and/or OIML type evaluation reports as the basis for a national or regional approval.

More information

For enquiries regarding the OIML-CS, please contact the OIML-CS Executive Secretary Mr Paul Dixon (executive.secretary@oiml.org). Visit the OIML website:

https://www.oiml.org/en/oiml-cs

OIML Certification System (OIML-CS)

List of OIML Issuing Authorities and their scopes

Updated: 2022-08-29

The list of OIML Issuing Authorities is published in each issue of the OIML Bulletin and can be downloaded at www.oiml.org/oiml-cs/oiml-issuing-authorities

		R 21:2007	R 46:2012	R 49:2006	R 49:2013	R 50:2014	R 51:2006	R 60:2000	R 60:2017	R 61:2004	R 61:2017	R 75:2002	R 76:1992	R 76:2006	R 85:2008	R 99:2008	R 106:2011	R 107:2007	R 117:1995	R 117:2007	R 117:2019	R 126:1998	R 126:2021	R 129:2000	R 134:2006	R 137:2012	R 139:2014	R 139:2018
AU1	National Measurement Institute Australia (NMIA)					■							■	■														
CH1	Federal Institute of Metrology (METAS)							■						■			■								■			
CN2	National Institute of Metrology, China (NIM)						■	■	■	■	■		■	■														
CZ1	Czech Metrology Institute (CMI)				■		■				■			■	■					■	■				■	■		■
DE1	Physikalisch-Technische Bundesanstalt (PTB)				■		■	■	■	■		■		■														
DK2	FORCE Certification A/S				■	■	■	■	■	■	■			■			■	■						■	■	■	■	■
FR2	Laboratoire National de Métrologie et d'Essais (LNE)			■	■		■	■	■					■								■	■					
GB1	Office for Product Safety and Standards (OPSS) (formerly NMO)				■		■	■	■				■	■						■	■							
JP1	NMIJ/AIST							■	■				■	■					■	■	■							
NL1	NMi Certin B.V.	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
SE1	Research Institutes of Sweden (RISE)						■	■	■	■	■			■	■				■	■	■							
SK1	Slovak Legal Metrology (SLM)			■	■									■														

OIML Certification System (OIML-CS)

List of Utilizers, Associates and their scopes

Updated: 2022-08-01

The list of Utilizer and Associate scopes is published in each issue of the OIML Bulletin and can be downloaded at www.oiml.org/oiml-cs/utilizers-and-associates

1 = Scheme A only
2 = Scheme A and MAA
3 = Scheme A and B
4 = Scheme A, B and MAA
5 = Scheme B only

		R 21:2007	R 35:2007	R 46:2012	R 49:2006	R 49:2013	R 50:2014	R 51:2006	R 58:1998	R 59:2016	R 60:2000	R 60:2017	R 61:2004	R 61:2017	R 75:2002	R 76:1992	R 76:2006	R 81:1998	R 85:2008	R 88:1998	R 93:1999	R 99:2008	R 102:1992	R 104:1993	R 106:2011
AU	National Measurement Institute, Australia (NMIA)				1	1	1				1					1	1								
BE	Federal Public Service Economy	3		3		3	3	3			1		3		3		1		3			3			3
CA	Measurement Canada										2	1			1		2								
CH	Federal Institute of Metrology (METAS)			1	2	2	1	1			2		1		1		2								1
CN	State Administration for Market Regulation (SAMR)							1			2	1	1	1		2	2								
CO	Superintendencia de Industria y Comercio (SIC)	3		3	4	4	3	3			2		3		3	2	2		3			3			3
CU	Oficina Nacional de Normalizacion (NC)	3	3	1		1	3	1	3	3	1	1	3	3	3		1	3	3	3	3	3	3	3	3
CZ	Czech Metrology Institute (CMI)					1		1						1			1		1						
DE	Physikalisch-Technische Bundesanstalt (PTB)	5		3	3	4	3	3			2		3		3		2					5			1
DK	FORCE Certification A/S				2	2	1	1			2	1	1	1			2								1
FR	Laboratoire National de Métrologie et d'Essais (LNE)	1		1	1	1	1	1			1		1		1	1	1		1			1			1
GB	Office for Product Safety and Standards (OPSS) (formerly NMO)	3				4	3	3			2	1	3			1	1		3						3
IN	Legal Metrology Division, Department of Consumer Affairs	3		3		4	3	3			2		3		3		2		3						1
IR	Iran National Standards Organization (INSO)				4	4					2	1				2	2								
JP	NMIJ/AIST										2	1				2	2								
KE	Weights and Measures Department		3	3	4	4		3			4	4	3	3		4	4		3						3
KH	National Metrology Centre (NMC)	3		3	3	3	3	3			1		3		3	1	1		3			3			3
KI	Ministry of Commerce, Industry and Cooperatives	5	5	5	1	1	5	1		5	1	1	5	5	5	1	1	5	5						5
KR	Korea Testing Certification (KTC)															2	2								
LV	LNMC Ltd. Metrology Bureau																								
NA	Namibian Standards Institution			3	4	4	3	3			2		3			2	2		3						3
NL	NMi Certin B.V.	3		3	3	4	3	3			2	1	3	3	3	1	2		3			3			3
NZ	Trading Standards (Ministry of Business, Innovation and Employment) (MBIE)				4	4	3	3			2					2	2		3						3
RU	VNIIMS																								
RW	Rwanda Standards Board	3	3	3	3	3		3	3	3	1	1	3	3		1	1					3	3	3	3
SA	SASO (Saudi Standards, Metrology and Quality Organization)			3		1						1					1								
SE	RISE Research Institutes of Sweden AB							3			2	1	3				2		3						
SK	Slovak Legal Metrology (SLM)				2	2											2								
TN	National Agency of Metrology (ANM)	3		3	2	2	3	3			2		3				2		3			3			3
UG	Uganda National Bureau of Standards (UNBS)			3	1	3					1	1				1	1								
US	National Conference on Weights and Measures (NCWM)										2														
ZA	NRCS: Legal Metrology				3	3		3			1					1	1		3						3
ZM	Zambia Metrology Agency	3		3	3	3	3	3			1		3		3	1	1		3			3			3

OIML Certification System (OIML-CS)

List of Utilizers, Associates and their scopes (Cont'd)

Updated: 2022-08-01

The list of Utilizer and Associate scopes is published in each issue of the OIML Bulletin and can be downloaded at www.oiml.org/oiml-cs/utilizers-and-associates

1 = Scheme A only
2 = Scheme A and MAA
3 = Scheme A and B
4 = Scheme A, B and MAA
5 = Scheme B only

		R 21:2007	R 35:2007	R 46:2012	R 49:2006	R 49:2013	R 50:2014	R 51:2006	R 58:1998	R 59:2016	R 60:2000	R 60:2017	R 61:2004	R 61:2017	R 75:2002	R 76:1992	R 76:2006	R 81:1998	R 85:2008	R 88:1998	R 93:1999	R 99:2008	R 102:1992	R 104:1993	R 106:2011
AU	National Measurement Institute, Australia (NMIA)				1	1	1				1					1	1								
BE	Federal Public Service Economy	3		3		3	3	3			1		3		3		1		3			3			3
CA	Measurement Canada										2	1			1		2								
CH	Federal Institute of Metrology (METAS)			1	2	2	1	1			2		1		1		2								1
CN	State Administration for Market Regulation (SAMR)							1			2	1	1	1		2	2								
CO	Superintendencia de Industria y Comercio (SIC)	3		3	4	4	3	3			2		3		3	2	2		3			3			3
CU	Oficina Nacional de Normalizacion (NC)	3	3	1		1	3	1	3	3	1	1	3	3	3		1	3	3	3	3	3	3	3	3
CZ	Czech Metrology Institute (CMI)					1		1						1			1		1						
DE	Physikalisch-Technische Bundesanstalt (PTB)	5		3	3	4	3	3			2		3		3		2					5			1
DK	FORCE Certification A/S				2	2	1	1			2	1	1	1			2								1
FR	Laboratoire National de Métrologie et d'Essais (LNE)	1		1	1	1	1	1			1		1		1	1	1		1			1			1
GB	Office for Product Safety and Standards (OPSS) (formerly NMO)	3				4	3	3			2	1	3			1	1		3						3
IN	Legal Metrology Division, Department of Consumer Affairs	3		3		4	3	3			2		3		3		2		3						1
IR	Iran National Standards Organization (INSO)				4	4					2	1				2	2								
JP	NMIJ/AIST										2	1				2	2								
KE	Weights and Measures Department		3	3	4	4		3			4	4	3	3		4	4		3						3
KH	National Metrology Centre (NMC)	3		3	3	3	3	3			1		3		3	1	1		3			3			3
KI	Ministry of Commerce, Industry and Cooperatives	5	5	5	1	1	5	1		5	1	1	5	5	5	1	1	5	5						5
KR	Korea Testing Certification (KTC)															2	2								
LV	LNMC Ltd. Metrology Bureau																								
NA	Namibian Standards Institution			3	4	4	3	3			2		3			2	2		3						3
NL	NMi Certin B.V.	3		3	3	4	3	3			2	1	3	3	3	1	2		3			3			3
NZ	Trading Standards (Ministry of Business, Innovation and Employment) (MBIE)				4	4	3	3			2					2	2		3						3
RU	VNIIMS																								
RW	Rwanda Standards Board	3	3	3	3	3		3	3	3	1	1	3	3		1	1					3	3	3	3
SA	SASO (Saudi Standards, Metrology and Quality Organization)			3		1						1					1								
SE	RISE Research Institutes of Sweden AB							3			2	1	3				2		3						
SK	Slovak Legal Metrology (SLM)				2	2											2								
TN	National Agency of Metrology (ANM)	3		3	2	2	3	3			2		3				2		3			3			3
UG	Uganda National Bureau of Standards (UNBS)			3	1	3					1	1				1	1								
US	National Conference on Weights and Measures (NCWM)										2														
ZA	NRCS: Legal Metrology				3	3		3			1					1	1		3						3
ZM	Zambia Metrology Agency	3		3	3	3	3	3			1		3		3	1	1		3			3			3

Promotion of the OIML Bulletin: Become a Mentor

The OIML Bulletin is one, if not the only, international publication dedicated to legal metrology topics.

In accordance with CIML Resolutions 2019/30 and 2020/21, there is a clear desire for the Bulletin to be an attractive publication for legal metrology worldwide, and for it to be an excellent advertisement for our Organisation.

This can be achieved through long-term planning of the future editions and identification of key topics of high interest, for instance, legal control of measuring instruments in the fields of energy, health and the environment, where important aspects such as new technology, legal requirements, or test/verification procedures will be addressed.

In addition, support is sought from CIML Members and Corresponding Member Representatives who are ready to take on the responsibility of acting as "**Mentors**" for certain key topics / editions and technical articles. These are not necessarily expected to be written by the "**Mentors**" themselves, but by experts that a "**Mentor**" has identified and contacted.

In order to identify key topics of significant interest and "**Mentors**" to lead them, it was proposed by the CIML President that the BIML prepares, and makes publicly available on the OIML website, a plan for the upcoming eight to ten editions of the Bulletin.

The table on the following page is intended to be "dynamic", i.e. proposed key topics may be moved to other editions depending on available "**Mentors**" and authors for technical articles. The table can also be found at www.oiml.org/en/publications/bulletin/future-editions.

All CIML Members and Corresponding Member Representatives are encouraged to support the OIML Bulletin, to share their legal metrology experiences with the legal metrology community worldwide, and to take responsibility either as a "**Mentor**" for one of the next editions of the Bulletin, or by promoting it at TC/SC/Project Group meetings, RLMO meetings, CEEMS AG meetings, and other opportunities.

CIML Members and Corresponding Member Representatives who would like to be a "**Mentor**" for a specific edition / key topic, or who would like to suggest that a new key topic be added to the list, are asked to contact the BIML (chris.pulham@oiml.org).

Edition	General key topic	Mentor	Proposed article submissions
October 2022	Training / CEEMS	Mr Peter Mason CEEMS AG Chair	▪ Summary of CEEMS AG achievements and outlook ▪ Revision of OIML D 14 *Training and qualification of legal metrology personnel* ▪ UNIDO QI4SD Index ▪ Performance of the local government Legal Metrology Unit in Indonesia ▪ EVSE Webinar account / Publication of OIML G 22
January 2023	Feature on the 57th CIML Meeting	BIML	▪ Summary Report ▪ Reports by the CIML President and the BIML Director ▪ Approved Resolutions ▪ Awards including Awards, Medals, Letters of Appreciation, etc.
April 2023	Feature on Regional Legal Metrology Organisations (RLMOs) + Prepackages / Statistical control	Dr Charles Ehrlich RLMO RT Chair	▪ TC 6 Prepackage control template ▪ Highlights of the status of legal metrology systems in the various Regions ▪ Information on prepackaging in the various Regions ▪ Type approval in the various Regions ▪ Prepackaging in the various Regions
July 2023	Renewable energy/energy efficiency	Mr Yizhi Qin CIML Member P.R. China	▪ E.g. hydrogen measurement, smart meters, electric vehicle supply equipment (EVSE), etc.
Future editions	National / Regional Metrology Systems		▪ Report on OTE (July 2023) in Bad Reichenhall (DE)
	Intellectual property		▪ Role of patents in legal metrology

2022-10-27

info

The OIML is pleased to welcome the following new

CIML Members

- **Bulgaria:** Mr Paun Ilchev
- **Canada:** Mr Benoit Desforges
- **Kazakhstan:** Mr Kuanysh Yelikbaev
- **South Africa:** Mr Jaco Marneweck

New Corresponding Member:

- **Saint Lucia**

OIML meeting

23-24 November 2022

TC 9/SC 2/p 10: Revision of R 51:2006

Automatic catchweighing instruments

Committee Draft

Received by the BIML, 2022.08 – 2022.10

Revision of OIML D 31: *General requirements for software-controlled measuring instruments*	2 CD	TC 5/SC 2/p 4	DE	2022-07-25

Call for papers

OIML Members
RLMOs
Liaison Institutions
Manufacturers' Associations
Consumers' & Users' Groups, etc.

- Technical articles on legal metrology related subjects
- Features on metrology in your country
- Accounts of Seminars, Meetings, Conferences
- Announcements of forthcoming events, etc.

The **OIML Bulletin** is a forum for the publication of technical papers and diverse articles addressing metrological advances in trade, health, the environment and safety - fields in which the credibility of measurement remains a challenging priority. The Editors of the Bulletin encourage the submission of articles covering topics such as national, regional and international activities in legal metrology and related fields, evaluation procedures, accreditation and certification, and measuring techniques and instrumentation. Authors are requested to submit:

- a titled, typed manuscript in Word or WordPerfect either on disk or (preferably) by e-mail;
- the paper originals of any relevant photos, illustrations, diagrams, etc.;
- a photograph of the author(s) suitable for publication together with full contact details: name, position, institution, address, telephone, fax and e-mail.

Note: Electronic images should be minimum 150 dpi, preferably 300 dpi.

Technical articles selected for publication will be remunerated at the rate of 23 € per printed page, provided that they have not already been published in other journals. The Editors reserve the right to edit contributions for style, space and linguistic reasons and author approval is always obtained prior to publication. The Editors decline responsibility for any claims made in articles, which are the sole responsibility of the authors concerned. Please send submissions to:

The Editor, OIML Bulletin
BIML, 11 Rue Turgot, F-75009 Paris, France
(chris.pulham@oiml.org)