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Manipulation of Vehicle Scales in Legal Metrology

Manipulasi Skala Kenderaan dalam Metrologi Undang -Undang

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ABSTRACT

To ensure Malaysia's economic growth aligns with modern technologies, a focused approach to legal metrology is essential, particularly regarding the manipulation of vehicle scales. This study aims to identify effective metrological legal controls to address the manipulation and modification of vehicle weighing devices prevalent in contemporary business transactions. It also analyzes the effectiveness of these legal controls in detecting and preventing such malpractices. Using a qualitative approach, including legal analysis, document reviews, and stakeholder interviews, the study identifies gaps in Malaysia's legal metrology system, highlighting that outdated legislation and inadequate software verification megsures enable traders to tamper with computerized weighing systems. Enforcement challenges further exacerbate these issues, as current inspection protocols often overlook digital manipulations. To address this, legal metrology must evolve by incorporating advanced software verification, updating the Weights and Measures Act 1972, and enhancing inspector training. Strengthening regulatory frameworks and enforcement mechanisms will reinforce compliance and accountability, ultimately protecting consumers and ensuring fair trade practices. Addressing manipulation within legal metrology is crucial for fostering a transparent trading environment that supports sustainable economic growth and enhances the integrity of vehicle scales in Malaysia's trade ecosystem.

Keywords: Legal Metrology; Vehicle Scales; Manipulation; Weights and Measures Act 1972; Malaysia

ABSTRAK

Untuk memastikan pertumbuhan ekonomi Malaysia sejajar dengan teknologi moden, pendekatan yang difokuskan kepada metrologi undang -undang adalah penting, terutamanya mengenai manipulasi skala kenderaan. Kajian ini bertujuan untuk mengenal pasti kawalan undang -undang metrologi yang berkesan untuk menangani manipulasi dan pengubahsuaian peranti berat kenderaan yang lazim dalam urus niaga perniagaan kontemporari. Ia juga menganalisis keberkesanan kawalan undang -undang ini dalam mengesan dan mencegah penyelewengan tersebut. Dengan menggunakan pendekatan kualitatif, termasuk analisis undang -undang, ulasan dokumen, dan wawancara pihak berkepentingan, kajian ini mengenal pasti jurang dalam sistem metrologi undang -undang Malaysia, yang menonjolkan undang -undang yang sudah lapuk dan pengesahan perisian yang tidak mencukupi membolehkan peniaga -peniaga untuk merosakkan sistem penimbang berkomputer. Cabaran penguatkuasaan terus memburukkan lagi isu -isu ini, kerana protokol pemeriksaan semasa sering mengabaikan manipulasi digital. Untuk menangani masalah ini, metrologi undang -undang mesti berkembang dengan menggabungkan pengesahan perisian lanjutan, mengemas kini Akta Berat dan Langkah 1972, dan meningkatkan latihan pemeriksa. Memperkukuhkan rangka kerja pengawalseliaan dan mekanisme penguatkuasaan akan memperkuat pematuhan dan akauntabiliti, akhirnya melindungi pengguna dan memastikan amalan perdagangan yang adil. Menangani manipulasi dalam metrologi undang -undang adalah penting untuk memupuk persekitaran perdagangan yang telus yang menyokong pertumbuhan ekonomi yang mampan dan meningkatkan integriti skala kenderaan dalam ekosistem perdagangan Malaysia.

Kata kunci: metrologi undang -undang; Skala kenderaan; Manipulasi; Akta Berat dan Langkah 1972; Malaysia

INTRODUCTION

The significance of a robust weighing and measuring system serves as a fundamental cornerstone for enhancing the economy of a country. Accurate measurements are essential in all trade transaction processes, directly benefiting traders, retailers, and consumers alike. The framework of legal control encompasses a series of activities associated with legal metrology, including the verification, calibration, and supervision of weighing instruments both before and after they are released into the market. Legal metrology plays a crucial role in society and the economy by establishing regulations that ensure weighing instruments comply with predefined legal standards. Without stringent regulation and oversight, the risk of fraudulent activities and unfair practices in trade escalates significantly. Consumers face the threat of inaccurate measurements, leading to potential financial losses and a growing distrust in the marketplace. Moreover, a reliable weighing and measuring system fosters confidence among traders and encourages fair competition, ultimately contributing to the overall growth and stability of the nation's economy.

In Malaysia, the regulatory framework mandates that all weights and measures used for trade undergo certification prior to use and re-certification every twelve months, as stipulated by the Weights and Measures Act 1972 (Act 71). Using uncertified weights and measures beyond their specified validity period is considered an offense. Traders may employ various manipulative tactics to distort weight readings, whether through physical alterations to weighing devices or by modifying computer software. Such manipulations often involve the installation of unauthorized devices or direct modifications to software, resulting in inaccurate and inconsistent weight readings. Therefore, this study aims to identify effective metrological legal controls to address the manipulation and modification of vehicle weighing devices prevalent in contemporary business transactions. It will also analyze the effectiveness of these legal controls in detecting and preventing such malpractices. By understanding and implementing these controls, businesses can ensure accurate and reliable weight measurements, promote fair trade practices, and protect consumers from potential fraud.

METHODOLODY

This study adopts a qualitative research approach (Atika, 2022) to examine the manipulation of vehicle scales in Malaysia and assess the effectiveness of legal metrology controls. The research methodology consists of three key components: legal analysis, document reviews, and stakeholder interviews.

1. Legal Analysis: A comprehensive review of the Weights and Measures Act 1972 and related regulatory frameworks was conducted to identify gaps in existing legislation and enforcement mechanisms. This analysis focused on the legal provisions governing vehicle scales and their applicability to computerized weighing systems.
2. Document Review: Various official reports, policy papers, enforcement records, and metrology standards were analyzed to evaluate the current regulatory landscape. Documents from agencies such as the Ministry of Domestic Trade and Cost of Living (KPDN), the National Metrology Institute of Malaysia (NMIM), and the Malaysian Palm Oil Board (MPOB) provided insights into inspection procedures and regulatory challenges.

3. Stakeholder Interviews: Semi-structured interviews were conducted with enforcement officers, regulatory officials, industry representatives, and metrology experts. The interviews aimed to capture practical challenges in enforcing metrology laws, detecting software manipulations, and ensuring compliance among traders. Data from these interviews were thematically analyzed to identify common issues and potential solutions.

By integrating these research methods, this study provides a holistic understanding of the legal and technical challenges associated with vehicle scale manipulation. The findings contribute to recommendations for strengthening legal metrology enforcement, updating regulatory frameworks, and enhancing inspection procedures to ensure fair trade practices.

THE ROLE OF LEGAL METROLOGY

Metrology is the science of measurement, while legal metrology provides rules to regulate measurements and measuring instruments, as well as providing protection for public safety, health, the environment, and the interests of commerce. Every consumer, trader, and business industry always makes decisions every day based on the results of measurements (Ardianto & Oktriana, 2021). The main objective of legal metrology is to protect traders and consumers from fraudulent activities in measurements through official affairs and commercial transactions, as well as in the fields of public safety, health, and the environment. Since there are differences in the interests of the parties concerned through measurement in the field, the characteristics of the weighing tools used cannot be fully controlled to the satisfaction of all market forces.

Therefore, legislation sets requirements not only for weighing instruments but also for measurement methods and verification tests. To achieve the legal metrology objectives, preventive and surveillance measures are required. These preventive measures must be taken before the weighing device is placed on the market or used, including the approval and verification of the pattern. Through market surveillance measures such as the inspection of weighing instruments at the premises of suppliers, owners, or users. Therefore, misuse of weighing equipment will be detected, and it can be convicted and punished. Legal metrology can also help the economy by controlling fraud or manipulation practices and taking legal action against traders to avoid disputes and transaction costs. Measurements made outside the framework of legal metrology will usually cause high costs and challenges for industry and consumers. Thus, effective governance remains the essential element in fostering progress and development (Nadirah et al, 2024).

The role of legal metrology can also support trade by mitigating any unfair trade practices by ensuring trade weighing instruments are fit for their intended purpose and meet international standards. For example, fuel dispensers or pumps at gas stations are of an approved and certified type to ensure that they show the correct amount of fuel to the user. All pricing at petrol stations is subject to the Weights and Measures Act 1972, under Section 14(1), subject to Subsection (5), which states that every weight and measure used for commercial purposes must be certified (validated) every 12 months before sales and purchase transactions take place. Consequently, offenders can be prosecuted and fined, and these weights and measures can be seized or confiscated. Hence, legal metrology is important in ensuring the fairness and accuracy of business transactions. By enforcing norms and standards of weighing devices, it helps prevent trade manipulation and fraud, thereby creating trust and confidence among traders and consumers.

Furthermore, legal metrology supports a level playing field by ensuring that all parties involved follow the same laws and regulations, preventing unfair advantages for certain market participants.

In the United States, weights and measures are commonly used interchangeably with legal metrology to refer to systems that underpin commercial measurement systems. Legal metrology also encompasses measures for medicine, environmental pollution monitoring, acoustics, ionizing radiation, and alcohol measurement on a global scale (National Institute of Standards and Technology, 2015). Responsibility for oversight is shared by the federal, state, and local governments. The majority of weights and measurement enforcement tasks fall under the purview of state and local governments; however, some federal agencies have been granted particular weights and measurement authority in certain sectors. These federal agencies include the National Institute of Standards and Technology (NIST) and the Food and Drug Administration (FDA). They play a crucial role in ensuring the accuracy and fairness of measurements in industries such as pharmaceuticals, food production, and consumer goods. On top of that, international organizations like the International Organization of Legal Metrology (OIML) work towards harmonizing measurement standards across different countries to facilitate global trade.

OIML is a major player in the development of worldwide standards for use in legal metrology legislation. Measurement and measuring instrument legislation is required in all cases: i) when it is necessary to safeguard both buyers and sellers in commercial transactions; or ii) when the measure is used to apply limits. The mission of OIML is to enable the economy to provide an effective legal metrology infrastructure that is mutually compatible and internationally recognized in all areas where governments are responsible, such as facilitating trade, creating mutual confidence, and harmonizing the level of consumer protection globally.

OIML is an intergovernmental treaty organization that does the following (APLMF, 2017): i) create model regulations, standards, and related documents that can be used by industrial and legal metrology authorities; ii) offer a mutual recognition system that lowers trade barriers and costs in the global market; iii) represent the interests of the legal metrology community in international organizations and forums related to metrology, standardization, testing, certification, and accreditation; iv) promote and facilitate the exchange of knowledge and expertise within the legal metrology community worldwide; v) work with other metrology bodies to increase awareness of the benefits that a strong legal metrology infrastructure can provide to the modern economy.

Legal metrology is crucial for ensuring accurate measurements in various sectors,such as trade, health, and the environment (Jessica et al, 2020). It helps to establish trust and confidence among consumers and businesses by guaranteeing the reliability of measurements used in commercial transactions. Moreover, legal metrology plays a vital role in promoting international trade by facilitating harmonization and mutual recognition of measurement standards across different countries. Almost all countries provide protection with legal metrology support and basic regulations. In addition, legal metrology will ensure fair tax payments for governments and businesses. This is because the government collects revenue through excise and measurement-based taxes, including excise duties on products manufactured, sold, imported, and exported. Sales by size in bulk can also be an important component of second-country exports and income, especially for items such as palm oil, wood, rice, coffee, coal, gold, gems, and natural gas that use the measurement system (Hockert et al, 2015).

STAKEHOLDERS IN WEIGHING INSTRUMENTS

In legal metrology, the powers and responsibilities of the weights and measures regulator must be clearly stated; this is a fundamental foundation for regulatory and enforcement action. The weights and measures statute serves as the foundation for the weights and measures supervisory organization. For example, no long-lasting structure can be built without a solid and sufficient foundation. In the same way, all protective measures cannot be fully implemented without adequate legislation because it is not possible to build a comprehensive supervisory system for each weighing and measuring instrument and to withstand unexpected changes in technical currents. Without clear regulations, there would be no framework for the weights and measures supervisory organization to carry out its duties effectively. The statute provides the necessary guidelines and authority for the organization to enforce compliance and take appropriate action against violators.

A regulatory agency in charge of ensuring accuracy and conformity with industry standards could be a stakeholder in weighing instruments. Inspections, audits, and certifications may be performed to ensure that weighing equipment is properly calibrated and fulfill the relevant standards (Vâlcu, 2017). Furthermore, weighing instrument makers and suppliers are key players since they play a major role in designing, manufacturing, and distributing these instruments to the market. Their knowledge and coordination with regulatory organizations can help ensure the quality and dependability of weighing equipment used in a variety of industries. In addition, end-users of weighing instruments also have a stake in their accuracy and conformity with industry standards. These end-users rely on accurate measurements for various purposes, such as manufacturing, research, and quality control. Therefore, they have a vested interest in ensuring that the weighing equipment they use is reliable and meets the necessary standards. Collaborative efforts between stakeholders can help establish a robust system for maintaining the accuracy and reliability of weighing instruments throughout their lifecycle.

As a result, it is critical that this fundamental rule be thoroughly developed along broad lines to fit the needs of business today, so that it may be executed with greater care and precision. Administrative provisions adopted in conformity with the Weights and Measures Act of 1972 must also be added to it. The authorities can also uncover infractions of regulations that will enable inspection and prosecution. Legal metrology authorities have concentrated on increasing the performance of their services by offering periodic weighing instrument testing and inspection. This is significant because it can contribute to and assist legal metrology authorities in establishing metrology standards infrastructure in order to meet the parameters outlined in the National Measurement System Act of 2007 (Act 675).

In general, a number of authorities in Malaysia are empowered to apply legal metrology in order to coordinate the removal of administrative and technical trade barriers in the field of legal metrology and to promote free and open trade throughout the Asia-Pacific region (Azman, 2016). Part IV of the National Measurement System Act 2007 specified the establishment of the National Measurement Council (NMC). The main function of the NMC is to act as an advisor in all matters related to national policy objectives for measurement system activities. The NMC is responsible for submitting proposals to increase international confidence in measurement activities in Malaysia, supporting Malaysia's international obligations regarding measurement, facilitating government policy in national and international trade, serving the public interest in health, safety, and the environment, enabling scientific research and development to be carried out, and facilitating Malaysia's economic development (MITI, 2020).

The Malaysian Institute of Standards and Industrial Research (SIRIM) manages the National Metrology Institute of Malaysia (NMIM), which acts as the National Measurement Standards Laboratory (NMSL), NMIM provides measurement traceability and pattern approval services based on the International Unit System (SI) and is responsible for ensuring national metrology infrastructure meets and complies with global measurement standards. According to Weights and Measures Act 1972, NMIM is in charge of approving new instrument patterns for trade purposes as well as assisting in the enforcement of measuring instruments used in commerce, including the design of measuring instruments. In order to provide accurate measurement results within the allotted time, NMI must first approve a pattern by looking over the instrument's design to make sure it is appropriate for use in trade or other legal contexts.

The Ministry of Domestic Trade and Cost of Living (KPDN), one of the government agencies concerned, is also responsible for enforcing and putting into effect legislation pertaining to the weight and measurement of trade metrics. In order to assure conformity with the set standards, KPDN appointed Metrology Corporation Malaysia (MCM) to execute periodic inspection, verification, and re-verification of all weighing and measuring instruments for commercial usage in Malaysia. The Malaysian government has granted MCM a fifteen-year concession to do lawful metrology activity in this nation. All measuring instruments that pass the necessary verification tests and are deemed suitable for use in the commercial sector are awarded a certificate of certification by MCM. This certificate serves as proof that the weighing and measuring instruments meet the required standards and can be trusted for accurate measurements. It is mandatory for businesses to possess this certification in order to ensure fair trade practices and protect consumer rights.

Under Section 26A(1)(b) of Weights and Measures Act 1972, KPDN formed and appointed De Metrology Sdn Bhd (DMSB) in April 2020 to provide testing and verification services for weighing and measuring instruments that also serve the same purpose in trade. This move was made to ensure accuracy and fairness in commercial transactions involving weighing and measuring instruments. DMSB's expertise and accreditation in metrology make them a reliable authority for upholding standards for trade practices. For inspection services pertaining to the verification of weighing instruments, including indicators that are still in excellent condition, and within the verification period, there are 34 De Metrology branches located throughout Malaysia. These branches are equipped with trained personnel and innovative equipment to conduct thorough inspections and verifications. Besides, DMSB also offers calibration services for weighing instruments to ensure their accuracy and reliability in trade transactions.

In accordance with the National Measurement System Act 2007 and the Weights and Measures Act 1972, DMSB will defend the rights of users. These acts provide a legal framework for the regulation and enforcement of measurement standards in Malaysia. They ensure that consumers are protected from inaccurate measurements and that businesses can have confidence in the reliability of their weighing instruments. By upholding these acts, De Metrology branches play a crucial role in maintaining fair trade practices and promoting trust in the Malaysian marketplace. The weights and measures have been used throughout history to ensure fairness and accuracy in commercial transactions. These standardized systems allow for consistency and transparency in the exchange of goods and services. From ancient civilizations to modern societies, trade weights and measures have played a crucial role in facilitating commerce and promoting trust between buyers and sellers (Haizum et al, 2023).

All trade weights and measures should be suitable, meet government norms and requirements, and safeguard consumers in commercial transactions in accordance with the

objectives of legal metrology. With the sophisticated technology of today, it is possible to manipulate different things, including weights and measures. The Weights and Measures Act 1972 equips the government with the power to license weights and measures, as well as weighing and measuring equipment, and to enforce form order compliance.

Section 14 (1), subject to subsection (5), provides that any weighing and measuring instrument used for trading purposes must be checked and have an expiration date of 12 months. Penalties or legal repercussions may follow noncompliance with these regulations. These regulations are in place to ensure fairness and accuracy in commercial transactions. By regularly checking and certifying weighing and measuring instruments, the government can prevent fraudulent practices and protect consumers from being cheated. It is crucial for businesses to comply with these regulations in order to maintain trust and integrity in their operations.

Section 14 (1) provides that every weighing and measuring device for use in trade must be verified and marked with a stamp by the Inspector with a confirmation stamp and a confirmation certificate.

The failure to utilize the international unit system (SI)(Birch, 2003), being inaccurate or unbalanced, and being altered or manipulated are a few of the flaws that were discovered. These flaws can have significant consequences, such as hindering effective communication and compromising the reliability of scientific data. On top of that, failure to adhere to the international unit system can lead to confusion and inconsistencies in research findings, making it difficult for scientists to compare and replicate experiments accurately.

The use of an unverified weighing device might result in the buyer receiving items that are not in line with the price paid, causing loss and victimization to the consumer. According to Weights and Measures Act 1972, every legal unit of measure, weight, and measure for commercial use must comply with the provisions of Section 12, and anyone who violates the provisions of this section can be convicted. This legislation ensures that consumers are protected from fraudulent practices and that businesses maintain fair trade practices. It also serves as a deterrent for individuals who may attempt to manipulate weighing devices for personal gain, promoting a more transparent and trustworthy marketplace.

Section 12 (3) provides that any person who contravenes any of the above provisions of this section commits an offense and may, on conviction, be fined not exceeding four thousand ringgit or imprisoned for a term not exceeding three years or both. Any weights or measures or weighing or measuring instruments used or in the possession of any person for use in contravention of any of the provisions shall be forfeited.

The purpose of this provision is to deter individuals from engaging in activities that violate the section's provisions. By imposing both fines and imprisonment, the law aims to ensure that offenders face significant consequences for their actions. As well, the forfeiture of weights, measures, or instruments used in contravention serves as an additional deterrent and reinforces the seriousness of the offense (Ahsan et al, 2019). Weights and measures components contribute to the accuracy and validity of commercial transactions based on weight, measure, or count, as well as ensuring that product quality fulfills specified quality standards. Without proper weights and measures, there is a risk of unfair trade practices, as inaccurate measurements can lead to financial losses for consumers and businesses alike. Besides, the use of standardized weights and measures promotes transparency and trust in the marketplace, as it allows for consistent and reliable comparisons between products.

A clear weighing tool ensures market equity, which implies that consumers obtain the appropriate quantity and quality of items and services for which they pay, and businesses receive

fair compensation for the products and services they supply (Crown & Olson, 2017). Additionally, standardized weights and measures help to prevent disputes and conflicts between buyers and sellers, as both parties can rely on a common system of measurement. This reduces the likelihood of misunderstandings or disagreements regarding the quantity or quality of goods exchanged. Moreover, market equity fosters a level playing field for businesses, encouraging fair competition and innovation in the marketplace (Rubiah, Hanif & Sayuti, 2024). Businesses are thus safeguarded from unfair competition by being able to verify that they operate in accordance with standards comparable weights and measurements.

In the early 1900s, the inspection of weights and measures was also focused on the testing of measuring instruments, because such a large percentage of trade took place in measuring instruments (Fedrizzi & Ventre, 2013). For example, the sale of gasoline and diesel fuel for cars and trucks, where gasoline and diesel fuel are measured when the fuel enters the vehicle's tank (Esche, Nischwitz & Toro, 2022). The user has no way of verifying the transactions accuracy and must rely on the fuel dispense's accuracy. As a result, weights and measures officers must inspect and test fuel dispensers on a regular basis. Similarly, farmers sell grain and produce on a vehicle scale, and in most circumstances, measurement on a vehicle scale is the only equipment that is appropriate to use. Farmers typically find it time-consuming and impracticable due to the difficulty in obtaining accurate measurements. As a result, most weighing and measuring tools are used in the vehicle weighing test from multiple sources. This is because reckless traders can utilize the device to change it in order to profit.

Validation of trade scales and measuring tools can help prevent accidents, particularly in the construction industry, as well as fraud in trade-to-consumer transactions. In construction, for example, the failure of contractors or developers to obtain accredited weighing equipment placed in concrete batching facilities used to generate concrete grades in construction work can have an impact on the structure's stability (Wirandi & Lauber, 2006). Failure by merchants, operators, and building developers to certify such equipment for commercial use is a serious crime under the Weights and Measures Act of 1972. People typically only see market transactions, such as weighing meat at a grocery store, weighing fruit at a checkout desk, and pumping gasoline at a gas station. Weights and measures, on the other hand, must be kept free of fraud and misbehavior because they have been an important part of transactions since the beginning of estimating the quantity of products. Although the number of parties who take advantage of possibilities for unfair or dishonest profit is minimal, the ramifications of this fraudulent behavior pose a severe challenge in trade.

LAW ENFORCEMENT

The enforcement of legal metrology regulations faces substantial challenges due to the increasing use of highly adaptable computers in weighing instruments (Azwan et al, 2018). These devices enable users to manipulate or modify the software installed on them, creating opportunities for unlawful adjustments that can result in substantial financial gains for unscrupulous dealers. By using weighing equipment that has been illegally customized to meet their needs, merchants can manipulate the results of commercial transactions. Although computer-enabled weighing instruments are designed to streamline operations and align with technological progress, their use has introduced new compliance issues for legal metrology authorities. These devices can interface directly with specialized software to extract the weight data of each item or load being weighed,

making them vulnerable to unauthorized modifications of the underlying program code and data, which poses a serious threat to the integrity of the measurement system (Grottker & Schwartz, 2002).

Authorities have implemented security systems to protect software-enabled weighing devices; however, existing safeguards have proven insufficient. A major gap exists in the regulatory approach for inspecting and verifying software used in commercial weighing, particularly in vehicle scales (Azwan et al, 2018). Current enforcement strategies focus primarily on the physical and mechanical components of the devices, often overlooking the software's compliance and integrity. Field inspections rarely involve officers with the necessary information technology expertise, leading to a significant limitation in the assessment process. Typically, a single enforcement officer is responsible for evaluating all aspects of the weighing device—mechanical, physical, and software—without having access to detailed reference materials or an understanding of the original software specifications. As a result, enforcement officers rely solely on printed certificates, leaving them ill-equipped to identify software modifications.

The absence of a systematic method to validate the authenticity and compliance of software on weighing devices has created a regulatory blind spot. This shortfall highlights the need for advanced software protection technologies and improved inspection protocols tailored to the unique challenges posed by software-driven weighing instruments. Implementing such measures would allow enforcement authorities to initiate more robust inspection procedures, ensuring that all computer-enabled weighing devices adhere to the established legal metrology standards and that any tampering or unauthorized modifications can be detected and rectified effectively.

DEVELOPMENT PROCESS OF WEIGHING INSTRUMENTS IN MALAYSIA

The license application process for weighing instruments requires registration with the authority in the verification of weighing instruments issued by manufacturers and suppliers. Validation is a weighing and measuring device that is tested and affixed with a safety sticker before it is legal to use. All weights and measures used for trading purposes need to be verified. For weighing instruments that have been certified for a period of 12 months, service and recalibration services are required to repair the weighing instrument after the expiry of the period.

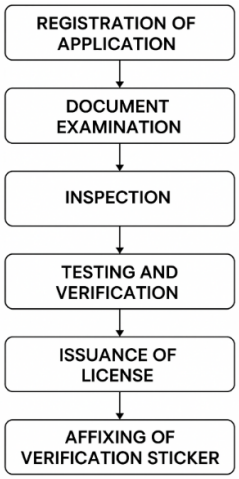

FIGURE 1. License Application Process for Weighing Instruments

Therefore, traders should re-check the weighing tools used so that they are legal to use according to the rules set by the authorities, to avoid violations of the law. Figure 1 shows the flow chart of the application process for verification of weighing instruments for trade purposes. The authorities have set detailed approval conditions to enable traders to conduct transparent business whether making, selling or repairing weighing and measuring devices. This situation gives a clear impression that the authorities are very thorough and strict in the process of issuing verification stickers to traders.

Prior to verification, weighing instruments with computerized hardware should be checked on site to ensure that they function adequately for their intended application. Initial operations are; i) identification of the weighing instrument (type, model, serial number); ii) pre-loading for several times the weighing device to near maximum capacity; iii) adjust the error approaching the maximum by using internal or sufficient external weights, to allow the reaction to change environmental factors such as temperature and, implicitly, air density (Valcu, 2006).

PROCESS COMPLIANCE

Compliance checks must be conducted in accordance with the standards established by the enforcement agencies in Malaysia within the legal metrology framework when a trade tool is issued. The process is separated into two parts: the design approval process (pattern) and field inspection (verification) before reaching the market level. During the initial inspection phase, every design of weighing and measuring instruments intended for trade must undergo a design test approval process. All reports will be documented based on the documents, functions, and codes that are required for inclusion in the design approval register of weighing and measuring equipment (Azwan, 2021). Next, the weighing equipment must undergo verification by the KPDN contractor. Only equipment that meets the necessary specifications will be confirmed and deemed fit for commercial use. The KPDN will conduct regular monitoring after the weighing and measuring equipment is introduced to the market to prevent any violations of the required regulations.

All conformity evaluation methods of these weights and measures, the NMIM employ the document OIML Recommendation R76. NMIM has two approval modes for pattern approval. i. Complete approval. This approval is granted to software that fulfils the comprehensive requirements of R76. This approval is valid for 10 years from the approval date and is conditional. This approval is granted to software that is not yet completely compliant with R76 standards but is undergoing enhancements. Approved software can be used normally, but updating it is prohibited. This approval is valid for a maximum of three years. During this time, the software maker must enhance the software to fulfil all conditions.

As per the Weights and Measures Act 1972, the KPDN is required to conduct inspections and reconfirmations every 12 months. Malaysia relies on international documentation for verifying and inspecting the software used in weighing instruments. The confirmation of the reference is determined according to document R76 clause 5.5.2.2 (c) (OIML, 2019).

Legally relevant software shall be identified as such and shall be secured. Its identification shall be easily provided by the device for metrological controls or inspections. This is followed by a calculation of a checksum over the machine code of the legally relevant software at runtime and indication on manual command. This checksum represents the legally relevant software and can be compared to the checksum defined at type approval.

During the verification or inspection process, it is only based on the identification of the relevant legal software, which is by using the checksum as an identification method produced by the software itself. This means that the examiner has no other method but to rely only on the identification shown by the software. There is no specific provision under the Weights and Measures Act 1972 provided for software for weighing and measuring instruments issued for the guidance of the enforcement authorities. Document inspection is the main basis for the assessment of design approval (conformity assessment) for the process of proving that measurement equipment has met the legal requirements on a basis (Velychko et al, 2019). In order to meet the guidelines set by OIML, Malaysia also needs to add provisions for the compliance of the software used in weighing instruments, so as not to be arbitrarily manipulated by irresponsible parties.

STAKEHOLDER CHALLENGES

There are many challenges and obstacles that have been faced by stakeholders in ensuring that all weighing and measuring instruments today are not tampered with and can be used correctly (Ahsan et al, 2019). The progress achieved in Malaysia has created various efforts to control the modification of computer-based weighing instruments to meet the prescribed compliance (APLMF, 2017). As a result of the development of technology, it also causes various positive and negative effects on traders, but if properly regulated, it will help more in ensuring that all weighing tools are used correctly according to the regulations under the Weights and Measures Act 1972 (Birch, 2003).

The assurance to all stakeholders who handle the administration of weighing instruments—from production to marketing, usage, and regulation—depends on the effective implementation of inspections by enforcement officers. These inspections ensure that weighing instruments are easy, safe, and transparent to use while guaranteeing user safety and ethical transactions (Ahsan et al, 2019). However, stakeholders face several challenges, including a lack of capital, insufficient spare parts, inadequate skills and knowledge, and competitive disadvantages for those who do not use computer-based weighing equipment (Wanjiru, 2012). Additionally, there is an over-reliance on manufacturers for approval and maintenance, which can hinder independent verification and compliance efforts (Kalejaiye, 2023).

CHALLENGES TO MANUFACTURERS AND SUPPLIERS

Manufacturers or suppliers of weighing and measuring equipment need to be aware of the regulations issued by the authorities to meet the guidelines that have been set. Each weighing device made by the manufacturer for commercial use must meet the specifications in compliance with regulation 17 under the Weights and Measures Regulation 1981 and the Weights and Measures Act 1972. Section 11(1) for the purpose of commercial use is subject to subsection (2) not applicable if the determination or statement regarding the quantity of goods required to be delivered to a place outside Malaysia and the transaction is not a retail sale.

Whereas for Section 11(3), any weighing and measuring device held in Malaysia for public use whether by charging a fee or otherwise shall be considered for the purposes of this section as a weighing or measuring device for commercial use, whether or not the device be treated as such but for this subsection. All necessary licenses such as license to make, repair and sell, license to

repair and sell and license to sell weighing instruments must be submitted for approval by the KPDN and have a period not exceeding 5 years of issue.

Therefore, the producers and buyers of these weighing tools need to look at the uniformity of the stored tools so that no modifications occur before they are released or marketed. It becomes more challenging when the weighing instrument has a computerized software system, which makes it difficult for manufacturers and suppliers to ensure the validity of the instrument. Producers now not only consist of individuals or small groups, but are also represented by multinational companies, international business combinations and overseas product suppliers. Dealers also admit that software-based computer-based scales require fewer repairs than mechanical ones. Those with weighing machines confirmed increased income, while those with mechanical weighing machines admitted losing more customers and profits (Wanjiru, 2012).

According to section 17 of the Weights and Measures Act 1972, it is an offense for a trader to possess false weights and measures for the purpose of fraud. Section 17 provides that any person who is in possession of any weight or scale or weighing or measuring instrument which he knows to be fake and intends to use the instrument fraudulently or has used such weight or scale or weighing or measuring instrument fraudulently commits an offense and may, upon conviction, a fine not exceeding five thousand ringgit or imprisonment for a period not exceeding four years or both. Any weights or measures or weighing or measuring instruments used or in the possession of a person for use in violation of this section may be forfeited. Section 16 of the act stipulates that it is an offense for a seller to use or possess weights and measures that do not have international system units (SI) for trading purposes. Although there is an act that controls the activity, the activities of illegal traders in this activity still cannot be stopped. The key to all these problems starts from the unethical activities of traders who obtain weighing equipment from manufacturers and suppliers, arbitrarily modifying the equipment to make a profit for users.

CHALLENGES TO THE AUTHORITY

In line with current technological development, it is a challenge for metrology authorities to implement various efforts to ensure that there is no abuse and manipulation of weights and measures in every transaction. Weighing instruments intended in the field of legal metrology, for commercial use.

Weighing equipment must be of an approved type before use and must be certified or verified by the authority of the verification officer appointed by KPDN at MCM and DMSB, as stipulated by the Weights and Measures Regulations,1981. For example a weighing device (weighbridge) that needs to be installed on a large scale before the inspection can be carried out on site. While for other small-scale weighing tools, it is required to be checked at the manufacturers or suppliers premises before being sent to the customer.

In the face of the challenge of modification and manipulation related to weighing instruments, the authorities have increased the number of personnel who have been trained to speed up the process and work productivity. Under the privatization of legal metrology verification offices such as MCM, the government will not face any budget constraints, as the MCM obtains greater investment in truck cranes and the implementation of a strategic marketing plan. Based on operations, experience and expertise, MCM has prepared recommendations in the amendment of the Weights and Measures Act, Pattern Arrangement and its Rules and Regulations (APLMF, 2017).

Enforcement seminars, workshops and weighing instrument courses have been created by NMIM in an effort to strengthen knowledge about measuring instruments. The competency and consultation course was implemented by the NMIM, in order to meet the requirements for the appointment of DMSB as a company licensed by the KPDN. This aims to carry out the work of verifying weighing and measuring tools for commercial use. The scope of the competency course is like a consultation covering fluid, time, hard line and mass weighing which is carried out over a period of two years. In addition, it also includes online theoretical courses and assessments, pre-recorded video practical courses and physical assessments at DMSB branches by region or third-party facilities as well as consulting and audits.

CHALLENGES TO ENFORCEMENT (KPDN, MALAYSIAN PALM OIL BOARD (MPOB))

The importance of protection from the authorities, which is KPDN always actively monitoring and regulating all trade activities presents a challenge from the point of view of enforcement. KPDN also strives to improve the quality of work in ensuring that there is no abuse related to weighing and measuring tools in transactions. Traders are advised not to buy weighing and measuring equipment through online sales because they are worried that the equipment will not be verified by the authorities. This is due to many traders who use or buy weighing equipment online due to the cheap price, but it is not verified and it becomes a legal offence.

The enforcement authorities are actively carrying out inspections related to weighing equipment at every premises where information about modifications has been obtained. Most of the cases involving scales that do not have verification stickers, have expired for more than 12 months and scales that do not meet the specifications of the international unit system are easy to detect by the enforcement authorities. Their challenge in dealing with weighing instruments that have computer software is quite difficult, because the software inspection is carried out depending solely on the observation of the printed approval certificate only. It requires an officer skilled in the field of information technology to make an inspection to ensure that there is no invalid software in the context of legal metrology (Tan et al, 2021).

MPOB is responsible for research and development to improve the efficiency and long-term viability of the oil palm industry (Choy, 2014). It also provides technical support and training to the individuals and organizations involved. MPOB advocates for sustainable practices and environmental protection and conducts regulatory activities, inspections, suspensions, cancellations, and non-renewal of licenses to ensure orderly transactions in the industry. MPOB enforces fair trade practices in the palm oil sector by implementing the Weight and Measure Act of 1972 and collaborates with government agencies and industry stakeholders for growth. MPOB faces challenges in addressing unethical practices in the oil palm industry, such as inaccurate weighing of palm fruit and a lack of weight indicators at corporate locations. The enforcement program aims to prevent manipulation activities that could impact transactions and the overall well-being of the country's oil palm business.

Figure 2 shows the scope of duties and responsibilities of the enforcement authorities to regulate weights and measures under the Weights and Measures Act 1972.

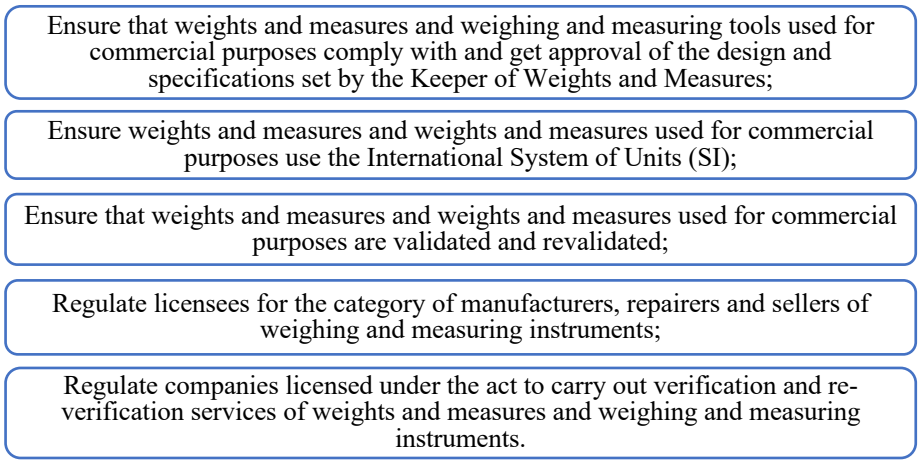

FIGURE 2. Enforcement of Weights and Measures

The software actually needs to get a design approval certificate from NMIM and the software that has been approved is not affected and its integrity is not in doubt. Validation of software with developed requirements remains essentially a challenging task, due to the absence of directly definable procedures (Richter, 2006). These challenges include a lack of training for officials on the application and testing of their equipment; too much reliance on technicians when doing verification work (Kalejaiye, 2023). With rapid changes in technology yet unable to match the speed of production of weighing instruments, it is clear that there is a lack of scale standards in the device on weighing instruments.

CONCLUSION

To ensure Malaysia's economic development keeps pace with rapid technological advancements, it is essential to strengthen regulatory frameworks and law enforcement efforts to facilitate smooth and transparent trade transactions. This goal requires the active participation of every stakeholder, including regulators, commercial entities, and consumers, to address manipulation issues that undermine fair trade practices. Government authorities such as the Ministry of Domestic Trade and Consumer Affairs (KPDN), the National Metrology Institute of Malaysia (NMIM), and the Malaysian Palm Oil Board (MPOB) have long been at the forefront, collaborating with industry players to conduct comprehensive enforcement and inspection programs. These initiatives, which focus particularly on the integrity of weighing devices, have garnered strong support from the public, who actively report unethical practices by unscrupulous dealers. Such collaborative efforts are vital to safeguarding consumer rights and fostering a fair business environment.

Despite these commendable efforts, certain traders continue to exploit loopholes, making both recurring and novel errors to manipulate weighing systems for their gain. The increasing complexity of these cases can be largely attributed to technological manipulations, particularly the tampering of computerized systems in weighing and measuring instruments. Research has shown that these traders employ sophisticated tactics to alter software programs and circumvent legal controls, thereby compromising the accuracy of measurements and undermining legal standards.

Addressing these challenges requires a more focused and decisive response from regulatory bodies. The use of advanced software verification has now become a critical component of the inspection process within legal metrology to ensure that weighing devices remain compliant and unaltered. Additionally, the Weights and Measures Act 1972, which serves as the legal backbone of metrology enforcement, needs to be updated to address the specific vulnerabilities associated with computer-based weighing instruments. By modernizing the regulatory framework, the authorities will be better equipped to pursue violations, minimize manipulation risks, and reinforce the integrity of Malaysia's trade system. This approach will not only enhance the effectiveness of enforcement but also bolster public confidence in the country's commitment to upholding legal metrology standards.

Ultimately, tackling manipulation in computer-based weighing instruments demands a multifaceted strategy involving regulatory updates, enhanced enforcement protocols, and collaborative partnerships between public and private stakeholders. By implementing these measures, Malaysia can ensure that its trade sector remains resilient, transparent, and aligned with global best practices, thereby supporting sustainable economic growth in an increasingly digital world.

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AUTHORS' CONTRIBUTION

All authors contributed to this study. Author 1 led the data collection, analysis, and writing. Author 2 conducted the literature review, data validation, and editing. Author 3 and Author 4 provided supervision and critical review.

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