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Market Consultation Weigh in Motion

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Author	Kenzo Oijevaar

Contents

Management Summary

This final report forms a representation of the insights that are obtained during the market consultation and thereby marks an important moment in the exploration of possible next steps regarding WIM. The consultation results in a rich and nuanced picture of the possibilities and limitations of WIM systems, as well as of the complexity associated with their application, particularly within an enforcement context.

At the same time, this nuanced picture does not arise from a lack of available solutions. On the contrary, systems and integral solutions are available that can be applied at product level for measurement, registration, and in some cases also data processing. The identified complexity therefore primarily relates to the application of these solutions within a broader, coherent chain and not to the availability of the technology itself. This chain complexity does not so much lie within the solutions themselves, but mainly in the external coherence between systems and their interfaces with other domains, such as legal assurance, process design, data integration, and organizational embedding.

What stands out is that the challenge surrounding WIM cannot be reduced to a technical implementation, but is characterised as a broader system issue in which technology, data, organization, and policy are closely intertwined. The discussions with market parties provide insight not only into the state of the technology, but especially into the preconditions required to arrive at a robust and practically applicable solution.

It is further evident that the technical building blocks are in many cases already available and that market parties are able to deliver these in coherence. The extent to which this coherence is offered as an integrated and product-based system differs between solutions and varies from configurable platforms to more development-oriented approaches, in which the required further development depends on the chosen solution.

The challenge therefore does not lie in the development of new technology, but in the selection, combination, and application of existing solutions within a context in which organizational, legal, and policy aspects are also taken into account.

The added value of WIM systems is to a significant extent related to the scale and continuity of measurements. Whereas measurements in other applications, such as manual inspections or temporary measurement campaigns, often take place incidentally and at specific locations, WIM systems make it possible to structurally and network-wide collect data on passing traffic. This forms an essential basis for obtaining consistent insight into traffic behaviour, vehicle loads, and possible deviations from applicable standards.

In addition, it appears that certain system types, such as bridge-based solutions, are relatively quick to deploy and can be applied flexibly. Because these systems make use of existing infrastructure and do not require intervention in the road surface, they can be installed more easily and, if necessary, relocated. This makes it possible to gain experience in a targeted manner, to explore locations, and to roll out systems in phases, for example for obtaining insight into the loading of infrastructure at specific locations.

Furthermore, choices in system architecture, such as the degree of local versus central data processing, have a direct influence on robustness, data flows, and manageability. These choices largely determine how dependent the system is on

infrastructure and external connections and thereby play an important role in the eventual design of the solution.

In the discussions, this is regarded as an important precondition for scaling applications, such as pre-selection and broader forms of application. Not so much the individual measurement, but rather the combination of frequency, distribution, and repeatability makes it possible to recognise patterns, detect deviations, and act in a more targeted manner. The application thereby shifts from incidental observations to structural and repeatable insight.

It also appears that the applicability of WIM systems, including for enforcement purposes, does not depend exclusively on maximum technical accuracy, but on the extent to which reliability in their application can be ensured. By applying margins and selecting situations with a clear exceedance, consistent and legally defensable applications can be realised even in the presence of variation in measurement accuracy. At the same time, the collected data also remains valuable without direct use for enforcement, for example for monitoring, policy analysis, and insight into traffic loads.

Although the application of WIM systems is associated with a certain degree of complexity, the consultation shows that this can be organised in a manageable way through a phased and step-by-step approach. The possibility to apply systems in phases and to make use of existing solutions forms an important starting point in this regard.

The picture that emerges from the consultation is therefore not that of a completed solution that can be directly applied, but that of a development direction in which choices have to be made and in which room must be provided for further elaboration and validation. This further elaboration relates only to a limited extent to the technology itself, and to a greater extent to the organisation of the chain surrounding the application, including legal assurance, process design, data processing, and organizational embedding. At the same time, the insights obtained provide sufficient guidance to direct next steps and to make targeted choices that align with the reality of the current market and technology.

With the publication of this report, the aim is to be transparent about the way in which the input from the market is processed and what its significance is for possible next steps. In doing so, not only is a reflection made on the insights obtained, but also a forward look is provided on how these insights can guide the choices to be made.

This report is published on TenderNed. By participating in the consultation, market parties grant permission to RWS to use the information provided in anonymised form for the preparation of this report and any subsequent steps. The information is processed in aggregated form, without including traceable data, names of parties, or financial information.

With this report, the consultation phase is concluded and a basis is established for further decision-making and possible next steps, building on the solutions available in the market and focusing on a coherent and manageable application.

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1 Introduction

As part of the exploration of possible next steps for Weigh in Motion (WIM), Rijkswaterstaat conducts a market consultation. With this consultation, the aim is to obtain insight into the available solutions, the level of maturity of the technology, and the conditions that are decisive for the successful application of WIM in the Netherlands, including within an enforcement context.

In the discussions with market parties, a diverse and nuanced picture emerges. On the one hand, it appears that various solutions are available that, whether in whole or in part, can be regarded as mature and applicable. Both road-based WIM systems and bridge-based solutions are applied in practice for monitoring and weighing, and some parties offer integrated systems in which measurement, data processing, and presentation are combined. These solutions can to a certain extent be considered product-based available and are capable of being implemented without extensive development processes for specific applications, such as data collection and pre-selection. At the same time, it becomes clear that the level of maturity differs between solutions, varying from configurable, product-based systems to more development-oriented approaches.

At the same time, the consultation makes clear that this product-based availability does not automatically mean that a complete and directly deployable enforcement solution is available. The application of WIM within an enforcement chain brings additional requirements, including in the areas of data quality, verification, legal assurance, and integration with existing systems and processes. These aspects are to a large extent dependent on the specific context in which the system is applied and require further elaboration, alignment, and in some cases further development. In this regard, choices in system architecture, such as the way of data processing and integration, also play an important role in the eventual configuration of the solution.

This creates a two-layered picture of the challenge. On the one hand, solutions are available that can be used as building blocks and that form a solid basis for measurement and data collection. On the other hand, the application of these solutions within a robust and legally sound enforcement chain requires a broader elaboration in which technical, organizational, and policy aspects come together. It is precisely this second layer in which the complexity of the challenge becomes visible and in which choices must be made that are decisive for the ultimate functioning of the system.

The consultation thereby shows that WIM cannot be approached unambiguously as a standalone technical product, but takes different forms depending on the application.

For applications focused on monitoring and data collection, WIM systems can in many cases be applied relatively independently, with the emphasis on measuring and analysing traffic data.

For application within an enforcement context, however, this picture changes fundamentally. In that situation, a system solution emerges in which measurement, data processing, and application must be designed in coherence. The success of the solution is then not only determined by the quality of the individual components, but especially by the way in which these components function together within the broader chain, including legal, organizational, and process-related aspects.

This report aims to present and interpret the insights from the market consultation in coherence. In doing so, an explicit distinction is made between the extent to which solutions are available as products and the extent to which further elaboration is required for application within the enforcement chain. Through this nuance, the aim is to provide a realistic and balanced picture of the state of the market and the challenge faced by RWS.

The content of this report is based on both written responses and in-depth discussions with market parties. The information obtained is analysed, clustered, and processed in anonymised form, without including traceable data, names of parties, or financial information.

With this report, the consultation phase is concluded and a basis is provided for further decision-making and possible next steps, whereby the insights gained can be translated into choices, requirements, and boundary conditions.

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2 Overview of system types and solution directions

From the market consultation it emerges that the market for WIM does not have a single uniform solution, but consists of a number of clearly distinguishable approaches that each provide a different interpretation of measuring, processing, and applying data. At the same time, it appears that, in contrast to a purely conceptual market, mature and concrete COTS solutions are in fact available that can be acquired and applied as products, although these solutions do not automatically lead to a complete and directly deployable enforcement chain.

A first distinction that emerges from the discussions concerns the measurement principle on which systems are based. On the one hand, there are systems that operate with sensors in the road surface, where axle loads are measured directly through the interaction between vehicle and infrastructure. These systems are generally positioned as proven technology and align with existing standards and certifications.

Within this category, however, differences exist in the way in which sensors are integrated into the infrastructure. Whereas some systems make use of sensors that are directly embedded in the asphalt and are therefore highly dependent on the lifespan of the road surface, there are also approaches in which the measurement system is more independent from the asphalt and focuses on a longer lifespan and a different maintenance strategy. These differences have direct implications for management, replacement, and lifecycle costs.

On the other hand, there are systems that make use of existing infrastructural objects, such as bridges, where measurements take place based on the response of the structure. This approach distinguishes itself in that no intervention in the road surface is required and systems can be installed and relocated relatively flexibly.

In this regard, several parties emphasise that this type of system is relatively quick to deploy, as no intervention in the road surface is required and existing infrastructure can be used. This makes it possible to apply systems flexibly, for example for temporary measurement campaigns, pilots, or deployment at varying locations.

This flexibility makes this type of system particularly suitable for applications where rapid insight into the actual loading of infrastructure is required, such as in structures with a usage restriction (for example, a maximum permitted load). In such situations, valuable information can be obtained with relatively limited effort and without intrusive modifications to the infrastructure.

Both types of measurement principles are presented by the market as functioning solutions that are capable of recording vehicle weights and configurations. It can therefore be stated that, at the level of measurement and detection, technology is available and applicable to a significant extent. In this sense, a considerable part of the solutions can be regarded as product-based, particularly for applications such as monitoring, data collection, and pre-selection.

In addition to the measurement principle, the method of data processing forms the second and more determining distinguishing factor between solutions. In the consultation, broadly two architectural approaches emerge. On the one hand, there are systems that strongly rely on central processing, where all data is collected and transmitted to a central environment. In this environment, data is enriched, combined with other sources, and interpreted. This approach offers flexibility and makes it possible to apply complex logic and integrations, but at the same time is strongly dependent on software development and the configuration of the central chain.

Opposed to this are solutions that focus on processing closer to the source. In these systems, a significant part of the interpretation and filtering is carried out locally, for example in a roadside controller. At this stage, it is already determined early in the process which data is sufficiently reliable to be used further. This approach limits data flows and makes the system more robust, but requires clear upfront choices in the method of interpretation, as adjustments at a later stage are less straightforward.

In the discussions, it is emphasised that this local processing does not necessarily mean that data is not centrally available. In particular, for applications aimed at monitoring and statistics, there is a need to retain all measurement data and make it available for analysis. In such cases, local processing can be used to identify and flag measurements that are suitable for enforcement, while the full dataset is still transmitted and remains centrally available for broader analysis and use.

What clearly emerges from the discussions is that these architectural choices cannot be seen separately from the way in which systems are applied in practice. Solutions that strongly rely on central processing are often positioned as integrated platforms in which data from multiple sources is brought together and in which enforcement is realised based on combined insights. Solutions with more local processing place greater emphasis on the reliability of individual measurements and the selective use of data for enforcement.

A third dimension in which solutions differ concerns the degree of integration and the positioning within the chain. Some parties present their solution as a relatively demarcated system that is primarily focused on measuring and recording, and that subsequently needs to be integrated into a broader chain of systems and processes. Other parties explicitly position themselves as system integrators and offer a solution in which multiple components—such as sensors, cameras, and software—are delivered in coherence.

Nevertheless, it appears that, even for solutions that are positioned as integrated systems, application within a full enforcement context remains dependent on choices and alignment. Aspects such as data quality, verification, legal assurance, and integration with external data sources are strongly dependent on the specific deployment and in almost all cases require further configuration. This means that solutions are indeed available that can be acquired as systems, but that the eventual performance and applicability are determined by the way in which these systems are configured and embedded within the chain.

The overall picture that emerges is that, on the one hand, the market offers solutions that can be applied as building blocks or even as relatively complete systems, but that, on the other hand, these solutions cannot be considered separately from the context in which they are applied. As a result, the challenge shifts from selecting a specific technology to making integrated design choices, in which it is determined how different components together form a functioning system.

The consultation therefore makes it clear that distinguishing between system types is not only a technical exercise, but forms an essential part of the design of the overall solution. The choice for a specific type of system or architecture has direct consequences for data flows, management, flexibility, and the way in which applications, including enforcement, can be organised. This distinction therefore forms an important basis for making further choices in the possible configuration of WIM systems.

3 Key insights from the consultation

3.1. Data quality and verification as the central challenge

From the market consultation, it emerges very consistently that data quality forms the central success and failure factor within WIM applications. Whereas the emphasis initially often lies on the accuracy of the sensor or the measurement system itself, in practice it appears that the real challenge lies in ensuring the reliability of data over time and in demonstrating this reliability within a legal context.

The discussions show that all parties recognise that a single measurement on its own is insufficient to serve as a basis for enforcement. The focus is explicitly on the extent to which it can be demonstrated that the measurement system produces consistent and reproducible results under comparable conditions, and how this behaviour develops over time.

In practice, this is not determined solely on the basis of individual measurements, but rather on the basis of repeated measurements, reference vehicles, and the analysis of larger datasets, in which patterns and deviations become visible. This requires a fundamentally different approach to data quality than in traditional measurement applications, where periodic calibration is often considered sufficient.

In the context of WIM systems, it appears that the reliability of measurements is the result of an interplay of factors that can only be controlled to a limited extent by the supplier or the system itself. Factors such as the condition of the road surface, changes in traffic behaviour, temperature effects, and degradation of infrastructure have a direct influence on the measured result. This creates a situation in which the system may function according to specifications, while the quality of the outcome nevertheless fluctuates.

At the same time, the consultation makes clear that this issue occurs regardless of the type of system that is applied, including systems that are positioned as product-based available and operational. This means that even when using existing solutions, the assurance of data quality cannot be “purchased” as a fixed property, but remains dependent on the way in which the system is configured, managed, and applied within the chain, as well as on the environment in which the system is deployed. Data quality therefore is not a product property, but a system property that emerges in the context of use.

In addition, it becomes clear that the way in which data is processed and interpreted plays at least as large a role as the measurement itself. In systems in which large volumes of data are collected centrally and only filtered and assessed at a later stage, responsibility for data quality shifts to the software layer. In such cases, the reliability of the final outcome is largely determined by the applied algorithms, the selected validation rules, and the way in which exceptions are handled.

An important and recurring tension that is explicitly identified in the discussions concerns the handling of extreme values in the data. From a technical perspective, there is a strong tendency to consider outliers as potential measurement errors and to filter these out. At the same time, it is recognised that precisely these extreme values may indicate violations and are therefore relevant for enforcement. This leads to a fundamental dilemma: increasing reliability through filtering may result in missing relevant cases, while retaining all data increases the risk that unreliable measurements enter the enforcement chain.

The different parties apply varying strategies to address this dilemma. Some adopt a conservative approach in which only data with very high reliability is used, while other systems collect all data and only make a selection at a later stage. In addition, the importance of continuous monitoring of data patterns is emphasised, whereby deviations in trends are used as indicators of potential issues in the system, for example due to wear of the road surface or drift in sensors.

The overall picture that emerges from this is that data quality cannot be ensured by a single mechanism, but requires a combination of technical measures, continuous monitoring, and organizational processes. This means that data quality is not only a design requirement, but an ongoing management process that requires attention throughout the entire lifecycle of the system.

For the further elaboration of the WIM challenge, this means that requirements for data quality cannot be limited to specifications of sensors or accuracy classes, but must also relate to verification processes, monitoring mechanisms, and the way in which uncertainties are handled. The focus thereby shifts from "how accurate is the measurement of the system?" to "how reliable is the outcome over time and how can this be demonstrated?"

3.2. Architecture and data processing as a determining design choice

A second key insight from the consultation concerns the fundamental role of the chosen system architecture. Whereas differences between systems at first sight appear mainly technical—for example in sensor type or measurement principle—in practice it becomes clear that the configuration of data processing has a much greater influence on the functioning, complexity, and manageability of the system as a whole.

In the discussions, broadly two dominant approaches become apparent. On the one hand, there are systems that rely on central data processing, in which all measurement data, including vehicle identification and image data, is collected and transmitted to a central environment. In this environment, data is enriched, combined with other sources, and interpreted. This approach offers flexibility, because new insights, algorithms, and rules can be applied retrospectively to already collected data. This makes it possible to improve and adapt the system over time without physical modifications at the location.

At the same time, this approach entails important implications. The volume of data that is generated and transmitted can be significant, which places demands on infrastructure for storage, processing, and security. In addition, the reliability of the final outcome becomes to a large extent dependent on the software layer in which the processing takes place. Since the consultation indicates that this software in some cases is still under development, this introduces uncertainty in performance.

Opposed to this is an approach in which processing takes place as much as possible locally, directly at the measurement location. In this so-called edge architecture, data is assessed and filtered already at the source, whereby only those data that meet predefined criteria are used further. This approach limits data flows and makes the system less dependent on central infrastructure. In addition, the system becomes more robust in situations where network connections are limited or unstable.

The downside of this approach is that important choices regarding interpretation and filtering are made at an early stage in the process. This limits the possibility to apply new insights retrospectively to existing data and requires that logic and criteria are carefully defined in advance.

The discussions emphasise that this early filtering does not necessarily mean that data is no longer available for other applications. For applications aimed at monitoring and statistical analysis, there is in fact a need to retain all measurement data. In such cases, local processing can be used to assess measurements and mark them for suitability for enforcement, while the full dataset remains centrally available for broader analysis and use.

At the same time, the discussions point to specific advantages of processing close to the source. By processing and filtering data locally, exposure to external access and data flows can be limited, which contributes to a smaller attack surface and greater control over the functioning of the system. This makes it clear that this approach not only affects functionality, but also contributes to robustness, data management, and cybersecurity.

What clearly emerges from the discussions is that the choice for a central or decentralised architecture is not neutral. It affects not only technical aspects, but also organizational, legal, and management dimensions. For example, central processing has implications for data management, privacy, and the configuration of the data chain, while decentralised processing affects flexibility, adaptability, and the way in which decisions are made within the system.

In addition, it becomes clear that in both approaches the role of software is crucial. Regardless of where processing takes place, a large part of the complexity shifts to the software layer, in which data is interpreted and uncertainties are handled.

The consultation thereby makes clear that the choice of architecture is one of the most determining design decisions within the WIM challenge. This choice affects not only the technical functioning of the system, but also the management effort, scalability, and the extent to which the system can evolve with future developments.

It is furthermore emphasised that both architectural approaches are available in the market in the form of concrete solutions that can be applied as systems. The choice between these approaches is therefore not primarily a question of technical feasibility, but of design and deployment. This underlines that architecture should not be an implicit choice that follows from a product, but should explicitly form part of the design of the solution.

3.3. Chain complexity and allocation of responsibilities

A third important insight that emerges from the consultation is the extent to which WIM systems depend on a complex chain of components, parties, and processes. In contrast to many traditional systems, where performance largely lies within the sphere of influence of a single supplier, it appears that the functioning of WIM systems is the result of an interplay between multiple disciplines.

At the same time, the consultation makes clear that solutions exist that offer a large part of this chain in an integrated manner, whereby multiple components—such as sensors, data processing, and presentation—are delivered as one system. It appears that the extent to which this integration actually covers all parts of the data chain differs between solutions. In some cases, data processing and application are largely organised as part of the system, while in other situations further integration and alignment within the chain remain necessary. This means that technical integration at system level can to a certain extent be acquired as a product. The remaining complexity, however, lies in the connection to the broader environment, including infrastructure, external data sources, policy frameworks, and operational processes. Even in the case of integrated solutions, this contextual alignment remains decisive for the eventual performance.

The discussions repeatedly emphasise that the final performance depends on factors that lie outside a single party. For example, the quality of the measurement is highly dependent on civil engineering aspects such as the condition of the asphalt or the properties of a bridge. At the same time, the configuration and maintenance of sensors play a role, as well as the way in which data is processed and interpreted in software. In addition, external data sources, such as vehicle registration databases, are required to enrich data and make it legally usable.

This interconnection of components leads to a situation in which responsibilities are not clearly delineated. When deviations occur in system performance, it is often not immediately clear whether the cause lies in the sensor, the infrastructure, the software, or the external data. It is explicitly stated in the discussions that this may lead to situations in which involved parties point to each other, which complicates the manageability of the system.

In addition, part of the factors that influence system performance cannot be controlled, or can only be controlled to a limited extent. Traffic behaviour, weather conditions, and external developments cannot be fully controlled, yet have a direct impact on measurement outcomes. This reinforces the view that WIM systems cannot be regarded as closed systems, but as open systems that are continuously influenced by their environment.

The consequence of this is that the configuration of the chain, including agreements on responsibilities, forms a crucial part of the overall solution. This concerns not only technical integration, but also governance, contractual arrangements, and operational processes. Ensuring performance requires cooperation between multiple parties, whereby it must be clear who is responsible for which aspects of the system and how deviations are handled.

This means that it is not sufficient to look solely at individual components, but that the coherence between these components is decisive for the functioning of the system. It is important to have explicit insight into the allocation of responsibilities, the way in which performance is monitored, and how situations are handled in which performance deviates from expectations.

3.4. Influence of physical infrastructure on performance

One of the most dominant and recurring themes in the market consultation concerns the influence of physical infrastructure on the performance of WIM systems. Whereas it is often initially assumed that a technical solution functions independently of its environment, in practice it appears that infrastructure is in fact one of the most determining factors for the quality of measurements.

For systems that are integrated into the road surface, variation exists in the way in which sensors are physically incorporated into the infrastructure. The discussions repeatedly emphasise that factors such as longitudinal evenness, rutting, material degradation, and local damage have a direct impact on the measured axle loads. Even small deviations in the road surface can lead to changes in the dynamic behaviour of vehicles, causing measurements to vary without there being any change in the system itself. These differences in integration partly determine the sensitivity to local disturbances and damage, and thereby influence the stability of measurements and the maintenance requirement.

In this regard, the specific Dutch context plays an important role. The use of porous asphalt (ZOAB), which offers advantages in terms of noise reduction and water drainage, appears to be less stable from a measurement perspective. The sensitivity to raveling and local damage may result in sensors, which are often directly integrated into the asphalt, functioning less reliably over time. This means that system performance is not only dependent on the initial installation, but is strongly related to the maintenance level of the infrastructure. Maintaining measurement performance therefore is not only a technical challenge, but also requires periodic maintenance, monitoring, and involvement from the asset management organisation.

For systems that make use of bridge structures, a similar dependency applies, albeit through a different mechanism. In these cases, it is not the road surface but the behaviour of the structure itself that determines the measurement. Factors such as stiffness, damping, and temperature effects play a role in this. In addition, the simultaneous presence of multiple vehicles on a bridge introduces additional complexity, as signals from different vehicles can influence each other. In practice, test measurements or pilots are often used for this type of situation to map the behaviour of the structure and traffic in advance. These provide valuable insight, but require careful analysis and interpretation.

What these insights have in common is that infrastructure is not a passive substrate, but an active component of the measurement system.

At the same time, systems appear to be designed differently in this regard. Some solutions are directly integrated into the asphalt and therefore move with the condition and lifecycle of the road surface. Other systems are designed in such a way that the measurement component is less directly part of the asphalt, meaning that replacement and maintenance are less strongly linked to road maintenance. This difference influences how changes in infrastructure affect measurements and how systems perform over time.

This means that the performance of WIM systems cannot be considered separately from civil asset management and maintenance. A system that functions well at the time of installation may show degradation over time due to changes in the road surface or the structure.

The implication of this is that the deployment of WIM systems requires close alignment with civil engineering asset management. It is not sufficient to design and install a system from a technical perspective; consideration must also be given to how the underlying infrastructure is maintained at the required level. This means that responsibilities for management and maintenance do not rest solely with the system supplier, but also with the infrastructure manager.

This dependency on infrastructure applies equally to systems that are available as products and can be installed relatively easily. Even for such solutions, final performance is not determined by the technology alone, but by the interaction with the physical environment. This means that location selection and infrastructure condition form structural preconditions that cannot be fully mitigated by the supplier.

3.5. Pilot phase as a development and validation phase

The role of the pilot phase is emphasised in all discussions as an essential and indispensable part of the implementation of WIM systems. It clearly emerges that this phase cannot be regarded as a traditional test of an existing system, but as a broad development and learning phase in which both technical and organizational aspects are further elaborated.

In multiple discussions, it is explicitly indicated that a significant part of the system, in particular the software layer and the configuration of the chain, is still under development. This means that important choices and configurations are not fully fixed in advance, but are determined and refined during the pilot. The pilot thereby takes on an iterative character, in which design, implementation, and evaluation follow each other.

The discussions make clear that the extent to which functionality is developed in advance differs between solutions. In situations where data processing still needs to be further elaborated, the pilot phase also plays a role in the development and refinement of interpretation and application, while for more product-based solutions the emphasis lies more on validation within the specific context.

Although parts of the solutions are available as products, it appears that the pilot phase remains necessary to determine how these products behave within the specific context of application. The pilot is therefore not intended to develop the technology itself, but to validate the application, configuration, and chain setup. This distinction is important, as it shows that the development effort primarily lies in the application and not in the underlying technology.

In addition to the technical dimension, the discussions also emphasise the importance of the pilot for the organization and the chain. This concerns, among other things, the establishment of processes for data processing, the allocation of responsibilities, and the development of procedures for verification and enforcement. In some cases, it is even indicated that the main challenges are not of a technical nature, but lie in the organizational and legal embedding of the system.

An important aspect in this regard is the building of trust in the data. Enforcement requires that all involved parties, from the asset manager to enforcement authorities, have confidence in the correctness and reproducibility of measurements. This trust cannot be fully established theoretically, but requires practical experience and validation over time. The pilot phase thereby serves as a necessary period in which this trust is built.

In practice, this validation is not only based on the analysis of measurement data, but also on comparison with physical checks. During the pilot phase, use can be made of additional static weighing, carried out in cooperation with enforcement partners, in order to provide insight into the relationship between measured and actual weights.

This means that the pilot phase is not only a technical and analytical effort, but also requires additional deployment of involved organisations, including enforcement authorities. The required capacity for such verifications therefore forms an explicit part of the implementation and should be taken into account in advance in the organisation and planning of pilots.

In addition, the discussions outline a clear phasing in the implementation. Many parties describe a trajectory in which an initial phase of monitoring and analysis is followed by a phase of soft enforcement, after which actual enforcement is only introduced at a later stage. This phased approach is not regarded as a delay, but as a necessary way to manage risks and increase the effectiveness of the system.

The joint conclusion is that the pilot phase forms an integral part of the solution and cannot be considered separately from the final application. This phase is essential for validating the system, building trust in the data, and establishing the associated processes, and should therefore be explicitly included in the further elaboration, including clear objectives and intended outcomes.

3.6. Network approach and location strategy

An important insight that emerges from the consultation is that WIM systems do not function optimally as standalone installations, but rather in coherence as a network of measurement locations. This network approach is regarded by multiple parties as a precondition for increasing both the effectiveness and the reliability of the system.

Within a network setup, measurement data from different locations can be compared with each other. By tracking vehicles between measurement points using license plate recognition, it becomes possible in certain cases to compare measurements of the same vehicle across locations, and thereby verify consistency and detect deviations. This is particularly effective when the same trip and comparable conditions are involved.

In addition, a network setup can be used to analyse patterns and deviations on the basis of larger datasets, thereby providing insight into measurement behaviour and system performance over time. This offers a powerful instrument for verification and quality assurance, which is less available in an isolated setup.

A network approach also makes it possible to assign different functions to different locations. Some locations can be primarily used for monitoring and data collection, while other locations are configured for pre-selection or enforcement. This differentiation makes it possible to organise the system efficiently and to deploy resources in a targeted manner at locations where this has the greatest effect.

At the same time, this requires careful consideration of the way in which enforcement is applied. Differentiation in functions should not lead to undesirable differences in enforcement or a non-uniform detection probability across the network. This means that choices regarding the use of locations must be explicitly aligned with the intended enforcement policy, and that consistency in application forms an important point of attention.

At the same time, it becomes clear that overloading is not concentrated exclusively on main roads. The discussions explicitly indicate that violations often occur on the underlying road network, for example in the vicinity of industrial sites or construction projects. This means that an effective location strategy must look beyond main corridors and take local situations into account.

An implicit but important design choice that follows from this concerns the balance between the number of locations and the accuracy per location. On the one hand, a limited number of locations with high accuracy can be selected, focused on specific points. On the other hand, a larger number of locations with lower accuracy can be chosen, focused on broader coverage and insight. Both approaches have different implications for costs, complexity, and effectiveness.

In addition, the network approach introduces additional complexity in the areas of data processing and management. Combining data from multiple locations requires consistent data standards, robust infrastructure, and effective coordination. This once again underlines that WIM systems cannot be considered in isolation, but form part of a broader data and management environment.

The network approach can be realised using existing systems that are deployed across multiple locations and interconnected. This means that, from a technical perspective, the realisation of a network is feasible with available solutions, but that its added value only emerges when data is actually combined and used for verification and analysis. The challenge therefore does not lie in the realisation of measurement points, but in leveraging the coherence between these measurement points.

3.7. Lifecycle costs and Total Cost of Ownership (TCO)

From the market consultation, a clear and consistent picture emerges that the costs of WIM systems are not primarily determined by the initial acquisition of hardware, but to a significant extent by factors that arise over the entire lifecycle of the system. This leads to a fundamentally different perspective on costs, in which Total Cost of Ownership (TCO) is central rather than solely the initial investment costs.

In the discussions, it is explicitly stated that the hardware components of WIM systems—such as sensors, cameras, and installations—are visible and relatively straightforward to budget, but in practice form only part of the total costs. A significant portion of the costs shifts to less visible components, such as software development, data processing, maintenance, and operational management. These components are often more difficult to quantify in advance and also involve a higher degree of uncertainty, as they are strongly dependent on the chosen system architecture and the way in which the solution is applied.

At the same time, the consultation shows that the availability of product-based solutions contributes to a certain predictability of initial costs and implementation effort. Systems and integrated solutions are available that can be acquired and deployed as a whole. The variation in TCO, however, does not primarily arise in acquisition, but in the choices that are made regarding deployment, scale, data processing, and management. As a result, systems with comparable initial characteristics can in practice lead to significantly different total costs over their lifecycle.

It also becomes implicitly clear that there are different ways to configure and manage such systems. In practice, this ranges from models in which systems are delivered as a service and managed by the supplier, to situations in which systems are procured and managed by the client. This choice has direct consequences for the distribution of costs over time, the required management organisation, and the degree of dependency on suppliers. This leads to a trade-off between, on the one hand, unburdening and predictable operational expenditure, and on the other hand maintaining control and flexibility in the further development of the system.

An important insight from the consultation is that the software layer in particular plays a dominant role in the cost structure. In almost all presented solutions, a significant part of the functionality—such as data processing, classification, verification, and integration with external systems—is realised in software. It becomes clear that this software cannot be regarded as a one-time development. Instead, it requires continuous maintenance, updates, and in some cases redevelopment, for example due to technological obsolescence, changing requirements, or new insights. Software components therefore have a shorter lifecycle than civil engineering and hardware components and form an important part of the ongoing costs.

It also becomes implicitly clear that the way in which software is configured and managed constitutes an important design choice. In practice, this ranges from solutions in which software is fully delivered and managed by a supplier, to situations in which (parts of) functionality are configured by or on behalf of the client. This choice has direct implications for cost development, flexibility, dependencies, and the degree of control over the system.

In addition to software, physical infrastructure also plays an important role in cost development. For road-based systems, sensors are directly integrated into the asphalt and therefore form part of the road construction. As a result, they are strongly dependent on the lifecycle and maintenance of the road surface.

At the same time, it appears that within this category there are differences in the extent to which systems are dependent on the lifecycle of the infrastructure. Whereas some solutions are integrated into the road surface in such a way that they follow the maintenance cycles of the asphalt and therefore require periodic replacement, there are also approaches that aim for a looser coupling with the infrastructure and a longer lifecycle of the measurement installation. These differences lead to varying lifecycle models and have direct implications for maintenance strategies, replacement moments, and the distribution of costs over the lifecycle of the system.

During large-scale maintenance, such as the replacement of asphalt layers, it is in many cases necessary to remove and reinstall sensors, or to replace them entirely, depending on the type of sensor and the method of anchoring. This means that road maintenance directly affects the lifecycle and costs of the measurement system. In addition, such maintenance may be accompanied by temporary traffic measures, such as lane closures, which leads to additional costs and operational impact for the infrastructure manager.

In addition, degradation of the road surface may lead to deterioration of measurement performance, which requires additional efforts in calibration and monitoring. For bridge-based systems, costs are more related to the maintenance of installations and the accessibility of locations, but the dependency on the physical environment remains.

At the same time, the consultation shows that bridge-based systems in practice distinguish themselves by a relatively high degree of flexibility in deployment and a more limited impact on infrastructure during installation. This may in certain applications result in different cost profiles and risk distributions, depending on the chosen deployment and the intended purpose of the system.

A third important cost component concerns the operational phase of the system. This includes activities such as data processing, storage, monitoring, calibration, and validation. In particular, for solutions in which large volumes of data are collected and processed centrally, the scale and frequency of data flows can be significant. This places demands on infrastructure for storage and processing and leads to recurring costs during operation. In addition, it becomes clear that in some situations human involvement remains necessary, for example for data validation or operational management, which can also form a structural cost component.

An important and practically relevant risk that emerges from the consultation concerns the relationship between investments and actual use of the system. In multiple discussions, situations are mentioned in which systems are procured but are not actively or not fully used, for example due to limited organizational capacity or insufficiently developed processes. In such cases, investment is made in technology without realising the intended value, which increases the effective costs.

In addition, it is emphasised that cybersecurity and compliance are not one-time implementations, but require continuous attention. Systems must be adapted throughout their lifecycle to changing requirements and threats. This means that costs for updates, monitoring, and compliance form a structural part of operations.

An important overarching insight is that TCO is strongly dependent on design choices that are made at an early stage. Choices regarding system architecture, the degree of centralisation, the volume of data collected, and the desired performance level have a direct influence on costs over the entire lifecycle. For example, extensive data collection and central processing lead to higher costs for storage and processing, while a more selective approach can limit costs but may also affect flexibility.

The overall picture that emerges from the consultation is that TCO cannot be regarded as the sum of individual components, but results from the interplay of technical, organizational, and policy-related choices. This means that managing costs is not only a matter of selecting technology, but primarily of making consistent choices in the configuration and application of the system.

In summary, the consultation shows that the financial challenge surrounding WIM systems is to a significant extent determined by factors that arise after implementation. A sustainable and effective deployment of WIM therefore requires an explicit focus on lifecycle costs and on choices that are not only technically, but also economically and organizationally sustainable over the long term.

3.8. Phasing and phased scaling towards enforcement

From the market consultation, a consistent picture emerges that the implementation of WIM systems does not lend itself to a one-off “all-or-nothing” introduction, but requires a phased approach in which technology, data, and legal assurance are developed in coherence. At the same time, it becomes clear that this phasing does not have to mean that value creation only occurs at the moment when full enforcement becomes legally possible.

The discussions with market parties show that a significant part of the technical solutions is already available and applicable for collecting, analysing, and interpreting data. This means that it is possible to roll out and operationally deploy systems at an early stage for monitoring and insight, without the need to immediately establish the full enforcement chain. This allows for early experience to be gained with the functioning of systems, the quality of data, and the dynamics of traffic flows.

A phased implementation can be structured along a number of clearly distinguishable steps. In the first phase, the emphasis lies on establishing measurement capacity and collecting data. In this phase, systems are installed and made operational, with the focus on gaining insight into traffic behaviour, loading, and violation patterns. Because systems are technically available, this phase can be scaled up relatively quickly, provided that locations are suitable and the basic configuration for data storage and processing is in place.

In a subsequent phase, the emphasis shifts towards data quality and verification. The collected data is used to assess system performance, analyse deviations, and build trust in the measurement results. This phase is essential for the further application of the data, but does not form a barrier to continuing the collection and analysis of information. On the contrary, the availability of larger datasets contributes to improving reliability and insight into system behaviour.

In parallel, a third phase can be established in which the data is used for so-called “soft enforcement” or policy-oriented applications. This may include informing transport operators, supporting supervision, or targeted planning of physical inspections. This phase makes it possible to already achieve behavioural change without the application of formal sanctions. In this way, value is created directly, while at the same time experience is gained with the practical application of data.

Only in a later phase is a transition made to formal enforcement, in which data is fully applied in a legal context for the imposition of sanctions. At that point, the conditions relating to legal assurance, responsibilities, and verification must be fully established. The preceding phases contribute directly to this step, as they build insight, trust, and experience that are necessary for a robust application.

An important insight from the consultation is that this phasing is not only a technical sequence, but also a way to manage risks. By first deploying systems for monitoring and analysis, uncertainties can be identified and addressed before they have an impact on enforcement. This prevents the system from being burdened at an early stage with requirements that cannot yet be fully met.

In addition, this approach makes it possible to decouple the rollout of technology from the speed at which legal frameworks are developed. The technical infrastructure and data collection can be scaled up, while the legal embedding is developed in parallel. This prevents implementation from being delayed due to dependencies in regulation and makes it possible to realise value at an early stage.

At the same time, this approach requires clear choices in the way in which the different phases are structured and connected. It is important that systems and data architecture are designed in such a way that they are suitable for scaling towards later phases, including enforcement. This means that choices regarding, for example, data quality, storage, and processing must align from the outset with the intended final application.

In summary, the market consultation shows that a phased approach is essential to implement WIM systems in an effective and manageable way. By scaling technology at an early stage and simultaneously working on legal and organizational assurance, value can be realised in all phases of implementation, while at the same time progressing towards a robust enforcement chain.

4 Generic building blocks and system composition

From the market consultation, a consistent picture emerges that WIM solutions, despite differences in technology and architecture, are fundamentally composed of a number of recurring building blocks. These building blocks together form the system required to measure vehicles, process data, and ultimately apply this data within monitoring and enforcement. The distinction between solutions lies less in the existence of these components, and more in the way in which they are combined, configured, and integrated.

The first and most fundamental building block concerns the measurement component. This consists of sensors that register the weight and configuration of vehicles during passage. The discussions show that various measurement principles are applied for this purpose, including sensors in the road surface and sensors on or attached to bridge structures. This component forms the basis of the system and largely determines the quality and nature of the raw data that becomes available for further processing.

From the consultation it appears that this measurement component is in many cases available as a mature and certified product. At the same time, the extent to which subsequent data processing and integration are elaborated differs between solutions. On the one hand, there are parties that have advanced product-based platforms in which data processing and application are largely configured, while on the other hand there are solutions in which these functions are to a large extent realised within the application and the chain.

In addition to the measurement component, almost all solutions make use of identification components, typically in the form of camera-based systems such as Automatic Number Plate Recognition (ANPR) and possibly overview cameras for side views. These components are in many cases delivered by specialised suppliers and integrated into the overall WIM solution by the system provider.

This makes it possible to link measurements to vehicles and to track these across locations. In some solutions, this identification is extended with additional visual information, for example for vehicle classification. The reliability and applicability of these components are related to image quality and the interpretation methods used.

It also becomes clear that the performance of camera-based systems, such as ANPR, is strongly dependent on location, image quality, lighting conditions, and the configuration of the applied software. As a result, performance cannot be characterised in a uniform way under all circumstances, but is to a significant extent context-dependent.

The discussions therefore implicitly show that the assessment of these components cannot be considered separately from the specific configuration and application. This means that obtaining reliable results is not solely dependent on the component itself, but rather on the way in which it is applied, configured, and assured within the system.

A next building block concerns data acquisition and initial processing. This takes place at or near the measurement location and is responsible for collecting, structuring, and in some cases already partially filtering the raw measurement data. In solutions with a more decentralised architecture, a selection of data that meets certain quality criteria is already made in this phase. In more centrally oriented architectures, the data in this phase is primarily forwarded to a central environment for further processing.

The subsequent building block is data processing and interpretation. In this layer, raw data is converted into usable information, such as vehicle weights, axle loads, and vehicle classes. In addition, data validation takes place here, in which it is assessed to what extent measurements are reliable and can be used for further application. The discussions make it clear that this building block is strongly dependent on software and is to a significant extent decisive for the final quality and usability of the system.

An essential part within this processing is the verification and quality assurance of data. This can take place via various mechanisms, such as statistical analysis, comparison between locations, or monitoring of trends over time. This building block is closely connected to the previously described challenges regarding data quality and forms an important link towards application in enforcement.

In addition, data storage and availability form an important building block. All solutions provide some form of storage in which measurement data, enriched data, and in some cases also image material are retained. The scale and complexity of this storage depend on the chosen architecture and the extent to which data is fully retained or selectively filtered. From this storage, data is also made available for analysis, reporting, and potential enforcement applications.

At the level of application, use is made of presentation and interface systems, such as dashboards and reporting tools. These make it possible to obtain insight into traffic flows, loading, and potential violations. In some solutions, these systems are extended with functionality for operational use, for example supporting supervision or generating signals for enforcement.

An additional building block concerns integration with external data sources and systems. This may include connections to vehicle registration databases, exemption data, or other relevant data sources. These integrations make it possible to further enrich and contextualise data, but at the same time introduce dependencies and complexity within the chain.

Finally, the discussions implicitly reveal an organizational and process-related building block. The functioning of the system is not solely dependent on technology, but also on the configuration of processes surrounding the validation, interpretation, and application of data. This includes, among other things, how uncertainties are handled, how data is assessed, and how decisions are made within the enforcement chain.

The overall picture that emerges from the consultation is that WIM solutions consist of a coherent set of these building blocks, whereby the choice for a specific solution primarily determines how these building blocks are implemented and interconnected. It also becomes clear that there are solutions in which a large part of these building blocks is offered in an integrated manner, while in other cases a modular structure is applied in which different components are combined.

This leads to the insight that the core of the challenge does not lie in identifying individual components, but in understanding the coherence between them and the way in which they jointly contribute to the functioning of the system. The description of these building blocks therefore forms an important basis for further defining the solution and making choices in the configuration of the chain.

5 Scope and practical applicability

From the market consultation it emerges that WIM systems are broadly applicable in practice, but that the extent to which they can be deployed depends on the specific objective and context of use. A clear distinction therefore arises between applications that are directly and relatively robustly feasible, and applications that require additional configuration, validation, or development.

In the discussions, it is consistently indicated that WIM systems are well suited for monitoring and data collection. Measuring vehicles and obtaining insight into traffic flows, axle loads, and loading patterns are regarded by all parties as feasible and proven applications. The required technology is available for this purpose and can, depending on location and system type, be rolled out relatively quickly. This makes it possible to obtain valuable information on traffic and infrastructure use in the short term.

In addition to monitoring, application for pre-selection is also considered broadly feasible. In this case, vehicles are identified that may deviate from applicable standards, after which they can, for example, be selected for further inspection. This application requires a higher level of reliability than monitoring, but falls within the capabilities of current systems, provided that uncertainties in measurements are taken into account. In this phase, it becomes clear that data quality and the way in which filtering and interpretation are carried out are of great importance for the usability of results.

The consultation mentions various concrete applications of WIM systems that span this spectrum. These include monitoring traffic flows and infrastructure loading, detecting potential violations of axle load and weight regulations, supporting targeted inspections by enforcement authorities, and using data for policy analysis and infrastructure management. These applications differ in complexity and require different levels of reliability and assurance, but can in practice be deployed alongside each other.

For certain system types, such as bridge-based solutions, it is noted that they can be deployed and relocated relatively quickly. Because these systems make use of existing infrastructure and do not require intervention in the road surface, implementation is generally less intrusive than for road-based systems. This makes it possible to respond flexibly to specific situations, such as temporary projects, changing traffic flows, or targeted investigation of locations.

This flexibility is regarded by market parties as an important advantage in the practical application of WIM systems, particularly in situations where a static and permanent configuration is not immediately necessary or desirable.

In addition, the discussions indicate that the added value of WIM systems is largely derived from the scale and continuity of measurements. Whereas measurements in other contexts often take place at specific moments or locations, WIM systems make it possible to collect data on passing traffic on a structural and continuous basis. This results in a broader and more consistent understanding of vehicle behaviour and infrastructure loading.

This continuous data collection is regarded by market parties as an essential prerequisite for applications such as pre-selection and enforcement on a larger scale. It is not so much the individual measurement, but rather the volume, distribution, and repeatability of measurements that enables the identification of patterns, the detection of deviations, and more targeted intervention. In this sense, the focus shifts from incidental observations to structural insight.

For the application of WIM in direct enforcement, a more nuanced picture emerges. Although systems are capable of providing data that can be used for enforcement, the consultation shows that this application depends on additional conditions. These include, among other things, the assurance of data quality, the traceability of measurements, and the legal verifiability of outcomes. As a result, enforcement is in practice regarded as a later phase, building on earlier steps of monitoring, analysis, and validation.

In this regard, the discussions implicitly indicate that the applicability of WIM systems for enforcement is not determined solely by the technical accuracy of individual measurements, but by the way in which technical performance and legal requirements are considered in coherence. This means that maximum technical precision is not required in all cases, but that the focus lies on the extent to which measurements are sufficiently reliable and reproducible for the intended application.

In practice, this leads to a balance between technical strictness and legal verifiability. Systems can be configured in such a way that only those measurements are used for which reliability can be demonstrated to be sufficient. For example, conservative thresholds or margins can be applied, ensuring that only situations with clear exceedances are selected. This makes it possible to realise reliable and consistent applications even in the presence of variation in measurement accuracy.

This approach makes it possible to process parts of traffic with a high degree of certainty, while for other situations additional verification or alternative measures are applied. This aligns with the previously described phased approach, in which applications are gradually expanded and the use for enforcement is based on data domains for which sufficient confidence and assurance have been achieved.

An important aspect in the practical applicability concerns variation in vehicle categories. As previously noted, standard freight vehicles can generally be processed effectively within WIM systems. For vehicles with deviating characteristics, such as special axle configurations or different dynamic behaviour, detection is often possible, but interpretation of measurements may be uncertain. This means that such vehicles are not in all cases suitable for automated processing in enforcement applications and that additional measures may be required.

In addition, the applicability of systems appears to be strongly dependent on the physical environment in which they are deployed. Factors such as road surface quality, infrastructure type, and traffic conditions have a direct influence on system performance. This means that deployability of WIM is not uniform across the network, but must be assessed on a location-by-location basis. In certain cases, this may lead to limitations in applicability or to additional requirements for configuration and management.

The consultation also shows that scalability of systems is technically feasible. It is possible to establish multiple measurement locations and connect them. The practical applicability of such scaling, however, depends on the configuration of the data chain and the extent to which data is effectively used. The mere realisation of measurement points is insufficient; added value only emerges when the collected data is analysed and applied within the intended processes.

Another important aspect concerns the possibility to deploy systems in phases. The consultation makes clear that it is not necessary to immediately meet all requirements for enforcement in order to create value. Systems can be deployed for monitoring and analysis, while work in parallel continues on the further configuration of assurance and enforcement. This makes it possible to scale technology and gain experience without being dependent on full legal or organizational completion.

More broadly, the consultation shows that WIM systems primarily provide value in gaining insight into traffic loading, supporting targeted and efficient supervision, and enabling applications at larger scale. In addition, they offer opportunities for data-driven policy and better-informed infrastructure management. This value is not only realised in the final stage of enforcement, but already emerges in earlier phases of monitoring and analysis.

The overall picture that emerges is that the scope of WIM systems cannot be defined in a binary way, but exists on a spectrum of applications ranging from monitoring to enforcement. Within this spectrum, there are clear differences in feasibility, complexity, and required configuration. This calls for a deliberate and phased approach, in which applications are gradually expanded and deepened.

In summary, it can be concluded that WIM systems are broadly applicable, particularly for monitoring and pre-selection, and that further applications such as enforcement are feasible provided that additional conditions are addressed. The practical deployment of these systems requires attention to context, vehicle types, infrastructure, and data quality, and is best structured through a phased approach in which systems and processes are developed jointly.

6 Assumptions and limitations

From the market consultation it emerges that the application of WIM systems is accompanied by a number of recurring assumptions and inherent limitations. These do not constitute exceptions, but are structural in nature and to a large extent determine the conditions under which systems can be effectively deployed. By making these explicit, a more realistic picture emerges of what can be achieved with WIM systems and under which conditions.

A first important assumption concerns the reliability and stability of measurement data. In the discussed solutions, systems are assumed to be capable of measuring vehicle weights and configurations within certain accuracy classes. At the same time, the discussions emphasise that these performances are strongly dependent on the conditions under which measurements are carried out. Factors such as infrastructure quality, traffic behaviour, and environmental influences result in measurement outcomes that may vary over time. The assumption that performance is constant and location-independent does not hold in practice.

Closely related to this is the limitation that data quality cannot be assured by technology alone. Although systems include mechanisms for calibration and validation, the quality of data remains dependent on external factors that can only be partially controlled. This means that uncertainties in measurements are inherent to the system and that it is necessary to explicitly take these into account in the interpretation and application of results.

The discussions make clear that these uncertainties do not necessarily form a barrier to application, provided that they are taken into account in the configuration of the application. By, for example, applying margins or selecting situations with a clear exceedance, it can be ensured that only those measurements are used for which reliability can be demonstrably considered sufficient. In this way, it becomes possible to achieve consistent and legally defensible applications despite variation in measurement outcomes.

A second important assumption concerns the applicability of systems to different vehicle categories. The consultation shows that WIM systems perform well for standard freight vehicles, but that limitations exist for vehicles with deviating characteristics. These include vehicles with special axle configurations or different dynamic behaviour. The assumption that all vehicles can be processed in the same way does not fully apply in practice. As a result, part of the traffic is not, or only with additional measures, suitable for applications such as automated enforcement.

The discussions make clear that this limitation does not necessarily form a barrier to application, but requires targeted configuration of the application. In practice, this can, for example, be addressed by excluding certain vehicle categories from automated processing and handling these through follow-up checks or alternative enforcement measures. In addition, the importance of network-wide insight is highlighted, in which patterns across multiple locations are used to better interpret deviations and to act more effectively.

In this context, the use of soft enforcement is also mentioned, where systems are deployed to gain insight and influence behaviour without direct sanctions. This combination of selection, additional verification, and phased application makes it possible to achieve an effective and manageable deployment of WIM systems despite differences between vehicle categories.

A third important assumption concerns the role of software and data processing within the system. Many solutions assume advanced software that is capable of interpreting, validating, and enriching data. At the same time, the discussions indicate that this software is to a large extent decisive for final performance.

It also becomes clear that the extent to which this functionality is available and elaborated differs between solutions. On the one hand, there are systems in which a large part of the software functionality is already available as a product and is primarily configured to the application. On the other hand, there are solutions in which parts of the functionality are still under development and require further elaboration in practice.

The assumption that functionality is fully fixed at the moment of implementation is therefore not realistic in all cases; in many situations, systems require further development and adjustment over their lifecycle. At the same time, the consultation shows that the extent of required further development strongly depends on the selected solution and the way in which it is applied and configured within the chain.

In addition, there is an important limitation in the dependency on physical infrastructure. Both road-based and bridge-based systems are directly influenced by the characteristics of their environment. Changes in the road surface or the structure may result in deviations in measurements, without the system itself being modified. This makes it clear that performance cannot be considered separately from infrastructure management and maintenance, and that this dependency forms a structural element of the application.

A further assumption implicit in the discussions concerns the availability and quality of additional data sources. For certain applications, particularly in enforcement, use is made of connections with external systems, such as vehicle registration databases or other data sources. The effectiveness of these applications is therefore dependent on the availability, timeliness, and quality of this external data. This introduces a dependency that lies outside the direct sphere of influence of the WIM system.

The discussions make clear that this dependency forms a structural part of the application and is taken into account in practice in the configuration of the system. For example, use can be made of validation steps, fallback scenarios, or selective use of data, in which only data with sufficient quality and availability is used. In this way, reliable applications can be achieved despite dependencies on external sources.

There is also a clear limitation with regard to legal applicability. The consultation shows that the use of WIM data for enforcement places additional requirements on reliability, traceability, and explainability. The assumption that technical measurements are directly usable for legal applications therefore does not fully apply.

In practice, this means that data is not applied directly, but is first validated and assured. This includes, among other things, verifying measurement results, demonstrating reliability over time, and documenting how data is generated and interpreted. This determines for which measurements reliability is sufficient to allow their use in further application.

The discussions make clear that this validation and assurance are not regarded as a separate final step, but as an integral and stepwise process that aligns with the configuration of the system. Data is first used for monitoring and analysis, then for pre-selection and support of supervision, and only at a later stage—when reliability has been sufficiently demonstrated—for formal enforcement.

This phased approach makes it possible to build the required legal assurance in practice and ensures that application takes place on the basis of demonstrably reliable data. Legal applicability therefore does not form a hard boundary, but a development step that is linked to the way in which data is validated and applied.

Finally, it becomes clear that the functioning of WIM systems depends on the configuration of the chain in which they are applied. The assumption that a system can function as a standalone entity is not supported by the market. Instead, performance appears to arise from the interplay of components, processes, and involved parties. This means that uncertainties and variations are not only technical in nature, but are also related to organizational and process-related factors.

The discussions emphasise that this chain dependency does not in itself form a limitation, but requires an explicit configuration of roles, responsibilities, and processes. By consciously organising this coherence and establishing agreements on data processing, verification, and use, the complexity of the chain can be managed and performance can be better assured.

In summary, the consultation shows that the application of WIM systems is based on a number of implicit assumptions that only partially hold in practice, and that structural limitations exist that cannot be fully resolved by technology. By making these assumptions and limitations explicit, it becomes possible to better manage expectations and to design and apply systems realistically within the given context.

7 Risks and dependencies

From the market consultation it emerges that the application of WIM systems is accompanied by a number of structural risks and dependencies. These risks are not incidental, but are inherently linked to the nature of the technology and the context in which it is applied. Making these risks explicit is important in order to obtain a realistic understanding of the challenge and to provide insight into the factors that influence system performance and effectiveness.

A first and most explicitly identified risk concerns the quality and reliability of data. As the discussions show, data quality depends on a combination of sensor technology, infrastructure, traffic behaviour, and data processing. As a result, there is a risk that measurement outcomes vary or are not in all cases sufficiently reliable for the intended application. This risk is reinforced by the fact that deviations are not always immediately visible, but only become apparent through analysis over time or during application in enforcement. Data quality therefore is not only a technical risk, but also a risk in the interpretation and application of data.

An additional point of attention that implicitly emerges from the discussions concerns trust in the functioning of the system. In applications where WIM systems are used for supervision and enforcement, it is important that the functioning is perceived as consistent, explainable, and reliable by users and involved parties.

The discussions make clear that deviations, inconsistent outcomes, or unclear interpretations of data can negatively affect this trust, and thereby the acceptance of the application.

At the same time, it appears that these risks are to a large extent manageable through the way in which the system is configured and applied. Reference is made, among other things, to the importance of transparency and reproducibility of outcomes, the use of margins and the selection of situations with clear exceedances, and the application of additional verification steps where necessary.

The phased deployment of systems also plays an important role in this regard, whereby experience is first gained and trust is built through monitoring and pre-selection, before formal enforcement is applied. Through this combination of consistent operation, careful application, and step-by-step introduction, trust in the system can be ensured and a robust basis is established for acceptance of the application.

Closely related to this is the dependency on infrastructure as an important risk factor. For both road-based and bridge-based systems, performance is influenced by the physical environment. Changes in asphalt condition, wear, or structural behaviour may lead to deviations in measurements, without the system itself being modified. This means that performance cannot be fully controlled from within the system and that there remains a structural dependency on external factors that can only be partially influenced.

A third important risk concerns the complexity of the chain in which WIM systems operate. The consultation shows that final performance depends on an interplay of multiple components and parties. This introduces dependencies between sensors, software, infrastructure, and external data sources. In situations where performance deviates, it may be difficult to determine the cause unambiguously. This increases the risk of unclear responsibilities and makes system management more complex.

In addition, the dependency on software and data processing is identified as an important point of attention. In many solutions, software plays a central role in interpreting, validating, and enriching data. This means that errors, imperfections, or limitations in software have a direct impact on final outcomes. Moreover, it becomes clear that software in many cases continues to evolve, resulting in a situation in which the system adapts over time. This introduces uncertainty in performance and requires continuous attention to management and updates.

A further dependency concerns the availability and quality of external data sources. For applications in which vehicle information is enriched or interpreted, connections are often required with systems managed by other parties, such as the RDW vehicle registration register and exemption databases. This means that system functioning is partly dependent on the quality, timeliness, and availability of this external data. Failures, inconsistencies, or limitations in these data sources may have a direct impact on the usability of results.

A risk is also identified with regard to legal applicability. The discussions make clear that the use of WIM data for enforcement places additional requirements on reliability, traceability, and explainability. If these requirements cannot be met, there is a risk that data cannot be used for enforcement, even if it is technically available. This may lead to a mismatch between technical capabilities and operational application.

At the same time, this does not mean that the value of the data is lost. Even without direct use for enforcement, WIM data can be applied for monitoring, policy analysis, and insight into traffic loading and infrastructure use. The availability of data therefore remains of significant value, even if application for enforcement requires further development.

Another risk that is mentioned in multiple discussions concerns the extent to which systems are actually used and embedded within the organisation. Attention is drawn to the risk that systems are implemented, but that the available data is not or insufficiently used, for example due to lack of capacity, insufficiently configured processes, or lack of prioritisation. In such situations, the potential value of the system is not realised.

In addition, risks related to scalability and data volume are identified. As systems are applied at larger scale and generate more data, the demands on data processing, storage, and management increase. This may result in complexity and costs that are difficult to fully anticipate in advance. The extent to which systems are scalable therefore depends not only on the technology, but also on the configuration of the data chain.

Finally, cybersecurity and regulatory compliance are identified as ongoing points of attention. Systems that process large volumes of data and are connected to other systems must continuously be adapted to changing requirements and threats. This does not constitute a one-time risk, but a structural dependency that requires attention throughout the entire lifecycle of the system.

In summary, the consultation shows that risks and dependencies within WIM systems arise from the combination of technical, physical, and organizational factors. These risks cannot be fully eliminated, but can be managed through deliberate system configuration, clear agreements within the chain, and a phased approach in which experience and insight are built up over time.

8 Implications for data and management

From the market consultation it emerges that the deployment of WIM systems has direct and extensive implications for the configuration of data and management processes. Whereas the initial focus often lies on establishing measurement capacity, in practice it appears that system success is to a large extent determined by the way in which data is processed, managed, and applied within the chain.

A first important insight concerns the nature and scale of the data flows generated by WIM systems. Depending on the chosen architecture and system type, significant volumes of data may be involved, particularly where image data is stored and processed in addition to measurement data. In solutions with central data processing, these data flows are consolidated in central environments, which places demands on storage capacity, processing power, and network connections. In more decentralised solutions, data is processed and filtered closer to the source, which results in smaller data flows but at the same time imposes different requirements on local systems and configuration.

Closely related to this is an important design choice regarding data management: the extent to which data is fully stored and remains available for analysis, or is selectively retained based on predefined criteria. The consultation shows that both approaches exist in the market and that this choice has direct consequences for flexibility, costs, and complexity. Full data storage provides opportunities for reanalysis and further development, but leads to larger data volumes and higher management costs. Selective storage limits these burdens, but reduces the possibility to apply new insights retrospectively.

A second important aspect concerns the assurance of data quality within the management process. As the discussions show, data quality is not a static characteristic, but a dynamic outcome that is influenced by infrastructure, system configuration, and use. This means that management cannot be limited to maintaining hardware, but must explicitly also relate to the monitoring and validation of data. In practice, this requires processes and tooling through which deviations are detected, trends are analysed, and, where necessary, corrective measures are taken.

In addition, it appears that the processing and interpretation of data are to a large extent dependent on software. This software forms an essential part of the system and requires continuous management, maintenance, and in some cases further development. This means that management does not only concern technical upkeep, but also includes the management of algorithms, validation rules, and interfaces with other systems. Changes in this software may have a direct impact on system outcomes and must therefore be carefully managed and documented.

A further implication concerns the dependency on external data sources. For applications in which data is enriched or interpreted, connections are required with other systems, such as vehicle registration databases or additional data sources. This means that the availability and quality of this external data become part of system management. Failures, changes, or limitations in external systems may have a direct impact on the functioning of the WIM system and require agreements and alignment between involved parties.

There are also clear implications in the area of data accessibility and use. The value of the collected data is only realised when it is available for analysis, reporting, or operational applications. This requires a setup in which data is presented in an accessible and understandable manner, for example through dashboards or reporting tools. At the same time, it must be ensured that access to data is controlled and secured, in compliance with privacy and security requirements.

Cybersecurity and regulatory compliance form a structural part of management. WIM systems process potentially sensitive data and are connected to other systems, which makes them part of broader IT and data landscapes. This means that they must comply with applicable requirements in the area of information security and privacy. This is not a one-time configuration, but an ongoing process of monitoring, updates, and adjustments.

An important organizational aspect that emerges from the consultation is that the management of WIM systems requires specific knowledge and capacity. This concerns not only technical management of hardware, but in particular also data management, analysis, and interpretation. In practice, this responsibility lies largely with the commissioning asset management organisation and requires appropriate tools and expertise to assess data, interpret deviations, and steer systems. Without this capacity, there is a risk that data is collected but not effectively used.

Finally, it becomes clear that management and data configuration must be taken into account from the outset in the design of the system. Choices made at an early stage, for example regarding architecture and data collection, have direct consequences for management effort and complexity in the long term. This means that data and management should not be regarded as a derivative of technology, but as an integral part of the design challenge.

In summary, the consultation shows that the deployment of WIM systems leads to a significant management challenge in which data plays a central role. The effective functioning of the system depends not only on technology, but to a large extent on the way in which data is managed, validated, and applied. Data and management processes therefore form an essential part of the overall solution and are a determining factor for its success.

9 Confirmed and adjusted assumptions

The conducted market consultation has resulted in a number of important insights that on the one hand confirm existing assumptions, but on the other hand also give reason to adjust and refine these assumptions. What stands out in this regard is that many of the initial expectations with regard to WIM systems are partially supported by the market, but at the same time require nuance or correction on important points based on the practical experiences and developments brought forward by the various parties.

At the same time, the consultation makes clear that these adjustments do not mean that the market is in an early or underdeveloped stage. On the contrary, at the level of sensor technology and basic functionality, solutions are available that can be acquired and applied as products. The nuance lies mainly in the transition from product to application within an enforcement chain, where additional requirements and dependencies play a determining role.

First of all, the consultation confirms the view that WIM systems cannot be regarded as standalone technical solutions, but as integrated chain systems in which various components and processes converge. This concerns not only sensor technology, but also the processing of data, the interpretation of measurement results, and the legal assurance of outcomes. The discussions show that this chain approach is widely supported and that the success of a system is to a large extent determined by the coherence between these components. This confirms that a focus on technical specifications alone is insufficient to achieve a functioning solution.

It also appears that some market parties offer solutions that cover a large part of this chain in an integrated manner, whereby measurement, data processing, and presentation are delivered as a coherent system. This confirms that integrated solutions are technically available. At the same time, the effectiveness of these solutions remains dependent on the way in which they are embedded in the broader context of infrastructure management, data verification, and enforcement, meaning that the chain approach remains fully applicable.

At the same time, a number of assumptions are clearly adjusted. One of the most important adjustments concerns the expectation that WIM systems are relatively directly deployable for enforcement. The consultation shows that this assumption, in its original form, does not hold. Although the underlying sensor technology is in many cases available and in some cases certified, this does not apply to the entire chain. In particular, the software layer, data processing, and the legal embedding of the system appear in many cases to still be under development. In addition, it becomes clear that building trust in data is a process that requires time and cannot be skipped. This leads to the understanding that enforcement cannot be taken as a starting point, but rather forms the end point of a phased trajectory in which monitoring, analysis, and validation take place first.

It is important to distinguish that this limitation does not arise from the absence of functioning systems, but from the requirements associated with application within an enforcement context. For applications such as monitoring and pre-selection, systems appear in many cases to be directly deployable. The step towards enforcement, however, introduces additional requirements that cannot be fulfilled by the system alone, but are related to verification, legal assurance, and trust in the data.

A second important adjustment concerns the concept of accuracy. In earlier explorations, accuracy was often approached as a fixed property of a system, expressed in a certain class or standard. The consultation shows that this approach is too simplistic. Accuracy appears to be strongly dependent on the context in which the system is applied, including infrastructure quality, vehicle behaviour, and environmental factors. Moreover, this accuracy may change over time as a result of wear or external influences. This shifts the perspective from a static to a dynamic approach to accuracy, in which continuous monitoring and adjustment are required.

This does not mean that accuracy in existing systems is insufficient, but that the meaning of accuracy must be placed in the context of use. A system may demonstrably meet a certain accuracy class under specific conditions, but this performance remains dependent on the extent to which those conditions can be ensured and maintained in practice.

An important adjustment also takes place with regard to the scope of enforcement. Whereas a broad applicability of automated enforcement may have been assumed in advance, the consultation shows that not all vehicle categories can be included in the enforcement chain with the same degree of reliability. In particular, vehicles with deviating characteristics form a structural challenge. This leads to the insight that automated enforcement is by definition selective and that additional instruments remain necessary to achieve full coverage.

This insight also applies to solutions that are offered as integrated systems. Although these systems are capable of processing a large part of traffic automatically, there remains a category of vehicles for which additional interpretation or verification is required. The limitation therefore does not lie in the availability of systems, but in the complexity of the real-world context in which these systems are applied.

The discussions make clear that this additional processing does not constitute an exception, but a logical part of system application. In practice, this can be addressed by identifying such cases and handling them through follow-up checks, additional analysis, or alternative enforcement instruments. This makes it possible to process a large part of traffic efficiently and automatically, while applying additional care to specific situations.

Another important point of adjustment concerns the role of software and data. Whereas the initial focus often lies on hardware and sensor technology, the consultation makes clear that the main functionality and complexity shifts to the software layer. It is here that data is interpreted and where it is determined which information is ultimately used for enforcement.

At the same time, the level of maturity of this software differs between solutions. On the one hand, there are suppliers that offer advanced, product-based, and configurable platforms in which functionality is largely available and can be applied relatively quickly. On the other hand, there are solutions in which parts of the software functionality still need to be developed or adapted to meet the specific application.

This means that software cannot be regarded as a supporting component, but as an integral and determining part of the system. The extent to which further development and adjustment are required strongly depends on the selected solution and the way in which it is applied and configured within the chain.

At the same time, the consultation shows that a significant part of this software functionality is already available in existing solutions, particularly for applications such as data integration and monitoring. The extent to which this functionality is offered as an integrated part of a platform differs between solutions. In some cases, highly integrated systems are available in which data processing and application are largely standardised, while in other cases the implementation of this functionality depends on further configuration within the chain. The development component primarily lies in aligning this functionality with the specific requirements of the application, including enforcement, integration with external systems, and assurance of data quality.

In addition, the perspective on the cost structure is adjusted. The discussions make clear that the total costs of WIM systems are not primarily determined by the initial acquisition of hardware, but by costs over the entire lifecycle of the system. These include, among other things, maintenance, calibration, software development, and adjustments in response to changing requirements. In addition, organizational aspects, such as the availability of capacity and the configuration of processes, play an important role in the extent to which the system actually delivers value.

In this context, the availability of product-based solutions contributes to a certain predictability of initial investments, but variation in costs primarily arises in operation and use. Systems with comparable acquisition costs may in practice lead to significantly different total costs, depending on choices in architecture, data processing, scale, and management.

Finally, it is confirmed that cybersecurity and compliance cannot be regarded as one-time conditions, but must be seen as ongoing points of attention that need to be actively managed throughout the lifecycle of the system. This is particularly relevant for systems that process large volumes of data and involve integration with other systems.

In summary, the consultation leads to a shift in thinking about WIM systems. Whereas initially a relatively clearly defined technical solution may have been assumed, a picture now emerges of a complex and dynamic system that evolves over time and in which technology, data, organization, and policy are closely intertwined.

This shift does not mean that the challenge has become fundamentally more uncertain, but that it has been better defined. Where initially a technical implementation may have been assumed, it now becomes clear that achieving a functioning solution primarily lies in consciously combining and applying available building blocks within a well-organised chain.

These adjusted assumptions form an important basis for further decision-making and provide direction for the choices that need to be made in the possible configuration and application of WIM systems.

10 Use of the outcomes for further elaboration and decision-making

The insights from the market consultation have a direct and significant impact on the way in which possible next steps regarding WIM can be shaped. Whereas an initial approach might focus on a more clearly defined technical solution with predefined performance, the consultation makes clear that such an approach does not sufficiently reflect the nature of the challenge. Instead, a picture emerges of a complex, evolving chain solution in which multiple uncertainties and dependencies play a role, and in which design and configuration choices are decisive for eventual success.

At the same time, the consultation shows that this shift in approach does not arise from a lack of available solutions. On the contrary, systems and integrated solutions are available that can be applied as a whole. The need for a broader approach mainly lies in the fact that the performance of these solutions does not stand on its own, but depends on the way in which they are applied within a broader chain of data, processes, and use.

A first important consequence concerns the way in which the scope of a potential solution is approached. The consultation shows that it is insufficient to limit the challenge to the delivery and installation of measurement systems. The functioning of WIM largely depends on how data is processed, validated, and applied. This means that a solution should be considered in a broader sense, in which not only measurement, but also interpretation and assurance of data form part of the scope. The focus thereby shifts from hardware towards an integrated approach in which software, data quality, and chain configuration take a central position.

At the same time, this broader scope does not imply that all components need to be developed from scratch. In many cases, these aspects already form part of existing solutions. The challenge lies in selecting the appropriate degree of integration and aligning this functionality with the specific requirements of the application and the context in which it is deployed. In this regard, the choice between more product-based, integrated solutions and more modular or development-oriented approaches plays an important role, as this choice has a direct impact on the required effort for integration, management, and further development.

In addition, the consultation shows that there is a need for making fundamental design choices. In particular, in the area of system architecture, it appears that no single solution exists, but that different approaches each have their own advantages and disadvantages. The choice between central and decentralised data processing has far-reaching implications for data flows, management complexity, and flexibility. It is therefore important that these choices are made explicitly and substantiated, rather than implicitly resulting from a selected solution.

The consultation shows that suppliers often have implicitly embedded these choices within their systems. By making these choices explicit, it becomes possible to compare and assess different solution directions at this level, instead of focusing solely on individual technical components.

Another important aspect concerns the configuration of data quality and verification. As the consultation shows, data quality cannot be assured through predefined accuracy requirements or periodic calibration alone. Instead, it is a continuous process in which monitoring, analysis, and adjustment are necessary. This means that, in further elaboration, explicit attention must be given to how systems deal with uncertainties, how deviations are detected, and how data reliability is demonstrated over time.

At the same time, the consultation shows that uncertainties in measurements do not necessarily form a barrier to application, provided that they are explicitly taken into account in the design of the system and its use. This means that the deployment of WIM systems does not have to focus exclusively on maximising technical accuracy, but also on configuring the application in such a way that the reliability of outcomes is sufficient for the intended use.

In practice, this can be achieved, for example, by applying conservative thresholds or margins, whereby only situations with a clear exceedance are selected. This makes it possible to achieve consistent and defensible applications even in the presence of variation in measurement accuracy. This approach enables effective deployment of systems within a broader context, in which not all measurements need to be exact, but in which the reliability of selected cases is demonstrably sufficient.

In this regard, systems often already include mechanisms for data processing and validation, but their application introduces additional requirements in terms of transparency, reproducibility, and assurance. It is therefore important to consider not only the available functionality, but also the way in which it is applied and managed in practice.

The role of the pilot phase forms a crucial element in this respect. The consultation makes clear that a pilot cannot be regarded as an optional testing phase, but as an essential part of the development and validation of the system. In this phase, not only are technical performances assessed, but the chain is also configured, software is adapted, and trust in the data is built. This phase therefore has an iterative character, in which practical insights lead to adjustments and refinement of the solution.

The configuration of responsibilities within the chain also requires explicit attention. As the consultation shows, the performance of WIM systems depends on multiple factors and parties, ranging from sensors and software to infrastructure and external data sources. This makes it necessary to have clear insight into how responsibilities are allocated and how dependencies between different components are managed.

Even in solutions that are presented as integrated systems, these dependencies remain present. Although suppliers may cover a large part of the chain, the final functioning remains dependent on the environment and the way in which systems are used and managed.

Furthermore, account must be taken of the limited scope of automatic processing for all vehicle categories. As the consultation shows, not all vehicles can be processed with the same degree of reliability. This means that applications should be based on a clear delineation of situations in which reliability has been sufficiently demonstrated, and that additional approaches remain necessary for specific cases.

The discussions make clear that this delineation forms an inherent part of system configuration and does not constitute a barrier to application as such. In practice, this can be realised by focusing automated processing on vehicle categories and situations for which reliability can be demonstrated, while other cases are handled through additional verification, follow-up checks, or alternative enforcement measures.

In addition, network-wide insight offers opportunities to recognise patterns across multiple locations and to better handle variation in vehicle behaviour and measurement results. The use of applications such as soft enforcement is also mentioned, in which systems are used for signalling, warnings, and behavioural influence without direct sanctions.

This combination of delineation, additional processing, and phased application makes it possible to achieve an effective and manageable deployment of WIM systems, despite differences in processability between vehicle categories.

The insights from the consultation also have implications for the way in which location selection and network design are approached. Instead of a uniform rollout of identical systems, a picture emerges of a differentiated network in which different locations can fulfil different functions. This means that room is needed for location-specific tailoring and that explicit consideration must be given to the strategy behind the placement and deployment of systems.

This network setup can technically be realised using existing systems that are deployed across multiple locations and interconnected. However, the added value only emerges when these locations are actually used in coherence for analysis and verification, which requires an appropriate configuration of data and management processes.

Finally, the consultation calls for explicit attention to lifecycle costs and management. The discussions make clear that the largest costs and efforts do not lie in the initial implementation, but in the management and further development of the system. Aspects such as software updates, cybersecurity, calibration, and organizational capacity play a central role. This means that the deployment of WIM systems should be regarded as a long-term management challenge, rather than a one-time implementation.

In summary, the outcomes of the market consultation lead to a fundamentally broader approach to the challenge than may initially have been assumed. Instead of a clearly defined technical solution, a picture emerges of an integrated and phased approach, in which flexibility, cooperation, and continuous development are central. This approach aligns with the nature of the challenge as it emerges from the consultation and provides a solid basis for further decision-making regarding the potential deployment of WIM systems.

11 Concluding remarks

This final report forms a representation of the insights that are obtained during the market consultation and thereby marks an important moment in the exploration of possible next steps regarding WIM. The consultation results in a rich and nuanced picture of the possibilities and limitations of WIM systems, as well as of the complexity associated with their application in an enforcement context.

At the same time, the consultation shows that this nuanced picture does not arise from a lack of available solutions. On the contrary, systems and integrated solutions are available that can be applied at product level for measurement, registration, and in some cases also data processing. The identified complexity primarily relates to the application of these solutions within a coherent chain, and not to the availability of the technology itself.

What particularly stands out is that the challenge surrounding WIM cannot be reduced to a technical implementation, but manifests itself as a broader system issue in which technology, data, organization, and policy are closely interconnected. The discussions with market parties provide insight not only into the state of the technology, but also into the conditions required to achieve a robust and practically applicable solution.

It becomes clear that the technical building blocks are in many cases already available and that market parties are able to deliver these in coherence. The challenge therefore does not lie in the development of new technical solutions, but in the selection, combination, and application of these building blocks within a context in which organizational, legal, and policy aspects are also taken into account.

At the same time, the consultation shows that the added value of WIM systems is to a significant extent related to the scale and continuity of measurements. Whereas measurements in other contexts often take place at specific moments or locations, WIM systems make it possible to collect data on passing traffic in a structural and network-wide manner. This continuous data collection forms an essential basis for obtaining consistent insight into traffic behaviour, vehicle loading, and possible deviations from applicable standards.

In the discussions, this is regarded as an important precondition for scaling applications such as pre-selection and broader forms of use. Not so much the individual measurement, but rather the combination of frequency, distribution, and repeatability makes it possible to recognise patterns, detect deviations, and act in a more targeted manner. The application thereby shifts from incidental observations to structural and repeatable insight.

It also appears that the applicability of WIM systems, including for enforcement purposes, does not depend exclusively on maximum technical accuracy, but on the extent to which reliability in their application can be ensured. This can, among other things, be achieved by applying margins or selecting situations with a clear exceedance, allowing consistent and defensible applications even in the presence of variation in measurement accuracy.

Although the application of WIM systems is associated with a certain degree of complexity, the consultation shows that this complexity is an inherent characteristic of the challenge and can be managed through a phased and step-by-step approach. The availability of existing solutions and the possibility to apply these in phases provide an important starting point in this regard.

The picture that emerges from the consultation is therefore not that of a completed solution that can be directly applied, but that of a development direction in which choices must be made and in which room must be provided for further elaboration and validation. At the same time, the insights obtained provide sufficient guidance to direct next steps and to make targeted choices that align with the reality of the current market and technology.

In this regard, it is important to emphasise that this “development direction” does not primarily concern the further development of the technology itself, but the elaboration of application, configuration, and assurance of existing solutions within the Dutch context.

With the publication of this report, the aim is to be transparent about the way in which the input from the market is processed and what its significance is for possible next steps. In doing so, not only is reflection made on the insights obtained, but a forward-looking perspective is also provided on how these insights can guide the choices to be made.

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With this report, the consultation phase is concluded and a basis is established for further decision-making and possible next steps. This builds on the solutions available in the market, with the emphasis on achieving a coherent and manageable application rather than developing new technical components.