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A New Indicator for Measuring Efficiency in Urban Freight Transportation: Defining and Implementing the OEEM (Overall Equipment Effectiveness for Mobility)

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Featured Application: This work defines a KPI for the measurement of efficiency in urban freight transportation. It also develops a methodology that explains how to obtain data in real-time and the development of the programming language for the calculation of the previously defined KPI to, finally, visualize it in a control panel. This work serves as a basis for several companies to apply this methodology to the measurement of efficiency in their urban freight transportation activities.

Abstract: Urban freight transportation is the activity that has the greatest impact on urban areas in terms of sustainability and livability, and it is, therefore, necessary to reduce its impact. Currently, there is a lack of methodologies to validate the methods proposed by companies to reduce their impacts. The proposed methodology presents the implementation of a KPI (Key Performance Indicator) based on the triple bottom line approach: economic, social and environmental, since a company with good results on the "triple bottom line" will experience an increase in its economic profitability and its environmental commitment while reducing the impacts that generate negative perceptions of it. This KPI is the OEEM (Overall Equipment Effectiveness for Mobility), a redesign of the well-known OEE (Overall Equipment Effectiveness), but adapted to the needs of urban freight transportation since this indicator provides a quick overview of the efficiency or performance of the activity according to five components: quality of deliveries, vehicle utilization, availability of the vehicle–driver tandem and efficiency (result of traffic and efficiency of delivery stops). The methodology developed will be implemented in a case study where the KPI will be calculated on the basis of real-time data and visualized on a control panel; thanks to this KPI, the company will be able to validate whether the measures taken have a positive or negative impact.

Keywords: the key technologies of intelligent transportation; operating vehicle management system; traffic big data analysis; information acquisition system; 4.0 technologies; measuring efficiency in transportation

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1. Introduction

In increasingly turbulent and volatile markets, where competition is no longer just between companies but between global supply chains, organizations must act to improve their performance and competitiveness [1]. In such a context, transport management has become a key element in the strategic agendas of companies and governments, not only from an economic perspective of cost reduction and service improvement but also increasingly as a means of reducing resource consumption, carbon emissions and traffic congestion [2,3].

Urban freight transportation (UFT) is one of the main actors in the daily life of cities. New emerging business models, such as online sales, or traditional ones, such as physical trade and catering, have one important thing in common: their proper functioning could not take place without the support of a good distribution network since a good distribution network, compared to an inefficient distribution, allows to reduce costs and environmental impact [4] and to improve customer satisfaction [5]. The UFT is, therefore, a key link in the supply chain, but its influence goes much further due to its relationship with all the elements that make up the city [6].

In this respect, it is essential for companies to have resources that provide them with greater visibility into their logistics processes, enabling them to make decisions that contribute to optimizing their operations [7]. In addition, if companies want to maintain their competitive advantage, they must not only monitor the performance of their operations but also improve it. It is not always necessary to allocate resources to technology, equipment or facilities, but it is possible to increase process efficiency through sustainability-related improvements [8]. Consequently, the company needs to identify useful tools to measure the efficiency and productivity of a transport process in order to eliminate or reduce activities that do not add value to the process [9].

At present, there is a problem in urban freight transport as companies cannot measure efficiency because there are no efficiency meters in this area [10,11], so we will develop an indicator to measure efficiency in this sector.

OEE (Overall Equipment Effectiveness) is a concept commonly used in the industrial sector to measure the productivity and efficiency of equipment [12]. It is an essential indicator for companies that want to know their weak points or possible inefficiencies and implement improvement measures.

This concept of OEE can be extended, albeit with some adaptation, to other sectors, not only industrial. In recent years, a large number of research papers [13] have been published on OEE, as well as case studies, implementations and new adaptations of OEE. OEE has been adapted to the needs of industry in various areas, such as line manufacturing [14], mining equipment [15] and assembly tasks [16]. There are also studies where OEE losses are evaluated in terms of energy consumption losses (ECL) [17] and economic losses (Cost Loss Indicator (CLI)) [18].

In the logistics sector, there is no defined methodology for its calculation [19]. Although there has been a great deal of research, there is no consensus, and in fact, the concept has not yet been fully developed in this field. These studies have worked on the definition of an OEE for transport [8,20], where, instead of equating the vehicle with industrial equipment according to the classical concept of OEE, these studies focus on the analysis of the efficiency of each "route" individually [8] and on the analysis of the efficiency of the loading and unloading process of a truck [20], where it is observed that the efficiency does not depend only on the efficiency of the vehicle but also on that of the driver or that derived from other external factors.

However, the OEE concept presented in both studies is designed for medium-distance logistics, and given the significant differences with UFT, it is not possible to apply such an OEE to the route of a medium-distance truck. Due to the above limitations, this study aims to develop its own proposal of OEE applicable to UFT, consisting of five indicators, thus integrating all possible variables to provide companies with a tool to monitor and improve their processes.

Our research aims to design and calculate a new KPI based on the OEE theory (Six Big Losses) called OEEM (Overall Equipment Effectiveness for Mobility). This indicator is designed and calculated for real-time calculation and displayed on a dashboard. The OEEM provides a quick overview of the efficiency or performance of the activity according to five components: quality of deliveries, vehicle utilization, availability of the vehicle–driver tandem, efficiency as a result of traffic and efficiency at delivery stops.

As part of the challenge of accelerating the digitalization of companies, this study moves the proposed OEEM to a unique tool that allows user interaction and operates in an automated way in real-time. This tool, designed and programmed in its entirety, allows the input of data by the driver through an M5Stack wireless device, the consultation of external data in real-time, the automatic calculation of indicators through a program written in the Python language and the visualization of all this in an intuitive dashboard on the Grafana platform. This tool is a solution that can be immediately adopted by any company in the UFT sector, offering very new functionalities in this sector and, therefore, representing an important added value, and it is easily adaptable to other distribution models.

This paper is organized as follows: In Section 2, the methodology followed is explained, where the OEEM indicator is theoretically defined, the formulas of the OEEM and the indicators that form it are developed, and, finally, the methodology used for data acquisition and processing is described. In Section 3, a case study is carried out where the concepts explained in the previous section are put into practice, and the results are visualized in a control panel. In Section 3, a case study is carried out where the concepts explained in the previous section are put into practice, and the results are visualized in a control panel, and, finally, Section 4 develops the conclusions of this study and the future lines to be followed after the development of this research.

2. Materials and Methods

2.1. Theoretical Definition of OEEM

The OEEM is a concept that allows measuring the productivity and efficiency of vehicles in the delivery of goods. It is an essential indicator for those companies that wish to know their weak points or possible inefficiencies and implement improvement actions. This KPI follows the triple-bottom-line approach: economic, social and environmental [21] (Figure 1). In other words, improving the value of this indicator will eliminate or reduce process losses, resulting in both an economic and environmental improvement of the process. Consequently, this will lead to a better social perception by society. This is due to an improvement in the efficiency of the process, which translates into time savings, improved distribution to avoid bottlenecks and fuel savings.

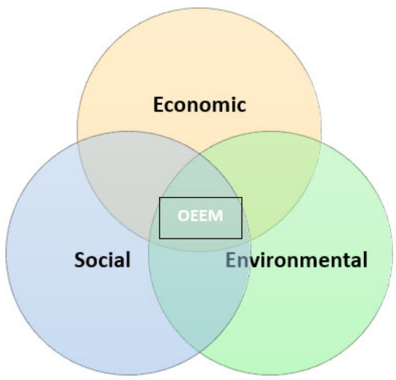

Figure 1. Venn Diagram for Indicators.

The proposed methodology is based on the OEEM calculation, a redesign of the well-known OEE, but adapted to the needs of the UFT.

OEE in the industrial sector is calculated using Nakajima's six major losses [22], defined as activities that consume resources without adding value [12] by multiplying the following three indicators in percentage format: availability (equivalent to productive time vs. theoretical availability), yield (related to units produced vs. units expected in productive time) and quality (reflecting the percentage of defective units) [23].

In the logistics sector, there is no defined methodology for its calculation, so it has been necessary to develop an OEE applicable to UFT activities (OEEM), integrating all possible variables to provide companies with a tool to monitor and improve their processes.

Research has been carried out [8,20] to define an OEE (Overall Equipment Efficiency) adapted to transport, focusing on the analysis of the efficiency of individual routes and the loading and unloading process of trucks. These studies do not consider the vehicle as a traditional industrial equipment in the classical OEE concept. It is recognized that transport efficiency depends not only on the vehicle but also on external factors and driver efficiency. However, these OEE concepts are specifically designed for medium to long-distance logistics and are not applicable to UFT. Due to these limitations, a new OEE adapted to UFT is proposed, consisting of five indicators.

Next, we develop our own OEE proposal applicable to UFT, consisting of five indicators divided into three blocks (Figure 2), following Nakajima's methodology in OEE [20] (Figure 2).

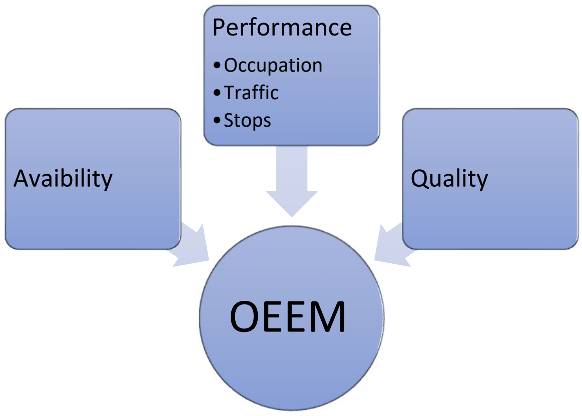

Figure 2. Components of the OEEM.

For the definition of the OEEM, a sheet has been drawn up showing its main characteristics. This is based on the descriptive table model for the definition of KPIs that appears in the ISO 22400 standard [24].

2.1.1. Availability

This indicator is very similar to that used in the industrial sector or medium- and long-distance logistics. In a factory, it is understood as the time during which a piece of equipment is available, excluding the time during which it is stopped due to breakdowns or the unavailability of personnel if this is the case [4]. In the case of UFT routes, this availability can also take into account the times when the vehicle is stopped, either due to a breakdown (puncture, failure to start, etc.), weather conditions that prevent driving, an accident in which the vehicle is involved or due to the unavailability of the driver (answering a call, personal errands, etc.). All of these unforeseen events are classified as unplanned stops. It is important to note the difference between planned stops (those related to the parcel delivery task) and those that are part of the route (traffic jams, traffic lights, etc.), which are also measured but do not affect this indicator. This indicator is characterised in Table 1.

Table 1. Availability indicator.

Indicator Availability (A)		**Units** %	**Type** Actual Time
Description	Displays the % of the total shift time that the vehicle is available		
Formula	$A = [1 - (DSNP/DT)] * 100$		
Variable	**Units**	**Description**	**Source**
DurationTurn (DT)	Minutes	Time elapsed from the start to the end of the shift	Input User
DurationStopsNotPlanned (DSNP)	Minutes	Unavailable time	Input user

2.1.2. Index Occupation

The index of vehicle occupation is one of the most important indicators to work on in order to reduce transport costs. The best possible use should be made of the capacity of the delivery vehicle, provided that the fleet is correctly sized in terms of both number and capacity. Inadequate sizing can lead to serious inefficiencies, such as the need to run extra routes if capacity is insufficient or exorbitant transport costs per parcel if capacity is excessive. It is difficult to determine the level of utilization, so it is suggested that an average volume per parcel should be used as an estimate. This indicator is characterised in Table 2.

Table 2. Index Occupation Indicator.

Indicator			**Units**	**Type**
IndexOccupation (IO)			%	Pre-route
Description	Displays the % utilization of the total capacity of the vehicle			
Formula	IO = (OPR ∗ VMP/VC) ∗ 100			
Variable	**Units**	**Description**		**Source**
VehicleCpacity (VC)	m^3	Vehicle storage volume		Technical data
ObjectivePackagesRoute (OPR)	Uds	Number of packages to be delivered on the route		Input user
VolumenMediumPackage (VMP)	m^3	Average volume occupied by type of packages transported		Input user

2.1.3. Efficiency Traffic

The calculation of this indicator is essential to quantify how the service has been affected by unforeseen traffic incidents or congestion, driver actions such as failing to follow directions or other driver and vehicle-specific actions, such as excessive or lack of fluidity in driving. Although these are variables that could be monitored more specifically by other GPS technology tools, this indicator quantifies the existing margin for improvement, which can be a first step to initiate a more in-depth analysis and search for solutions to improve the index. To calculate this indicator, only the time taken by the vehicle to travel from the start of the route to each of the locations where it has to stop to make one or more deliveries is taken into account. This is then compared with the forecast based on current traffic conditions provided by a navigator such as Google Maps, Waze or other professional tools. Time spent on both planned and unplanned stops is therefore excluded. In order to facilitate subsequent planning and to be able to obtain the value in real time, it was decided to use the route duration per parcel for the calculation. This indicator is characterised in Table 3.

Table 3. Efficiency Traffic Indicator.

Indicator			**Units**	**Type**
EfficiencyTraffic (ET)			%	Actual Time
Description	Shows the performance of the vehicle in making the trips derived from the resulting from the delivery			
Formula	ET = [1 − (DRP/DRRP)] ∗ 100			
Variable	**Units**	**Description**		**Source**
DurationRoutePackage (DRP)	Minutes	Estimated travel time invested per package		Script
DurationRealRoutePackage (DRRP)	Minutes	Actual travel time invested per package		Script

2.1.4. Stopped Efficiency

In the case of UFT, the interruptions along the route (stops) to make deliveries are significantly different compared to traditional medium- and long-distance logistics, where the loading/unloading process only takes place at the end of a route that can last hours. In the case of UFT, the multiple stops and the fact that the total duration of the stops can be even longer than the time spent traveling along the route make it essential to include an indicator to evaluate the driver's performance in this regard, whether the determination of the locations where the stop should be made was adequate or whether the driver had to make an excessive journey on foot to complete one of the deliveries associated with that location. It also makes it possible to take into account the difficulty of finding a parking space and the resulting delays, including the time spent looking for a parking space.

This duration of planned stops has been defined per package. It is crucial to set the target stop time per parcel correctly in order to obtain a realistic result that does not override the influence of the other OEEM indicators. This indicator is characterised in Table 4.

Table 4. Stop Efficiency Indicator.

Indicator		**Units**	**Type**
StopEfficiency (SE)		%	Actual Time
Description	Displays performance in completing planned package delivery stops		
Formula	SE = (TTSP/ASTP) − 100		
Variable	**Units**	**Description**	**Source**
TheoricalTimeStopPackage (TTSP)	Minutes	Planned planned downtime invested per package	Script
ActualStopTimePackage (ASTP)	Minutes	Actual planned downtime spent per package	Script

2.1.5. Quality

The service quality indicator also allows a different perspective from that of traditional logistics. Whereas in traditional logistics, delivery times are strict, and maintaining the condition of the product is a challenge, UFT is not affected by these constraints: delivery times are set by the company and, because the routes are short and slow and the products are individually packaged, the possibility of damage to the goods is reduced. In UFT, the focus is on the relationship with the customer, and the main inefficiency is the number of packages that cannot be delivered, usually because the address is wrong or the customer is not at home. Tracking the number of undelivered parcels allows the company to evaluate the final stage of its service and assess the adoption of measures such as better communication with customers to avoid these situations since the remaining stages are wasted and have an even more negative impact on the company's objectives if the latter is not completed. This indicator is characterised in Table 5.

Table 5. Quality Indicator.

Indicator		**Units**	**Type**
Quality (Q)		%	Actual Time
Description	Displays the % of packages delivered successfully		
Formula	Q = 1 − (PDF/OPR) ∗ 100		
Variable	**Units**	**Description**	**Source**
PackagesDeliveredFailed (PDF)	Minutes	Number of packages whose delivery has not been completed	Input user
ObjectivesPackagesRoute (OPR)	Minutes	Number of packages to be delivered on the route	Input user

2.1.6. OEEM

As a result of the combination of the variables defined above, the OEEM is obtained, The characterisation of the indicator can be seen in Table 6.

Table 6. OEEM Indicator.

Indicator		**Units**	**Type**
OEEM		%	Actual Time
Description	Shows the % of OEEM referred to the delivery service.		
Formula	OEEM = A ∗ ET ∗ SE ∗ IO ∗ Q		
Variable	**Units**	**Description**	**Source**
PackagesDeliveredFailed (PDF)	Minutes	Number of packages whose delivery has not been completed	Input user
ObjectivesPackagesRoute (OPR)	Minutes	Number of packages to be delivered on the route	Input user

2.2. Data Acquisition Methodology

2.2.1. Implementation Scheme

Once the OEEM has been defined, the final step is to develop a tool to which the previously defined indicators can be transferred. To be truly useful, this tool should have the following characteristics: it should allow user interaction, it should be able to extract data and update the indicators in real-time, and it should display them in an accessible and visual dashboard.

In the end, the integration of three different tools was chosen according to the following scheme because they fully met the defined requirements, because of the future development possibilities they offered and because the necessary hardware was provided by the Department of Design and Manufacturing Engineering of the University of Zaragoza.

Because of the future development possibilities they offer, we have chosen to integrate three different tools using the following scheme (Figure 3).

Figure 3. Implementation scheme.

(1) Input → M5Stack: it is a programmable device based on an ESP32 processor with a Wi-Fi connection that allows data input by the user.
(2) Modeling → Pycharm: It is a code editor in Python language. Through the programming of multiple scripts, the data entered in the M5Stack device are obtained, data are extracted in real-time through HTML code from various websites, and these data are processed for the calculation of the indicators and sent to a viewer.
(3) Visualization → Grafana: it is a metric data visualization and formatting software that allows the creation of dashboards from the calculated indicators.

2.2.2. Data Input via M5Stack

Obtaining quality data in real-time is the main pillar on which a tool such as the one developed in this study is based, which is guaranteed by the use of an M5Stack device.

In this case, an "M5Core2" device has been used, which, in addition to the Wi-Fi connection, has a touch screen and a "FACES" keyboard, thus increasing the possibilities for data entry.

With this device, it is possible to record in real-time six basic variables for calculating the indicators: "Target Route Packages", "Packages Delivered", "Packages Delivered Failed", "Shift Duration", "Planned Stops Duration" and "Unplanned Stops Duration".

2.2.3. Modeling of the OEEM Using Python

The modeling consists of transferring the whole proposal of indicators to an automated calculation tool. Of all the existing programming languages, we have chosen Python because it is currently one of the most widely used and because it is open source, so there are many resources to consult. In addition, Pycharm, as an editor, also supports the loading of several libraries containing preprogrammed scripts that can be called from the main code and are useful for various purposes.

The calculation algorithm carried out in Python follows the following scripting scheme, Figure 4.

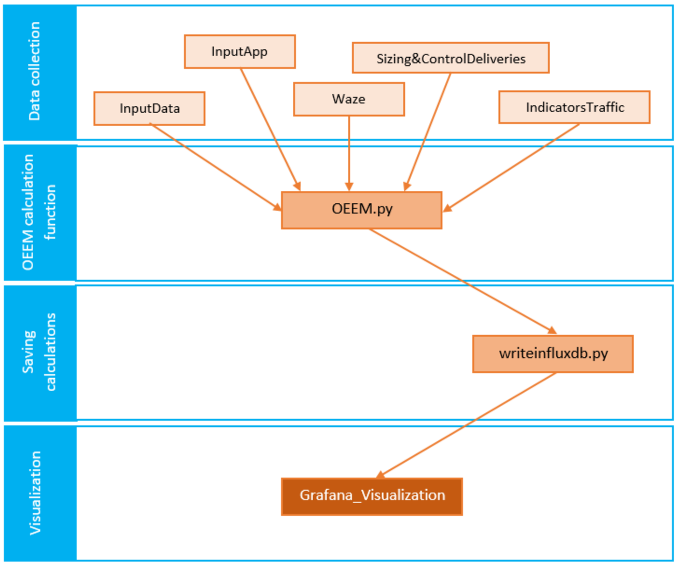

Figure 4. Scripts scheme.

The main features of each are described below:

- "InputData" script: Includes predefined constants such as delivery addresses or packet volume.
- "InputAPP" script: Allows the import of data entered in the M5Stack device by launching an API request to the MQTT server where the data are stored.
- "Waze" script: It is based on the use of the "Geopy" library for the conversion of the entered delivery addresses to coordinate points. These are used by means of the "WazeRouteCalculator" library for the calculation of expected and ideal route times and distances in a traffic-free situation. This allows the creation of a new indicator, "CongestionTraffic", that reflects whether the route to be taken has lower or higher than normal traffic.
- "Sizing&ControlDeliveries" script: It performs, from the data coming from the M5Stack device, the continuous calculation of the pending packages and the vehicle occupancy.
- "IndicatorsTraffic" script: It allows obtaining the traffic situation data from the DGT website by means of the "web scrapping" technique. The "BeautifulSoup" library is used to access the HTML code, a markup language that indicates the structure and content of the web page. Using Python functions, the data from all the active traffic sensors is extracted from the HTML code and used to calculate the average of each indicator of the traffic situation on the ring roads.

2.2.4. Visualization of the OEEM Using Grafana

Using Grafana, the selected visualization tool, a dashboard has been designed for the visualization of the OEEM, this dashboard displays the information in a simple and visual way. This dashboard is hosted on a web IP accessible only to registered users, where they can navigate through the different screens depending on the information they are interested in accessing.

As for the programming of the tool, for each indicator to be displayed, a call is made to the data calculated in Python, and the output format (bar chart, pie chart, data table, individual data) or other options (custom units of measurement, color scales, rounding) are configured. In general, it is important to focus on an intuitive and visual design of the dashboard, as well as to configure the update frequency of the indicators (the minimum available is 5 s).

3. Results

3.1. Description of the Use Case

The definition of the OEEM and its characterization for the creation of a visualization tool was based on a specific case to evaluate its performance. However, all the variables mentioned below are fully configurable by the user according to his needs. The tool is applied to a petrol engine van whose main activity is home delivery of parcels. Specifically, the 100 hp petrol Opel Combo Cargo was chosen, and its data sheet was used to obtain data such as capacity (3.6 m^3) [25].

The city of Zaragoza was chosen as the location, although the tool could easily be adapted to any other city since the data sources used are universal and not exclusive to the city of Zaragoza and to any other type of vehicle (from cyclocargos to electric vans), with only the modification of some parameters.

Finally, other predefined data used are the average size of each parcel (0.055 m^3) and the delivery route. The route starts from the Plaza Industrial Park (Zaragoza Logistics Platform), stops at three locations in the city center to deliver parcels, and returns to the starting point.

Through the execution of the specific case study, the operation of all the elements that make up the tool is demonstrated. The result that can be visualized by the user on the M5Stack device for this case can be summarized in the following phases:

(1) Initial screen (Figure 5): Allows the introduction of the variable "Target Packages Route" through the keyboard. It could also be enabled through the screen if you prefer to perform without it.

Figure 5. M5Stack. Initial screen.

Once the packet target has been entered, the user can start the route ("Start Route" button) (Figure 6).

Figure 6. M5Stack. Initial screen (start route).

(2) Main screen: The "Shift Duration" counter is started. The six variables that are recorded with this device are displayed in the upper part. In the central part there are buttons to access the rest of the menus and to start or stop counters. This information is shown in Figure 7.

Figure 7. M5Stack. Main screen (start route).

(3) Planned stop screen: When starting a planned stop (button "Start P. Plan"), the counter of the variable "Duration of Planned Stops" is started, while the counter of "Shift Duration" continues running. Its menu is accessed and new buttons are displayed (Figure 8).

Figure 8. M5Stack. Planned stop screen.

As can be seen in Figure 9, the 'Packages delivered' and 'Packages not successfully delivered' buttons increment the 'Packages delivered' and 'Packages not successfully delivered' variables. The count of the "Packages delivered" and "Packages not delivered" variables is incremented and updated immediately in the variables displayed in the upper area. The user can carry the device with him to record each delivery one by one, or do it when he returns to the vehicle.

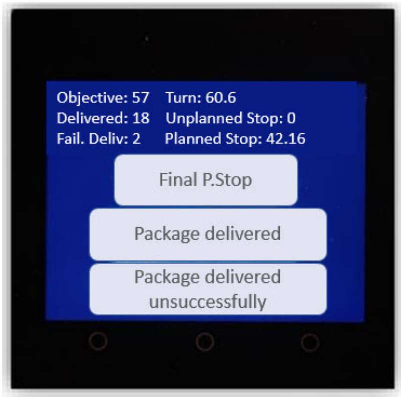

Figure 9. M5Stack. Planned shutdown screen (delivery log).

At the end of the stop, by pressing the "End P. Plan" button, the counter of the "Duration of Planned Stops" variable is stopped, and you return to the main menu (Figure 10).

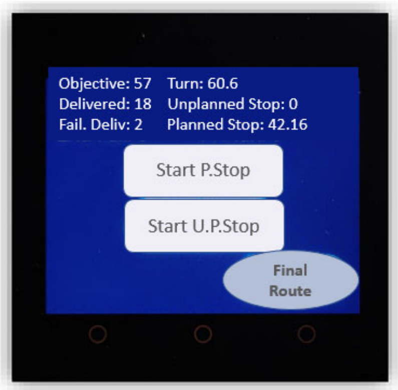

Figure 10. M5Stack. Main screen (after planned shutdown).

(4) Unplanned stop screen: When initiating an unplanned stop ("Start P. No Plan" button) (Figure 11) accesses its menu and starts the "Duration of Unplanned Stops" counter.

Figure 11. M5Stack. Unplanned shutdown screen.

(5) Final screen (Figure 12): All variables continue to be recorded during the course of the route.

Figure 12. M5Stack. Main screen (final route).

The "Route End" button stops the counter of the "Route Duration" variable and takes you to the final screen for displaying the variables (Figure 13).

Figure 13. M5Stack. Final screen.

When each button is pressed, a short sound, fully configurable, is emitted as a confirmation.

At any time, you can reset all variables and return to the initial screen by pressing for three seconds the central red button located in the black margins of the screen (see Figure 5).

The final objective is to connect all the data entered by the user to the indicator calculation engine. This is done using an MQTT (Message Queuing Telemetry Transport) server, which is a lightweight messaging protocol for exchanging messages between devices with limited memory or bandwidth. M5Stack itself includes the ability to program the server to which these data are to be sent using Blocky. The ThingSpeak platform was used to generate the MQTT server, as it has a free plan for exchanging up to three million messages, allows the creation of private channels for storing variables and supports API (Application Programming Interface) requests, which act as an interface between applications, in this case for sending data to Python. The value of the variables is continuously updated on the MQTT server (and, therefore, in Python) at the same time as on the M5Stack device. Below is the last variable update for the above case study, which takes place at path completion time (Figure 14).

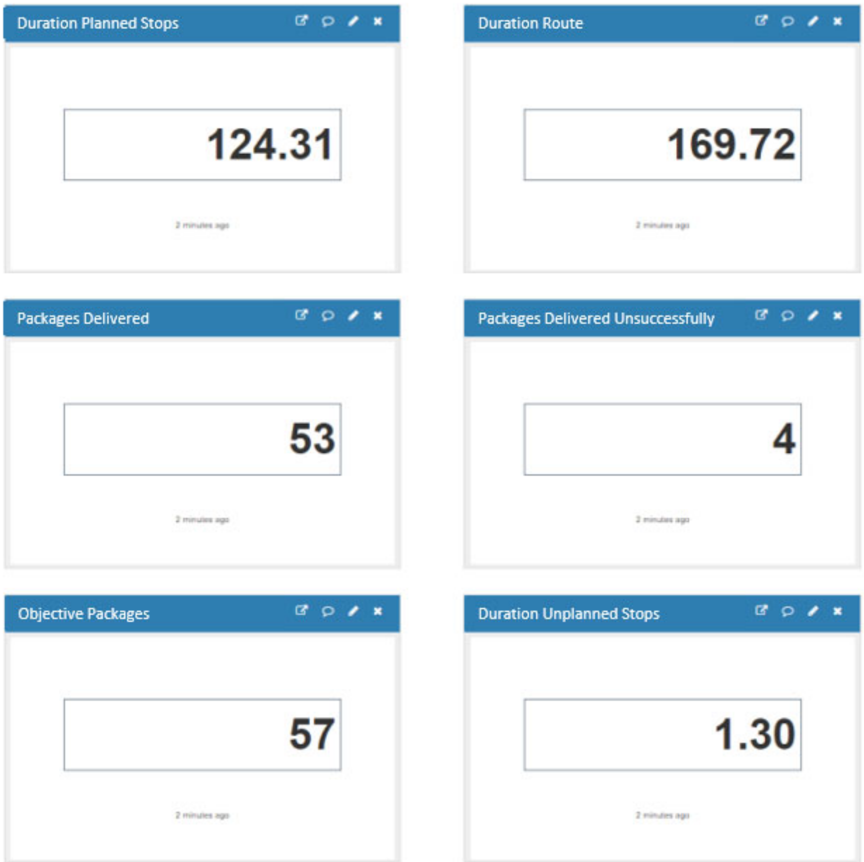

Figure 14. ThingSpeak. MQTT variable storage server.

3.2. Results

The following control panel (Figure 15) shows the OEEM (%) and the percentages of the five influential factors in the calculation of this indicator in order to visually identify which factor is the most problematic and to act on it.

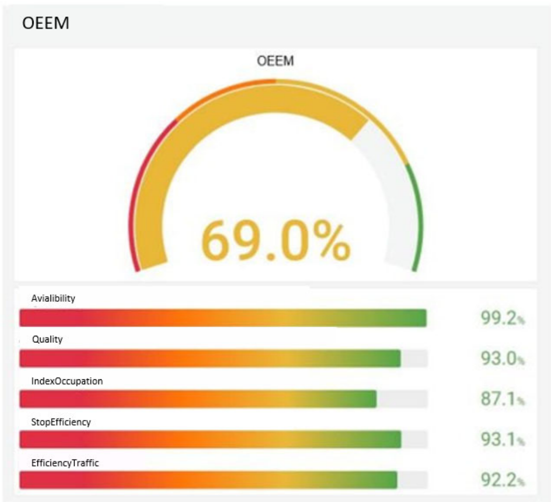

Figure 15. Grafana. OEEM Dashboard.

A color scale was established to evaluate the OEEM and its components according to the following intervals: 0–30% red (very poor), 30–50% orange (poor), 50–80% yellow (good), and >80% green (very good). Thanks to the color scale, it is easy to see visually which indicator has the greatest negative impact on the OEEM and thus to take measures to improve it and also to check whether these measures have a positive or negative impact by comparing it with the previous value.

In addition, this dashboard was developed in such a way that, in addition to visualizing the OEEM value, the parts that make up this indicator are displayed so that it is possible to visually identify which indicator is contributing the most negatively and work on it to improve it, thus improving the OEEM value, i.e., the overall efficiency of the process.

This dashboard is able to present all the information obtained from the data in a different way, in real-time, in order to support decision-making. These visualizations need to be detailed, but at the same time, they need to convey the information in a simple way. Therefore, when designing a dashboard, it is not better because it displays a greater number of indicators but because of the quality of these indicators [26].

The following dashboard (Figure 15) shows the OEEM (%) and the percentages of the five influencing factors in the calculation of this indicator in order to visually identify which factor is the most problematic and to act on it.

4. Discussion and Conclusions

Nowadays, the industrial sector is constantly looking for improvement methods, especially when it comes to repetitive processes, one of which is the calculation of efficiency, of which OEE is the most common calculation to obtain its value. In addition to calculating efficiency, measures and approaches are being developed to eliminate process waste, i.e., activities that do not add value.

In the field of transport, the question arises as to why not calculate efficiency and find a way to eliminate process losses; so in this study, the OEE concept has been redesigned to define OEEM, which is based on OEE, but in this case, is made up of five components, grouped into the three groups that make up traditional OEE.

The first success of this study was the calculation of an indicator that measures the efficiency of the DUM, and this indicator was defined according to the ISO 22400 [24] standard, where for each indicator that makes up the OEEM and for the OEEM, a sheet has been prepared in which its main characteristics are reflected. In addition, this indicator has been designed to be applicable to any vehicle and any city.

The second success of this study is the development of a methodology that explains the acquisition of data in real-time, thanks to the manual input by the driver on the M5Stack device and its modeling in Python. As in the first success, this methodology has been developed to be applied to any vehicle and any type of distribution in different cities.

The third success of this study is to transfer this theoretical definition and methodology to a practical case where the OEEM has been digitized by creating a dashboard through Grafana; this platform was chosen because it is an open-source tool that provides a user interface to analyze data and create graphs and visual elements from them. This dashboard visualizes not only the OEEM but also the five indicators that make up the OEEM. As can be seen in the case study, once the equations have been developed and implemented, the real-time calculation is immediate, thanks to digitalization.

Thanks to the calculation and digitization of the OEEM, it is possible to measure the efficiency of a vehicle in a given delivery activity, and also, thanks to the calculation of the five OEEM indicators, it is possible to evaluate more specifically which indicator has a low value and to take measures to improve the OEEM, i.e., to try to adopt approaches based on the elimination of activities that do not add value. Furthermore, by calculating the OEEM, it is possible to check whether the measures taken have a positive or negative impact.

Therefore, also in line with what is proclaimed in the SDG 2030, the UFT must be analyzed from the point of view of the so-called "triple bottom line": economic, social and environmental, since a company with good results based on the "triple bottom line" will experience an increase in economic profitability and its environmental commitment, while reducing the impacts that generate a negative perception of this [21]. Therefore, this new KPI, based on the triple bottom line approach: economic, social and environmental, is a key indicator for the continuous improvement of the UFT and an advantage for companies.

The limitations of this study were, first of all, that no similar indicator was found for UFT, so we had to think about how to define it, as well as solve the problem of how to obtain quality data that would not involve a great deal of effort for the drivers. Once these limitations had been resolved, the last issue was how to handle this data and how to create a control panel so that the client could see it in an intuitive and simple way.

This research does not stop at the definition of the OEEM; we will continue to study both the definition of the indicators and the technical implementation of the tool. This study is carried out with the purpose of being able to give it a continuation and aims to serve as a starting point for future parallel developments in several directions.

On the definition of indicators: This study makes its own proposal of OEE for UFT, but the existing bibliography on this concept is limited, so it is worth continuing to analyze in-depth new indicators or other ways of calculating them that provide added value.

In addition, indicators will continue to be defined in order to improve the efficiency of the UFT and thus improve the UFT in economic, social and environmental terms.

The M5Stack device was chosen for data entry because it allows interaction with the user, one of the essential requirements of the tool, but this method can lead to inaccuracies due to human error, as well as take up some of the workers' time with manual data entry. As a future line, it is proposed to continue the research to obtain automated data by incorporating sensors in the vehicle control unit so that it can automatically and more reliably record the moments when the vehicle stops, when the driver gets out of the vehicle or other data that allow monitoring the state of the load (temperature, humidity, vibrations). The study of these sensors or other modules available for the M5Stack is a possible object of study that would allow us to obtain more and more accurate data and calculate the proposed KPI without the interaction of the driver.

Finally, the data visualization tool chosen for this study is the Grafana tool, which offers a large number of configuration options that can be explored for better visualization of the indicators by the user, i.e., the control panels will continue to be developed with the new indicators defined in order to continue to offer the customer information that can be analyzed in a simple and visual way.

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Conflicts of Interest: Authors Paula Morella and Juan Carlos Sánchez were employed by the company TECNALIA. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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