Terms of Reference

Optimisation of Routes

Project:

Business Cases for Improved Waste Collection and Valorisation

Optimise Waste Collection Routes

in Your Municipality

October 2019

CONTENTS

1 INTRODUCTION

Waste collection is a functional element of the waste management system and involves the transfer of solid waste from the point of its use and disposal to the point of its treatment or landfill. The most important reason for waste collection is the protection of the environment and population health, however, at the same time, it provides a logistical framework and a precondition for the separation of recyclable materials from waste. The subsequent activities in the waste management system such as waste transport, separation, recycling, treatment and disposal, significantly depend on the waste collection efficiency.

Low coverage of either urban or rural population by waste collection services leads to various environmental threats caused by uncontrolled waste disposal. The transposition of the EU waste management legislation (Waste Framework Directive and Landfill Directive) into the national laws have somewhat improved the sector situation in the Western Balkans, but population's access to this type of services in some municipalities is still low compared to EU members.

Given that the waste generation scheme is becoming more and more complex, and that the total quantity increases as a result of economic development growth in the region, the logistics of waste collection and transportation is becoming more complicated. As one of the costliest operations in the waste management system, waste collection must be well analysed and planned.

Public Utility Companies responsible for waste collection are usually faced with problems due to their chronic lack of financial means. This mainly results in outdated collection and transportation vehicles, insufficient number of collection workers compared to the real needs and relatively low salaries in this sector. Cost reduction and extension of waste collection services are possible through a detailed analysis and planning of this process, reflected in the optimisation of the collection process (routing, collection frequency, optimal number of workers), use of adequate equipment (selection of collection vessels, vehicles of adequate volume), distribution and accessibility to containers and bins, etc.

By the implementation of **route optimisation,** the following benefits could be achieved: increased waste collection rates, improvement of communal services and customer (citizens') satisfaction, creation of a logistical framework for the separation of recyclable materials from waste, reduction of waste collection costs (fuel, tyres, spare parts, maintenance etc.). The benefits will be further elaborated in a separate part of this document.

German Development Cooperation implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), through the Project Open Regional Fund – Modernisation of Municipal Services (ORF MMS) aims to support local authorities and public utility companies to provide better and higher quality waste management services in Southeast Europe.

In this context, the Project: Business Cases for Improved Waste Collection and Valorisation, with the Partner Projects GIZ Climate Sensitive Waste Management (DKTI) and GIZ Sustainable Municipal Services (SMS), as well as with partner organizations Network of Associations of Local Authorities of SEE (NALAS) and Serbian Solid Waste Association (SeSWA) has developed a methodological approach (Terms of Reference – ToR) for the introduction/optimisation of five (5) business processes:

1. optimisation of routes,
2. home composting,
3. cost centres,
4. health & safety, and
5. customer base.

This model has been developed by the Project "Business cases development for improved waste collection and valorization", implemented by the GIZ Open Regional Fund for South East Europe - Modernisation of Municipal Services, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). The Project was implemented in Western Balkan partner economies, in the period October 2017-October 2019, in partnership with the Serbian Solid Waste Association (SeSWA) and the Network of Associations of Local Authorities of South East Europe (NALAS).

Routes optimisation as one of the piloted business processes has been piloted in the city of Šabac, Bijeljina, Bitola and Kumanovo.

The purpose of this document is to describe the methodological steps for application of a waste collection routes optimisation process, which can be implemented either by the Local Governments and their Public Utility Companies, if they possess enough internal capacities and expertise, or by outsourcing advisory services specialised in this kind of tasks. In this respect, the process complexity needs to be considered, as well as the fact that its implementation requires extensive knowledge of data management, use of specific indicators, application of GIS (Geographical Information System) based route optimisation tools and possession of licensed software. In the case of outsourcing, the document's content and structure provides good understanding of the process, activities required and outputs expected from the Advisor, and the document allows for easy derivation of Service Terms of Reference.

2 OBJECTIVE

This TOR objective is to provide guidelines on the implementation of waste collection route optimisation and thus achieve economic efficiency for PUCs, better service for citizens and positive environment and health.

3 BENEFITS OF WASTE COLLECTION ROUTE OPTIMISATION

Route optimisation is a process of planning one or multiple routes, with the purpose of minimizing overall costs, while achieving the highest possible performance under a set of given constraints. It combines routing or route planning, which is the process of creating the most cost-effective route by minimizing the distance or travelled time necessary to reach a set of planned stops, and route scheduling, which is the process of assigning an arrival and service time for each stop, with drivers being given shifts that adhere to their working hours.

Upon the implementation of route optimisation, the following benefits can be expected:

- Reduction of waste collection costs (improvement of economic efficiency)

  The optimisation of waste collection routes leads to an increase in waste collection efficiency by reducing the costs for fuel, tyres, spare parts and maintenance per ton of waste collected. This means that the same quantity of waste will be collected with fewer kilometres driven. By the reduction in length, vehicles will spend less fuel and tyres, and associated oil and spare parts.

- Reduction of waste collection time

  The increase in waste collection efficiency leads to a waste collection time reduction. Route optimisation means to avoid routes overlapping and eliminate dislocated waste collection points, which would also result in the reduction of time spent for waste collection that can consequently lead to a reduced number of vehicles and workers serving them. This benefit is obvious by following the reduction in kilometres covered or work hours spent per ton of waste collected.

- Protection of the environment and population health

  Waste collection vehicles have a great environmental impact. By increasing waste collection fuel efficiency, less exhaust gasses would be emitted, less tyres, oil and brake shoes would be spent resulting in lower pressure on the environment. Consequently, the reduction in air pollution as a result of more efficient waste collection can also lead to fewer chronic and acute respiratory diseases in the PUC workforce and in the general public. This benefit can be expressed through the reduction of CO_2 emitted per ton of waste collected.

- Improvement of communal services and customer (citizens') satisfaction

  By optimizing the system for waste collection and transport, communal services will be improved. It would lead to a clean environment and if communicated properly, to the satisfaction of citizens in the municipality.

- Creating a logistical framework for the separation of recyclable materials from waste

  In order to increase the recycling rate, separate collection of recyclables is desirable. It requires waste collection vehicles for recyclable waste that collect the recyclables separate from other waste. More recyclable components that are collected separately will multiply the above-mentioned benefits if the waste collection routes for recyclables are optimised.

4 WASTE COLLECTION ROUTE OPTIMISATION METHODOLOGICAL APPROACH

In order to introduce waste collection route optimisation in an environmentally friendly way as for the benefits stated above, municipalities and their utility companies should be advised and guided to perform the following activities.

4.1 Preparatory activities

Thorough and comprehensive optimisation of waste collection routes based on the advisory service can take place only if there is a substantive level of awareness and a clear political will shown by decision-makers at the local level, both in local governments and PUCs, to get engaged in this kind of process. Obtaining political backing for this process and ensuring willingness of decision-makers at company and local government level to support such approach should be the first step in the process.

In order to provide the advisory service, there needs to be a clear idea and vision among the leadership about the benefits of Waste Collection Route Optimisation, as well as the negative consequences to the company, local community, citizens and environment in case of a status quo scenario. The political support is best obtained through direct contact with decision-makers and in the best-case scenario, it should be documented and provided in the form of a Letter of Interest signed by the Mayor and/or a Decision by the PUC Director. Such Letter or Decision should clearly state the division of responsibilities and obligations between the PUC, local authority and other actors in the process. Elements for the Letter or Decision should come out as a result of discussions and meetings with the company and municipal leadership, and drafted after these meetings containing but not being limited to elements like the establishment of a Working Group for Waste Collection Route Optimisation, participants in such Working Group, a person in the company responsible for the process, time frame etc.

4.1.1 *Meeting with municipal administration and Public Utility Company (PUC)*

The first step after initial contacts with the political leadership is to organize a meeting in the PUC. This meeting should be attended by decision-makers and technical teams from both municipal administration (the Council Member in charge of communal services and/or environment, the administration executive or staff members in charge of communal services/environment, the staff member responsible for IT or data collection and the like) and the Utility Company (the Technical Director, the executive responsible for the collection vehicle fleet, the staff member responsible for IT or data collection, the Head of Accounting Unit etc.).

The purpose of the meeting is to present the scope of the advisory service, the process to be implemented by the local government authority and the PUC, and to inform the main actors at the local level about the steps and activities to be taken. At the meeting, an initiative for setting up a Working Group for process implementation should be launched, followed by a discussion and exchange regarding the tasks and responsibilities to be performed by the Group. Finally, initial information on possible routing tools, data needed and data formats for the implementation of the process will be provided by the Advisor at the meeting.

4.1.2 Establishment of a Working Group

As a result of the meeting with the PUC and the local authority, a Working Group should be formed by a Decision of the Mayor or the PUC Director. The Decision should specify the responsible executive from the PUC appointed by the Director who is going to oversee the implementation of the process. Furthermore, the Decision should specify the composition of the Working Group which should consist of at least one municipal administration representative responsible for communal services or environmental protection and/or project management (the Data or IT Manager, if any, should also be part of the Working Group) and PUC representatives responsible for waste collection planning and a team leader/dispatcher for the collection vehicle fleet. NGO sector representatives should also be included if they are active in the municipality.

The main tasks of the Working Group are to develop an Action Plan for Process Implementation, organize the process within the municipality, decide on the equipment purchase and the use of route optimising tool, monitor the process implementation and report on activities to policy decision-makers. Regarding all these tasks, the Working Group should have the support of the Advisor.

4.1.3 Development of an Action Plan (AP)

The AP should include detailed activities for process implementation, goals, monitoring indicators, responsible persons, budget and timeframe. It should also define the coordination between different stakeholders. In addition, the Action Plan should consider and be harmonized with other municipal waste management plans and activities, if they are applicable and exist in the given municipality.

It is developed by the Working Group with the support from the Advisor.

4.2 Data collection on existing waste collection practices and planning the implementation of route optimisation

4.2.1 Determining the route optimisation tool

Data collection is one of the critical parts of the entire route optimisation process and advisory service. Although the data required for route optimisation is standard, the format in which it is provided and collected can vary depending on the tool (route optimisation software) used. The route optimisation software offers one of the most affordable ways to significantly improve the profitability and productivity of waste collection.

There are many route optimising tools out on the market and some of them are specialised for the waste collection service. All of them have specific characteristics or different attributes like price, data formats, data mapping processes, possibility of integration with the existing GIS, terms of licencing etc. Therefore, from the very beginning, it needs to be clear which route optimising tool/software is going to be used. Some possible software options are: ESRI ArcView, MapInfo, GeoMedia or specialised waste collection routing tools. The Advisor needs to come up with a proposal and arguments in favour of the specific software, and the Working Group should endorse it at the initial meeting.

4.2.2 *Obtaining necessary information/data collection for route optimisation and preparation of the baseline*

The existence of precise, complete and georeferenced data is a necessary precondition for the successful route optimisation. As part of the advisory service, the Advisor needs to define all necessary data and inputs in desirable file formats for route optimisation, implementation of optimised routes, follow-up and monitoring activities, and check whether and in which format the data exists. Since route optimisation is based and performed by specialised Geographic Information System (GIS) software, providing a GIS-Plan data in a machine-readable format is of great importance. Therefore, as one of the crucial steps in the advisory service is to define the data gap, which would then be followed by data collection.

Typically, data regarding the existing PUC technical capacities (vehicles, equipment and collection process) is also collected. Vehicle information includes the number and types of vehicles used for waste collection and transport, vehicle capacities (tonnage and compaction), age and condition, purchase price, designated lifetime, fuel consumption (litres per km driven, litres per ton of collected waste), number of working hours (amount and distribution per shift), container loading time and vehicles' unloading time, annual vehicle operation and maintenance costs, number of operating staff. Container information includes the type, size and number of containers, their condition, purchase price, designated lifetime, annual maintenance costs, geo-location, number and type of consumers or customers using them. Collection characteristics needed are shift starting time, shift duration, lunch period, other breaks, starting and end point etc. Most commonly, an Excel based coma separated value or CSV format is used for data collection and storage. Also, for identification and collection of this kind of data, tools like SWIS (Solid Waste Information System) and CFM (Cost and Finance Model) could be used. Those are NALAS-based waste management tools whose development was supported by GIZ Open Regional Fund. Both tools are available at the NALAS website: http://www.nalas.eu/News/swis_model and http://cfm.nalas.eu/

In order to be able to monitor the achievement of the goals set in the Action Plan, baseline data should be determined through the data collected, and monitoring indicators should be developed by the Advisor. These indicators should be based on parameters like litres of fuel used per ton of waste collected, mileage per ton of waste collected, working hours per ton of waste collected, CO_2 emitted per ton of waste collected.

Besides the data on technical capacities, information on the street network is an essential input for route optimisation. The street network should include all necessary data such as road width and slope, one-way streets, prohibited turns, average vehicle speed, etc. The Advisor will define the exact data collection format.

Data collection activities should also include field work with the purpose of data verification and/or collection points database and street network dataset creation. Field work should be done by the Advisor supported by an Assistant.

Location points database should include collection points' GPS position with the size, type and number of containers, loading time, time windows for waste collection and other relevant data identified by the Advisor.

If necessary, the Advisor should provide training for PUC representatives on data collection and storage.

4.2.3 Route optimisation

The Advisor's task following data collection is to review the existing collection routes and set criteria for route optimisation. The criteria should be based on goals set by the Working Group in the Action Plan and can include but not be limited to route length, route duration, fuel consumption, CO_2 emissions, number of workers engaged etc.

In some cases, an analysis and redefinition of collection areas need to be performed based on waste quantities generated and waste equipment and vehicles' characteristics.

Finally, the optimal waste collection routing according to the criteria set, vehicle performance, equipment characteristics and other relevant inputs, is performed by the Advisor using the route optimising software agreed with the Working Group.

The Advisor should prepare a Report on Optimised Routes which should be endorsed by the Working Group and then presented to the leadership in the PUC and Local Government. Once the new routes are confirmed, they should be incorporated into the official PUC documents.

4.3 Provision of route optimisation equipment

4.3.1 Development of detailed Technical Specifications regarding the equipment required for route optimisation

The Working Group supported by the Advisor should develop detailed Technical Specifications for the procurement of GPS equipment for remote waste container fill level measurement and collection routes optimisation (vehicle GPS trackers and sensors for bin/container's fill level detection). The equipment is required to implement route optimisation and to monitor the effects of the measures implemented. The equipment should come in a package with the monitoring software that can also produce various reports on collection vehicle movement, time spent on routes and collection points, detours etc.

4.3.2 Tender procedure for the procurement of GPS vehicle trackers and GPS container sensors and equipment purchase

The Working Group should give inputs for the tender procedure regarding the procurement of equipment in line with the Law on Public Procurement.

Upon the selection of the best offer, the Working Group should follow with a process of signing the contract and purchasing the equipment.

4.4 Implementation of a route optimisation information campaign towards citizens

4.4.1 *Planning the information campaign and preparation of promotional materials*

The Working Group supported by the Advisor should develop a Plan for an information campaign towards the citizens in order to promote the measures implemented in waste collection. Since there could be some changes in waste collection timing (i.e. another day of the week), the PUC should inform the citizens about such changes. Promotion activities should be foreseen in the Action Plan and precisely defined based on the route optimisation results – e.g. meetings with local communities, promotional events, dissemination of information along with utility bills, etc.

The Working Group supported by the Advisor should also discuss the kind of promotion materials to be used in the informative campaign, target groups to be addressed, desired effects and the campaign budget available. Based on such discussion and agreement with the PUC and municipal leadership, promotional materials containing basic information on the importance and benefits of the process and citizens' responsibilities can be prepared. For these activities, the Working Group should be expanded by a local government or PUC public relation officer or an employee that is in charge of these duties.

The Working Group needs to define the elements and be in close communication with the responsible individual or group in charge of campaign implementation.

The Working Group also needs to propose a date when the collection of waste according to revised routes will start. This decision should be finally made by the executives in the PUC. The date should be clearly communicated to citizens.

Route changes or any other change in the service that could arise from this process needs to be communicated to all of the PUC and relevant local government employees because they could, at any time, be faced with questions from citizens and customers that they should be able to respond. This especially goes for the customer service department in the PUC, since it is on the forefront of communication with citizens.

4.4.2 *Information campaign implementation*

Once all the preparatory activities and communication in the PUC are done, the information campaign in the selected part of the municipality should be implemented according to the Campaign Plan defined.

4.5 Implementation of optimised waste collection routes

4.5.1 *Implementation of a waste collection monitoring system*

After the equipment for waste collection system monitoring is delivered by the selected company, vehicles should be equipped with GPS trackers so the PUC can start monitoring the collection vehicles. The delivered equipment should be accompanied by a mobile monitoring and reporting application.

The Working Group should make a proposal for a new or updated monitoring procedure based on the new equipment followed by the Director's Decision that would formalise such proposal. The monitoring task should be assigned to a specific employee or an executive in the company which needs to be trained on the new monitoring procedure. The Advisor should supervise the implementation of this process.

4.5.2 *Start of the optimised waste collection process*

Once new collection routes are defined, endorsed and incorporated into the PUC documents and procedures, the equipment is installed and monitoring system is in place (described in chapter 4.6.2), and when the information campaign has successfully been implemented, the Utility Company can start to collect the waste by using the optimised waste collection routes.

4.6 Evaluation of achieved benefits, sustainability, monitoring and reporting on the process conducted

4.6.1 *Evaluation of achieved benefits*

The evaluation of the benefits achieved will be done in comparison to the baseline data defined prior to the implementation of the process and goals set in the Action Plan. The task is done by the Advisor and verified by the Working Group.

For the evaluation of achieved financial benefits, a tracking model will be developed in an Excel application by the Advisor (the model will be further described in chapter 8).

4.6.2 *Setting up a monitoring system*

The objective of this step is to develop a system for the Public Utility Company to monitor the appropriate implementation of new routes. The minimum period for monitoring is 6 months after implementation. The task is done by the Advisor and should include but not be limited to the following activities:

- Setting up a new baseline for each of the routes in terms of maximum mileage, time and fuel consumption per route;
- Designing a monitoring log that should include elements like start and end mileage, beginning and end time of the route and refuelling;
- Designing the procedure for checking the logs against the new baseline in terms of who is doing it and how often and to whom it is reported;
- Designing procedures in case of irregularities, i.e. excessive mileage or fuel consumption or time spent on the route, together with mitigation measures.

4.6.3 *Evaluation and assessment of project sustainability*

Regarding the goals set and benefits achieved, the task encompasses the evaluation of both present and future sustainability of the process implemented. Key weaknesses (if identified) will be assessed, and actions for improvement will be developed. The task is done by the Advisor.

4.6.4 Preparation of a report on the process implemented

Report on the activities implemented is to be prepared by the Advisor. It should consist of general information on the Project, Municipality, Public Utility Company and the expected outcomes of the engagement. It should also refer to baseline data and give the main characteristics of the existing situation. The Report should contain information regarding the involved parties (Advisor, Working Group, appointed employees) and activities conducted by them. It needs to show the obstacles encountered and the mitigation approaches to overcome them. Finally, the Report has to provide information on results and benefits achieved and if applicable, suggestions for further work and development.

5 ACTION PLAN FOR IMPLEMENTATION

Activity	Time frame																								Impleme ntation days[1]	Responsible entity
	Month 1				Month 2				Month 3				Month 4				Month 5				Month 6					
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
1. Preparatory activities																										
1.1. Meeting with the municipal administration and Public Utility Company																									1 day	Advisor
1.2 Establishment of a Working Group																									0.5 days	Municipal administration
1.3 Development of an Action Plan (AP)																									1 day	Working Group/Advisor
2. Data collection and planning																										
2.1 Determining the route optimisation tool																									1 day	Working Group/Advisor
2.2 Data collection/analysis																									10 days	Working Group/Advisor
2.3 Preparation of inputs for route optimisation																									30 days	Working Group/Advisor
2.4 Development of a collection scheme																									7 days	Advisor/Working Group
3. Equipment provision																										

[1] Implementation days may vary depending on the size of local governments, current status of routes, equipment required etc.

3.1. Development of detailed Technical Specifications																									2 days	Working Group/Advisor
3.2. Cost calculation and specification																									2 days	Advisor
3.3. Tender procedure for equipment procurement /contracting																									30 days	Working Group/Municipal Administration (Procurement Department)
3.4. Equipment purchase																									30-60 days	Working Group (Procurement Department)
4. Implementation of information campaign for route optimisation																										
4.1 Information campaign planning and promotional material preparation																									10 days	Advisor/Working Group
4.2 Information campaign implementation																									5 days	Working Group/Advisor
5. Implementation and monitoring of optimised waste collection routes																										
5.1 Implementation of the waste collection monitoring system[2]																									3 days	Working Group/Hardware, software producer
5.2 Implementation of optimised routes																									14 days	Working Group/Advisor
6. Evaluation phase																										
6.1 Evaluation of implemented activities																									1 day	Advisor

[2] Immediately after starting the implementation of new optimised routes, a monitoring system for measuring the effects is going to be set up. The monitoring should be continuous and the first results could be measured after 2-3 months

6.2 Evaluation of achieved benefits																									5 days	Advisor/Working Group
6.3 Evaluation and assessment of project sustainability																									0.5 days	Advisor
6.4 Provision of a follow-up plan for the municipality																									2 days	Advisor

6 SETTING UP A METHOD OF FINANCIAL BENEFITS' MONITORING

The model (method) of monitoring (Annex 1) the process implemented should be set up such that it should produce a report on financial benefits projected. Namely, the purpose of the monitoring model is, by using the specific case, to calculate the positive impact on the company's financial results achieved through its reduced costs generated by the process (of waste collection route optimisation).

The model of progress monitoring and calculation of benefits resulting from the implemented route optimisation process includes the following three data groups established:

1. **Company Level Data** as the first group of indicators, should basically present the initial state of the company, i.e. its state prior to the time of the route optimisation process commencement.
2. **Route Optimisation Monitoring Data** as the second set of indicators should present the situation from the baseline level to the level of full application of the process implemented - its effects.
3. **Monitoring of the Routes Optimisation Process –** indicators showing the business performance achieved as a result of the process implemented.

Using a monitoring model, data important for actual direct cost determination is monitored, i.e. actual costs after process implementation (movement of expenses in the considered period on two levels, including vehicle fleet costs in the area selected to be subject of optimisation and cost monitoring of company's remaining fleet vehicles covered by the software solution).

Regarding vehicles on which the route optimisation system is fully implemented, i.e. that have optimised movement routes, are equipped with the necessary equipment (GPS, probes, etc.) and have software tracking and control by the network administrator, for each individual vehicle, the following parameters are monitored:

- number of working hours,
- number of kilometres passed,
- maintenance costs (internal and external), and
- vehicle performance and the amount of waste collected on a monthly basis.

The second level of tracking refers to vehicles to which the route optimisation system is partially applied, i.e. they are equipped with the necessary equipment (GPS, probes, etc.) and have software monitoring and control by the network administrator, but aggregate parameters are also monitored for all vehicles together. This category does not include vehicles which are not covered by the software solution and are not equipped with tracking equipment.

The expectation is certainly to see a falling trend in expenses resulting from the process introduced, and to be at such levels that within a reasonable timeframe justify the costs for the introduction of the process. It is also important to appoint a Local Government person responsible for monitoring and supplying the data on a monthly basis.

6.1 Case studies

6.1.1 Optimisation of waste collection routes in the city of Šabac

Implementation

The city of Šabac in Serbia was one of the Local Governments that applied and was selected for the piloting of the Waste Collection Route Optimisation Process within the Project “Business Cases for Improved Waste Collection and Valorisation”. By making an application for piloting, the city of Šabac clearly expressed its dedication and political will to implement the process. SeSWA (Serbian Solid Waste Association) as a partner organization in the Project, designated a solid waste management expert to guide the city through the process.

The first meeting in Šabac was organised for Municipality and PUC representatives. The advisory service was presented, and the PUC was informed about the benefits of implementing the route optimisation. Also, steps and activities to be implemented were presented. A Working Group was established and responsibilities were assigned among Group Members. An Action Plan was also created.

PUC representatives were responsible for providing the data on the existing waste collection scheme (existing routes, vehicles, shift length, etc.). These data were collected during the following several weeks. The municipality representative was a GIS expert engaged for urban planning. The advantage of this case study was the fact that this group member provided the following data: an ortophoto city map, a street network dataset, a waste collection points database.

The street network dataset had to be revised by the SeSWA representative in order to meet the GIS requirements for route optimisation. The waste collection points database was also extended with individual users of the service (120 garbage bins), and this was done by PUC and SeSWA representatives within the following three months. In this period, the SeSWA representative made several visits to the PUC. Since its vehicles were already supplied with GPS trackers, fuel level sensors were installed in the vehicles in order to measure the measures implemented.

The route optimisation was done for eight city sectors (all routes in the municipality).

Monitoring and evaluation

In Šabac, within the four months of continuous monitoring (March-June 2019), the use of the route optimisation process implemented in the local Utility Company showed that the work which had been previously performed with 19 vehicles at the beginning of the period, after the 4 months of optimisation (the commencement of the tracking method application was in March 2019), could unburden its total fleet engaged in the entire area of the city by 3 vehicles. In comparison with 2018, since the process is not fully implemented yet, the Company has, on average, in the first 6 months of 2019, used one vehicle less to perform the same or similar type and number of operations.

Proportionately to the reduction in the number of operating vehicles, the number of working hours of the entire crew has also been reduced. In the same period of the previous year, 9,672 working hours were realized, while in the same period of 2019, the working hours decreased by 5.8% or there were 564 fewer working hours.

The introduction of the route optimisation process in Šabac did not produce additional burden for the vehicles. In 2018, one vehicle transported on average 0.108 kg of waste per kilometre passed, while in the course of 2019, when the same work tasks were performed by using a smaller number of vehicles (on average one vehicle less), 0.106 kg has been transported per kilometre passed. In addition, during 2019, the amount of municipal waste generated has been increased by 4.24% in Šabac, while practice has shown that the new system of work with optimised routes can handle this quantity growth easily, even with the same number of trucks. Route optimisation in Šabac resulted in a more rational fleet use in general, so today, a greater amount of municipal waste is disposed by less intense engagement of utility vehicles. Thus, the lower engagement of utility vehicles for the execution of a larger volume of work has led to technical savings of 5.33%. It may be noted that in this case, the introduction of the process has fully justified its purpose and in the city of Šabac, it has produced the desired and expected benefits. By predicting the costs based on six-month performance, the annual amount of savings is estimated at around €18,500, but once the conditions are in place for the full implementation of the process, it is estimated that the savings could be twice as large.

6.1.2 Optimisation of waste collection routes in the Municipalities of Bitola and Kumanovo

Implementation

Municipalities of Bitola and Kumanovo in North Macedonia are also Local Governments that applied and were selected for the piloting of the Waste Collection Route Optimisation Process within the Project "Business Cases for Improved Waste Collection and Valorisation". Both Bitola and Kumanovo, by sending in their applications, clearly expressed their dedication and political will for the implementation of the process. SeSWA (Serbian Solid Waste Association), as a partner organization on the project, designated a solid waste management expert to guide the municipalities through the process.

These case studies are presented together because of the similar situation in these municipalities. At the first meeting, the advisory service was presented, Working Groups were created and Action Plans were made. The Groups consisted of representatives of the PUC, Municipality and SeSWA. The responsibilities were divided among the Group Members.

All attempts of the Working Group to acquire the GIS data were unsuccessful. Instead of using the ortophoto map, online Google maps were used. Also, street network data had to be created by the SeSWA representative, which resulted in the extension of the time planned for data collection.

In order to overcome the lack of collection points database, Google maps were used for its creation. This was made by PUC representatives after the training provided by the SeSWA expert. The Working Group organised, implemented and monitored the tender procedure for procurement of GPS tracking equipment in both municipalities. Upon selecting the best offer, the Working Group organised signing of the contract and the equipment was purchased. Waste collection vehicles were equipped with GPS trackers.

After all necessary data was collected, route optimisation was made by the SeSWA expert in these municipalities. Routes within one city area were optimised, resulting in shorter waste collection routes.

Monitoring and evaluation

Unlike the experience of the city of Šabac, in Kumanovo and Bitola, the introduction of the route optimisation process did not yield a reduction in the number of vehicles involved, so in this segment, rationalisation was not achieved. However, after introducing the process in Kumanovo, considerable savings were still achieved, while the effects of this process in Bitola could not be fully considered, since during the period when the process was to be implemented and monitored, the Utility Company conducted organizational and staff reorganisation.

In the Municipality of Kumanovo, during the first six months of monitoring the use of optimised routes (January-June 2019), in terms of cost structure, thanks primarily to the fact that the introduction of the process achieved far better and more comprehensive control of vehicle performance, the biggest savings were made in fuel and lubricant costs. The analysis also showed that there were significant savings on tyres, which was directly correlated with the optimised routes. By predicting these costs based on six-month performance, the annual amount of savings is estimated at around €14,552.

6.1.3 Optimisation of waste collection routes in the city of Bijeljina

Implementation

When it comes to process implementation, after analysing the current situation in Bijeljina, in the implementation phase, it was concluded that in this case, routes could be optimised without changing the path of vehicles, but by changing the structure of waste disposal containers, such that the existing smaller containers are replaced by larger containers. In this sense, the expectation was that savings could be achieved by short vehicle stoppage (i.e. by shortening the waiting time). 12 metal communal waste containers with a volume of 1.1 m3 were procured. This equipment was used to reduce the frequency of waste collection at 12 locations. Containers are located in the northeast part of the city of Bijeljina, mainly to cover the area of legal entities that generate waste.

Monitoring and evaluation

By establishing a tracking method in Bijeljina, during the monitoring (January - June 2019), the reduction in the number of working hours was identified among the crews engaged in the collection and disposal of municipal waste. Taking into account the amount of work that was slightly increased, the number of working hours decreased by 3.53%. Also, some savings were made on fuel and lubricant costs. Overall, considering that in this case, the route optimisation plan was far less ambitious, significantly less savings were achieved. By predicting these costs, the annual amount of savings is estimated at only €717.

7 KEY DELIVERABLES, INPUTS and QUALIFICATION of the ADVISOR

For the implementation of the advisory service and tasks given above, it is required to engage an Advisor and Assistant with the profiles as given in the next section of this ToR. It is important to note that the number of days is indicative and depends on the Utility Company's capacity level and the phase of development of particular processes.

7.1. Key tasks and deliverables of Advisors

The key deliverables and inputs to be provided by the Advisor for each stage of service implementation are as follows:

Key tasks and deliverables of Advisors	Number of days required	Total
1. Preparatory activity		3 days
a) Preparation for a meeting with the municipality	1 day	
b) Meeting with the municipality	1 day	
c) Support in defining the Action Plan	1 day	
2. Data collection/analysis		23 days
a) Data collection/analysis	5 days	
b) Data collection/analysis and preparation of inputs for route optimisation	10 days	
c) Preparation of inputs for route optimisation by the Assistant (field work)	7 days	
d) Development of a collection scheme	1 day	
3. Provision of equipment		1.5 days
a) Development of Technical Specifications	1 day	
b) Calculation and specification of costs	0.5 days	
4. Information campaign		5 days
a) Planning	1 day	
b) Preparation of promotional materials	2 days	
c) Implementation of the campaign	2 days	
5. Start of monitoring process		3 days
a) Monitoring the process of implementation, vehicle tracking, and route optimisation set-up	3 days	
6. Finalisation phase (implementation and evaluation of results)		9.5 days

a) Evaluation of the implemented activities performed	1 day	
b) Evaluation of the benefits achieved/development of a financial benefits calculation model	6 days	
c) Evaluation and assessment of project sustainability	0.5 days	
d) Provision of a follow-up plan for the municipality	2 days	
		45 days

7.2. Advisors' Qualifications

7.2.1. Advisor

1. Solid Waste Management Expert with a university degree (or higher) in engineering sciences with minimum 5-year experience in conducting waste management research and/or project implementation;
2. Knowledge of organization and work processes in utility companies in the field of waste management;
3. Proven knowledge and active use of specialized GIS or route optimisation software;
4. Experience in performing vocational training for public services will be considered an asset;
5. Computer literacy (MS Office) is a must;
6. Desirable strong organizational and facilitation skills.

7.2.2. Assistant

1. Solid Waste Management Junior Expert with a university degree in engineering sciences;
2. Experience in specialized GIS software;
3. Experience with data collection and data management;
4. Computer literacy (MS Office) is a must;

This model has been developed by the Project "Business cases development for improved waste collection and valorization", implemented by the GIZ Open Regional Fund for South East Europe - Modernisation of Municipal Services, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). The Project was implemented in Western Balkan partner economies, in the period October 2017-October 2019, in partnership with the Serbian Solid Waste Association (SeSWA) and the Network of Associations of Local Authorities of South East Europe (NALAS).

8 Annex 1 – Monitoring Tool

The annex is provided in a separate MS Excel File:

Route Optimization - Annex 1 Monitoring Tool

9 Annex 2- Regional working group inputs - lessons learned through implementation

During the third meeting of the Regional Working Group on Solid Waste Management held in Belgrade on 21 November 2019, the main focus was dedicated to discussion and presentation of the activities, changes and benefits of the piloted business process. The applied interactive method World Café resulted in outputs regarding three aspects: applicability of the piloted process in other local contexts, possible improvements and way of dissemination of the project products. The content of this Annex is an added value to the ToR by bringing pragmatic reflection and recommendations on the process by the experienced practitioners from the region.

Waste Collection Routes

World Café Outputs

Applicability of the process

Having in mind the actions taken during the implementation and benefits of the process achieved in Sabac, the general opinion of the participants in the World Café leads towards the conclusion that the process could be beneficial and applicable in all local self-governments. It was concluded that the process is cost benefit even in small local governments as savings for are inevitable (for instance, if GPS for truck are invested). However, for this Process, the most important is to prepare detailed baseline analysis (it could be done also with support od advisor/external expert), especially because of particularities of the field (ground, area, slope) in each local government. For instance, some municipalities are suitable for placing underground containers some are not. Also, some municipalities have need for increasing working hours, some to decrease. The arising challenge for all public utility companies are lack and/or leaving of drivers. New made streets as well rural areas (especially not approachable) are also challenge.

Political support for optimization of the routes is very important from the beginning. Moreover, information regarding municipal mapping routes (basis) are ownership of municipalities (if they have them), so cooperation with municipal administration is crucial.

Improvement of the process

One of the Improvements during the process introduction should be unification of bins as well as approach one household (customer) one container.

This has positive effect on proper and optimized waste collection. Moreover, optimization process should be applied not only for waste collection, but also for emptying of containers. Also, special price should set only for packaging waste (reducing price for customers). Continuous education for citizens but also control and fines are to be necessary.

Dissemination of the process

Besides the regular institutional channels of dissemination of the local level actors, such as utilization of the capacities of the associations of the PUC and LSG (and their regional networks), the process and its benefits could be furtherly disseminated within local, national and regional contexts through peer-to-peer cooperation (municipality to municipality, districts to districts, regional landfill to regional landfill). Local media and social networks play important role for dissemination as well as future GIZ events.