# Optimization of WEEE collection system: Assessment of key influencing factors for different scenarios in Novi Sad, Serbia

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## Abstract

Intensive economic development in terms of increasing productivity, introducing new technologies, and establishing employment dynamics within industrial activities contribute to a better standard of living in Serbia and play a key role in the increased demand for electrical and electronic devices. However, waste electrical and electronic equipment (WEEE or e-waste) is considered an emerging environmental problem because, in addition to its potentially hazardous nature, it is characterized by a high rate of obsolescence, while the rate of collection and recycling is at a very low level worldwide. Also, the special feature of e-waste is that it has "significant" value even after the end of its useful life in developing countries such as Serbia. Thus, after the guaranteed lifetime, the e-waste material changes hands more than once and usually ends up in the hands of informal recyclers or household warehouses. This phenomenon makes it extremely difficult to estimate the generated amount of e-waste, while data on the collected amount is not available because municipalities do not implement an organized system for the collection of e-waste. Therefore, this study aims to first identify different e-waste management scenarios in Novi Sad, the second-largest city in Serbia. The second goal is to identify the main influencing factors for each of the scenarios and subsequently analyze those factors that need to be addressed urgently to manage this issue. We have identified 4 primary factors and 26 sub-factors through an extensive literature review and expert inputs.

Keywords: waste electrical and electronic management, e-waste collection system, Serbia, influencing factors.

## 1. Introduction

The collection and recycling rates of WEEE are not keeping pace with the accelerated generation of waste equipment. This is supported by the fact that in 2019, as many as 53.6 million metric tonnes (Mt) of e-waste were generated globally and is expected to increase by an average of 2 Mt annually and double by 2050 [1,2]. While the amount of e-waste collected and recycled through the formal sector is only 17.4% [3]. The remaining 44.3 Mt of global e-waste flows are not documented, the great majority is likely dumped, traded, or even, partially recycled in a non-environmentally sound way, and it is estimated that 0.6 Mt ends up in waste bins in European Union countries [2]. The WEEE Directive (2012/19/European Union) sets collection, recovery, recycling, and reuse targets. Countries in the EU, including Iceland, Switzerland, and the Balkan countries, have similar laws [3].

In Serbia, the legal regulations in e-waste management have been changed in the last thirteen years in order to harmonize them with the legal provisions of the European Union. However, partial or incomplete transposition of legal provisions, as well as non-compliance with implementation measures, led to an insufficiently developed WEEE collection system. In Serbia, although the law prohibits the disposal of e-waste with other waste, it is common to mix e-waste with other waste streams such as metal waste and municipal waste. The collection target is set to 45% of electrical and electronic equipment (EEE) placed on the market in the previous 3 years, but it is not achieved. There is no organized collection of electrical and electronic waste from households at regular time intervals by the municipality. The exception is when in the spring actions, once a year for the collection of bulky waste, large electronic devices can also be handed over. Also, municipal authorities have no obligation to set up infrastructure or collect this type of waste from citizens. The collection is provided by several private companies that are licensed to collect hazardous waste or, in most cases, to collect metals [4]. Nevertheless, the most significant part of e-waste is collected through actions organized by leading recyclers, which enable the delivery of e-waste to a specific location or on-demand pickup at the address. In addition, the informal sector plays a dominant role in the collection of electrical and electronic waste, exposing themselves to health risks in an attempt to extract as many valuable substances as possible to sell on the raw material market.

Serbia has partially transposed the WEEE Directive, but the level of transposition is quite low, with slightly less than half of the provisions fully transposed by national legislation [5]. One of the most important principles for the field of WEEE management is the principle of "Extended Producer Responsibility" which

requires producers to finance the collection, treatment, recovery (reuse), and ecological disposal of e-waste. The Serbian LWM has set out two principles that reflect the main provisions of this principle. However, the first one "polluter pays principle" has not been fully implemented, while the "producer responsibility principle" is not represented at all in the management of special waste streams [4].
One aspect of the EPR principle is the "one for one" rule, which allows consumers to deliver waste free of charge if they buy an equivalent electronic device, which is poorly implemented in Serbia. Another aspect is reflected in the payment of the tax, which is mandatory for all producers/importers. In reality, to avoid paying the fee for WEEE management, many producers and importers of EEE do not follow obligations to record and refer to all quantities placed on the market. The current situation in the e-waste management system in Serbia does not follow any compliance scheme to meet the objectives of the EPR principle [4]. While one of the biggest problems is the insufficient definition of financial and physical responsibility for setting up the infrastructure for collection as well as the logistics of e-waste from households. As collection points for separate collection of e-waste in municipalities play a significant role in the overall waste management system, it is necessary to determine the competencies and responsibilities between public and private partnerships.

The aim of this work is to define suitable models for the collection of e-waste that should be efficient, with low emissions into the environment, promoting a circular economy through the use of secondary raw materials. However, in low-GDP countries, attention must be paid to the socio-economic characteristics of the population for which these systems are designed. In addition to economic profitability, the level of education, knowledge, and awareness of electronic waste and environmental problems related to it, as well as the presence of the informal sector, greatly influence the successful implementation of the e-waste collection system. In order to define the most optimal system for e-waste management, it is necessary to compare different scenarios and make a final decision on choosing the most ideal solution. In order to make a valid decision, it is necessary to know as many influential factors as possible that characterize these systems, as well as the mutual dependencies that these factors have on the observed system.

## 2. Methodology

This study reviews literature data and examples of best practices in developed European countries and compares solutions to overcome problems in implementing e-waste collection systems in developing countries such as Serbia. Three different e-waste collection scenarios were developed that can be applied on the territory of the Novi Sad waste management region.

The Serbian city of Novi Sad was chosen for this study because it is a good example of most medium-sized cities in Serbia, not only in terms of economic development but also in terms of the income level of its inhabitants. And like many other Serbian cities, Novi Sad has a serious problem with e-waste management. The survey conducted in Novi Sad in 2020 addressed the demographic and socio-economic characteristics of the respondents. It found that the majority of Novi Sad residents (46%) dispose of non-functional appliances in containers along with municipal waste, while only 14% of appliances are sent for recycling. The majority of functional appliances (31%) are kept by respondents in the household as a reserve or given to a friend (28%) [6].

The city of Novi Sad, together with the municipalities of Bačka Palanka, Bački Petrovac, Beočin, Žabalj, Srbobran, Temerin and Vrbas, forms one of the waste management regions with an area of 2,861 km². The city of Novi Sad is the administrative center of the Južnobačka district and the capital of AP Vojvodina and occupies an area of 129.4 km². The Public Utility Company (PUC) has no organized collection of electric and electronic waste. The construction of a recycling yard for the separate collection of hazardous waste streams and bulky waste in the area of the landfill is planned for the near future. However, based on examples of good practice in larger European cities (Hamburg (Germany), Zagreb (Croatia) and Ljubljana (Slovenia)), selected on the basis of data on area, number of inhabitants and population density, it was calculated that a city like Novi Sad should have at least two recycling yards (Table 1). Based on the data from the study by Hobohm [7], it can be calculated that at least 24 underground deposit containers for e-waste should be placed in the streets of Novi Sad.

Table 1. Estimated number of recycling yards in Novi Sad depending on the area characteristics

| | | Hamburg | Zagreb | Ljubljana | Novi Sad |
|---|---|---|---|---|---|
| Number of recycling yards | (Ca.) | 12 | 10 | 2 | 2 |
| Area | ($km^2$) | 755 | 641 | 163.8 | 129,4 |
| Number of inhabitants | (Ca.) | 1750000 | 806341 | 284293 | 250439 |
| Population density | (inh./$km^2$) | 2464 | 1398.488 | 1736 | 1935 |

## 3. Results and Discussion

Based on the example of e-waste collection schemes in developed European countries and after a careful analysis of systems implemented in developing countries, three scenarios are contemplated that can offer solutions to problems related to WEEE management in Novi Sad. The scenarios that will be discussed are:

- Scenario I: Stationary system
- Scenario I: Mobile system
- Scenario III: System of recycling yards

The scenarios vary depending on the management, logistics, and infrastructure solutions, considering economic and social criteria. It is equally important to design a system that will be accepted by the local population, which would contribute to greater efficiency and financial sustainability of the system. The comfort of citizens is measured by their satisfaction when they have an available timely collection and the ease of requesting service greatly influences the functioning of the implemented system [8,9]. Additionally, the behavior of residents in the disposal of WEEE can be influenced by the knowledge about environmental issues that are reflected in their attitude towards the proper disposal of e-waste and recycling and the willingness to pay for waste removal [10 - 13].

In developing countries, such as Serbia, the main actors in the collection of e-waste are informal collectors, so it is necessary to take care of this sector's inclusion when planning to introduce a new collection system. In China, the informal sector dominates the collection of e-waste from households, where almost 60% of e-waste undergoes informal recycling processes, which is considered the main reason for the large lack of supply in the formal recycling sector [14, 15]. Based on this, it can be considered that the basic socio-economic obstacles that need to be overcome are related to the competition between the formal and informal sectors. While, socio-cultural factors include low environmental awareness, poor social status of informal collectors, poor consumer buying behavior, lack of willingness and pessimistic attitude of residents regarding e-waste recycling, backyard recycling, as well as the need to change their mindset and develop habits related to e-waste recycling [16 – 21, 14, 15].

Infrastructure facilities play an essential role in e-waste management issues. Infrastructure barriers include a lack of infrastructure facilities (collection sites, storage, transportation), limited planning and forecasting of e-waste generation, and a lack of coordination or cooperation between collectors and recyclers [17, 22, 23].

When choosing the most adequate system for a given area, it is necessary to consider the level of service coverage as well as the quality of the collected products, which, according to the Hobohm [7] study, is ensured through the depot container system, while the fulfillment of the collection quotas of the required quantities can be ensured by introducing a system of recycling yards. Based on data from the literature and a study conducted in Hamburg [7] collection quotas for different scenarios were calculated in mass percentages (Table 2). Assuming that the goal of e-waste collection is 45%, according to Directive 2012/19/EU, and the estimated amount of products placed on the market in Novi Sad, it is calculated how much waste should be collected on an annual basis.

Table 2. The efficiency of the system and the amount of waste that can be collected depending on the selected scenarios

| Waste collection system | The efficiency of the collection system | Amount of waste that can be collected |
|---|---|---|
| | (%) | (t/y) |
| Scenario I (Stationary system) | 2 | 37,835 |
| Scenario II (Mobile system) | 8 | 151,340 |
| Scenario III (Recycling yard) | 89 | 1683,663 |

In this paper, the stationary system is the bring bank type of waste containers placed at strategically selected locations in the city. A stationary collection system is a combination of a mobile system and a recycling yard system because the physical and financial responsibility is shared between the citizens and the waste collection company [7]. From this perspective, the citizens bear part of the responsibility in terms of bringing waste and transportation costs to the container. The waste collection company bears the same responsibility for the rest of the logistics when the waste is brought to the recycling center. In contrast to the pick-up arrangement, the collection vehicles are only allowed to drive to central locations and are not allowed to pick up the waste at the curbside in front of the houses. This type of waste collection is most economical in areas with a high population and is particularly suitable for source-separated recyclables [24]. As this system is centralized, it is possible to ensure good service coverage in each part of the city, and therefore great comfort for citizens [7]. According to [25, 26] the coverage of the system decreases sharply with increasing distance of the container and therefore user

friendliness and the motivation of citizens to dispose of waste on their own [24]. Therefore, locations for container placement should be planned near larger residential areas, parks, public facilities, and shopping centers where citizens can drop off their waste as part of their daily activities. Successful locations for collection points have high visibility and high traffic and people frequency, such as in parking lots [27]. When choosing the location, it is also important that the places meet special requirements for concrete surface, roof, and special containers for placing the equipment [27] It is of great importance that the containers are supervised, as they are exposed to the influence of the informal sector, which can alienate the collected equipment and physically damage the containers to a great extent. The stationary collection system includes the collection of appliances with small dimensions such as gas discharge lamps, IT and telecommunication equipment, and small household appliances whose dimensions do not exceed 25 $cm^2$ [28]. The disadvantage of this type of collection is that only small appliances can be placed in the containers, so a large amount of waste cannot be collected. However, devices such as tablets, phones, electrical and electronic tools, and other IT and telecommunication systems contain a high percentage of rare and valuable metals, so their recycling provides very important secondary raw materials. In addition, natural resources are conserved and the cost of collection and recycling is negligible compared to the benefits of recovering metals from these devices. Because the containers are placed on recycling islands where containers for paper, glass, and metal are also lined up, citizens may be more willing to recycle because they can dispose of other types of waste at the same time.

The next possibility of setting up collection points in retail shops is the legal provision that introduced the "one for one" rule into Serbian legislation. This legal provision obliges the retailer to accept household waste appliances free of charge from the end user who buys a new appliance from them. In this case, large appliances are usually transported to a store where the new appliance was purchased [27]. There are also promotions where one can get a voucher for an old device, such as in Univer Export and DM stores. These options are hardly present in Serbia, mainly due to the lack of initiative and insufficient funds for campaigns, which leads to a lack of awareness among citizens.

Table 3. SWOT analysis of the first scenario

| Strengths | Weaknesses |
|---|---|
| - Centralized collection point - trucks can easily collect all waste from one location<br>- A practical system for densely packed neighborhoods and the city center<br>- Citizens can dispose of e-waste during their daily activities (going to the shopping mall, kindergarten, public space, etc.)<br>- Collecting equipment rich in CRM and precious metals<br>- The retailers are obliged to provide space for the collection of WEEE<br>- High user friendliness | - Low collection rate (2%)<br>- Places needed for containers<br>- The cost of purchasing, setting up and maintaining the container<br>- Citizens who own small home appliances and IT equipment are stored or handed over for further use<br>- Only certain types of equipment can be disposed of<br>- There is a need for a transfer station |
| **Opportunities** | **Threats** |
| - Extraction of CRM and other metals is possible<br>- The use of natural resources is reduced, and the environment is protected<br>- Income is generated by recycling<br>- $CO_2$ emissions are reduced because extraction is not performed<br>- Fuel consumption and gas emissions from collection trucks are reduced | - Lack of public environmental consciousness<br>- The possibility of the presence of the informal sector if the containers are not well secured<br>- Lack of willingness and pessimistic attitude of residents for WEEE recycling<br>- Hygiene must be maintained at the locations where the containers are<br>- User comfort decreases as the distance from the container increases, so both the quantity and quality of the disposed can be reduced |

*Scenario 2 - Mobile collection*

Mobile collection means a decentralized collection model at the point of waste generation, e.g., in households or near the homes of waste generators [26, 24]. The collection vehicle (truck or lorry) circulates around the city from one predetermined location to another, where bins or containers are usually placed for collection. The system is also referred to as curbside collection [24]. This model is suitable for suburban and urban areas that are not densely populated. The lack of parking spaces where the truck can stop to load the waste can cause congestion for other vehicles and further complicate traffic in densely built urban areas. Households can bring

their waste equipment in front of the site where they live, which would simplify the collection process and reduce the time trucks spend at each site.

Mobile collection can be organized by one company that is responsible for the entire area or by distributing the responsibility among several private companies. The question here is who is responsible for the collection of this waste. The municipality can transfer the responsibility to a public utility company, which collects this waste together with the bulky waste, as this type of collection has already been introduced in Novi Sad. Another option is to cooperate with private waste management companies, which could collect waste from a specific location once or twice a month at the request of citizens or according to a set schedule [8]. Citizens can apply for waste collection through the application, website, or by phone [29]. The schedule for waste collection can be created along optimized truck routes if citizens are informed about the location where they should bring their waste via local newspapers, the website of the collection company, or similar. Locations can include larger parking lots of markets, public facilities, or places where waste loading can be organized so that it does not interfere with the flow of daily activities. One problem that arises in planning the collection is the unknown number of calls and the type of equipment that must be collected. Therefore, it is not possible to know the exact amount of waste that can be collected monthly in Novi Sad. The location of households is also an unknown factor. Other problems in the disposal of WEEE are the obligation to use legal disposal methods, alternative storage in the household or illegal disposal [30,31,20]. Because bulky waste, including WEEE, must be placed in accessible locations (e.g., roadside) for collection, WEEE can be picked up by unauthorized collections [7]. The only solution that offers the best protection against the illegal collection of waste by the informal sector is the direct loading of the equipment at the point of origin.

In Novi Sad, there are three companies that deal with the collection of WEEE. The collection can be ordered through the customer service, by phone or through the website. These companies come to the address and buy the waste, with prices ranging from 80 dinars for small to 1000 dinars for large household appliances. PUC also organizes a bulky waste collection campaign once a year in each municipality and offers citizens the opportunity to rent a 5 $m^3$ container. In this case, the container is placed near the citizen's house, and after it is filled, it is collected by PUC. In the capital of Serbia, it is planned to hold an organized bulky waste collection every first Saturday of the month. On that day, Belgrade citizens should put unusable bulky items, old furniture, household appliances and similar waste next to the container, and PUC "Gradska čistoća" will take them away free of charge.

In general, the financing of bulky waste collection is borne by citizens at their request [7]. However, the disposal company bears all the costs of collection, if the collection is organized at equal intervals. In addition to the purchase of a truck and fuel costs, the company must hire a driver, and often another person is needed to help load large household appliances or other bulky waste. On the other hand, collection arrangements in remote locations can be quite costly due to the long distances between collection points [24].

Table 4. SWOT analysis of the second scenari

| Strengths | Weaknesses |
|---|---|
| - Collection of large household appliances and hazardous waste<br>- Collection of waste is organized at the point of origin fixed collection schedule or planned collection (scheduling via communication channels)<br>- New jobs<br>- Good implementation of EPR (organization of collection is borne by producers or PUC)<br>- Collection costs are borne by producers (exception is in the case of on-demand mobile collection, i.e. hauling away bulky waste)<br>- Citizens have the greatest comfort – the easy availability of services<br>- Highest service coverage<br>- The on-demand mobile collection method is beneficial for residents interested in a convenient WEEE disposal, especially when the equipment is large or heavy | - Weakly applicable in densely populated urban areas and city cores<br>- Low collection rate (8%)<br>- Needed developed road infrastructure for access to locations<br>- Lack of parking places where trucks can stop and citizens can bring waste<br>- One more person is required for loading in addition to the driver<br>- Pick-up arrangements in remote places can be rather costly for collection companies due to the long distances between the individual collection points |
| Opportunities | Threats |

| | |
|---|---|
| - Ability to collect equipment with high content of CRM, GHG, and CFC<br>- Possible route optimization (based on requests sent by citizens)<br>- Reduction of transportation costs by avoiding empty routes<br>- Citizens' awareness is raised because the collection is done in the neighborhood | - High representation of the informal sector - may be subject to unauthorized collection<br>- Existence of empty truck routes if the system is not optimized<br>- An unknown number of calls/requests that citizens can make on a daily basis<br>- Find an adequate type of truck that will be able to take over a larger volume of waste (depending on the order and method of loading)<br>- Management body - private or public partnerships<br>- Poor acceptance of the new method of scheduling waste pickup via app, chat or call. |

*Scenario 3 - Recycling yard*

In the system of recycling yards, there is no waste collection company, but households bring their waste directly to the collection point, which is usually located a few kilometers from the city. Since it is necessary to organize waste transportation independently, each household can collect waste annually and bring it to the recycling yard after reaching a sufficient amount [27]. The advantage of the recycling yard is that, in addition to e-waste, citizens can dispose of other types of household waste such as batteries, waste oil, paints, tires, pharmaceutical waste, and other types of special waste streams. This greatly facilitates logistics and reduces costs for the end user, as the collected waste of various types from households can be taken to the recycling yard in just one visit. Recycling yard locations should be near major cities, where disposal of most waste, especially e-waste, should be free of charge, as the general waste fee already includes part of the recycling yard's operating costs. Collection of waste for recycling by recycling yards usually results in better quality (purity) of recovered materials thanks to direct control at the entrance of the recycling yard [27]. In addition, these sites have specific working hours and are staffed by people trained to handle household hazardous waste, which further contributes to the quality of sorting recyclables [28]. However, for this system to work, a strong will of citizens to recycle is required. According to the law, submitted waste must be sorted beforehand, and damaged items may be rejected, which can negatively affect citizens' willingness to drop off waste. Since the locations of the recycling centers are far from homes, the convenience of citizens is the lowest in this system compared to the other two scenarios. In addition, citizens should be well informed about the options for dropping off waste as well as the environmental benefits of their actions in order to achieve greater efficiency of this collection method. Recycling stations can be well combined with social assistance programs and charity activities. For example, disabled, unemployed, or otherwise handicapped people can be involved in the dismantling of electronics and household appliances to recover spare parts and valuable materials, thus benefiting economically or socially from this waste management solution [24].

Table 5. SWOT analysis of the third scenario

| Strengths | Weaknesses |
|---|---|
| - Good quality and quantity of material<br>- 89% collection rate<br>- All types of WEEE can be disposed of<br>- New jobs, programs for social cases and the handicapped<br>- No transfer station required<br>- There is no threat of illegal collection<br>- Excellent application of EPR<br>- Citizens can make money from handing in waste<br>- The highest quality of raw materials | - Citizens bear all financial costs<br>- Distance from place of residence<br>- High maintenance costs - a lot of workers, equipment, construction of canopies, floors, gutters...<br>- Minimum collection service coverage<br>- The equipment can only be handed in by those who pay the garbage collection fee in the given region<br>- Damaged and certain types of equipment (light bulbs, fluorescent lamps...) are not accepted. |
| Opportunities | Threats |
| - Other types of waste can also be disposed of (packaging, tires, metal...)<br>- The comfort of citizens can be optimized (citizens can plan to bring stored waste once a year)<br>- Fuel savings and emissions of internal combustion engine gases | - Low environmental awareness,<br>- Lack of willingness and pessimistic attitude of residents regarding e-waste recycling,<br>- Backyard recycling,<br>- The least comfort for citizens<br>- Waste must first be sorted by citizens |

When choosing the most adequate system for a given area, it is necessary to consider the level of service coverage as well as the quality of the collected products, which, according to the Hobohm [7] study, is ensured through the depot container system, while the fulfillment of the collection quotas of the required quantities can be ensured by introducing a system of recycling yards. Based on data from the literature and a study conducted in Hamburg [7] collection quotas for different scenarios were calculated in mass percentages (Table 2). Assuming that the goal of e-waste collection is 45%, according to Directive 2012/19/EU, and the estimated amount of products placed on the market in Novi Sad, it is calculated how much waste should be collected on an annual basis.

Table 6. The efficiency of the system and the amount of waste that can be collected depending on the selected scenarios

| Waste collection system | The efficiency of the collection system | Amount of waste that can be collected |
|---|---|---|
| | (%) | (t/y) |
| Scenario I (Stationary system) | 2 | 37,835 |
| Scenario II (Mobile system) | 8 | 151,340 |
| Scenario III (Recycling yard) | 89 | 1683,663 |

Analyzing the scenarios and situations that are characteristic of the city of Novi Sad, four main influencing factors were singled out, which have a different meaning for each of the proposed collection models. The figure below shows the breakdown of the main influencing factors: financial aspect, aspect of the efficiency of the established system, socio-economic and cultural differences, while the last criterion is presented as system boundaries. Each of the main factors is broken down into sub-factors, of which there are twenty-six in total (Figure 1).

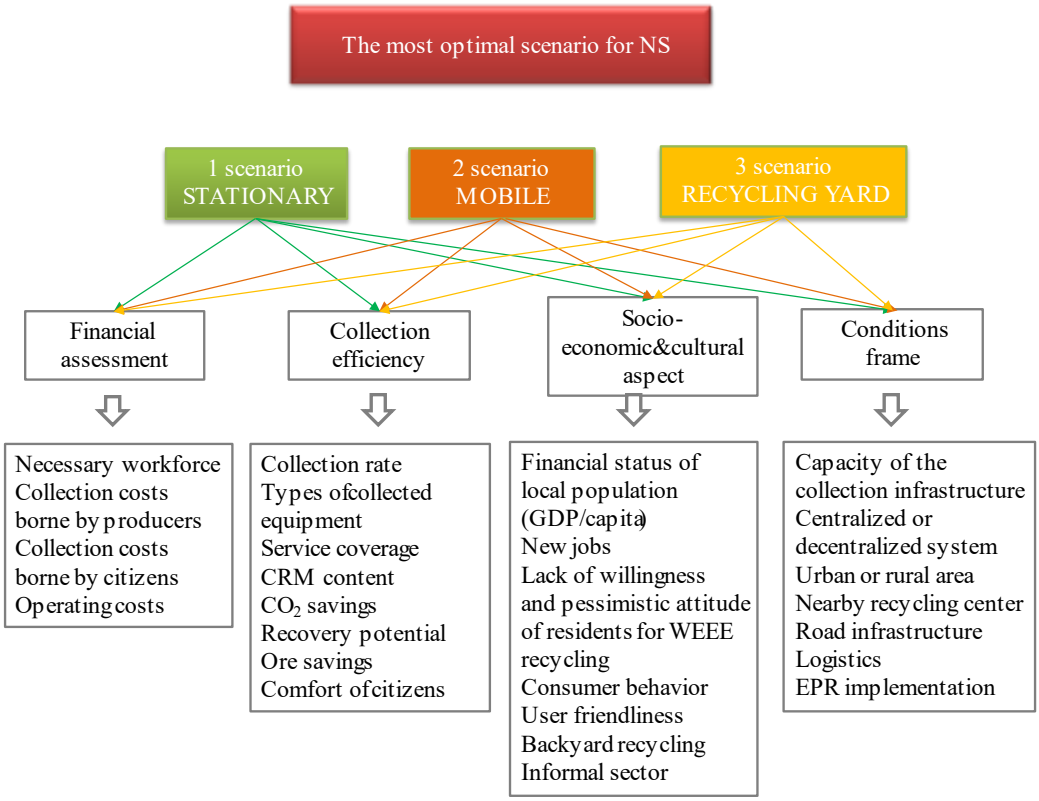


Figure 1. Identification of influential factors

## 4. Conclusion

In order to define the most optimal system for the management of e-waste, it is essential to analyze scenarios and make a final decision. Furthermore, it is essential to know as many factors as possible that characterize these systems and the interdependencies that these factors have on the observed system. From the current literature reviews on e-waste management, most of the published studies deal with the economic aspects, system efficiency, socio-economic and cultural barriers, and technical capabilities to set up the system such as infrastructure and logistics.

Waste collection under the first and third scenarios is centralized, therefore it is most economical in areas with high population and is particularly suitable for source-separated recyclables. This is in contrast to mobile systems, which describe decentralized collection at the point of waste generation, e.g. in households. The advantage of a centralized system compared to a decentralized one is that the collection vehicles only have to drive to central locations and do not have to collect waste in front of every house. In addition, this model has the disadvantage of being inefficient for cities with high traffic volumes or poorly developed road infrastructure. However, unlike the mobile system, the distance of the collection point from the user's home requires a high degree of independent motivation to hand over the waste in the other two systems, and the greater the distance to the container, the lower the convenience for the user. It also imposes additional costs on citizens, thus reducing the amount of equipment collected, as the distance from the containers, i.e., recycling centers, greatly decreases their reach. If citizens have to transport their waste themselves, they are less interested in proper disposal. Accordingly, the recycling yard system is the least convenient for users. In a stationary system, costs are shared between the end user and the waste collection company. The waste collection company covers the cost of handling the containers, and the central collection point saves on logistics costs. Collection of waste via depot containers is most economical in areas with high population density, although collection with a large number of collection points leads to additional costs for public companies. The mobile collection is associated with the lowest costs, as the route can be covered once a month by a vehicle equipped with a larger type of container. However, collection in remote areas can be quite expensive due to the long distances between collection points. The last type of collection does not require the involvement of a collection company. Collection and storage is done where the residents live. However, in this scenario all costs are borne by the citizens and it is the most inadequate from this point of view.

However, after the first study on this topic in the Novi Sad region, a total of twenty-six factors were identified. Many of these factors have a contradictory relationship with each other, and it is not easy to decide which of them has a greater or lesser importance. In the following period, it is planned to continue the research in the direction of determining the degree of dependence of selected parameters using mathematical algorithms characteristic of multi-criteria decision-making methods. The application of decision support systems based on multi-criteria analysis helps the decision maker to find one of the best solutions by reconciling all criteria, different preferences and conflicting interests. The obtained data can be of great importance for decision makers in this field and can significantly contribute to the selection of appropriate guidelines for the establishment of an adequate system of e-waste management in Novi Sad.

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