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EFFICIENCY IN ORGANIZING TRANSPORT ROUTES AS PART OF THE CITY WASTE MANAGEMENT: PROPOSAL FOR INNOVATIVE WAY OF TRANSPORT

Abstract: *Research presented in this paper is primarily focused on the theoretical model of transportation routes' optimization, by means of using an innovative approach, projected to countries in transition. This paper presents part of the research, whose main parameters are directly related to basic research hypothesis, and are result of author's stay in vocational training in the Japanese city of Osaka, in the period 12.01. - 07.03.2015. Based on the transport routes' calculations, we came to an answer set in the research problem of this paper, as well as to the optimization of costs and avoiding a "downtime" during the collection of waste conducted by utility companies, who will be the beneficiaries of this model. The primary goal of the work is to, on the base of knowledge and experience acquired in Japan, create an Optimization Model of Transport Routes adjusted to countries in transition (Bosnia and Herzegovina and others), which will, in the long run, be of benefit to these countries, in terms of a sustainable waste management.*

Keywords: *3R, globalistion and countries in transition, inovation in transport, rationalisation of espenses*

1. Introduction

From an ordinary observer's point of view, waste management, with particular emphasis on the waste collection, transport and disposal, does not represent a big problem, even more so, it is steady, daily work involving a few crew members and the truck driver.

However, the picture is not nearly equal from the angle of observation, because if we find ourselves in a situation that during only one day a week, the above mentioned crew "takes brake", city or municipality in which the waste is being collected, will turn into a real "wild" landfill.

Also, if the utility company engaged in the waste collection and disposal has no clear goal and a plan for dealing with this business, very soon it will find itself in a "mat" situation, when it will not be able to carry out their daily tasks in a timely manner, because the plan itself, without continuous, long-term planning, means nothing.

To avoid being witnesses of previously described scenario, in this work we will try to reach the adoption of a Model for Rationalisation of Waste Management in

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countries in transition (such as: Bosnia and Herzegovina, Montenegro, Macedonia, Serbia…). We intend to achieve that by review of literature related to relevant researches commenced in the specific field of "green" economy (includes a special segment of the economy that studies the environment and health of citizens) and theoretical economics, using part of empirical research, that was for the purpose of this work, created after the author's attendance in vocational training about the solid waste management in the Japanese city of Osaka (course named "Comperhensive Waste Management" (C). JICA. Japan). In this paper, the focus is on "green" transport and "green" technology in the field of innovations in utility transport.

Thus, starting point from which we start in this paper is the research problem, which we decided to put in the form of questions, for which we seek answers. That starting point is: „*Does organizing of transport routes in order to collect, transport and dispose municipal waste, contributes to the reduction of time, "idling time" and costs?*"

On the other hand, subject of research in this document is defining an innovative way of organizing transport routes and promotion of 3R activities (Reduce, Reuse and Recycle) in countries in tranzition. Therefore, the immediate area of research will contain fields of theoretical and "green" economy, in the area directly related to the subject of research, while all other scientific fields will be declared as constants, except for those directly related to the subject of research.

The main and only hypothesis from which we start in this document is: Xo" Organization of transport routes in an innovative way will contribute to the rationalization of time used for transportation of city waste and company's rational expenses management".

When we say an *innovative way*, we do not mean something that has to be entirely new, and so far not published in the world (whether it is the innovation of products or services). So, we can talk about a new way of interpreting the existing models, products or services that are entirely new to the country (i.e. city or municipality) where an innovation is being introduced.

The first section of the document refers to the theoretical review of the literature issued by renowned authors and their researches directly related to the subject of this study, with special emphasis on researches conducted by Japanese experts, as world leaders in this field.

In the second chapter, we will present key steps in an innovative policy concerning the creation of transport route's models, adjusted to countries in transition. Third chapter is the central part of the document, and it concerns projecting part of research results commenced on territory of Doboj City (Bosnia and Herzegovina) during the month of august 2015, pointing to all the benefits of innovative model, and serves to prove / disprove basic research hypothesis. Then, we will present time calculation method for calculating time required to achieve the optimization of transport in city activities, after which we will give our proposed Model adapted to the above mentioned countries.

Document ends with a discussion and conclusion, with concrete measures to be taken in order to achieve greater efficiency and effectiveness in the city waste management, creating optimal transport routes and giving proposal for a new academic research.

2. Literature review

The growth of the World population at 7.2 billion in 2015 (prediction from 2005) and rapid urbanization, predicts that, by 2025, about 2/3 of the total world population will live in the cities (UNEP, 2005). According to the same document, urbanization will begin in countries in transition, with the increase of population, for some new 150,000 inhabitants per day.

On the other hand, urbanization does not have to be a serious problem (Medina, 1997), but population growth in urban areas can "turn on a red alarm" in the field of environmental pollution, which is reflected in solid waste creation, water pollution, climate disruption, etc. (Thapa, 1999).

Numerous studies have documented that there is huge gap between the developed countries and countries in transition in terms of solving the problem of solid waste management (Daskalopoulos et al., 1998; Hanyu et al., 2000; Domina & Koch, 2002). Developed countries are more industrialized in the field of waste disposal and potential nature pollution (water, air etc.), while countries in transition do not have the technology for waste management nor budget to pull each year for this purpose (Johnson et al., 2004).

Waste management is still not at a high level, both in the developing countries and in countries in transition (Urabe, 2015). According to the same author, until one hundred years ago, Japan was one of the "poorest" countries in the world in terms of waste collection, transport and disposal. The waste management system was deficient to the extent that city waste, as well as all other types of waste (i.e. hard, industrial, bulky etc., read the RS Official Gazette no. 111/2013), was disposed by inhabitant's inertia, to the green areas, public asphalt surfaces, into oceans and seas…(Uemura, 2015). Canada (2015), claims that in Japan, during the period prior modernization of systems for waste management, there was no mechanism of waste disposal, waste collection system - waste transport and disposal were reduced to manual insertion of waste in containers similar to today's *corn panniers*, and afterward it was disposed in transport vehicles with trailer of volume up to 3 tons.

In described manner, in the mentioned time frame, Japan was "devastated" by numerous and deadly viral epidemics, mostly caused by "damage" to environment in a way that the whole biodiversity was threatened, including the health of residents (Environment Bureau, 2014; Yamashita, 2014).

At the beginning of the 20th century, there was a complete revival in the management of city waste in Japan, under strict rules regarding waste disposal and the mode of its transport to sanitary landfills or incinerators (Eiho, 2013). This means that all of the waste originated from households or from the economy, was cared for in a timely manner, and the results arising from it's treatment, were related to obtaining useful "raw materials" from waste, such as compost, electricity, binding material in construction, etc. So, from that period to the present, in Japan, but also in developed countries, city waste management system was promoted, what reduced possibilities for development of numerous unwanted, dangerous viruses and endangering the health of their populations.

Sanitary landfill is a special kind of landfill covered with sanitary material to prevent the spread of odors and potential creating of viruses (transmitted by mice and the like), while incineration furnace include high calorific value, in which all the recycled waste is being burned, waste that can not be treated as a secondary raw material in recycling centers, and after it is burnt we get energy from burning waste or bonding materials in the construction industry.

Finally, between 2001 and today, Japan has developed itself into a world superpower in terms of city waste management, by innovations in technical and technological achievements in the field of city waste transport, then in establishing planned routes what led to the most efficient waste management, working hours rationalization and elimination of the so-called "idlling" during the day as well as during monthly activities in this field. Japan also became the bearer of a new ecological paradigm called "3R".

In addition to Japanese market, researches from the same domain were conducted in Europe and the rest of the world. According to Padberg & Rinaldi (1991), each utility vehicle crew, in order to achieve an optimization of its costs and time for waste collection, must calculate the optimal route covered in the course of their duties, thus eliminating the possibilities of having two or more vehicles operate in the same street. Transport route optimization, according to Castillo (1999), is calculated on the base of establishing the shorthest route connecting start and end points enroute. Route length and containers in which the waste is being disposed are the initial criteria for selection of utility vehicles, crew and for calculation of optimal time for collection, transport and disposal of waste (Fisher, 1995).

One utility vehicle must be in charge of cruising along the entire transportation route (Cheng & Rich, 1998), to awoid making any unnecessary multiplication of travel routes (Nanry & Barnes, 2000), with the final aim to pick up all the waste from households and industry during its shift, and to transport collected waste to the landfill or incinerator (Moon, et al., 2002).

According to Begur et al. (1997), it is essential to minimize the total time spent on the road, as well as seeing, identifying and planning the order of collection of city waste on one route. There is no such thing as unique transport route for every town or region (Chakroborty, 2002), it is all about alculation of transport route length, efficiency of utility equipment ment for waste collection and transport (Crainic et al., 2005), as well as of speed of crew working on manual waste collection (Campbell & Savelsbergh, 2006).

From all of the above, the thematics this work is following will focus on problem solving in the field of waste management, emphasising the definition of efficient transport routes in terms of collection and transport of such waste. Starting point in the resolution of this problem is related to identification of strategies for effective and efficient determination of transport routes and cost's rationalization. Preservation of the environment and health of population in these countries should be one of the most important priorities defined in their economic policy. Reason for this is following: if we have a healthy natural environment and population, we will fight for stable economy in the economic sense, in the long run.

3. The influence of globalization on innovation in transport routes modeling

Since the beginning of 21st century, every day we hear terms like globalization, global action, global change and the like. There are many definitions defining the term “globalization”. According to Dujšin (1999), it's about the internationalization of goods, technology, labor and capital, so the given term in the broad sense is defined as globalization. On the other hand, Turek (1999) explains this phenomenon as a social process that tends to universality and unity of the World.

Some authors are pointing out that globalization is a process of increasing the interconnections between companies in a way that events in one part of the world more and more have an impact on distant countries and societies (Smith & Baylis, 2001). Globalization is also defined as a reduction of the distance at the world level through the strengthening and multiplication of connecting lines (Stiglic, 2002). Nye (2003), does not imply universality under globalization, because he believes that globalization is defined as a worldwide network of interactions, but in this way it is not viewed as a homogenous nor fair, but sees globalization as growing gap between rich and poor.

So, we want to say that time is changing, as well as lifestyle, habits, there are innovations in products, services and processes, what

happens greatly "on global level". The internationalization of business leads to creation of an entirely new "prism" that forces countries in transition to undertake constructive actions to follow developed countries of the world and leaders in specific areas of business. If we want to operate in an efficient and effective way, we have to ignore business policy dated 20 and more years ago, and to adapt ourselves to the new situation, which 21st century brings with it.

We are connecting the *efficiency* with costs, what further means making a product in accordance with defined requirements, at no additional costs (i.e. scrap, defect, upgrade, etc.). According to Todorović (2012), efficiency is reduced to realization of „Zero Effects" or minimum expences related to product. Same author tried to explain the difference between effectiveness and efficiency - efficiency is associated with income, meaning to meet wishes and demands of customers, to sell products and to generate revenue. If the company is efficient, this means that it achieves minimal cost per unit of product, and if we say it is effective, it means that the company achieves maximal revenue per product, which means it achieves maximal profit. Therefore, each utility company aims to have minimal costs per unit of time, what creates all the preconditions for extension of program operations (hiring new employees, purchasing new machinery, innovations in processes, etc.).

3.1. Modeling of optimum transport routes

Transport routes modeling is representing increase in quality of services and shortening of transport routes (Davidović, 2013). If we use an algorithmic analysis of transport routes, we can define optimal routes, then the fleet size and structure, each point of interest at which utility vehicle stops to collect municipal waste, etc. (Braysy et al., 2009). By using the implemented algorithms, it is possible to effectively create a master plan, which will be adapted to all key transport routes, but it will also be used to create each new travel route in accordance with the needs of each utility company, individually speaking. After the commencement of this plan's implementation, it is possible to follow all steps from starting to end point of transport route, what includes waste collection at defined points of interest, then transport to the closest transfer station for reload and final disposal on the sanitary landfills or transport to incinerator.

On the other hand, for utility company we have to define what represents the optimization of resources, and optimization of transport costs. This is retade to generating major travel routes, which effectively perform the optimization of transport resources, through a cycle of planning, respecting all defined constraints such as: roads, vehicles, etc. In the figure below, we will present all steps leading to finding the optimal travel routes. Figure represents a good starting point for the empirical part of the study, which follows in the next chapter.

In the presented figure, starting and final stops were given, between which the utility vehicle is moving when collecting city waste, in accordance to marked points of interest. The aim is to achieve cost optimization and time efficiency in collection of city waste between starting and final point. *Starting point* was marked as the garage from which vehicle is starting towards it's work assignments, while the *final stop* is actually final destination of our vehicle, that we named as the city landfill.

If we take a better look at Figure 1, we will see that given transport routes (points of interest) are pretty much dispersed between the starting and final stop. It practically means that, on its way of collecting the city waste, vehicle has about 50 stops till the final one (city landfill). Thus, it is of essence to determine the exact route (shortest distance between starting and final stop)

which will be used by utility vehicle in order to avoid the so called route's multiplication (if the utility vehicle is moving along the same route two or three times, it creates the so called knot). Besides, it is important to choose the utility vehicle with optimal characteristics, for waste collection, bearing in mind the distance between reloading stops from starting to final stop, as well as the city landfill, since only one vehicle is participating in waste collection along the transport route.

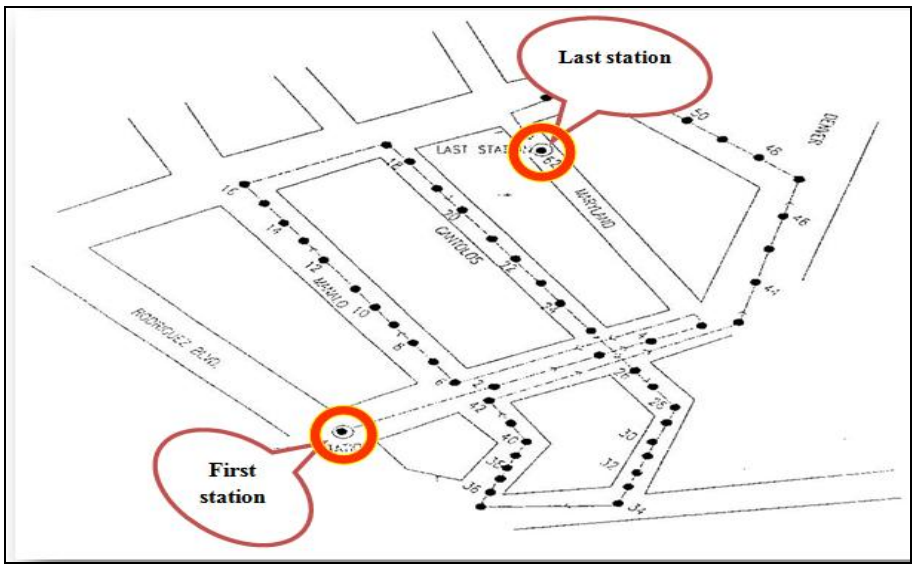


Figure 1. Determining transport routes and points of interest (instead of city waste collection) with shown starting and final stops. *Source:* Adapted in accordance to Ryo Hiraga, 2015

To achieve the optimal level of transport in calculation of transport routes, here are key guidelines for efficient collection, transport and disposal of city waste, and it includes following:

1) *Equipment selection* (payload and type of trucks, depending on street width (for example, narrow or wide street require different payload of utility vehicle - between 5 and 15 t));
2) *Frequency of city waste collection and transport* (eg. mixed waste is being collected and transported every day between 07:00 hrs and 19:00 hrs, with lunch break between 13:00 hrs and 15:00 hrs, while secondary raw materials separated from waste (plastic, PET, cardboard, paper, metal and other) are beeing collected and transported every Wednesday and Friday between 10:00 hrs and 15:00 hrs));
3) *Standardization of garbage cans* (bucket volume is prescribed by law, so green bins are used for mixed waste, blue and yellow for secondary raw materials, and the volume of bucket is 120 liters);
4) *Crew* (behavior of drivers and auxiliary workers in the utility vehicle, during field visits and discharge of municipal waste from buckets);
5) *Private or public enterprise* engaged in collection and transport of city waste, with the ultimate aim of optimizing costs;
6) *Time calculation between two transport routes* (purpose is to determine the „idlling time" and worker's lost time during waste

collection, between the first and each subsequent point of interest);

7) *Condition of roads* (greater efficiency in waste collection is achieved if roads are in good condition (we assume that streets in the city are covered with asphalt and there are no visible damages to te road), and vice versa);
8) *Distance between landfill and starting point* (greater distance between a landfill and garage where from utility vehicle starts will cause higher costs for fuel, lubricants, etc.) and
9) *Number of transfer stations* (the higher the number of so-called transfer stations on utility vehicle's route, time is achieved as well as profit maximization, but it also reduces operating costs).

Therefore, on the basis of the prevoiusly presented, we say that city waste management, both in the city and in the suburban areas, requires planning and analysis in the calculation of transport routes. Based on that we will get the right trajectory and the time course of collection and transportation of waste, what we will repeat with the ultimate goal of cost optimization.

Below (Figure 2), we will present correct path by which utility truck needs to move (in the proposed city or municipality), in order to avoid unnecessary repetition (enter the same street to collect waste two or more times) and in order to maximize profit on monthly basis. Also, it is important to emphasize that the following analysis is an excellent strategy for all companies dealing with waste. Companies can use this analysis to achieve its goal (to overcome the problem almost every such company in Bosnia and Herzegovina and region is facing), and that goal is efficient management.

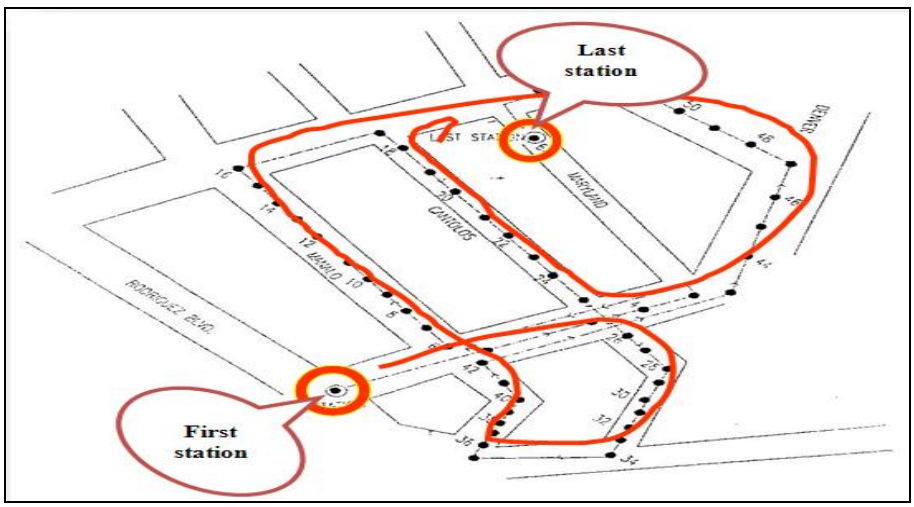


Figure 2. Proposal for determining transport routes and points of interest (city waste disposal facilities) with the initial and final stop. *Source:* Adapted in accordance with Ryo Hiraga, 2015

The first thing to notice in Figure 2 is only one multiplication (movement of utility vehicle along the marked route) from starting point and the first street at the beginning of the first settlement, in observed town or municipality. This also means that we are well on the way to minimize the time our crew needs to collect all city waste during one day's working hours, and drive it to the city landfill (last stop).

Further, using the bold line in Figure 2,

we've shown a path that includes all points of interest (from first to last), so we can safely claim that all city waste (provided that it is properly packed in bags and placed in the bins) will be taken away on schedule.

Authors gave their opinion on the shortest and most efficient transport route, which is shown in Figure 2, which may not be the only possible choice of the city in the collection of waste and its transport to the city landfill. Transport route defined in Figure 2 is an effective method of determining the optimal movement of utility vehicles for the purpose of waste collection, transport and disposal. In this section, we can ask ourselves a simple question: *Is it at all important to determine the transport route along which the utility truck is moving*? Although the answer is affirmative, in the sequel we will prove its confirmation using mathematical calculation, with which we will conclude that the sequence-related events, determining the exact transport routes are leading to efficiency in cost management of the Waste Management Company and to profit increase in the long run.

4. Empirical research

In this paper, we'll investigate the possibility of theoretical formulation of transport routes' optimization, which will facilitate the long term operation of all utility companies in Bosnia and Herzegovina, which decide to apply it in their societies.

Place of experimental research is limited to the territory of Doboj (the city located in one of the two BiH entities - The Republic of Srpska). For the purpose of this project, we've conducted a field survey in August 2015, randomly in the area of Doboj.

4.1. Methodological Basis of Research and Limitations

Research for this study included a sample forming part of the city core of Doboj, and it's about four settlements (when conducting research, sample covered randomly chosen 23 blocks out of 64 or 35.93%) and its suburbs named Bare (which has four streets). Thus, the sample consists of 5 out of 15 settlements (33,33%). So, as a starting point for research we took into account the frequency of utility vehicles' movement (waste collection and transport) and the distance between the garage from which the vehicle starts, transfer stations and landfill. In this document, primary focus was on optimal "creation" of transport routes with an output that represents a theoretical optimization model of transport routes, and we will declare as constants the analysis related to settlements, streets and other parameters of Doboj.

On the other hand, research has been conducted on a relatively small sample of streets and urban settlements, given the size of the population. general limitation in this study is the lack of financial resources that would be required for initiation of extensive research on the territory of the entire city as well as from the aspect of the regional principle in The Republic of Srpska.

To commence more serious study, of which would benefit not only local communities and utility companies, but also the academic community, "financial injection" is needed to make possible purchase of equipment needed for the implementation of this and similar studies, as well as from the aspect of availability of the latest innovative devices for mapping the transport routes.

4.2. Identification of Variables and Determining of Indicators

If we look again at the basics and the only research hypothesis of this study, we can conclude that *organization of transport routes in an innovative way* represents an independent variable, while *rationalization of time for transport of city waste and managing company's expenses*, represents a dependent variable. Therefore, in our work we have looked at the possibility of

organizing transport routes in an innovative way, from the viewpoint of rationalization of time needed for transport of city waste and optimal management of company's expenses. Therefore, as indicators of an independent variable, we will observe following: points of interest on transport route; transfer stations; distance between the so-called transfer stations and landfill, as well as the possibility of forming a theoretical Model for transport route's optimization.

On the other hand, dependent variable follows the concept of mapping the terrain and time consumption which one utility vehicle with crew spend on the field (visiting, respectively, all the points of interest) and is linked to the collection, transport and disposal of waste, which leads to the elimination of the so-called "idling" and gives formula for an optimal strategy allowing company to have a rational cost management.

4.3. Research results

At the beginning of this research we have mentioned that, if company has no the long-term plan, or if it does not test all the settings mentioned in the plan, it will not achieve the optimal results in the field it operates in. In continuation of this document, we will present basic parameters every company needs to adhere to, if it wants to optimize its working hours during the day, as well as it's tasks.

Table 1 shows basic parameters of the so-called terrain mapping, what is starting point for travel routes determining and mapping of points of interests in them, in order to calculate the time necessary for collection, transport and disposal of waste. Mapping proccess is actually a tour of terrain during which we enter different points on which we are to carry out certain actions in the future, and in our particular case, we are visiting the settlement in the town or municipality where city waste will be collected, using certain methodology within defined time frame, and with certain crew members. Field is being recorded (visually as well as by recording anything observed in the field), actions to be carried out in real time are being defined and all changes on the visited terrain are being analyzed.

Table 1. Defining main points of interest for waste collection and calculation of time needed for waste collection and transport

	Time		**Distance**	**Collecting time**	**Travel time**	**Remaining time**
	Departure	**Arrival**	**(km)**			
Garage						
1. stop						
2. stop	**Enter data in columns (in the field)**			**Calculate by phases (in office)**		
3. stop						
4. stop						
n. stop						

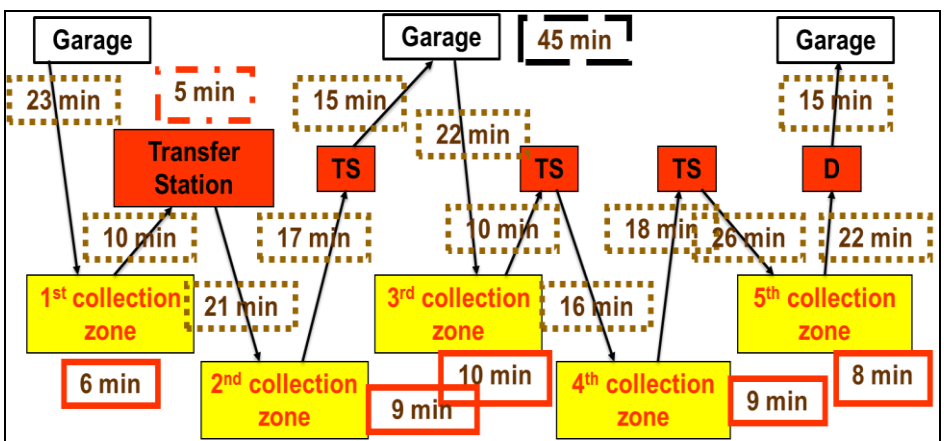
Source: Authors

So, for purpose of terrain mapping, it is necessary to provide all the necessary equipment and human resources for implementation of operation, which includes following steps:

- Assigning two crew members who will, with company's vehicle, visit all points of interest;

- One crew member who will measure time of travel between each stopping point;
- Another crew member who will record distance (measured in kilometers) between each previously defined point of interest;
- Camera recording of all points, for purpose of creating visual identity of entire route;
- Determining actual road condition (writting an official note on the state of unclassified roads needed for utility vehicle's movement, as well as on all roads on transport route with damaged pavements);
- Calculation of total time needed for waste collection;
- Determining total time spent on waste collection operation;
- Determining the total time spent during waste discharging at the landfill;
- Calculation of „iddling“;
- Calculating the total time spent at the gas station,
- Other.

In the Figure 3, on the basis of the study in the city of Doboj (Bosnia and Herzegovina), in period between August, 7th and 19th 2015, each individual step related to calculating the optimal transport time, expenses and „iddling" needed to achieve the effect of transport route's optimisation is shown.



Working Hour		8.00 hour	100 %
Travel Time	23+10+21+17+15+22+10+16+18+26+22+15=215min	3.58 hour	45 %
Collection Time	6+9+10+9+8=42min	0.7 hour	9 %
Dump Time	5X5=25min	0.42 hour	5 %
Lunch Time	60 min	0.75 hour	9 %
Maintenance Time	55 min	0.92 hour	12 %
Unnecessary Time	98 min	1.63 hour	20 %

Legend: *G –garage; TS –Transfer station for reload of colected waste; D – landfill.*

Figure 3. Calculation of working hours required for the collection, transfer and disposal of waste in the course of one working day. *Source*: Adapted according to Ryo Hiraga, 2015, 13

At this point, we must emphasize that the research for this study was conducted only one year after catastrophic floods (May 2014), when the city of Doboj collected and

deposited a total of 10.000 m^3 of bulky, hard, animal, construction and mixed waste, what corresponds to an average period of ten years of collecting waste in the same city, under normal circumstances. However, thanks to the strategy of KP „Progres“ a.d Doboj, the local community and the Government of The Republic of Srpska, all waste was disposed of in a timely manner, given the planned route and sufficient machinery (bulldozers, trucks. etc.).

In this study, active participation was taken by company's management, as well as three crew members, one of which was utility truck driver. Task of company's management, along with authors of this study was to monitor the entire process of visiting transport points, waste collection, discover the so-called "idling" between these points, and define a clear strategy to rationally manage company's expenses. That means time optimization, avoiding route multiplication and reducing operative costs (fuel, etc.).

On the other hand, crew of utility vehicle was tasked to follow all guidelines and instructions given by company's management, but also to point out the eventual difficulties in collecting waste in certain parts of transport route, primarily in the segment referring to the lost time during the collection (negligence of citizes in a sense of improperly packed waste and its disposal in caontainers, etc.). For greater efficiency, and in the period of the study commencement, participants in the survey communicated with each other via the mobile network, provided by local operator who is a member of a VPN group, so that the cost of calls via mobile phone were equal to zero, what certainly facilitated the entire process of research.

Figure 3 represents an innovative way of costs calculation and determining the amount of time spent on transport route, and it helps us answer the question: *Is it at all important to determine the transport route along which utility vehicle is moving?*

So, the elements that need to be learned in the said figure, and they are key steps for calculating the optimal time needed by utility vehicle with crew members to spend during the day, are:

- Establishing total number of working hours per day;
- Establishing total number of garages, necessary stops and transfer stations on designated route;
- Calculating time required for travel to each stop, waste collection and disposal;
- Establishing total time for lunch break, and
- Calculating „idling“ and unnecessarily spent time during certain operations on transport route

Therefore, based on research, and in order to facilitate visual monitoring shown in Figure 3, we can see that time for collection, transport and disposal of waste, within one working day is eight hours. Also, out of total time spent during circling the town and collection of city waste, 45% of the time spent on transport route was spent on driving (3,58/8,00hrs). Since we have five transfer stations on route, and utility truck spends 5 minutes on each, we will need a total of 25 minutes (5% of total time) for unloading of waste collected in these stations. Length of lunch break is 45 minutes, what is 9% of total time spent on work during one day. Finally, we can conclude that about 12% of total time is spent on vehicle maintenance (visit the garage, refueling, small repairs, etc.), and the remaining time of 98 minutes (20%) is wasted on the so-called "idling", what can be attributed to the negligence of the workers themselves and their irresponsibility on work, and that negligence can be used by their immediate supervisor as an argument for verbal or written warning, what could lead to reduction of guaranteed salary (for example, the next 3 months their basic salary will be reduced for 10%).

Speaking of "idling" and based on research we have conducted in the city of Doboj and its suburb Bare, we have come up with an answer that the loss of time was caused by the fact that utility vehicle was "caught" in the so-called *rush hour* on certain road sections. Therefore, based on previously explained, utility company's management was advised to avoid waste collection and driving along the streets during the congestion of city traffic, which is manifested in the early morning hours (between 7 a.m. 8 a.m.) and later during the day (between 3 p.m. and 5 p.m.), because that is the time when majority of employees inhabiting this city goes to work or from work to home. All of the above applies in cases of religious and national holidays as well as during the holiday season.

Out of total time spent at work during one day, we saw that about 45% of total time was spent on circling along transport routes and on waste collection. This situation can not be characterized as desirable and optimally planned, because it still entails significant time of "idling", what we want to avoid in the long run.

Finally, we suggest utility company to increase time for lunch break and leisure activities during the day, from 45 minutes to 1 hour. The reason is simple - to increase the productivity of workers, to make them more willing to strive for common problem solving while commencing a tour on route during working hours.

5. Model of optimization of transport routes

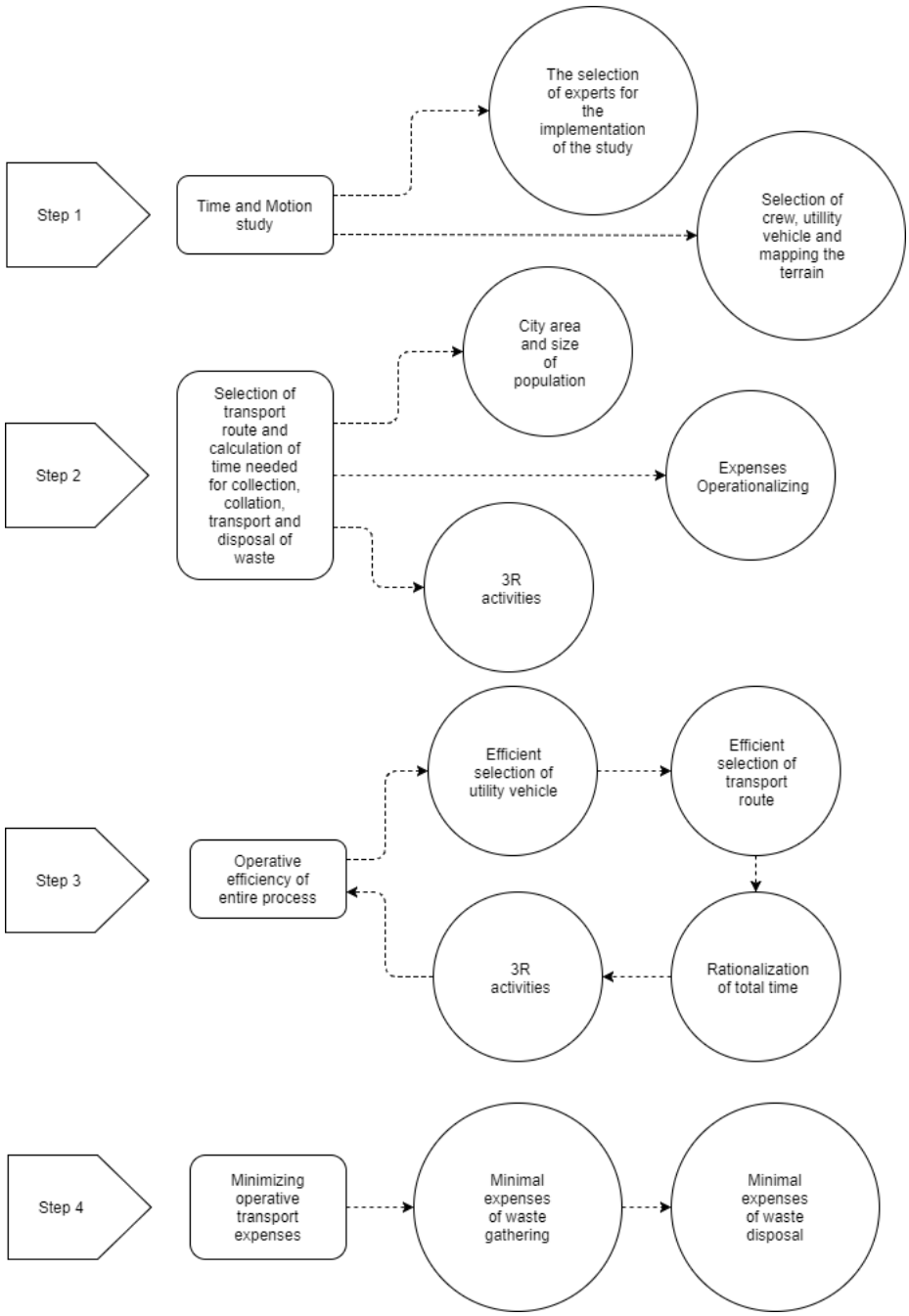
Based on analysis of transport routes presented in this document, as well as the research results, we can safely conclude that the organization of transport routes in an innovative way would contribute to the rationalization of time spent in waste transport, as well as to the rationalization of company's cost management.

Below, we have presented a theoretical model of optimal planning of transport routes in the given city or municipality, adapted to countries in transition, and created on the base of experience gathered by developed countries as leaders in the field of city waste management (Scheme 1).

Step one in developing the Model of transport routes optimization (hereinafter referred to as Model), refers to the study of terrain where collection, transport and disposal of city waste takes place. So, it is a stage that requires engagement of a professional team directly involved in all study stages on the ground [*first team member* will measure the time spent on moving between all points of interest on transport route, to the last point – city or regional landfill; *second team member* will keep track of all changes during a tour on transport route; *third team member* will monitor behavior of crew members and assesses their speed of waste collection, their resourcefulness when they find themselves in a transport collapse - traffic jam, etc., as well as their will to fulfill their duties; *fourth team member* will revise the transport route, what includes selection of utility equipment (bins, containers, etc.), utility vehicle, crew and time organization managed by authorized Company)].

In *Step 2* of the Model, based on mathematical analysis and statistical operations, we strive to determine the optimal choice of travel route in the city or municipality where we perform analysis. This primarily relates to determination of demographic characteristics, followed by prediction of time spent on collection, transport and disposal of waste, because the ultimate goal is achieving the cost optimization and implementation of 3R activities. Each company in Bosnia and Herzegovina, as well as in other countries in transition in the region, need to adapt it's business strategy to optimal use of working hours and employees, but also to try to partially or fully implement the 3R strategy in its business. That further means that we

will focus with reduction of useful raw materials from waste, and its reuse (for example, old t-shirts and other clothing items thrown into the containers, we'll wash and prepare them for use by residents who can not afford to buy new ones), and finally we come to recycling secondary raw materials (cardboard, paper, plastics, etc.).



Scheme 1. Suggested Model of Optimization of transport routes. *Source:* Authors

If the first two steps of this model are completed in accordance with defined parameters, we will start *Step three*, in which we actually measure overall effectiveness of the Model, what is primarily related to selection of optimal transport route, achieved optimization of time, optimal Company's cost management, but eventually to the most important step - elimination of "idling" on daily or monthly basis, what causes the most damage and losses to the Company. Here we must underline that in the long run, Company will benefit if it respects the principle of optimal cost, ie. if it rationaly uses fuel and lubricants for utility vehicles, by avoiding unnecessary multiplication of travel routes, etc.

6. Discussion

In this chapter, we will compare survey results from this study with other similar studies conducted in the world and in our immediate environment, with the aim of giving recommendations for new academic research.

In fact, studies have shown that modern world economies (except Japan and Western Europe), have a big problem with waste management, regardless if we are talking about densely or sparsely populated area (Rekiek, et al., 2006).

In time of globalization and global economic crisis, extremely small amounts of money are being invested in innovation in waste management activities (for example, the introduction of utility machines that are absolutely oriented towards robotics, which will replace the work of people), what in the long run leads to creation of illegal dumps, water and air pollution and, in one word, to damage to the environment and human's health.

According to conclusions of research commenced by Cheng and Rich (1998), it has been proven that unnecessary multiplication of utility vehicle's routes contributes to the growth of costs for fuel and lubricants, as well as to increase of time needed to pass the entire route, what leads to unwanted overtime hours required for this job. According to conclusions of research commenced by Geetha Shanmugam (2011), better created network of transport routes leads to reduction in fuel consumption (funds), improvement of environment, better quality of service and better coverage of terrain. Case study conducted in Sweden, clearly showed that savings are possible in transport costs and „idling", respectively by 20% or 7% (Eveborn et al., 2006).

In his research, Haughton (2007) proved that developed countries as opposed to countries in transition and those underdeveloped have specific modalities referred to as „day - to – day", and those modalities refer to planning of potential problems in the collection of waste and transition to plan „B". In urban areas, it is necessary to develop a plan for mapping the terrain, after which it is needed to create all conditions for a cost-effective and optimal way of collection, transport and disposal of waste, respecting the mechanisms and directives of 3R (Desrosiers et al., 1995).

On the other hand, according to research conducted in Croatia, economies of scale play a key role in achieving efficiency in logistics, and finally it directly affects the profitability of company (Šamanović, 1999). According to the same author, in proces of distribution, due to large number of delivery locations, and aiming good quality of service, it is necessary to have sufficient number of vehicles, mainly because of the large number of delivery points and specific shape of Croatia. Although utility companies and other companies working in similar business are in possession of large number of vehicles, unfortunately they have very little use of them.

According to Ilić and Trumić (2006), the main disadvantage of waste management in Serbia is lack of finance, insufficient number of utility vehicles with optimal capacity and performance, as well as route organization

and matrix of movement of utility vehicles, what should be based on a thorough analysis that are based on the frequency of container's filling and capacity of the vehicle, instead of free estimate.

In countries in transition, lack of funds, which are largely spent on "patching" the budget and on salaries of employees in huge administration in the public sector, leads to impossibility of investing in utilities, primarily from the perspective of waste management. If we talk about Bosnia and Herzegovina, there are very few incinerators, which after incineration of waste are working on production of electricity, etc. True, the process of building incinerators, as well as long-term profits from the same, represents an extremely high cost to the budget of one city or municipality, but in the long run, this investment represents a fortune, because the waste after treatment in incinerator's furnaces with high calorific value, becomes the raw material in further electricity production and binding material in the construction industry, instead of garbage. Thus, not only that from incinerators we create a new value in the form of useful energy, but we gain all the prerequisites to replace inadequate landfills with useful incinerators, as well as all the prerequisites to implement in practice the theoretical consideration of transport routes "usage".

7. Conclusions

The theme this document follows is extremely topical and represents a "burning" issue, not only in countries in transition, but also in far more developed countries both in Europe as well as in the rest of the world. So, in this paper, we have presented the latest research, done by renowned experts in the field of waste management and we have pointed to all the potential opportunities related to innovations in rationalization of waste management that can have an impact on economic prosperity of utility companies in Bosnia and Herzegovina (survey was conducted in the city of Doboj) and in all the other countries in transition in the region. In addition, authors of this study presented method and procedure of calculation of transport routes, with an emphasis on calculating the optimal path (route) along which utility vehicle should move during the collection and transport of waste, what contributes to achieving efficiency and effectiveness of the Company in the long-term. Based on empirical research and on confirmation of basic research hypotheses, we have proved that Company must reduce so-called "idling" while circling the settlment in waste collection process (1,63 hrs or 20% of total time spent in the performance of their work), as well as to increase the daily break (from 45 minutes to 1 hour), for the purpose of greater efficiency and productivity in the work. Finally, in order to achieve optimal performance, company needs to reduce the total travel time from 3.58 hrs or 45% of total time to 30% or 2,4 hrs, because only this way it can achieve full control over operating costs and evaluation of crew performance.

Practical contribution of this document to the wider academic community, utility companies in the country and to interested public is manifested through theoretical Model of transport routes optimization, through what we are trying to expand horizons to all utility companies in the country and wider environment, so they can implement the same in their operations. Benefits which mentioned target groups will have from this Model are:

- *Rational expenses management* (reducing expenses for fuel and lubricants, reducing the unnecessary "idling" during a tour around settlements for waste collection, and investment in expansion of existing machinery and recruiting new experts in the area of waste management);
- *Implementation of strategy "3R"* (primary emphasis is on the re-use of usable waste, such as textiles, etc.);

- *Utilization of secondary raw materials gathered from waste* (plastic, PET, cardboard, paper, etc., will be used in the new recycling cycle, and in addition, this non-degradable waste will not end up in landfill) and
- *Increasing the overall efficiency and effectiveness of utility enterprise* (rational waste collection reduces the total amount of its depositing, and thus reduces the costs of waste disposal in the city or regional landfill).

Based on the foregoing, we conclude that, in time of rapid global changes, internationalization of business, falling world economic standards, migrant crisis which is far from over - which is problem for the EU, but also for the world in general, innovations and efficient / effective thinking represents one possible solution in the resuscitation of faltering economies of countries in transition.

In order to encourage researchers and experts in the field of waste management, to further research the subject of this paper, it will end up in the form of a question: *Does Bosnia and Hercegovina, as a country that is, for many year, struggling with its identity crisis, have the courage to tackle with everything that globalization brings with itself, to bring its position in the company of the world community on a higher level, thanks to a higher proportion of GNI used for research of new technologies in waste management.*

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