Analysis of citizens' behaviour with respect to formal and informal waste selective collection in Bolivia

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Abstract

The introduction of selective collection systems in developing cities represents a challenge for stakeholders and local authorities. Social inclusion is compulsory for obtaining good results, and social surveys should be introduced in order to understand population behaviour about recycling activities. The research presented in this article was conducted in La Paz (Bolivia) in 2018. Totally, 774 citizens were interviewed for understanding how they support the formal or informal selective collection implemented in the city. Two types of questionnaires were submitted: to the users of the formal selective collection points and to the citizens of the city. Results report that less than 8% of the population implement the formal selective collection although about 48% of the inhabitants select the waste at home. The majority of them (79.2%) deliver the waste to the informal sector or throw it into the mixed containers in order to facilitate the collection of the waste pickers. The outcomes of the research allow implementing a formal selective collection system at the end of 2018. Two neighbourhoods of the city were considered for implementing the pilot plan, taking into account the behaviour of the population and justifying the action with the indicators obtained by the survey. Moreover, the research allows considering that the informal sector could be an alley for improving the RR of the city, boosting the circular economy principles. The outcome is of interest also for international stakeholders for introducing appropriate policies for improving the circular economy considering social behaviour and the inclusion of the informal sector.

Keywords: Circular economy, Developing countries, Municipal solid waste, Social survey, Informal recycling.

1. Introduction

The implementation of formal waste selective collection systems (SCS) represents a challenge for Bolivia due to the multifactorial and multi-sectorial issues that are related to this practice. However, the introduction of the circular economy (CE) principles (reduce waste and pollution, keep materials in use, regenerate natural systems) represents a key strategy for improving social, environmental and economic sustainability, so it should be introduced for boosting sustainable development [1].

A first issue for introducing SCS in developing big cities of Bolivia, as common in other countries, is the provision of municipal solid waste (MSW) infrastructures [2]. Moreover, other concerns are the lack of awareness and involvement of the population, uncollected fee, environmental and health impacts due to open burning or open dumping and insufficient policies [3]. Since the success of recycling programs depends on households' participation [4], and one of the main barriers is the lack of knowledge about the waste separation and classification among the citizens [5], the actors involved in MSW service provision should make community recycling information accessible, inform about what happens to waste that are not properly segregated, and explain environmental issues through mass media [6].

For that purpose, information about citizens recycling behaviour should be gathered since it helps to support the design of recycling policies. Generally, many social factors should be considered in order to cope with the

requirements of the population. The income of the families, the awareness about recycling facilities [4], the distance from home to the collection site [7], the level of environmental knowledge (De Feo and Williams, 2013) and the attitude to waste separation [5], are all drivers of waste separations behaviour. As a result, for developing new policies, social surveys can be useful for understanding the status of residents' attitudes and can be used for promoting waste recycling [9].

This study introduced a questionnaire survey in a Bolivian developing big city for introducing reliable SCS considering social attitudes and habits in recycling. The research refers to the recycling behaviour of the citizens of La Paz, where the introduction of CE policies and plans is still under development [10]. The aim of the work is to assess the behaviour of the citizens in the formal recycling points available in the city by a questionnaire survey, comparing the results obtained with another study conducted in parallel at municipal level. The questionnaire survey investigates why and how the citizens implement the selective collection, understanding if the population is used to deliver the recyclable waste also to the informal collection, which is not still included in the formal MSW management system.

The research was conducted for supporting the requirements of the local government, which intends to improve the recycling rate (RR) of the city for reducing environmental impacts and improving economic sustainability, as well as social inclusion and the liveability of the city. As consequence of the survey, two pilot projects of selective collection were introduced within the city, within the areas where the selective segregation at the green points was higher. This contribution provides also useful information to stakeholders involved in the MSWM management in developing big cities, where the RR is still low and should be improved considering the activity of the informal sector.

2. Method

The study was conducted in the residential area of La Paz, developing big city of Bolivia. The research was directed in cooperation with a local public university (Universidad Mayor de San Andrés), an Italian University (Insubria University) and the local Government. The respondents of the study were selected in two different areas: Formal selective collection points and Neighbourhoods. The results of the questionnaire were collected and assessed, critically analysing the outcomes for understanding how the RR of the city could be enhanced by the formal SCS.

2.1. Study area

La Paz, Bolivian municipality with about 900,000 inhabitants and a growing rate of about 1.1%, is a city inserted in a low-middle income country. The gross national income (GNI) of the country is about 3070 USD per inhabitants with a poverty ratio of about 39.5%. The city is located in a particular geographical area, between the *Cordillera Real* mountain range and the Andean plateau, at an altitude of about 3,600 m above the sea level. It makes MSW collection, treatment and final disposal a real management issue, also due to the lack of space available for improving management facilities. In this context, where about 623 t of MSW are generated per day, less than 8% of which are recycled mainly by the informal sector, the SCS should be introduced in order to reduce the waste streams inflow into the sanitary landfill [10], waste mainly composed of organic waste (47.3%) and recyclable materials (32%). La Paz could be considered a good example for other low-middle income developing big cities, since the service provided, mainly introduced by mixed street containers and compactor trucks, covers the 89% of the city and the sanitary landfill is controlled and monitored by the local authorities and the private sector [10]. The main issue is the financial sustainability of the system, since it is covered only for less than 40% by municipal charges.

Recycling policies were introduced in the last five years, so the city lacks a wide formal recycling system. In particular, in 2014 a Swiss non-governmental organization (NGO) introduced a plan for including the informal sector and introducing a pilot SCS in the city. This project, applied also in other Bolivian cities [11], was the first experience of SCS. The project introduced a sorting plant and selective collection areas called "Green Points" (GP) for gathering recyclable materials. In 2017, after the end of the project, the local government continued to support the activity of the GP, although in low amount, while the formalization of the waste pickers stopped and continued to be informal. So, at the end of 2016, the SCS applied in the city was introduced in two different systems: the formal collection with the GP and the informal collection of the waste pickers and recycling shops.

In 2018, the GP available in the city were ten, located in different neighbourhoods of the city. Nine of them operates every Sunday, while the other works in the central area of the city, from Monday to Friday. The management of the GP is in charge of the local government, which select, transport, and sort the recyclable waste. Then, the sorted material is sold to private companies. At the same time, the activity of the informal sector operates in parallel. In the city there are many informal shops that buy the recyclable provided by the citizens. Data about

the material segregated are not available, although could be estimated to be around 40 t per day of recyclable waste [10].

2.2. Survey modes

The survey was conducted at the GP and through the streets of the neighbourhoods in order to assess the recycling behaviour of the users of the GP and of the citizens. Therefore, two structured questionnaires were built. The face-to-face method was employed since it was the only way useful for detecting the users of the GP and so was replicated for the interviews implemented in the neighbourhoods.

For the implementation of the survey campaigns, 10 students of the University, volunteers who would support the research, were trained and involved for providing the questionnaire to the population. The questionnaire survey was implemented during the Sunday morning, from 9 am to 1 pm, for a total of 13 weeks, from February to April 2018. The areas for the surveys were pre-determined and planned for making the results representative both for the GP and the municipality.

The users and citizens interviewed were considered as "families interviewed" since the questions were reported for understanding households' behaviour. The interview was conducted with people from 18 to about 75 years old, selected from the users of the GP and the citizens in function of their availability to participate in the interview. The motivation of the questionnaire was carefully introduced to the citizens before its submission, so interviews only proceeded when respondents provided informed agreement.

2.3. Sample size and location of the interviews

In order to generalize the data obtained for the whole population, a confidence interval (CI) with 95% confidence level was introduced for each question. The population size for both study areas was calculated in order to obtain a CI lower than five. In particular, for the GP the sample size was proportionate in function of the number of users per point, while at city level the number of inhabitants was considered.

The data available at the GP were the quantity of recyclable materials collected per year and the average number of families who provided the waste per Sunday. The GP were divided in a north, central and south area, representative for the development of the city, from the less (the north) to the most developed (the south). Data are reported in Fig. 1. Can be noted that the quantities of waste and the number of families that deliver the waste per week are proportionate and are higher in the south area of La Paz, the richer area of the city.

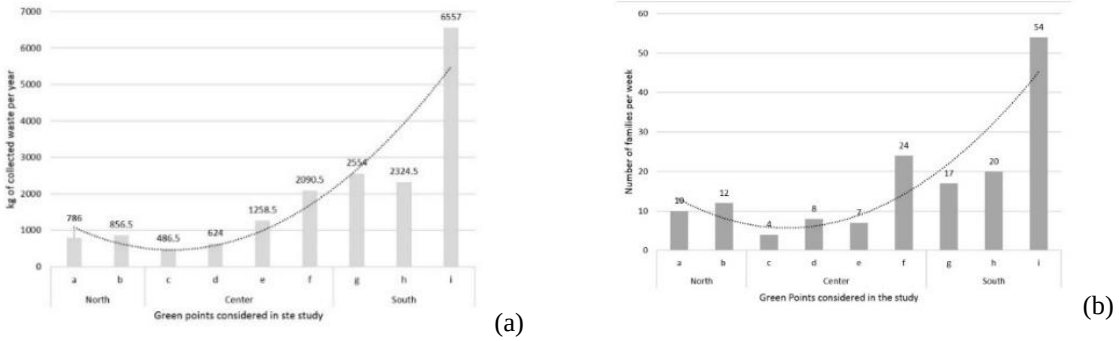


Fig. 1. Data considered for measuring the proportion per GP: (a) amount of waste collected per year (2017) and (b) average number of families per week.

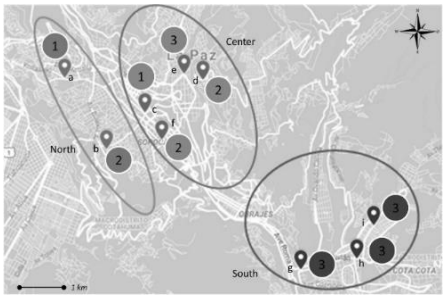
These data were used for counting how many families should be interviewed per GP. The total sample size was calculated in function of the total users of the GP, about 4600 families, which is about 2% of the population. So, the total sample size is of 354 users. The proportion of each point and the sample interviewed are reported in Table 1. The real data allow planning also the days required for interviewing the sample per GP in order to achieve a sample statistically significant. However, obtaining the exact user number per point was logistical difficult, due to the variable number of users which delivered the waste per Sunday. For this reason, the real number of the sample size per GP are not perfected related to the theoretical. Finally, 364 families were interviewed.

Table 1
Theoretical sample size considered in function of the number of families per GP compare with the sample interviewed.

	GP considered	Total

	a	b	c	d	e	f	g	h	i	
Theoretical sample size	23	27	9	18	16	54	39	45	123	354
Sample interviewed	18	23	8	13	21	90	18	54	118	364
Days required for the interviews	1	2	1	2	3	2	3	3	3	

As regard the municipal survey, the sample size was calculated in function of about 900,000 inhabitants of the city. As a result, for obtaining a CI lower than five, 384 citizens should be interviewed. Finally, 410 citizens answered to the questionnaire survey. The neighbourhoods considered for the study were 23. For optimizing the time required for the study, 11 points were selected for the campaigns, in agreement with the requirement of the local Government. The 11 neighbourhoods were choose considering both the north and south part of the city, in order to obtain a sample that can be considered representative of the city. Moreover, the points were selected in areas of high-density population (i.e. supermarkets, bus stops, graveyard, markets, squares), and near the areas where the GP are located. Fig. 2 reported the maps with the GP and the districts considered for the interviews. At the end of the survey campaigns, 774 citizens were interviewed.



(a)

(b)

Fig. 2. Areas considered for the social survey: (a) Green points and (b) Neighbourhoods, in dark grey the points where the campaigns took place, in light grey the points planed.

2.4. Questionnaires

The questionnaires were implemented for the GP and the neighbourhoods. In both cases, the personal attributes were evaluated, in terms of gender, age, people per family and socio-economic status. In particular, the socio-economic status was determined in function of the job and was divided in four main categories:

A. Jobs where a graduation is required or where the economic level is high (lawyer, engineer, professor, business owner, ambassador…)
B. Jobs where a higher education level is required or where the economic level could be associated to the middle class (secretary, government employee, owner of a business, professional sports man …)
C. Retired or University students
D. Jobs where the scholar level is low as well as the economic level (bricklayer, electrician, newsagent, baker…)

This categories division was introduced since, during the first implementation of the questionnaire, there were difficulties by the interviewed to provide personal information about the salary and the scholar level. So, the questions were modified for obtaining at least an indication of a socio-economic status.

2.4.1. Questionnaire at the GP

The first questionnaire included eight questions (Qi), while the second is composed of seven ones. The main conceptual difference between the two questionnaire is that for the GP the users surely implement the formal selective collection, so the questions are related to understand how they implement this practice; while in the second questionnaire, where there are no previous information provided by the context, the data gathered are related to the knowledge of the GP and the implementation of the SCS at home. In both cases, the questionnaire was implemented for assessing a few factors that influences the behaviour of the citizens and for detecting some information required for the application of a SCS. The factors were assessed in function of previous information collected by the local government at the GP, while the unknown information was introduced for understanding citizens' opinion and behaviours. For the GP, three factors were assessed:

- Factor 1 (F1): the citizens who deliver the material live nearer than 500 m from the GP,
- Factor 2 (F2): the users of the GP are mainly of high education level,
- Factor 3 (F3): the users deliver the waste more than one time per month.

One important information regards the delivery of the waste also in other informal collection points. At the same time, understand how the citizens knew the operation of the formal collection system, what they think about the need of other GP, and why they implement the selective collection are also information requested by the local government for planning the municipal SCS.

Therefore, the questionnaire was divided in five sections, the first for analysing the personal attributes, while the rest for assessing where they live (Location), the delivering behaviour (Delivering), the knowledge about the GP (Knowledge), and the view about the selective collection (Opinion). These topics were assessed in order to understand: how far the GP could be introduced; how many times per month the people use the GP, so if the GP should be fixed or is enough introduce it each Sunday; how the population knows the activity of the GP, for understanding which kind of public campaigns should be introduced; if they think that other GP are required and why they implement the selective collection, for planning publicities and the implementation of other selective collection areas.

2.4.2. Questionnaires at the neighbourhoods

The factors assessed with the questionnaire submitted to the citizens at the neighbourhoods are:

- Factor 4 (F4): less than 2% of the interviewed use the GP,
- Factor 5 (F5): More than 2% of the population do the selective collection at home,
- Factor 6 (F6): The citizens deliver the recyclable waste to the informal recycling shops.

The interest of the local Government was about the typology of waste segregated, where the citizens delivered the recyclable waste selected and why they do that. The main objective is to assess if a part of the population could be immediately involved in the formal SCS and how it should be introduced. For this reason, the questionnaire was divided in three main part: The first for assessing the personal attributes, as for the questionnaire provided at the GP, the second for asking about the GP, so for evaluating how many people know the presence of the GP but do not use them, and the last for assessing the recycling behaviour at home, so for understanding if the population do or do not implement the selective collection. The questions are listed in Table 2.

Table 2
Face to face questionnaire provided to the 774 citizens at the GP and districts.

Aspect	No.	Question	Choices for each question
		Green points	
Personal attributes		Gender	Male/Female.
		Age	<20; 20-30; 30-40; 40-50; 50-60; 60-70; 70-80.
		People per family	1; 2; 3; 4; 5; 6; ≥7.
		Socio/economic status	A; B; C; D.
Location	Q_1	Do you live in this area of the city?	Yes; No.
	Q_2	How far do you live from here?	<250 m; <500 m; <1 km; >1 km.
Delivering	Q_3	How many times per month do you deliver the waste?	1; 2; 3; 4; 5.
	Q_4	Do you deliver the waste only to the green points?	Yes; No.
Knowledge	Q_5	When did you start to deliver the waste to the GP?	< 3 months ago; 3-6 months ago; 6-12 months ago; more than 1 year ago; 2-3 years ago; When the selected collection started
	Q_6	How did you know the operation of the GP?	Publicity; speaking with the family/friends; in television; walking; other.
Opinion	Q_7	In your opinion, other GP are required in the city?	No, more points are not required; yes, more points are required; more collection time and more days are required; Yes, more points are required as well as more collection time.
	Q_8	Why do you do the selective collection of the MSW?	For the environment; for cleaning the city; save space at home; recycling the waste; personal education; do what the municipality say; other.
		Neighbourhoods	
Personal attributes		Sex	Male/Female.
		Age	<20; 20-30; 30-40; 40-50; 50-60; 60-70; 70-80.
		People per family	1; 2; 3; 4; 5; 6; ≥7.
		Socio/economic status	A; B; C; D.
Knowledge of the GP	Q_1^N	Do you know the GP for the collection of the recyclable waste?	Yes; No.

	Q_2 N	How did you know the GP?	Publicity; speaking with the family/friends; in television; walking; others.
	Q_3 N	Do you use the GP?	Yes; No.
Recycling behaviour	Q_4N	Do you do the selective collection at home?	Yes; No.
	Q_5N	How do you separate the recyclable materials?	Paper; Cardboard; Paper & Cardboard; PELD & PET; PEHD; All plastics together; Cans; White glass, coloured glass; all glass together; Organic waste separated; Organic waste all together; WEEE; batteries.
	Q_6N	Where do you deliver the recyclable materials selected at home?	Sold to the informal sector; Left on the road; always at the green points; other uses; mixed containers; separate containers; gave to the informal sector; exchanged with other products; accumulated; used in the workplace; Burned; to the animals (organic waste).
	Q_7N	Why do you do the selective collection of the solid waste at home?	For the environment; cleanness of the city; save space at home; recycling the waste; to accomplish with what the government said; other.

2.5. Data analysis

The study participants' answers were analyzed using descriptive statistics. While quantitative variables were introduced as mean ± Standard Deviation (S.D.), the others were expressed as average percentage providing its CI. The Chi-square (χ^2) test for independence was used in order to determine whether some answers were related to each other. A p-value less than 0.05 was considered to be significant ($p<0.05$).

3. Results

3.1. Characteristics of the respondents

The people interviewed at the GP are representative of the users, while the ones interviewed at district level, chose trying to balance the sample in terms of age, gender and socio-economic status, can be considered representative of the population. Table 3 reports the descriptive statistic and CI of the socio-economic status of the respondents.

The majority of the people interviewed at the GP are female (62.6%, CI 4.93), with a socio-economic status of class A (45.6%, CI 4.27). The average age of the people interviewed is 48.8 ±14.9 years old, with the majority between 30-60 years old (63.9%, CI 3.46).

At the neighbourhoods, the gender considered is balanced, with 51.7% male and 48.3% female (CI 4.84), as well as the socio-economic status which is 31.3% of class A, 21.8% class B, 26.9% class C and 20% class D (CI 4.19). The population average age is quite similar for both questionnaires. It ranges between 26-58.8 years old for the sample interviewed at the neighbourhoods and 33.9-63.7 years old for the users of the GP. Finally, also the people per family could be considered comparable, since they are 3.55 ±1.49 at the GP and 4.1 ±1.6 at the neighbourhoods, on average.

Table 3
Basic social information for the citizens surveyed.

Basic information	Group	Population	Proportion of total (%)	CI	Sample average	
					Mean	S.D.
Green points (n = 364)						
Gender	Male	136	37.4	4.93		
	Female	228	62.6			
Age	<20	13	3.6	3.46	48.8	14.9
	20-30	29	8			
	30-40	73	20.1			
	40-50	85	23.4			
	50-60	74	20.4			
	60-70	69	19			
	70-80	20	5.5			
People per family	1	23	6.3	3.46	3.55	1.49
	2	66	18.1			
	3	91	25			
	4	95	26.1			
	5	53	14.6			
	6	15	4.1			
	≥7	21	5.8			
Socio-economic status	A	166	45.6	4.27		
	B	74	20.3			

	C	102	28			
	D	22	6			
Neighbourhoods (n = 410)						
Gender	Male	212	51.7	4.84		
	Female	198	48.3			
Age	<20	31	7.6	3.36	42.4	16.4
	20-30	82	20.2			
	30-40	87	21.4			
	40-50	93	22.9			
	50-60	50	12.3			
	60-70	41	10.1			
	70-80	22	5.4			
People per family	1	23	5.6	3.36	4.1	1.6
	2	36	8.8			
	3	93	22.7			
	4	107	26.1			
	5	77	18.8			
	6	36	8.8			
	≥7	38	9.3			
Socio-economic status	A	128	31.3	4.19		
	B	89	21.8			
	C	110	26.9			
	D	82	20			

3.2. Users of the GP

The users of the GP live mostly in the district where the point is located (75.8%, CI 4.93). In particular, 48.6% (CI 4.27) live not farer than 250 m and 22.3% live between 250 m and 500 m. Only the 17.3% live in another district and farer than 1 km from the GP, so they recycle due to a strong attitude.

About 29.8% (CI 3.94) of the users provide the recyclable waste every week, the majority (59%), deliver it one or two times per month. This behaviour could be due to the numerosity of the people per family, the proximity to the GP or the socio-economic status, which influenced the amount of waste produced per day [12]. However, at a statistical point of view, there is not any dependence about these three factors, nor for the family number ($\chi^2_{[4]} = 4.28$, $p = 0.37$), for the closeness ($\chi^2_{[12]} = 5.3$, $p = 0.9$) and for the socio-economic status ($\chi^2_{[12]} = 9.1$, $p = 0.7$). It means that the factors influencing the delivery time should depend to other factors which were not considered in this research. As regard Q_4 (Do you deliver the waste only to the green points?), 89% (CI = 4.93) of the interviewed answered positively. Therefore, the majority of the users deliver the recyclable waste only at the GP, while 11% use also other GP or sell it to the informal recycling shops.

The GP are available to the public from 2014, so about four years before the implementation of this social survey (2018). About 66.5% (CI 3.67) of the users started to use the GP before 2017 (Q_5 - When did you start to deliver the waste to the GP?), so when the project introduced by the NGO was still in action. Therefore, less than 35% of the users were involved in 2017/2018. It means that after the project the involvement of the population started to decrease.

In relation with Q_5, Q_6 (How did you know the operation of the GP?) was introduced. Results reported that 53.3% (CI 3.1) of the users knew the GP walking through the city, seeing the activity of the GP during the Sunday morning. Only 32.4% stated that they came to know the SCS by the publicity, in various form. The relation between when the users started to use the GP and how they known the GP is statistically significant ($\chi^2_{[40]} = 57.706$, $p = 0.035$). The majority of the people that knew the formal SCS by the publicity or in television, started to use it in 2014, while during the years the amounts decreased to less than 5%. At the same time, it could be noticed that the information by walking and speaking with the family/friends increased until the end of 2016, before the end of the project, and it decreased significantly in 2017. This is also due to the reduction of the GP available at city level, reducing also the availability of its use. Therefore, the result shows how the reduction in information, divulgation and availability of infrastructures, considerably influenced the involvement of the population into the formal SCS.

Considering the opinion of the users about the number of GP required for improving the SCS, results reported that 48.1% (CI 4.27) suggested introducing more GP, without considering the improvement of the collection time, or both. Summing the percentage of users that considered important the introduction of new GP and the application of the GP more days during the week, turns out that about 70% of the users need more GP. Relating this result

with the one obtained for Q_2 (How far do you live from here?), we get that this consideration is mostly provided by the people who live farther than 1 km ($\chi^2_{[3]} = 10.611$, $p = 0.014$).

Finally, results obtained for Q_8 (Why do you do the selective collection of the MSW?) provided the indication that the majority of the users (51.6%, CI 3.46) implement the selective collection to protect the environment and 21% to recover the material for recycling. Only 1.2% of the users do it for supporting the activity of the municipality, while 14.6% do it for personal education.

3.3. Municipal recycling behaviour

The first three questions submitted to the citizens regards the knowledge and use of the GP. The inhabitants who know the formal SCS are 25.6% (CI 4.84), so the majority of the population is not aware about the presence of the recycling points scattered in the city. Considering the answer provided to Q_3^N (Do you use the GP?) only 8% (CI 4.84) provided an affirmative answer, which is in agreement with the data available (about 2% of the population use them).

Differently with the questionnaire provided at the GP, where the socio-economic status was mostly high, in this case there is not any statistical dependence between socio-economic level and use of the GP ($\chi^2_{[3]} = 0.06$, $p > 0.9$). Finally, 63.6% (CI 3.36) of the people who know the GP (25.6% - Q_1^N) stated that they knew the activity of the GP (Q_2^N) walking though the city during the Sunday morning, while less than 20% thanks to the publicity, according to the results obtained for the GP. Therefore, only one fourth of the population knows the GP and of them only one fifth was informed by public campaigns or advertising.

The second part of the questionnaire investigated the recycling behaviour of the population. Results reported that 48% (4.84 CI) of the population implement the selective collection at home. Again, there is not any statistical dependence with the socio-economic status ($\chi^2_{[3]} = 2.48$, $p = 0.48$), so in contrary as expected since the majority of the people that comply with the formal SCS are of higher socio-economic status (45.6%, CI 4.27).

Fig. 3 reports the type of waste which is segregated by the people who implement the selective collection at home, so which answered positively to Q_4^N (every interviewed could provide more than one choice). The highest percentage is obtained by the mixed plastic (22.8%, CI 2.47), followed by mixed paper and cardboard (17%) and the PEHD and PET (16.5%). Overall, 78.7% of the population who implement the selective collection at home separate plastic and paper in different method. Waste from electric and electronic equipment (WEEE), used batteries, organic fraction, cans and glass are not separate autonomously by the population.

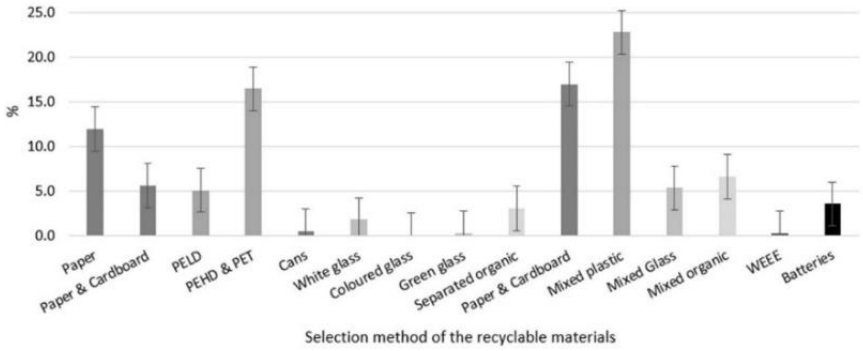


Fig. 3. Answer to Q_5^N - How do you separate the recyclable materials? (n = 395)

Fig. 4 sums up where the recyclable materials sorted by the population are delivered. The highest percentage (23.3%, CI 3.25) is obtained by the mixed containers available for the MSW collection system. It means that a significant part of the population that implement the selective collection at home, throws the selected material into the mixed waste. The motivations provided by the interviewed are two: they think that the material is then selected at the landfill; they would facilitate the work of the waste pickers who gathered the material from the bins and containers. The second answer provided is that they sell the materials to the recycling shops (21.7%), followed by "left on the road" (15.3%), where the waste pickers could collect it. In addition, 12.2% stated that they give it to the waste pickers which pass though their house, while 1.1% change it with toilet paper. Only 14.8% provide the waste always to the GP (which represent the 8% of the total sample interviewed). It means that the majority of the population that select the waste provide it to the informal sector or in mixed containers (73.5%).

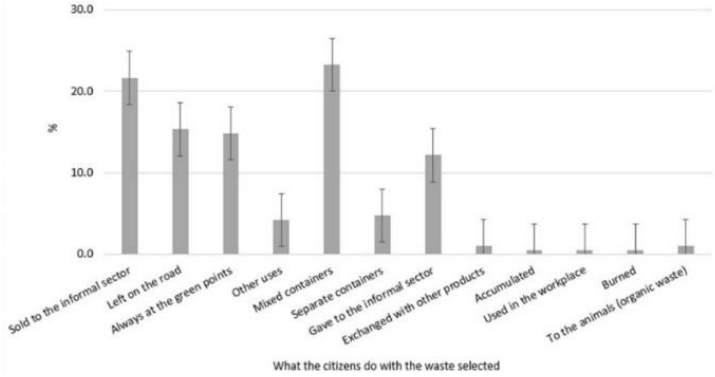


Fig. 4. Answer to Q_6^N - Where do you deliver the recyclable materials selected at home? (*n*=189).

Finally, the motivation that leads the citizens to recycle was assessed. Results of Q_7^N show that 52.3% (CI 3.64) of the population do it to protect the environment and 26.9% for recycling the material. So, 79.2% of the citizens who implement the selective collection at home, do it for environmental reasons. Only a few people stated that they wanted to earn money (less than 2%) or to support the work of the municipality (2.1%).

4. Discussion

The first factor assessed (F1) regards the distance of the GP. Results underlined that the citizens that mostly used the recycling areas live not farther than 500 m, so it could be considered for planning the introduction of other collection points. In particular, the introduction of more recycling points was suggested by the users of the GP, who stated that it could be more beneficial than the application of more time or more days per week (Q_7). This is also supported by the last factor assessed (F3) for the questionnaire survey implemented at the GP, which considered the delivering time. The questionnaire demonstrated that the population mainly deliver the waste one or two times per month, although without any statistical dependence which could support this habit.

As regard F2, the results demonstrated that the socio-economic level of the people who use the GP is high. However, this is partly true, since analysing the population behaviour of the second questionnaire there is no dependence between the socio-economic level and the selective collection, which could be formal or informal. Therefore, the motivation for the implementation of SCS should not be search in the socio-economic status, but in other factors, such as political, infrastructural or promotional.

Considering the results obtained by the questionnaire for assessing F4 and F5, the population that use the GP is only 3-13%, while more than 45% implement the selective collection at home, in agreement with a previous study implemented at the university, where 57% (CI 5) of the students stated to separate the waste at home [13]. Again, this behaviour has not dependence with the socio-economic status. About this 45%, more than 70% deliver the waste to the informal sector in different forms (F6), or to the mixed containers, suggesting that the information system is not supporting the formal SCS. This statement is reinforced by the results provided by the people who know the presence of the GP (less than 30%) and by the media where the people sow the GP (mainly walking).

It should be highlighted that the results of this research reported that the recycling behaviour is not influenced by the socio-economic status, differently from the formal SCS. It could be motivated by the fact that recycling is a dynamic process that is influenced by personal and environmental factors [6] and the formal SCS was not supported by sufficient information campaigns. Anyway, this represents another good point which should be considered since the introduction of recycling policies could be direct to the whole population, diversifying the selective collection methods considering the districts where the informal sector is just present and the geographical conformation of the area. So, the introduction of formal recycling plans is not the only choice for improving the RR in the city. This is supported also by the answers provided to Q_7^N, where the majority of the citizens stated that they do not do the selective collection because it provides an economic benefit, but for "green" reasons. Therefore, some indications were provided to the local authority for improving the SCS: The implementation of drop-of areas for selective collection or new GP which are not so far from households, therefore providing suited infrastructure; Introduce campaigns that could support the introduction of new selective collection strategies in order to involve the people that do the selective collection at home and the attitudes of those who do not implement the waste separation, considering individuals personal beliefs and factors that may motivate and inhibit waste separation behaviour [14]; Involve the informal sector for supporting future MSW selective collection plans.

Such policies were taking into account at the end of 2018 for implementing a new formal SCS with the implementation of separate street containers for selecting paper and plastic. The pilot plan is still under assessment;

the main objective is to implement the SCS in the whole city, assessing the quality of the waste collected and the compliance of the population with the new system.

5. Conclusions

This paper reported the results of a questionnaire survey implemented in La Paz, Bolivian city where MSW separation strategies are still under development. The findings of this research have various implications for developing a selective collection system in La Paz where the coexistence of the informal recycling and formal SCS should be considered. Results reported that: The socio-economic status does not influence the recycling behavior of the population, differently from the formal SCS; About 45% of the residents implements the separate collection at home although only less than 8% use the formal SCS; The selective collection is mainly implemented for environmental reasons; The formal recycling points are mainly used by people of high socio-economic level who live not farther than 500 m. In conclusion, the survey reported that the informal sector could be considered an alley for improving the RR in developing big cities. La Paz can be considered as a good example for implementing recycling policies since the population supports the SCS for environmental reasons. Although CE could be considered a challenge for low-middle income countries, this study demonstrated that the population could be ready for implementing waste separation strategies, and the method used allows supporting the implementation of a formal SCS by street containers. However, the application of sensitivity campaigns, information programs and advertising, where sustainable development is encouraged in an environmental vision, is compulsory for boosting the sustainability of the plans.

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