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## Feasibility of a gender-driven paratransit service at Sapienza University of Rome

Maria Vittoria Corazza<sup>a\*</sup>, Silvia D'Eramo<sup>a</sup>

<sup>a</sup>*Sapienza University of Rome, Via Eudossiana 18, Rome 00184, Italy*

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### Abstract

Problems of women harassment on transit are often reported by the local press, and the situation in Rome is no exception. This is a serious issue also for the Sapienza University of Rome female community, especially when commuting back home in the evening. A specifically night-dedicated transport service provided by Sapienza could be a solution, but the research questions behind are those of its acceptance and affordability for the so-called “Sapienza Women”, i.e. students, teaching and administrative staff, along with the profitability for Sapienza as its operator. This is the background for the feasibility of a gender-dedicated university-to-home paratransit service, called MinervaMove, from the Sapienza’s main campus and other premises in city. The multistep methodology adopted relies on: i) the initial development of a series of questionnaires and focus groups targeted to assess travel preferences by the Sapienza women community; ii) the data process to highlight recurring patterns and origin/destination sets, and create the service coverage area; iii) the service design; and iv) eventually, the analysis of the profitability of the service. From an initial investigation on Sapienza female population, the acceptance for a women-only-dedicated Sapienza night transport service was full, giving a positive answer to the first research question. This led to develop the MinervaMove multi-option night supply, i.e. a station service starting from the main campus of Sapienza to Rome’s two main railway stations, plus a door-to-door shared taxi service also originating at the main campus. MinervaMove also provides a daytime service supplied to the entire Sapienza community (men and women). Within the methodology, two different scenarios (A-optimistic and B-pessimistic) were developed to generate an appropriate service in terms of operational performance and affordability, with also scenario B enabling the generation of revenues.

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\* Maria Vittoria Corazza. Tel.: +39-06-44585718; fax: 39-06-44585718.

*E-mail address:* [mariavittoria.corazza@uniroma1.it](mailto:mariavittoria.corazza@uniroma1.it)

## 1 Introduction

Gender is, nowadays, a mainstream issue in many agendas in a number of policy sectors (e.g., employment and education) thanks the work of many advocacy groups worldwide and some milestones in the supranational political process, with the OECD - Organization for Economic Co-operation and Development's statement in 2011 on women's segregation and discrimination as barriers in the path towards sustainability (Duchene 2011), and the United Nations' acknowledgement of gender equality as a goal in its "Agenda for sustainable development by 2030" (United 2015), as the most important endorsements. However, in the transport sector and especially in the development of mobility policies, not the same can be told due to some factors. Traditionally, the sector has been male-dominated, by "mature men" as Duchene (2011) put it; at the same time, public transport was long considered an option for the less affluent, and among these the women, who in past time were not even allowed to have a driving license. This generated a lack of female decision-makers which resulted in the development of non-gendered policies, unable to meet women's needs in public transport services when it came to security, reliability, and accessibility. Nevertheless, scientific literature abounds (e.g. in Law 1999, Rivera 2007, Gardner et al. 2017, Hortelano et al. 2021) and so case studies both in developed and developing countries (e.g. in Dunckel-Graglia 2013; Plyushteva and Boussauw 2020; Rahman 2010; Kim 2021). Virtually all originate from the acknowledgement of one major problem for women, i.e. security. Women who use transit are usually victims of robbery and sexual harassment (non-verbal, verbal, and physical); they are preferred victims for crimes as the feminine figure has always been considered as easier to overcome (Hanlon 1998). What is more, in studying the problem, it is difficult to find data about sexual harassment associated with transit because the phenomenon is often unreported (Ball and Wesson 2017) and even less about the fear related to the walking leg of a trip, usually the initial or ending one, for night transit travels. In fact, women who travel at night, independently from the purpose of their trip, prefer to spend for a taxi instead of using public transport, because the former performs a door-to-door service (Plyushteva and Boussauw 2020). Often transport planners propose mollifying solutions which might mitigate the negative effects of the cultural gender inequality, but not solve them until such cultural gap is filled. All of the above was the starting point to develop a case study on the possibility to operate a night service specifically designed for the female community of Sapienza University of Rome, Italy. Here, the phenomenon of harassment on-board of buses or underground trains is often reported by the local press, at city level, but never addressed at policy level; very often victims are student girls. The designed service called "MinervaMove" (being Minerva the Roman goddess of wisdom and the symbol of Sapienza University) relies on two research questions: i) the acceptance by the "Sapienza Women" (i.e. the whole community of female teaching and administrative staff, and students) of a women-reserved night transport service operated by Sapienza; ii) the economic feasibility of such service for the University. The multi-step methodology adopted to design the service is described in Section 2 and results elaborated and discussed in Sections 3 and 4 where MinervaMove operational and economic features are reported; some concluding remarks, eventually, are provided highlighting the study potential.

## 2 The adopted methodology

As initially observed, although case studies for women-dedicated transit service are many, they just originate as direct field solutions, often in response to emergencies. This implies that practice prevails over theory and no real large-scale methodologies are available to tackle the problem of the women's security in transit. Moreover, as also above observed, availability of facts and figures to describe the phenomenon is very little, thus also thwarting the possibility of benchmarking solutions. As a result, to design a service like MinervaMove, a multistep methodology is required to fill both the gaps of poor reference approaches and lack of data. Bearing in mind these two barriers, the methodology for Minerva was developed to answer to the two research questions above mentioned, starting from a survey among the Sapienza Women, as a way to collect information to identify Sapienza Women's mobility choices and their acceptance of a women-only transport service. To this end, a questionnaire was designed and complemented by a multi-session focus group, composed by respondents who agreed to participate in, once having filled in the questionnaire. The focus group was specifically targeted to corroborate the questionnaire's stated preferences and especially the respondents' willingness to pay.

An additional analysis was also needed to understand the current situation in Rome in terms of gender-driven transport policies and services and the potential for MinervaMove to comply with current regulations. Results from

both survey and this background analysis enabled to identify the main user's needs and to build two demand scenarios: a) optimistic, and b) pessimistic, as the basis to design MinervaMove. The service supply (schedules, terminals' locations, fleet and staff sizing) was designed and described via performance indicators. Though survey respondents and participants in the focus groups reiterated their preferences to travel with no men on-board, to dispel any potential issue of exclusion from the Sapienza male community, and with the goal to achieve more profitable operations, a further study on how to exploit the night service fleet during the day was eventually carried out. As a result, a day-time and open-to-all transport service for Sapienza community was also developed, which is the MinervaMove third option. Facts and figures on MinervaMove were, at this point, sufficient to answer to the second research question, i.e. that of the economic feasibility, the study of which was carried out according to the European Commission funded project TIDE approach (2015). TIDE was specifically chosen as it combines aspects of Benefit-Cost Analysis (BCA) and Multi-Criteria Analysis (MCA). The study results highlighted the full profitability of the three MinervaMove options, as further described.

### 2.1 The questionnaire and the focus group

The Sapienza female population is composed of 61,362 students and 4,249 staff units (i.e. 1,939 academic and 2,310 administrative units, according to MIUR 2021). Thus, given the size of the total demand and in order to identify travel patterns, the questionnaire was sent to the Sapienza Women during the second semester of 2021, via email and posted on social networks (Facebook and Instagram). The questionnaire was divided in several sub-sections, i.e.:

- Personal data, including ZIP codes to identify origins
- Home-university and university-home travel behavior (including the modal choice among private car, public transport system and cabs)
- Experiences of harassment and/or similar problems when traveling in the evening
- Preferences about a possible shared night taxi service to commute home at the end of the day
- Voluntary participation in a subsequent focus group to analyze the results of the questionnaire and design the MinervaMove service.

The 291 respondents (147 staff and 144 students) were considered representatives of the Sapienza female community, according to the most common statistical assessment, as in Riley et al. (2014), and their replies provided the snapshot of the Sapienza Women's travel patterns. The next step was the focus group, which was organized to better understand the respondents' choices on some part of the questionnaire and, especially, those concerning the willingness to pay. A total of 25 participants were selected among those who previously agreed to be involved in this round of the survey, and subdivided into sub-groups, each with up to seven participants. They were initially asked to identify themselves with a typical profile, among the following four, as identified from the questionnaire results:

- Type 1: Student using either car or transit to reach always the same Sapienza venue; car is preferred when she has to combine other activities beside studies and due to her poor satisfaction with local transit; she considers security, safety and comfort as a value to take the door-to-door night service
- Type 2: Low-budget student using only transit to reach several Sapienza venues, who considers security as a value to take the door-to-door night service, having already experienced sexual harassment in the daily commute to the university;
- Type 3: Academic staff relying on private cars and working at several Sapienza sites, as transit is too risky at night. For this profile, costs associated with parking and time spent to find it are considered negatively, but necessary if she wants to hang around the campus area after working hours. Comfort is the main driver for the door-to-door MinervaMove service.
- Type 4: Administrative staff at Sapienza university; she is not familiar with her colleagues and the local transit system, therefore the night station service is perceived as a moment of social inclusion to get to know better her co-workers and share with them the way home.

The identification with a given type and the free talking during the sessions also helped to fine-tune some preliminary hypothesis for MinervaMove resulting from the questionnaire responses, thus enabling to progress towards the final design of the service.

### 3 Main findings from the survey

From the focus group, it was clear that the dominant profiles were Type 2 and 3, accounting for 45% of the participants (followed by 15% Type 1 and 5% Type 4), which seem to show that a driver for the service could be the binomial “security and comfort”. This is in line with the results from the questionnaire and the context analysis reported as follows.

#### 3.1 Sapienza Women’s requirements

In fact, travel times seem to be a not negligible issue, according to the questionnaire results. Most respondents, both students and workers, live in Rome within its metropolitan limits and, as expected, their favored modes to commute are typically private car for academic and administrative staff, and transit for students. Respondents also stated a general feeling of insecurity when using transit, reporting adaptive behaviors according to the different times of the day. The modal choice partly explains the responses to the key question, i.e. whether they were ever harassed when commuting back home at the end of the day. Positive answers were given by 56% of the students and 28 % of the staff and this might be in line with the fact that staff members generally use their cars to commute; for the students, a factor to consider might be also their age (Ball and Wessons 2017). All of the above is unacceptable, and even less acceptable is the fact that the majority of respondents felt insecure on the way back home after the harassment, causing some of them to change path (more than 30%) or mode of transport (more than 20%), not to live again the experience. Unsurprisingly, the acceptance of a university-home, women-only, dedicated transit service was high: 70% among staff and 64% among students. Most favored options were either a shared door-to-door taxi service (88% among students and 83% among staff) or a shared shuttle service to the closest rail or subway station (79% among students and 67% among staff). The door-to-door service’s higher percentage means that travel comfort might also contribute to the perception of security, as previously observed. More specifically, the station shuttle service is to be operated to and from over short routes, within a selection of destinations stated by the respondents and originating from Sapienza venues. The door-to-door one would be a typical demand-responsive service, with routing of vehicles as the major problem to solve; to this end, a routing simulation was performed by a route-optimization software.

#### 3.2 Analyzing the context maturity

Introducing a service like MinervaMove calls for a specific context maturity assessment. This was also prompted by the results of a previous study focused to assess the city’s maturity in order to introduce innovative services in the local transit supply; although the study showed that Rome can be considered a fertile ground for innovations, it also highlighted some constraints in the willingness to pay for them (Corazza and Carassiti 2021). One more reason to develop such context analysis was to assess MinervaMove’s compliance with local regulations and cope with possible constraints (if any) to the service, in light of the large number of Sapienza facilities across Rome to potentially serve, as further elaborated.

In terms of compliance with local regulations, a Sustainable Urban Mobility Plan (SUMP) and an Urban Traffic Plan (UTP) have been long enforced in Rome. The SUMP is strongly oriented to foster progress from the past conservative policies (Musso and Corazza 2006, Corazza and Carassiti 2021) and, as the UTP, to decrease the use of private cars and promote sustainability, but measures included in both plans are gender-neutral. This is in line with what observed by Woodcock et al. (2020) about contemporary SUMPs in general, which are tools poorly conscious of gendered imbalances in transport, due to the lack of research and data on gendered policies.

Sapienza University of Rome, in turn, given its status of largest educational institution in Rome, in 2018 developed its own Sapienza Sustainable University Mobility Plan (SSUMP). This plan was needed for several reasons: i) the large amount of facilities and properties scattered across the whole urban area (for a total of 21 off-campus facilities), some of which distant more than 10 km from Sapienza main campus (the so-called “Città Universitaria”; ii) the usual transport-related problems, which vary according to the area where each facility is located (Azzali and Sabour 2018), in many cases resulting in poor safety for pedestrians and lack of cycling lanes and bicycle racks; iii) the need to shift the commuting demand from motorized to non-motorized and collective modes, also meeting the goal to reduce the local high rate of accidents involving powered two-wheelers, mostly used by young riders (Sgarra et al. 2014, Corazza

et al. 2017). The SSUMP's overall goals are consistent with all of the above, i.e. to rebalance the modal share of those commuting back and forth from the Sapienza premises in favor of non-motorized modes, and promote sharing modes and public transport, thus progressing in the city's path towards full sustainability in transport. However, the SSUMP seems to miss measures specifically regarding women's inclusion and security. From all of the above, it is clear that MinervaMove is coherent with, and might complement, the city's SUMP and the Sapienza's SSUMP by increasing inclusiveness in both; it also meets the potential travel demand of a large amount of female students and staff commuting to and from 22 different destinations in the city, which also explains the relevance of "comfort" as arisen during the focus group sessions, given the long travel times.

#### 4 Operational and economic features for MinervaMove

Once collected all the information from the survey, the next steps were to quantify the potential demand and design operations. The former was determined by upscaling the rate of the respondents' acceptance of the service to the whole female university population. This led to assume two demand scenarios: a) optimistic (actual customers would be just 10% less than those who accepted the service); b) pessimistic (20% less), to compensate possible errors and change of opinions (in line with what suggested by TIDE 2015). Resulting figures are reported in Table 1.

Table 1. MinervaMove night service potential demand scenarios.

	Optimistic case ( <i>pax</i> )	Pessimistic ( <i>pax</i> )
Students	36,573	30,437
Non-academic staff	1,246	1,015
Academic staff	1,046	852
Total	38,865	32,304

##### 5.1 The service design

Respondents' interest was clearly for a fixed schedule service for MinervaMove, with night services operating from Mondays to Fridays between 19:00 and 22:00, with a departure every 15 and 20 minutes, respectively for the door-to-door service and the shuttle one. This schedule for both services conforms vehicle routing and driving staff assignment to those of the static public transport services, thus simplifying the service management (Dessouky and Adam 1998). Focus groups participants also stated that fixed schedules help them organize their working activities (as already observed in literature by Al-Ayyash et al. 2016). This and the consideration of the differences between periods when classes are hold and not ("term" vs "no-term") led to design two options: Alternative A – "term" and Alternative B – "no term", the former operational during Fall and Spring terms and the latter for the remainder of the year, excluding Christmas holidays.

For the door-to-door option, operated like a shared-taxi night service, the coverage area was delimited by the destinations reported by the survey participants across the whole Rome urban area which, to this end, was subdivided into 4 main sectors (North, South, East and West) to facilitate the solution of the routing problem. Origins were located at two central sites, the "Meeting Points", within the university campus. Full-hybrid, 5-seat vehicles seem to be the most suitable option to meet the security and comfort requirements. Also the use of full-hybrid cars might be more reliable for a public service than electric vehicles, still generating a higher reduction of fuel consumption and greenhouse gases emissions with respect to conventional cars (Hassouna and Assad (2020). Route optimization relied on a software, Optimoroute, which runs a vehicle routing algorithm "fed" by traffic data from one of the most popular web-mapping platforms and provides the best routes using a vehicle routing algorithm based on the shortest paths. Last to consider is the willingness to pay stated by the respondents which gave rise to a zonal fare system: 4 concentric areas with fees varying from 5 to 20 Euros, according to distance.

The approach to design the operations of MinervaMove's second option, the night shuttle service, is similar to that of the night-taxis. The shuttle service operates from the two Meeting Points to Rome's two main railway stations: Termini and Tiburtina, according to the stated preferences. Both stations are interchange nodes with both urban bus and underground services. The shuttle service would be operated via 9-seat minivans, thus replicating a successful

paratransit experience occurred in Rome around 20 years ago (Musso and Corazza 2006). Drivers for the service, with a work shift ranging from 18:00 to 23:00, could be hired among female students (to comply with the “no-men on board” preference stated) within regular scholarship programs. The focus group participants agreed on a fee of 5 Euros per single ride. Each of the two night options were designed considering typical operational parameters like those in Table 2, specific for the night shuttle service “optimistic scenario”, as a case in point.

Table 2. MinervaMove night shuttle service operational parameters

	Alternative A - term		Alternative B – no term	
	Termini Station	Tiburtina Station	Termini Station	Tiburtina Station
Travel time ( <i>min</i> )	10	10	10	10
Lap time ( <i>min</i> )	40	40	40	40
Commercial speed ( <i>km/h</i> )	6.9	6.0	6.9	6.0
Average fuel consumption ( <i>l/day</i> )	1.1	0.9	1.1	0.9
Average travelled distance ( <i>km/day/veh</i> )	13.8	12	13.8	12
Vehicles-km ( <i>veh*km/day</i> )	27.6	24	27.6	24
Seats-km ( <i>seat*km/day</i> )	248.4	216	248.4	216
Number of drivers ( <i>unit/year</i> )	2	2	2	2
Seats-km/Driver ( <i>km/day/unit</i> )	124.2	108	124.2	108
CO <sub>2</sub> emissions ( <i>g/day</i> )	4692	4080	4692	4080

As said, to avoid any problem of exclusion, the third MinervaMove option was planned to supply a daytime service for the general university population, which corresponds to two different options according to the two types of vehicles operated in the night time service. The night shuttle minivans would be operated as a daytime shuttle service from the main campus to two different destinations: the Philosophy Department - PD and the Oriental Studies Department - OSD. Both destinations are representative of the 21 Sapienza premises in terms of distance from the campus (with PD representing a close destination within 5 km and OSD a far one, more than 10-km distant). The operational parameters of this daily option are like those of the night shuttle service. According to the preferences from the focus group participants, costs vary from 3 Euros (one-way ride) up to 7 Euros (daily ticket). As observed by Dell’Olio et al. (2014) and Azzali and Sabour (2018), this type of service among different university premises might support ridesharing among Sapienza staff and students and foster the sense of community typical of higher educational institutions (Balsas 2003). In the daytime, the hybrid vehicles operated during the shared-taxi night service can be exploited, with the same operational features of the daily shuttle service and at the same costs of the night operations, to connect 4 institutional bodies (the school of Engineering and the Social Studies Faculty, each off-campus at specific compounds; the Psychology Faculty and the School of Architecture, both with several premises across the city).

## 5.2 Economic feasibility

To answer the second research question, i.e. the economic feasibility of the service and its profitability for the University, without being subsidized, the TIDE project approach seemed to be the most suitable, being the TIDE methodology including both Cost Benefit and Multi Criteria analyses to assess the affordability of innovative transport measures (TIDE 2015). The MinervaMove study was developed by comparing a do-something scenario vs a Business-As-Usual (BAU) one, over a 4-year horizon. The do-something scenario includes the two alternatives A – “term” and B – “no term”, and more specifically:

- Alternative A: MinervaMove daily and night services operated from mid-September to mid-December (Fall term) and from mid-February to mid-May (Spring term), for a total of 140 days. Considering the long break between the two terms, a market research highlighted short rental as the most appropriate way to lease the vehicles during each term.
- Alternative B: MinervaMove service operated from mid-September to the end of July, with only a break during the Christmas holidays, for a total of 240 days. In this case, the market research suggested a long-

term rental for the vehicles.

Once all the parameters were identified, they were clustered in three main evaluation categories: economy, society and environment. For the economic impact, a 5% discounting rate was applied (consistently with Hüging et al. 2013). Qualitative impacts (comfort, security and social inclusion) have been evaluated using references available in literature and focus groups preferences, and reported according to a “-10 to 10” scale, in line with the TIDE methodology. As an example, Table 3 summarizes the main outcomes for Alternative B, in the optimistic scenario (i.e. the case with actual customers being just 10% less than the potential demand, as explained at the beginning of this section).

Table 3. Alternative B effects (optimistic scenario)

Parameters	Year 0	1	2	3	Total
Vehicle investment costs (€/year)	-356234	-217366	-207015	-197157	-977,773
Vehicles operational costs (€/year)	-42957	-40911	-38963	-37108	-159,938
Personnel costs (€/year)	-697997	-664759	-633104	-602956	-2,598,815
Routing software costs (€/year)	-11674	-11118	-10588	-10084	-43,464
MinervaMove support charge (€/year)	1206740	1149276	1094549	1042427	4,492,992
Revenues day service (€/year)	603	1881	6768	10426	19,678
Revenues night service (€/year)	15620	48686	175166	269863	509,334
CO <sub>2</sub> emissions (€/year)	-1383	-1317	-1254	-1194	-5148
Passenger comfort	6	6	6	6	
Passenger security	8	8	8	8	
Social inclusion	4	4	4	4	

Among the parameters itemized in Table 3, there is the “MinervaMove support charge” which is needed to reduce the overall investment expenditures and can be obtained by adding 10 Euros (optimistic scenario) or 7 Euros (pessimistic scenario) to each student’s tuition fees. These values were proposed during the survey and deemed as acceptable costs, if compared to the benefits achievable thanks to MinervaMove. According to the TIDE approach, all considered parameters were further normalized and weighted; the results per evaluation category are synthesized in Table 4. It is evident that in both scenarios alternative B seems to be the best solution: even if the evaluation category “society” has the same score in the two alternatives, B becomes definitely more advantageous when “economy” is considered.

Table 4. Alternatives performances with respect to the areas of interest.

Scenarios	BAU	Alternative A	Alternative B	BAU	Alternative A	Alternative B
	(Optimistic)			(Pessimistic)		
Evaluation Category						
Economy	0.0	-25.7	13.2	0.0	-36.1	21.7
Environment	-150.0	-0.2	-0.3	-200.0	-0.3	-0.4
Society	-81.3	550.0	550.0	-63.8	300.0	300.0
Total	-231.3	524.1	562.9	-263.8	263.6	321.2

## 5 Conclusions

MinervaMove is viable, well accepted and highly beneficial in terms of security, social inclusion and comfort, with the best scenario relying on alternative B. Investment costs play a major role in this, but probably more favorable leasing terms and conditions would apply for longer rental periods, thus reducing the overall expenditures. Yet, MinervaMove’s 4-year horizon risks to be negatively affected by the SSUMP 5-year duration, forcing to hypothesize that MinervaMove starts and consolidates within this timeframe, so as to be replicable in the next SSUMP and become

an asset for Sapienza. Profitability might increase when upscaling the service. A limited number of origins and destinations were considered when designing the service, but should this be operated across the 21 off-campus premises and more railway stations or other intermodal nodes in the city, revenues would increase and costs be mitigated by the larger scale of operations. The next step now is to include MinervaMove within the Sapienza SSUMP, to be operational, which could pave the way to further opportunities like upscaling service to other universities in Rome, several of which, like Sapienza, encompass several premises in the city, with the goal of creating both a dedicated paratransit option for the women community at night and a complement to the regular transit supply during the day.

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