JOINT DEVELOPMENT FEASIBILITY OF A GREENING TRANSPORT ALTERNATIVE

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INTRODUCTION

The purpose of this paper is to demonstrate the feasibility of conceptual applications developed by the Mobile Research Group/UFRJ – presented at the 8th Thredbo and published by Elsevier – on transport service quality and social responsibility oriented to articulate stakeholders' interests regarding the specific productive chain of the transport and land use relationship in a sustainable way (that is: encouraging greening transport alternatives - collective modes, cycling or walking) (Bodmer et al.,2005a). It demonstrates the economic and financial viability and performance of a proposal whereby the accessibility provided by the collective transport mode is presented as a feasible alternative to the construction of compulsory parking lots for traffic generator buildings.

The data for this research were collected in a survey whereby managers of real estate companies indicated 14 main criteria, clustered into four decision factors (managerial, marketing, social and legal), that would confirm the feasibility of the proposal.

Through the use of hierarchy multi-criterial analysis, applied to all the criteria, it concludes that, from a managerial perspective, large urban enterprises demonstrate a 26% superior performance when they offer collective services to handle the demand instead of parking lots for automobiles. Considering, in a simulation, the conversion of 50% of the parking spaces at a shopping center to productive area, together with the provision of equivalent collective transport services, it would generate 44 times greater productivity and increase employment by 78 times, in comparison with the present levels. Using a traditional economic and financial analysis, taking present liquid value, cost /benefit ratio, internal return rate and pay-back index as the main parameters, the economic viability was demonstrated, when the traffic generators assume the costs of special collective transport services for their clients, partially converting their mandatory parking lots to useful area for urban enterprises, justifying greater densification without any harm to the environment.

The 9th Thredbo presents two other papers (Martins *et al.,2005*, Bodmer *et al.,2005b*) that make complementary reading to this one.

ACCESSIBILITY VS URBAN ENVIRONMENTAL QUALITY: FORMULATION OF THE PROBLEM

The densification of human activity (economics of agglomeration) occurs around locations that are particularly accessible (economics of location). These two types of urban economics are the reason behind private investment in land use. They only become location inhibitive when the concentration of activity reaches the point of generating diseconomies; in other words, the costs exceed the advantages of the proximity to the urban facilities provided, due to an environmental surcharge (pollution), the price of overcrowding (congestion) or a combination of the two, leading to declining property values. The urban space then loses its original location attributes (with negative repercussions on land productivity). To ensure the development of the area (or even to secure its market area), it is necessary to intervene in the urban space.

This intervention, in twentieth century Latin America, was quite separate, in terms of the policies for transport and land use: decisions that were distinct, yet connected, were taken by the State and by real-estate interests. Recent practice has demonstrated the existence of a mechanism formed by two gears involved in the production and management of urban space. One, the responsibility of the State, relates to the inducement of usage value; while the other, in the sphere of the real-estate capital (developer-constructor-financier), relates to the exploitation of exchange value (Martins, 1991). It is the combined workings of these two gears that drives the main axis that is central to the urban environmental problem: transport/location policy. Hence, if the exchange value depends on the usage value, in the production of urban space, the success of the real-estate capital depends on public policy and investment (building accessibility and legislation, which define the constructive potential or right to build), the value of which is absorbed by the real-estate capital, but is not reinvested in public assets or in the financing of transport policy.

This is the mechanism defined by Soja and Hadjimichalis (Soja, 1983, *apud* Martins, 1991) as the "direct geographical transfer of value" that is the pattern for unequal geographical development. Thus, transport and urban activities inter-relate dialectically: the complementation of opposing movements that have historically affected the urban environmental quality and the fair distribution of public and private investment (Martins, 1991).

The urban legislation itself helps to promote this separation of roles and the gap between the land use and transport policies. This is because, despite the structure of the traditional transport planning model being defined by four stages (trip generation, trip distribution, modal split and the traffic allocation), the laws governing the use and occupation of the land induce exclusive dependence on the highway mode, with emphasis on the use of the automobile. It is impossible to build in Latin American urban centers without incorporating parking space within the useful area of the building.

Indeed, large urban undertakings, major traffic generating centers that they are, represent a form of land use that typifies the urban environmental problem. A center that is an attracter/generator of trips can impose economics of location and agglomeration on an urban

space, attracting other enterprises around it. But, on the other hand, it can generate negative externalities related to the quality of the environment; Sanjad, (2003) illustrates the case of a shopping center in Rio de Janeiro/Brazil, after studying the alterations in the shopping center area of influence for almost 20 years: the indirect traffic, generated by the buildings that have been located at this area, is of the same scale or order of the direct traffic generated by the shopping center. Nevertheless, when it comes to the laws governing land use and occupation, the responsibility imposed on the developers of traffic generating centers, in order to minimize these negative externalities, is limited to the mere construction of parking space.

When a law governing land use and occupation mandates the provision of parking spaces, in order that a traffic generating center does not affect the local quality of circulation, in this case, only the static capacity - the need for physical space in which to store the vehicles attracted is being taken into consideration. There is no requirement on the part of the entrepreneur with regard to the dynamic capacity - the need for road space to accommodate the expected demand, the burden of which falls upon the public authorities.

Maintaining stock (or, in this theme: vast areas for parking) was one of the Ford-inspired pillars of the last post-war economic cycle, which ceased long ago, though its influence still prevails in urban policy. One cannot bring competitiveness to our urban centers if these still live by outmoded rules and thinking that have no future. The urban legislation, by making parking space obligatory for traffic generating centers, ends up transferring to the public the responsibility for mitigating the potential impacts (supply of accessibility). And in so doing, it also disengages land use policy from transport policy, or rather, it reduces the relationship between them to a single commitment: it is up to the entrepreneur to construct the parking space; it is up to the authorities to provide the road space and transport services that make the undertaking and its parking space functionally viable. Looked at from another angle, every automobile on the Latin American city streets carries an average of less than 1.5 people, occupying the place of 12 people who could be seated in a collective transport mode (for the mass transport modes, this ratio is greater still).

How can one expect urban property to fulfill its social function if the very way that the urban legislation provides for accessibility to these buildings works against the use of public transport modes?

By tying garage space to the right to build, the “modal allocation of trips” stage of the transport planning process goes unheeded: it determines exclusive access via the highway mode, with emphasis on the automobile, thereby attaching usage value to the entire production chain of this item, from the manufacturing of fuels to the construction of buildings with garages. In this way, it also ensures the low competitiveness of public transport in comparison with the automobile.

SUSTAINABILITY STRATEGY: THE MOBILITY MANAGEMENT

With the markets organized in economic regions or blocs, these are redefining the rules and flows of volatile capital and a world economy that is ever more globalized, riding on the advances in ICT (Castells, 1999). The bottleneck of the world economy has proven to lie in urban logistics. In terms of capital circulation, after all, the technological achievements (in

processes and products) surrounding the movement of people and goods lag far behind what was achieved in the second half of the 20th century with regard to the broad and almost instantaneous diffusion of information.

It is nowadays clearly impossible to introduce competitiveness to a local economy and the surrounding region without a foundation of environmental quality and ecological self-sustainability (environmental, economic and financial) indicators. With regard to the economic bottleneck (circulation and transport), these indicators require that the focus no longer be on providing accessibility (for example: the number of motor vehicle trips per capita), which ends up generating transport demand growth that exceeds the level that it has historically been possible to serve with quality, but on managing the transport demand (for example: the number of urban activities that a citizen performs within the community). Instead of a constant readapting of the supply (accessibility), there is a redefining of the transport needs, with a view to maximizing the mobility of the citizens while minimizing the environmental and financial costs, and avoiding the long-distance vehicle transfer of people and goods within the local economic sphere. This strategy has been called, particularly in Europe, the "Mobility management". So, rethinking the system of urban circulation and transport according to the Mobility management approach, in order to consolidate the new cycle that is beginning, involves altering the economic basis: its socio-spatial organization, in other words: the way in which society is distributed within the available space.

In Europe, since the 1980s, there has been a focus on urban economic and physical regeneration, particularly in the medium-sized and large urban centers. Urban strategy has centered on the involvement of social segments in programs to improve the quality of life and special emphasis has been given to defining strategies that integrate the transport and land use policies on an urban and regional scale.

The urban reproduction rationale – that is: the set of regulations for redefining the value and economy of a location – that was a mark of the 20th century, is not only pollutant. It can no longer afford to follow the modernist North American post-war model, due to the diseconomies and socio-spatial inequality that seriously threaten its long-term ecological sustainability (economic and environmental). As a result, since the mid-nineties, there has been worldwide interest in analyzing the efficiency of the compact patterns of land use (above all, in Europe and Asia), allied to collective transport systems, due to the reduction of the average trip distance (and consequently, of energy consumption, time spent and pollution emission) and the greater productivity of the space that is so necessary in a highly competitive urban-regional system.

Martins *et al* (2004) suggest the construction, in a European urban center, of an undertaking they call an "*Eco-Mobile*", a theme park intended to be a benchmark for Self-sustainable Urbanism in the 21st century, whose goal is to make feasible and spread the idea of the city having environmental quality, social inclusion and the effective participation of the citizens in the designing of the urban networks.

Regarding transport (or, more broadly speaking, mobility), the principles of the design and implementation of the "*Eco-Mobile*" are intended to demonstrate that Self-sustainable Urbanism, unlike the modernist paradigm (based on the readapting of the transport supply),

calls for the managing of demand, as an effective strategy for the Mobility Management, by means of three central themes or subject areas: (1) Integrated Planning of Transport and Land Use; (2) the Public Transport Management; and (3) the Traffic Management. The objective is to integrate the day-to-day activities in the transport-activities chains of the different social segments, keeping long distance trips to a minimum. This minimal subject structure appears also to be born out by the recent critical analysis of Jacobs (2004), which suggests that one should not expect much from traditional transport engineering, as an independent discipline, when it comes to the future of cities.

JOINT DEVELOPMENT USING THE "MOBILE CONCEPT"1

Based on these principles of Sustainable Mobility, Bodmer *et al*, 2005a and 2005b, suggest that the production of an urban space is linked to transport production ("Mobile Concept"), and propose that the large urban undertakings be offered the possibility of liaising with others (stakeholders), in networks, to provide special urban logistics services, instead of the mere obligation to simply provide parking space. The main idea behind this is to encourage the creation of economic activity networks (stakeholders) that take part the daily activities chains of "clients-citizens", so that, while an urban undertaking will keep its focus on the good or service it is providing (core activity), it will broaden this considerably by offering the public access to other connected activities, integrating them all to the point that each undertaking or activity in the network will offer the public an expanded product-service (urban logistics).

Successful experience in strategic partnerships aimed at developing demand loyalty can be seen in air transport (mileage programs). In a similar fashion, the urban activity networks providing special transport services intend, over the long term, to develop loyalty among the community inhabiting their area of influence or local market, attracting part of the consumption that currently does not take place within the community's area, as it is connected to external activities (clothing purchases, for example, which Mobile's research has shown to be preferably linked to the trips to and from work).

The strategic importance of the concept developed by the Mobile Group lies in the fact that an urban undertaking, in liaising with its stakeholders, will broaden its relations with the urban center and with its potential customers, while fulfilling a function that is of public interest: providing accessibility. In this way, instead of the image of polluters that is presently associated with traffic generating centers, the undertaking that becomes part of a network effectively assumes the role of station or terminal, a *Nucleus of Efficient Traffic* (NET), and will be regarded as an undertaking that is socially responsible. But not for that reason alone. Urban logistics that provide for the integration, within the community area, of the daily activities of the citizens serves the interests of urban communities wishing to preserve the

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[1] More detailed information about the Mobile Concept can be obtained from the following sources:

- Bodmer *et al* (2005a and 2005b) and Martins *et al* (2002), who, at the request of the Brazilian Development Bank (BNDES), applied the model to the reorganization of ten urban waterway transport systems in Brazil;
- Martins *et al* (2005), who discuss the ethical-epistemological foundations of socio-environmental responsibility in the business sphere; and
- Martins *et al* (2000), who present the elements of relationship marketing, based on the concept "Expanded Product-Service", originally formulated by Kotler (2000).

environmental quality of their territory and attract investment in micro-accessibility (circulation within the territory) that will connect the urban activities among themselves and with a structural mode that provides metropolitan reach (macro-accessibility). Thus, the interior of the community territory ("environmental zone") will be protected from the impacts of the circulation of people in transit, like Buchanan (1963) has attempted teaching us since the 1960's.

COMPARISON OF "PARKING SPACE" VS "MOBILE CONCEPT"

The main characteristics

In this work, a comparison was made of two different alternatives for an hypothetical development, a shopping center, located in the district of *Lagoa* (population density greater than 70,000 inhabitants/km^2), in Rio de Janeiro; namely, "Parking Space" and the "Mobile Concept".

Under the "Parking Space" Alternative, the legislation governing land use and occupation in Rio de Janeiro requires the construction of one parking space for every 30 m² of productive area, making it necessary for the undertaking to provide 1,500 spaces, each with an average area of 33.35 m² (according to field research), leading to a total parking area of 50,025 m², representing around 47% of the total building area (106,275 m²). The area of the shopping center would amount to 56,250 m², of which 20% would be occupied by support facilities (administration, circulation, etc.), leaving a productive area (stores) of 45,000 m² (42% of the total building area).

The "Mobile Concept" Alternative would be to convert part of the parking space to productive shopping center space, in return for providing a community transport service. In other words, the "Mobile Concept", applied to this hypothetical case, would involve replacing part of the parking space with seats on collective transport modes and, therefore, in offering a combination of parking space and places on collective transport, in equivalent proportions, in order to ensure the ratio of places / productive area required under the land use and occupation legislation. In this manner, retaining the same total building area as under the "Parking Space" Alternative (106,275 m²), the "Mobile Concept" Alternative, in replacing 50% of the spaces required under the land use and occupation legislation (981 spaces[2]), would bring about a 30.77% increase in productive area, from 45,000 m² to 58,847 m² and a 34.60% reduction in the parking space, from 50,025 m² to 32,716 m² (31% of the total building area).

In order to cover the shortfall in parking space and provide an equivalent supply of collective accessibility to the undertaking, the calculation was based on the conversion index (11.82) of parking spaces per seat on a collective transport mode presented by Martins *et al* (1999) *apud*

[2] It is important to note that, by increasing the total productive area, in order to maintain the same ratio of one parking space per 30 m² of productive area, laid down by the law, it would be necessary to also increase the number of spaces, hence the new total of 1,962 parking spaces for a productive area of 58,847 m² under the "Mobile Concept" Alternative, instead of the 1,500 spaces under the "Parking Space" Alternative.

Martins *et al.* (2002) and cross referenced by the Mobile research group in report for the Rio Sul Shopping Center[3]. Thus, by adopting the "Mobile Concept" and replacing 50% of the parking spaces, the undertaking would have to provide 11,590 seats per day on collective transport modes (a system comprising two round-trip routes operating within a radius of 2.7 km would yield the characteristics shown in *Table 1*).

Table 1 – Characteristics of a public transport system option under the "Mobile concept" alternative

COLLECTIVE TRANSPORT SYSTEM	
Daily capacity (seats)	11,590
Round-trip distance (km)	5.70
Headway (minutes)	3 min
Trips per hour	20
Daily operating duration (hours)	13
Trips per day	260
Average speed (km/h)	15.65
Trip time (minutes)	22
Fleet requirement	8
Fleet reserve	1
Vehicle capacity (seats)	22
Round-trip capacity (seats)	44
Average number of operational days per month	30
Monthly total kilometers (26-day month)	44,460

A summary of the characteristics of the undertaking, upon adopting the "Parking Space" or "Mobile Concept" Alternatives that are compared in the analysis, can be seen in *Table 2*.

Table 2 – Comparison between the alternatives "parking space" and "Mobile concept"

	"PARKING SPACE"	**"MOBILE CONCEPT"**
Total Building Area	106,275 m²	106,275 m²
Productive Area	45,000 m²	58,847 m²
Number of Parking Spaces	1,500	981
Seats on Collective Transport Modes	-	11,591
Total Parking Space	50,025 m²	32,716 m²
Shopping Center Area	56,250 m²	73,559 m²

Methodology: Hierarchical Analysis Method and Financial Viability Analysis

Results of the Hierarchical Analysis Method

The Hierarchical Analysis Method (HAM), developed by Saaty (1977a, 1977b, 1991) *apud* Martins and Bodmer (2003), was utilized in order to simulate the decision making process of the real-estate developers in opting to construct garage space or to provide transport services under the "Mobile Concept". Briefly, the methodology for obtaining the data, applied by Silva (2005) and Lentino (2005) comprised:

[3] The conversion index (11.82) is obtained as follows: average vehicle turnover at shopping center parking lots (4.67 = 12 hrs in operation / average time a vehicle remains in the parking lot, i.e.: 2.57 hours) multiplied by the equivalence factor for the area occupied by an automobile or by a standard urban bus (2.53).

i carrying out a survey, by means of a questionnaire, of the seven largest shopping centers in Rio de Janeiro and Niterói, located in central areas and in urban expansion areas (urban periphery), to obtain data on the physical and economic aspects of the undertakings and the operational aspects of the parking lots (number of spaces, number of stores, average area of garage space, percentage of garage space in relation to the total building area, gross revenue, number of jobs created, etc.);

ii carrying out a structured survey, by means of a structured questionnaire, of a representative sample (significance of 95% and error of 5%) of the companies in the real-estate sector, so as to identify the chief decision making criteria, and their respective weightings, to be adopted in putting together the "Decision Tree" used in the Multicriteria Hierarchical Analysis. The criteria were organized in 4 groups: “Productive Efficiency”, “Market”, “Social” and “Legal-Bureaucratic”. These four decision making areas (groups of criteria) were applied to the two alternatives ("Parking Space" and "Mobile Concept"), with the fourteen principal criteria, of a total of twenty-six, accounting for 80.27% of the weighting in the decision making process, as shown in *Table 3*.

Table 3 – Decision making criteria and their weightings, according to the entrepreneurs

DECISION MAKING AREA	**WEIGHTING (%)**		**CHIEF DECISION MAKING CRITERIA**
Market	44.51	8.39	Company image
		8.39	Customer satisfaction
		6.57	Product differentiation
		6.20	Product value enhancement
		5.84	Value added for the customer
		4.74	Technological innovation
		4.38	Generation of new business
Productive Efficiency	21.90	7.30	Cost of operation and maintenance
		6.57	Cost of implementation
		4.38	Productivity
		3.65	Easiness to sell or lease
Social	9.48	6.93	Quality of life
		2.55	Jobs
Legal-Bureaucratic	4.38	4.38	Legal incentives (counterpart)
TOTAL	**80.27**		

iii focused research, involving a semi-structured questionnaire given to the companies that participated in the earlier survey, for the comparative determination of the objective variables (performance indicators) of the alternatives for each decision making criterion. The questionnaire adopted a standard rating of "5.00" as a performance indicator for each of the criteria under the "Parking Space" Alternative, with the developer awarding a relative performance rating for the same criteria under the "Mobile Concept" Alternative. The results can be seen in *Table 4*. The developers’

pessimism regarding the Mobile Concept's performance under the criteria of implementation and operating costs is noteworthy. For all the other criteria, the assessment of the performance of the "Mobile Concept" compares favorably with that of the "Parking Spaces".

Table 4 – Objective variables for the decision making criteria, in yhe qualitative assessment of the real-estate developers

DECISION MAKING CRITERIA	**"Parking Space" Alternative**	**"Mobile Concept" Alternative**	
	PERFORMANCE	**AVERAGE PERFORMANCE**	**STANDARD DEVIATION**
Generation of new business (see Note 2)	5.00	7.50	1.84
Technological innovation	5.00	6.82	1.83
Legal incentives (counterpart)	5.00	6.73	1.95
Product differentiation (see Note 3)	5.00	6.36	1.21
Productivity	5.00	6.45	2.25
Company image	5.00	6.27	1.19
Quality of life (see Note 4)	5.00	6.18	2.04
Product value enhancement	5.00	5.64	1.50
Customer satisfaction	5.00	5.55	1.29
Easiness to sell or lease	5.00	5.36	2.16
Value added for the customer	5.00	5.27	2.33
Cost of implementation	5.00	3.64	2.20
Cost of operation / maintenance	5.00	3.55	2.58
Jobs (see Note 5)	5.00	-	-

Note 1: One company did not provide an evaluation of the degree of certainty of its responses.

Note 2: The average and standard deviation for this criterion were obtained from a total of 9 companies. Two companies did not provide an assessment.

Note 3: One company awarded two ratings: "5" and "8". The lower of the two values (5) was used, so as not to unduly favor the proposal.

Note 4: The companies did not evaluate the degree of certainty in their assessment of the criterion "quality of life".

Note 5: The criterion "Jobs" was not assessed by the companies, as it hadn't been initially identified as a chief decision making criterion, but was included during the analysis of the results.

iv complementary quantitative data was obtained regarding the implementation and operating costs, revenue and number of employees[4] under each alternative. *Table 5* presents the methodology for calculating the criteria that were verifiable in the field, that is to say, in addition to being evaluated qualitatively by the developers, they can also be collected objectively. The performances of the quantitative criteria were calculated in relation to the physical parking area (m^2), considering the area of parking space constructed in the case of the "Parking Space" Alternative and considering the area of parking space replaced by the transport system in the case of the "Mobile Concept" Alternative, as can be seen in *Table 6*.

[4] The criterion "Jobs" was not assessed by the companies in the second part of the survey, as it hadn't been initially identified as a chief decision making criterion, but was included during the data treatment phase. Nevertheless, as a quantitative decision making criterion (subject to field verification), the performance of the "Jobs" criterion was evaluated in accordance with the treatment of data collected in the field for each of the alternatives.

Table 5 – Calculation of the objective variables for the quantitative decision making criteria

CRITERION	"PARKING SPACE" ALTERNATIVE	"MOBILE CONCEPT" ALTERNATIVE
Revenue	**$P_{a1} = F_{es} / A_{es}$** P_{a1} = gross monthly revenue of the "Parking Space" Alternative F_{es}= gross monthly turnover of the parking lot A_{es} = area of the parking lot	**$P_{a2} = F_{sh} / A_{sh}$** P_{a2} = gross monthly revenue of the "Mobile Concept" Alternative F_{sh} = gross monthly turnover of the shopping center A_{sh} = area of the shopping center
Implementation Cost	**$CI_{a1} = CC_{es} + I_{es} + I_{il}$** CI_{a1} = cost of implementing the "Parking Space" Alternative CC_{es} = cost of constructing the parking lot I_{es} = investment in automating the parking lot operation I_{il} = investment in installing the lighting system	**$CI_{a2} = I_v + I_{eq} + CC_{con}$** CI_{a2} = cost of implementing the "Mobile Concept" Alternative I_v = investment in a vehicle fleet I_{eq} = investment in a system of electronic ticketing CC_{con} = cost of converting parking space to stores
Operating / Maintenance Cost	**$COM_{a1} = (5\% \ CI_{es})/ 12$** COM_{a1} = cost of operating / maintaining the "Parking Space" Alternative CI_{es} = cost of implementing the parking lot	**$COM_{a2} = CS_{tc} + CE_{est} + COM_{sh}$** COM_{a2} = cost of operating / maintaining the "Mobile Concept" Alternative CS_{tc} = cost of the transport service, including taxes CE_{est} = cost of storing the fleet COM_{sh} = cost of operating/ maintaining the parking space that was converted into productive shopping center space
Jobs	**$E_{a1} = E_{est}$** E_{a1} = direct jobs generated under the "Parking Space" Alternative E_{est} = direct jobs generated in the parking lot	**$E_{a2} = E_{tc} + E_{sh}$** E_{a2} = direct jobs generated under the "Mobile Concept" Alternative E_{tc} = jobs generated by the transport system E_{sh} = jobs generated by the parking space that was converted into productive shopping center space

Note: The objective variables for the chief quantitative decision making criteria were calculated based on data obtained by field research. The base values are those of October 2004.

Thus, when one analyzes the decision based exclusively on the performance perception of entrepreneurs from the construction sector in Rio de Janeiro, one can note a tendency in favor of the "Mobile Concept" Alternative, with 52.6% of the preference, or an 11% advantage over the "Parking Space" Alternative.

Table 6 – Results for the objective variables for the quantitative decision making criteria, according to the field research data

RESULTS	PRODUCTIVITY (US$)		COST OF IMPLEMENTATION (US$)		COST OF OPERATING AND MAINTENANCE (US$)		JOBS	
	PARK.	MOBILE	PARK.	MOBILE	PARK.	MOBILE	PARK.	MOBILE
WORST	2.71	117.47	183.84	125.92	0.77	2.69	0.000727	0.065387

AVERAGE	**4.26**	**172.20**	**183.62**	**100.00**	**0.77**	**2.26**	**0.000833**	**0.065510**
BEST	5.80	226.94	183.46	89.34	0.77	1.98	0.000975	0.065675

Note: Under the criteria relating to cost – "Cost of implementation" and "Cost of operating and maintenance", from the business point of view, the priority is inverted, so that the highest costs represent the "worst results" and the lowest costs are the "best results"; US$ 1.00 = R$ 2.50 (May/2005).

Moreover, when one analyzes the decision based not only on the entrepreneurs' perceptions, but replacing the quantitative criteria with objective variables calculated according to data obtained in the field, using the calculation methodology presented in Table 5, one can see that the average performance tends even further in favor of the "Mobile Concept", from 52.6% to 55.7%, or an advantage of almost 26% in relation to the "Parking Space" Alternative (44.3%).

Results of the Financial Viability Analysis

In the economic-financial viability analysis, the four main traditional criteria (present liquid value, benefit/cost index, internal rate of return and pay-back period of the investment) were taken into consideration.

The developer's annual net revenue is the total annual potential revenue, considering rents and *res separata* (the additional developer's revenue for improvement provided to the retailers), less the annual operating costs. Having deducted the total monthly costs from the gross monthly potential revenue, the *res separata* was calculated, on the basis of 50% of commercial fund, which was obtained using the following equation:

$$\textbf{\textit{Commercial fund} = (L . R . n) / (n/12) x (1 + j)}^{n}$$

where:
***L**: Rate of return on a store, based on the Net Revenue shown in Table 7 (50%)*
***R**: Gross Monthly Potential Revenue of the undertaking (Table 7)*
***n**: duration of a store commercial contract (60 months)*
***j**: interest rate (0.5% per month).*

Further to the parameters already presented in *Tables 5* and ***6***, the other parameters adopted for calculating the total costs and revenues for the two alternatives are presented in *Table 7*.

Table 7 – Cost and revenue structure for the undertaking adopted in the financial viability analysis

	"PARKING SPACE" (US$ 1,000)	**"MOBILE CONCEPT" (US$ 1,000)**
Monthly Operating & Maintenance Costs (3.0% of Implementation Cost)	727.36	774.38
Monthly Admin. & Marketing Costs (5.0% of Implementation Cost)	1,212.26	1,290.64
Monthly Cost of Personnel and Payroll Charges (including stores)	2,693.61	3,679.68
Monthly Cost of the Accessibility Alternative	100.54	139.11
Total Monthly Cost	4,733.76	5,883.81
Gross Monthly Potential Revenue	9,899.54	12,806.33

Monthly Net Revenue	5,165.78	6,922.53
Investment (Implementation Cost)	24,245.16	25,812.71

Note: US$ 1.00 = R$ 2.50 (May/2005)

For the financial viability analysis, the financing term was considered to be 20 years, the useful life of the undertaking to be 40 years, the rate of interest to be 0.5% per month and a discount rate of 12% per year. The performance results for the two alternatives in each of the financial viability criteria can be seen in *Table 8*.

Table 8 – Performance of the two alternatives under the financial viability analysis criteria

FINANCIAL VIABILITY CRITERIA	"PARKING SPACE"	"MOBILE CONCEPT"
Present liquid value (US$)	35,850.86	64,736.84
Cost/benefit ratio	2.09	2.18
Internal rate of return (%)	21	27
Pay-back (years)	8	6

It may be concluded, then, that the adoption of the "Mobile Concept" by large-scale undertakings is financially the best alternative, given that, as has been shown, replacing 50% of the parking space, in exchange for collective transport services, and occupying this space with stores raises the accessibility cost from 2.1% to 2.4% of the total monthly cost of the undertaking, while increasing the potential monthly revenue by 29%. Hence the superior performance in all the viability criteria: Present liquid value 81% higher; Cost/benefit ratio 28% higher, Internal rate of return 4% higher and pay-back range 25% lower.

CONCLUSION

It was concluded that, in a multi-criteria hierarchical analysis, the view of the real-estate development sector in Rio de Janeiro regarding the overall performance of the "Mobile Concept" Alternative is positive. However, with reference to the objective variables and those relating to the economic-financial viability of the proposal under analysis, they do not tend to indicate, *a priori*, a favorable performance by the "Mobile Concept". The criteria “Cost of implementation”, “Cost of operating and maintenance” and “Productivity” appear to be the ones that really define whether an undertaking will be implemented, despite a growing concern over the social and environmental aspects.

The real-estate developers have provided a positive assessment of the social and economic decision making criteria relating to the "Mobile Concept", presented as an alternative to the obligation to provide garage space when constructing any kind of urban undertaking.

In this respect, the sector placed the "Mobile Concept" Alternative significantly ahead of the alternative, but they still remain to be convinced when it comes to the traditional analysis of the alternative's economic-financial viability.

As has been demonstrated, converting 50% of the parking space to the use of collective transport services and filling this space with stores leads to an increase in accessibility cost, from 2.1% to 2.4% of the total monthly cost of the undertaking, but to a 29% increase in the monthly potential revenue. Consequently, we see the alternative perform better under all the viability criteria: Present liquid value 81% higher; Cost/benefit ratio 28% higher, Internal rate of return 4% higher and pay-back range 25% lower.

One may conclude, therefore, that, in financial terms, the adoption of the "Mobile Concept" by large-scale undertakings, as a network of transport services and urban logistics, is a better alternative for accessibility than the construction of parking space in compliance with the urban legislation, considering both the financial viability of the undertaking and the urban economy as a whole, since the replacement of parking space with productive space increases the average revenue of the undertaking by 41 times (from US$ 4.22/m² to US$ 172.20/m²), while the rate of direct job creation is increased by about 78 times (from 0.00083/m^2 to 0.06551/m^2).

Therefore, it is confirmed that if the municipal authorities were to induce the legislation governing land use and occupation to allow the conversion of parking space in traffic generating centers into a network of special collective services, this would augment the capacity for renewal of these undertakings by 25%, given the greater revenue flow and the reduction of the investment pay-back period. As these establishments become inter-linked by the network of collective transport services, there is a tendency towards an urban renewal also, over a 6-year cycle. There is, among the consumers within their area of influence, the prospect of developing loyalty towards the network of activities, as a result of both the increased number of stores and the image of a socially responsible undertaking, due to the investment in urban micro accessibility.

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