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Impact analysis of managerial decisions on the overall performance of a public transport operator: the case of STCP

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Abstract

This paper presents a case study from Porto-based public transport operator *Sociedade de Transportes Colectivos do Porto* (STCP) to closer investigate the relation between managerial decisions and economic indicators in public transport, such as efficiency and effectiveness. By means of Data Envelopment Analysis (DEA) the company´s performance results between 1946 and 2004 are analyzed. The second part of the analysis serves to explore the managerial history of STCP and to point out main decisions, policies or other decisive factors in the framework of the company's performance. Our approach aims at identifying the magnitude of these decisions within the operational framework and their time-lags. The analysis has shown that certain managerial decisions directly influence the operational activity in the following years and considerably affect the overall performance of the services provided. The decisions are mostly linked to an increase of social benefits and privileges, political and social environment, the implementation of the single agent policy and operational leasing. Another essential conclusion is the identification of a certain time-frame of such influence. Results show the existence of time-lags between decisions and performance, usually representing medium term periods from 2 to 4 years. The results might be translated into policy recommendations, e.g. for setting up the regulatory framework that achieves a systems best performance.

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Keywords: performance analysis; benchmarking; public transport; DEA; frontier analysis; efficiency; effectiveness

1. Introduction

Public transport (PT) aims at providing high levels of mobility to citizens. Thus, its adequate functioning contributes mainly to the quality of life in every city. Especially in times of economic crisis, soaring energy costs and increasing environmental concerns public transport is a meaningful alternative to cost-intense, congestion-prone private transport in urban agglomerations. In this respect, current trends and constraints, namely more

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people living on less space, overall financial shortages in the public sector or the changing regulatory environment require the management boards of public transport operators more than ever to act innovative and entrepreneurially sound.

Management practices of any enterprise have a vital impact on its global performance. Consequently it is of high importance to assess the magnitude of managerial practice, decisions taken and strategies applied in the operational framework. The set of applicable management decisions in PT is manifold and *inter alia* refers to adjustments in the business organization itself, new approaches to customer retention and acquisition, the introduction of pricing schemes and innovations in infrastructure, vehicles, control systems or ICTs.

However, regarding an organizations' performance decision makers in reality often have to face uncertainty about recognizing the true impact of their strategic choices and operational judgments. Thus, the relation between managerial decisions in PT and the company's performance in terms of *productivity*, technical, structural, and price *efficiency*, as well as *effectiveness* becomes an essential, yet rarely studied research topic.

Since urban public transport is managed as a public sector service, the analysis of data is done using Data Envelopment Analysis (DEA), giving good ground not only for determining the level of the company's performance, but also for defining the relationship between managerial decisions and operating years' efficiency/effectiveness. In this context, the performance of STCP is analyzed in a time-series for a period of 59 years (from 1946 to 2004), distinguishing between two performance indices: efficiency and effectiveness. On the next stage, the present study advanced to crossing the time-series performance analysis with the historical records of managerial decisions, which allowed identifying the ones that have had major influence on efficiency, effectiveness and productivity.

2. Literature Review

Given the context of our research, the literature review is representative rather than exhaustive. Much of literature on this relationship is of empirical nature. Its scope ranges from the firm-level to the macro-level analysis. More recently, at both scales of analysis, the debate is showing some concern on deepening the knowledge on the relationship between performance and decision-making. The new lines of research range from the recognition of a) the influence of multi-layer interactions on the performance measures and b) the multi-directional nature of this relationship and c) cost-orientation (not only benefits, but also costs, arise from decisions).

2.1. The link between Performance and Decision-making

Research Levels

At the micro-level scale, usually the effects of particular decisions on the performance of a company are analyzed, such as investment, operational decisions or the adoption of specific management practices. In this respect some studies attempt to quantify the benefits realized from IT or ICT investments (Wu and Chen, 2006; Matteucci and Sterlacchini, 2003) or focus on the effects of technology on the organizational performance (Devaraj and Kohli, 2003). On the other side empirical studies emphasizes the role of 'knowledge capital' and innovation to explain productivity growth (Czartitziki and Korneluis 2004, Co and Chew, 1997). In addition, over the past twenty years, other studies focus on the link between the implementation of Human Resources (HR) practices and organizational performance (Wright et. al, 2005; Sels et. al, 2006). At the macro-level scale, the main concern is upon how the performance of particular territories and government administrations is affected by the implementation of public programs and policies (Kim and McMillin, 2003), institutional features as well as structural and administrative arrangements (Heinrich and Lynn, 2001), and the adoption of management or institutional practices (Nicholson-Crotty, 2005). The term 'management capacity' is a key concept among these studies (Coggburn and Schneider, 2003).

Scope and Extent

Firstly, due to the difficulties to show how different structural administrative and managerial arrangements affect the global performance, most studies focus merely on isolated levels of organization. However, in the context of IT investment decisions, Wu and Chen (2006) argue that the value of IT is realized basically through a chain of relationships within the organizational hierarchy. Likewise, Heinrich and Lynn (2001) use multilevel models to evaluate how factors or variables measured at one level of an administrative hierarchy might interact with variables at another level. Donahue, Selden and Ingraham (2000) conclude, that it seems to exist "… a growing agreement that influences associated with administrative arrangements do matter to the efficacy of the policy and program delivery system".

Secondly, the most common analysis of the link between performance and decision-making merely addresses the unidirectional effects, i.e. the causal relationship in the sense that decisions, when implemented, lead to higher performance. For example it is argued that managerial decisions, e.g. related to personnel, information technology and networking activities, have a substantively important impact on performance organizations. However Nicholson-Crotty (2005) states that causal relationships between management and performance may also be multidirectional: performance causes management behaviour, which in turn influences future performance. In the context of the HR management-performance link, Wright et al. (2005) demonstrate that HR practices are both strongly related to future performance measures and past performance measures.

Finally, the majority of the research starts from the assumption that the decisions have only a value-creating effect, while neglecting the direct and indirect costs that arise from it. For example, investment in HR management practices does not only enhance the productive capacity of employees, but can also have cost-increasing implications for organizations, such as those that are due to work intensification, stress and/or job train. Sels et al. (2006) develop a conceptual framework that link HR management practices and performance. Their results show that the cost-increasing effect is so strong that it completely outnumbers the productivity gains.

Anyhow, in spite of these recent efforts on clarifying the link between decision-making process and performance, it seems that much of these inter-relations remain fuzzy and complex. Thus, this paper aims at helping to deep the knowledge on this relationship.

2.2. The importance of time-lags

Another feature uncovered by the literature review is that although most studies report a positive relationship between decisions and economic performance, there remains considerable uncertainty on the magnitude of the impact. In fact, the results mixed. While some studies found the existence of high impacts, others indicate that the magnitude of those impacts seems to be quite low or non-existing. The diversity of results found in the literature can be explained by either neglecting the existence of time-lags in general, or simply by misspecifying the length or structure of these lags.

Theoretical and empirical studies generally recognize that the values of particular decisions may be realized over an extended period of time. Thus, these studies stress the importance of including time-lags specifications, and the role they might have on the process of decision-making. For example in the context of price inventory models Lai and Pauly (1992) found that lags essentially determine the intertemporal structure of firms' decisions problems, in the sense that they affect their price and output behaviour in the production process. Nickel (1977) argues that the existence of lags between the decision to invest and the incorporation of the new capital stock in the productive process may affect a firms' optimal investment policy. Kim and McMillan (2003) argue that one of the critical issues that must be addressed when evaluating the effects of monetary policy on economic performance is the uncertainty about the true lag length and the type of lag structure of these effects. Some explanations for the existence of time-lags in the context of IT investment decisions are given by Brynjolfsson (1993). The author argues that "firms and individual users of IT may require some experience before becoming

proficient. According to models of learning-by-using, the optimal investment strategy sets short-term marginal costs greater than short-term marginal benefits. This allows the firm to 'ride' the learning curve and reap benefits analogous to economies of scale. If only short-term costs and benefits are measured, then it might appear that the investment was inefficient". Additionally Matteucci and Sterlacchini (2005) state that these lags are due to the need of further and complementary organizational changes and investments in tangible assets (such as the retraining of the employees, the re-distribution of tasks and the re-design of decision-making processes).

The literature reviews indicates that the lag lengths of the decisions' effects on performance seem both to vary across studies and to depend on the type of the decisions involved. While IT usage studies suggest that the lag lengths may vary from 25-60 days to less than six months, for IT and ICT investments lags appear to be of 2-3 years, 4-9 years for R&D investment and 1-3 years for HR management practices.

3. Research Methodology

3.1. Data Envelopment Analysis

The present study applies the non-parametric DEA Analysis (Data Envelopment Analysis). DEA was developed by Charnes et al. (1978) based on the initial work on efficiency measurement carried out by Farrell (1957). Charnes et al. (1978) solved the problem of evaluating efficiency for economic units that use multiple inputs and produce multiple outputs. Banker et al. (1984) later related the efficiency evaluations to the axiomatic formulations of Shephard's work (1970) which enable the consideration of variable returns to scale. This brings together the notions of efficiency and modern production theory which will be applied at a public sector service. Mostly the mission of those is to rather maximize outputs with the resources available, than to gain commercial profit. Given the fact that urban public transport is a public service characterized by multiple inputs and outputs, DEA is particularly practical for evaluating performance. Moreover, frontier methodologies allow to distinguish between efficient and inefficient production, and to estimate the degree of inefficiency by considering observed best-practice standards as benchmarks. Based on the research objective and context described above, the specifically chosen DEA method is the input-oriented model, considering two production cases that allow distinguishing between the operations' efficiency and effectiveness (see Appendix A for input and outputs used).

The mathematical formulation of the DEA used in this paper is the following:

$$\min_{\theta, s_i^-, s_r^+} (\theta - \varepsilon (\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)) \tag{1}$$

s.t.

$$\sum_{j=1}^{n} x_{ij} \lambda_j + s_i^- = \theta x_{i0} \qquad i = 1, \ldots, m \tag{2}$$

$$\sum_{j=1}^{n} y_{rj} \lambda_j - s_r^+ = y_{r0} \qquad r = 1, \ldots, s \tag{3}$$

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad j = 1, \ldots, n \tag{4}$$

$$\lambda_0 = 0 \tag{5}$$

$$\lambda_j \geq 0,\ s_r^+ \geq 0,\ s_i^- \geq 0 \quad \forall i, j, r \tag{6}$$

x_{ij}	the i-input of DMU j
y_{rj}	the r-input of DMU j
θ	the efficiency score of considered DMU
$\sum_{j=1}^{n} \lambda_j = 1$	the constraint of convexity (BCC model)
s_i^-	input slack parameter
s_r^+	output slack parameter
$\lambda_0 = 0$	constraint for applying the superefficiency measure

To perform the DEA calculations, the input and output data was processed using the KonSi DEA Software based on the BCC DEA model.

3.2. Performance Dynamics and the Efficiency-Effectiveness Matrix (EEM)

In the former method consecutive efficiency and effectiveness coefficients are analysed to identify the yearly variations of performance (e.g. from one operational year to another, or over a period of up to 6 years). The EEM serves to graphically illustrate results and to visually observe the dynamics of the company's performance (Appendix C).

4. Case Study: Sociedade de Transportes Colectivos do Porto, S.A. (STCP)

Given the fact that STCP has been present in the public transport sector for a rather long period and has extensive records of operational activity and organisational management, it was considered a suitable case study. Sociedade de Transportes Colectivos do Porto (STCP) is the public bus operator in Porto, the second largest city in Portugal and the core city of Porto's Metropolitan Area, which includes a total of 14 councils with an overall area of 1574.2 km² and 1551950 inhabitants (INE, 2001). The area of STCP's operations comprises 6 councils, of which Porto is the central one. The company's history in the framework of Porto's public transports dates back to 1872 but it was only in 1946 that the name "Serviços de Transportes Colectivos do Porto" appeared, following the grant of the public transport concession to a group of entrepreneurs by the Porto City Council. Later on, in 1994, the final transition to "Sociedade de Transportes Colectivos do Porto" S.A. was implemented. By 2004, STCP was operating 81 bus lines and 2 tram lines.

4.1. Operational and Management Data

The operational data analyzed was collected from STCP's Reports and Financial Accounts between 1946 and 2004 and included two inputs and two outputs (Appendix A). Considered as inputs were: the number of employees (as according to records of December, 31 of each year), and company's fleet (in number of vehicles). Due to the lack of uniform data available for the entire research period, only one output was considered for the efficiency analysis (i.e. vehicle-km), and one output for the effectiveness analysis (i.e. number of passengers). The management data was collected from the company's yearly reports and financial accounts, and consisted of managerial decisions taken along the operational period analysed.

4.2. Performance Measurements and Results

Data Envelopment Analysis

At the first the stage the yearly efficiency and effectiveness scores were calculated by means of DEA and the years of best and of poorer operations were identified accordingly. Figure 1 represents a long-term view on STCPs' performance: Generally speaking, the periods affected by major efficiency changes were the years 1965-1967, 1967-1972, 1973-1979, 1977-1984, 1995-1998, while fewer changes occurred mostly during years 1998-2000 and 2000-2004. Another general observation is that the company was more efficient than effective in the first half of the period evaluated in the study (1946-1967), and more effective than efficient in the second half (1977-2004). The two distinct periods were separated by a period of significant decrease in both indicators, more prominent in the period of 1967-1977.

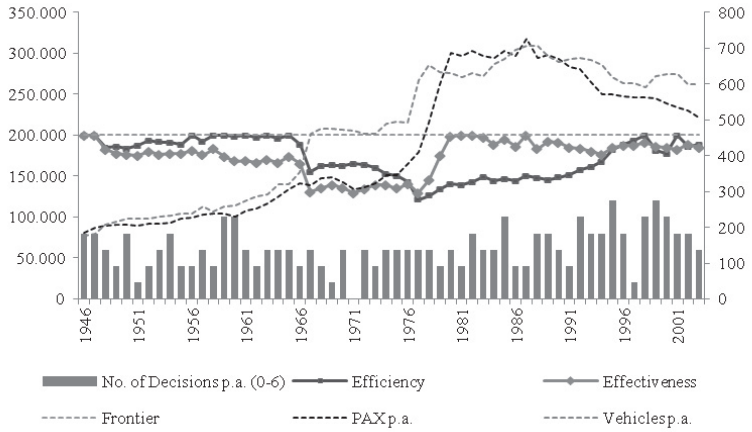


Figure 1. Efficiency and Effectiveness STCP 1946-2004

From the data (for detailed results see Appendix B) it can be observed that after the first two years of excellent results (1946 and 1947), in 1948 the performance of the company decreased from the value of 1 for efficiency and effectiveness to the values of 0.92 and 0.91 respectively. From 1956, while efficiency recovered registering high values until 1965, yearly declines in effectiveness were registered until 1977. Moreover, the year 1977 was the low point of the company's performance, displaying poor efficiency as well as effectiveness results – 0.608 and 0.649 respectively (with a

slightly lower value of 0.647 for effectiveness in 1971). After this "turning point" both performance indicators start to show a stable tendency of increase, maintaining in particular in the last decade (since 1995 to 2004) a high performance level with values between 0.9 and 1.

Performance Dynamics and the Efficiency-Effectiveness Matrix (EEM)

It can be observed that the company's efficiency exhibited a constant growth until 1998, while effectiveness registered a steep increase before 1980, but in the following years showed a mix of better and poorer results, displaying average yearly variations in the limit of +/- 5%. In particular, this part also revealed two big shifts registered in efficiency and effectiveness scores. Namely, in 1965 till 1967 there was a negative shift of more than 20% decrease for both efficiency and effectiveness, followed by a second drop, lasting until 1977. With respect to performance effectiveness, a significant change was identified after 1977, when performance results seem to improve: 8% in 1978 and 15% in 1979. Thus, the positive shift in effectiveness between years 1977 to

1980 amounted to a cumulative increase of 34%. An aggregate illustration of the efficiency-effectiveness pairs for each operating year is given in Appendix C which depicts the EEM.

4.3. Managerial Decisions

The second part of this analysis serves to explore the managerial history of STCP and to identify main decisions, policies or other decisive factors in the framework of the company's performance. A decisions data base was conducted from yearly reports to track the companies' managerial activity classification criteria were introduced for structuring the decisions. The criteria comprise six main categories, as depicted in Table 1: *network, fleet, schedule, personnel, financial policies,* and *servicing* (the last one including three subcategories: operational, technical and IT) and *context*.

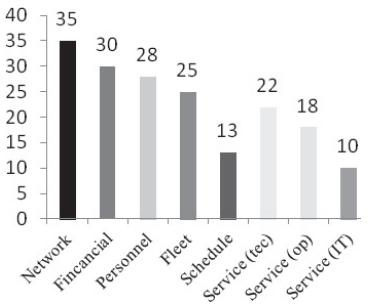
Table 1. Management Toolbox for Public Transport

Category	General Specification	Observations, Mayor Decisions & Comments
Network	*creation, alteration or elimination of lines; additional services (airport transfers, recreation routes, bus + bike routes); additional modes (cycling schemes, shared taxi); mergers and linked transport systems (transport integration)*	overall active concentration on developing, constructing and improving the lines and routes Network: 1950-1965; Porto concessions 1956 adding several peripheral zones; long break of almost 20 years (1980 – 1998) was later compensated by an active involvement in network changes (alteration, creation of new lines, introduction of additional services, e.g. tourist bus, etc.) **strategy:** create, experiment, exploit and observe, and then alter or up-date according to newly emerged requirements
Fleet	*fleet number and composition; engine and technology related issues, such as fuel used, maintenance interval*	more or less evenly distributed, indirect indicator of operations' development and demand capacity growth increasing the number of operated vehicles and fleet renewal **policy:** create efficient and well-maintained fleet in order to provide efficient services
Schedule	*alteration in the frequency of routes; new timetables; increased punctuality; reduced waiting time; increased speed*	schedule decisions are more intense in the beginning of the company's operations (years 1946 – 1964) almost absent in the second half of the year investigated changes to night routes in one year and decrease of frequency
Financial	*changes and adjustments in the pricing policy (incorporating subsidies etc); fares (single trip vs. monthly pass), price discrimination (student, social passes); revenues from advertisement*	extensively developed in the second half (starting from 1966) changes and revisions of the fare system (1981 - 1985) presumed to be interrelated with the external economic (social) context
Personnel	*number of staff (drivers, administration, maintenance); impacts social programs or company benefits and union restrictions; total work hours; training*	even distribution throughout the entire period social benefits, training: 1952, 1960-1963 implementing „single agent" policy 1970 to 1986 staff reduction 1988 the company is constantly surveying and adjusting its labour resources to its current or planned operational requirements

Servicing	*Technical: new equipment on vehicles operated, technical infrastructure, on-time information, billboards at stations, communication systems, operation assistance projects* *Operational: network servicing infrastructure: operational (stations and parking terminals, interchanges) and commercial (ticket selling points, vending machines)* *IT: provision, processing and analysis of operational information*	more intense in the last 10-15 years of the company's activity (explained by the implementation of so-called innovative applications) timing of technical decisions: 1950-1965: transport infrastructure; 1989 – 2004: the need of modernizing the technical infrastructure
Context	*External forces that could have had an impact on the results of the public transport operator's performance*	to lack of sufficient fleet complete re-designing of services oil prices increase and energy crises social revolution subsidizing policy organizational changes in the sector Metro Porto

Figure 2 depicts the number of decisions made in each category during 59 years. Initially the company was focused more on creating the product itself (building and enlarging network and fleet and setting up efficient schedules and staff). Later service decisions dominate the scheme. This can be regarded as an indicator of a balanced and strategically coherent management policy towards service creation and organization.

Figure 2. Decision count of STCP 1946-2004



4.4. Relation "Performance – Decisions" and Time-Lags

The following section aims at analyzing the interrelation and inter-dependency of managerial decisions and efficiency/effectiveness score by identifying the decisions which determined the changes in the performance scores of specific periods (several continuous years) as indicated in the performance dynamics approach (see as well Figure 1).

- In 1946, "Serviço de Transportes Colectivos do Porto" took the place of "Companhia Carris de Ferro do Porto" and the company was managed by the city council until 1950. This period was characterized by two major factors: managerial decisions were mostly related to the city transport network, and overall effectiveness was decreasing (more than 10%).
- Starting from 1950, the period of the next 15 years is a difficult one for the company as it involved consolidating the basis for future activity and building up the company's operating systems – from creating the product itself (new lines, building up the network, increasing the capacity offered), to elaborating the accompanying elements, such as creating an efficient human resources system, establishing a new work regime, skills building and training for personnel etc.
- During the period 1950-1965 the efficiency of the company's performance was maintained at a relatively stable level, as the positive and negative variations did not exceed 2% per year on average. This is the period when the company begins to focus more on the technical part of operations, the major of which is reorganising and building the network for electric trams, which included as well a total revision of the fare system.
- However, despite these measures, the company's effectiveness decreases, while efficiency stays near 100% until 1965-1967, when the first significant decline (more than 20%) was registered.
- The following 10 years were marked by generally low performance results until 1977. Due to the inconsistency observed during this period between performance results and decisions implemented (i.e. growth supportive decisions such as increase of capacity provided, changes in fare system, personnel benefits increase etc.), the study turned to evaluating the contextual framework in which the company was operating during this period. As a result, a series of important contextual factors were identified that probably determined a lower performance of the company: deficiency fleet, complete redesigning of services, oil price increase followed by an energy crisis, and the social revolution of 1974. The last one was particularly influential as in the beginning of the 70's certain political and social changes started to occur in Portugal. In this context, the need of closing the access of other operators to Porto area was felt, and in 1971 an agreement with all workers was reviewed. This situation may suggest that strong political and social context conditioned and maintained the general performance decrease until 1977.
- In 1976 social fares were introduced in the STCP's general fare system, which contributed to the long term effectiveness growth. Here, the research found indications of the existence of a lag (four years) between management decisions and their effects on performance as effectiveness only increased in the end of the 70's decade. However, the study assumes that this lag is probably more due to external (political, economic and social) influences.
- In 1979 the company launches the introduction of the "single agent" policy. The major impact led to a reduction of staff by about 1000 workers. Its implementation took about 10 years and its effects extended for another 10 years. In this case, the study can again conclude on a lag between a decision and its effect.
- During the 80's, efficiency tends to increase and registers significant growth throughout the 90's. Effectiveness, on the other hand, while attaining the highest level in 1980-1982, slightly decreases in the second half of the 80's and maintains the same tendency during the 90's. This entire period is marked by the following major decisions: introduction of the single agent policy, ceasing of electric trams operation and extension of the bus network. Further, some lines concessions were subcontracted to private bus operators.
- The decade of the 90's was customer-oriented. Decisions taken and implemented within this period were mostly concerned with customer policy. New tickets and a new STCP corporate image were created, and the SAE project started. STCP recovers some concessions that had been subcontracted to private operators. Only by the end of the 90's there's an effectiveness increase. Again the lag between decisions and effects is obvious.
- The bus leasing agreement was the major decision of the beginning of the new century, which led to a reduction of about 700 workers in maintenance (efficiency increased). In 2003 the process of the new fare system integration started. During the last 4 years both efficiency and effectiveness did not exhibit any

significant variations, displaying values close to 100%. This is presumed to be due mostly to frontier effects rather than being decision related.

All in all several key decisions have been identified: reduction of service of electric tram lines, modification of fares, implementation of "single agent" policy and fleet modernization. Apart from the strong influence of the operational context, the very steep increase in effectiveness after 1977 may be due to the effects of such major decisions as new fare system, opening new lines and introducing new buses. The last years' performance variations (1996-2004) are most likely again due to the contextual factors (such as social disturbances in the latter years, transport sector new regulations and company reorganization), which have generated some fluctuations in the company's performance results. For example, from year 2000 on, some declines and increases could have been induced by social disturbances and strikes, construction works in the city, as well as by the introduction of the metro service, which required a correlation and review of STCP's service.

5. Conclusions

In this paper we developed a method to assess the economic development of the Porto-based public bus operator STCP in the long-term by correlating its management decisions with its performance indicators, namely efficiency and effectiveness.

Referring to the performance measurements from DEA it can be concluded that although the efficiency and effectiveness values display some differences, the dynamics of their variation are very similar: The same years or periods are subject to decrease or increase in effectiveness and efficiency. The scores do not move in opposing directions. The joint and comparative analysis of the two sets (say *f(efficiency)=decisions* and *f(effectiveness)=decisions*) helped to identify the major decisions and the contextual factors. They relate to increase of social benefits and privileges, political and social environment (resulting from 25 April, 1974), implementation of the "single agent" policy and operational fleet leasing.

Further the study revealed the existence of a certain time frame of decisions to affect operational overall performance of the services provided. The research shows that on average these lags represent medium term periods from 2 to 4 years. They can however take rather extensive time, as for example in the case of application of the 'single agent' policy in STCP, which took about 10 years to be fully realized in terms of its influence on the company's performance.

To study the influence of managerial decisions on the company's operations and performance is important as it will help to identify and better understand the basic principles of that relation in public transport management. Consequently the evaluation of priorly applied strategies as shown in the STCP case can help to either avoid future management mistakes or to choose decisions that eventually lead to improved performance. However, at this work stage and due to the economic top-down approach chosen, it is impossible to say with empirical certainty how a public transport company could predict the impact of its managerial decisions precisely or to what extent specific decisions affect efficiency or effectiveness. For now it is only possible to identify the decisions that majorly affect one company's performance and to assess the extent of that influence by means of the performance dynamics concept. Further, the identified time lags between the implementation of a decision and its performance-related effects can support future strategic planning and management policies as they point in the direction, that a well-designed time-frame for attaining certain objectives or expecting specific results is crucial.

However, there is the strong need of advanced research in that area. Based on an extensive data base, samples and case studies of deeper evaluation, comparison, confrontation and analysis will help to create a general theory for further application.

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Appendix A. Operational Data: Inputs and Outputs Research Data Base (1946-2004)

Year	Nr of workers	Nr of vehicles	Nr of passengers (th.)	Vehicle km (th.)	Year	Nr of workers	Nr of vehicles	Nr of passengers (th.)	Vehicle km (th.)
1946	2328	177	80422	10491	1976	4198	493	165040	23663
1947	2612	182	87186	11357	1977	4236	612	180088	24088
1948	2827	206	89021	12066	1978	4030	652	215872	26432
1949	2842	217	90615	13143	1979	3951	633	261924	27272
1950	2716	225	91072	13236	1980	3916	630	300642	28372
1951	2688	225	89616	13537	1981	3835	619	296954	27746
1952	2652	223	91609	14111	1982	3833	630	303326	28700
1953	2670	231	91872	14449	1983	3884	623	296421	29600
1954	2676	232	93325	14517	1984	3864	657	294092	30013
1955	2769	238	98002	14907	1985	3808	670	302397	30958
1956	2725	237	99583	16177	1986	3844	695	296421	31354
1957	2753	258	102878	16638	1987	3888	707	318296	33138
1958	2838	243	104781	16894	1988	3818	706	293964	32593
1959	2909	258	104332	17960	1989	3729	677	297620	30979
1960	2920	260	100807	17908	1990	3672	661	292570	30897
1961	2974	274	107460	19023	1991	3612	671	283337	31912
1962	3047	286	111020	19640	1992	3548	674	280347	32988
1963	3116	292	116940	20354	1993	3224	666	265107	33305
1964	3210	319	125266	21562	1994	3036	654	250000	33680
1965	3412	321	133827	22454	1995	2935	620	249592	34701
1966	3643	355	141140	23146	1996	2952	603	247131	35097
1967	4027	462	139414	24312	1997	2908	603	246145	35784
1968	3888	474	146911	25704	1998	2812	592	246121	36223
1969	3657	474	148096	25641	1999	2606	623	244350	34543
1970	3655	473	142394	25550	2000	2486	627	238889	34021
1971	3739	471	134054	25766	2001	2423	627	234113	35310
1972	3691	460	136866	25165	2002	2240	599	230035	33875
1973	3520	461	141480	24371	2003	2197	599	221978	34322
1974	3654	489	151326	24539	2004	1844	559	219159	33827
1975	3870	495	151204	24649					

Appendix B. DEA Results on STCP Performance (1946 – 2004) – Efficiency and Effectiveness

Unit name	Efficiency	Effectiveness	Unit name	Efficiency	Effectiveness
1946	1	1	1976	0.7150455	0.703747429
1947	1	1	1977	0.6076476	0.64909782
1948	0.923971448	0.910551658	1978	0.6323497	0.727308308
1949	0.932342844	0.889129277	1979	0.6703846	0.873649545
1950	0.920778131	0.883208584	1980	0.7028293	0.991169509
1951	0.93632465	0.878598932	1981	0.6977549	0.996433862
1952	0.968532954	0.900520453	1982	0.7131688	1
1953	0.959128148	0.882177624	1983	0.7453633	0.988262913
1954	0.958369884	0.88785922	1984	0.7209929	0.943667001
1955	0.94487776	0.890757227	1985	0.7337879	0.973077436
1956	1	0.908364894	1986	0.718867	0.928866357
1957	0.963512247	0.879134788	1987	0.7518898	1
1958	1	0.915954158	1988	0.7400359	0.916046414
1959	1	0.868937242	1989	0.7283213	0.960513001
1960	0.991112227	0.842000714	1990	0.7433105	0.958579067
1961	0.999815536	0.8458549	1991	0.7607714	0.922702658
1962	0.989713751	0.835047681	1992	0.7870174	0.917286507
1963	1	0.8507314	1993	0.8092022	0.903264004
1964	0.979120951	0.834887066	1994	0.8364091	0.882920614
1965	1	0.868144018	1995	0.9108853	0.925592109
1966	0.942591185	0.827696081	1996	0.9464738	0.936019528
1967	0.779821362	0.655694603	1997	0.9677963	0.936548972
1968	0.814996625	0.678896692	1998	1	0.957527243
1969	0.817450728	0.698055875	1999	0.9081547	0.933586276
1970	0.815804829	0.679568872	2000	0.8897139	0.923257536
1971	0.825052636	0.647463313	2001	1	0.910643663
1972	0.821495587	0.670191241	2002	0.9295056	0.946332175
1973	0.801422582	0.696953043	2003	0.9439455	0.923327211
1974	0.763198815	0.695076763	2004	1	1
1975	0.751625014	0.675469404			

	Efficiency	Effectiveness
Minimal value	0.751625014	0.647463313
Maximal value	1	1
Mean	0.92003533	0.869938184
Standard deviation	0.085331695	0.106392208

Appendix C. Efficiency–Effectiveness Matrix (1946-2004)