System Dynamics based Decision Support System for Fleet Management: A Case Study

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Abstract

Nowadays fleet management is playing a fundamental role in private as well as in public organizations. Particularly important is considered the role of fleet management when decision makers have to decide whether to undertake strategic policies about fleet renewal or strategic policies aimed at containing investment costs through, for example, a better maintenance management. However, the adoption of such strategies may produce several effects in short and long term on business outcomes and may also affect other key performance drivers. This paper explores how the System Dynamics (SD) methodology can support managers for the effectiveness of decision-making process about fleet management, advising on a systemic perspective for analysing the main effects resulting by the adoption of different strategic policies. Moreover, a case study on how SD has been deployed to provide a fleet management decision support system for the managers of a public-owned company operating in the field of waste management services is provided. Finally, scenario analysis is presented and discussed.

Keywords

Fleet Management, System Dynamics, Human Resources Management, Scenario Analysis, Strategies, Maintenance, Waste Management

1. Introduction

Private and public companies, which provide public services previously contracted with public authorities, due to their budget constraints are not often able to freely decide which is the best strategy that would make the organisation running properly. In addition, the financial shortages that characterise current economies make cost-cutting policies particularly appealing and they are used as quick solutions for facing organisational financial problems in short term. However, despite their positive financial effects produced in short term, they may undermine the company sustainability as producer of side effects that decision makers may not forecast promptly in long term. In particular, financial constraints have a significant impact on the fleet management of those companies that employ vehicles for providing public services. Indeed, managers may decide whether to post-pone both preventive and scheduled

maintenance interventions, and even more often current and strategic investment (Bivona & Montemaggiore, 2005) in fleet renewal or yet to undertake the best strategy to make the organisation efficient and effective in its operations. Clearly, the financial benefits that cheese-slicing policies may have are difficult and of dubious relevance. On the other side, adopting a dynamic, systemic and long-term perspective it is possible to detect potential side effects that may arise from the decision of not undertaking a fleet renewal policy or a proper and prompt maintenance policy.

The first side effect that arises from the missed adoption of a fleet renewal policy is the increase of the fleet age. The growing fleet age generates an increase in breakdown rate, increase in maintenance costs and reduction in vehicles availability. Indeed, in literature in relation to the age of the vehicle three main kinds of breakdown trend have been identified (Abernethy & Robert, 2006):

- Infant mortality, many early age failures and few late age failures (declining breakdown rate);
- Chance failure, random ages failure rate without memory of previous events;
- Wear-out failures—few early age failures and many late age failures, breakdown increase with age;

Any strategy that may be undertaken by the decision makers that regards the fleet renewal and the maintenance management directly affects the availability and the reliability of the vehicles that must be considered as a strategic and necessary resource for carrying out its operations. Indeed, the literature of the last thirty years focused on developing a systematic approach that would allow vehicles-based companies "to carry out as little maintenance as possible and as infrequently as possible while at the same time preserving the availability" of the vehicles. Moreover, the availability and the reliability of vehicles have to be considered as performance drivers that according to a Dynamic Performance Management (Bianchi & Rivenbark, 2012) perspective, the company through the deployment of a given endowment of resources such as vehicles and personnel can provide the desired level of service. Indeed, to maintain the company healthy and sustainable in the long term, decision makers have to make sure that strategic resources have to be deployed and in the same time regenerated.

Given the complexity of a company system which core business is focused on the utilization of vehicles, maintenance and asset management deeply affect other sub-systems such as production, finance and human resources. Consequently, a systemic view for detecting cause and effect relationships has to be considered as a correct approach. The System Dynamics methodology appears to be particularly indicated in providing an effective support to decision makers in identifying and evaluating the most effective strategy to be adopted (Forrester, 1971, Sterman, 2000). Indeed, this article provides a quantitative and a qualitative model, "offering a medium/long-term perspective to evaluate the system response to a maintenance" and renewal policy "in a complex industrial environment" (Crespo-Márquez & Usano, 1994).

2. Methodology

This project has been developed adopting a mixed research methodology involving both qualitative and quantitative approaches. The development started with an analysis of the

literature related to the fleet management focusing on the maintenance management. After the literature review, a series of semi-structured interviews to the personnel of the maintenance sector involving mechanics, administrative clerks, middle management and top-level management have been made. Particularly fruitful have been the conduction of such interviews in gathering relevant qualitative data that otherwise would not have been possible to collect through the mere analysis of the formal reports and data stemming from the company monitoring system.

The second phase of the research project focused on developing a Causal Loop Diagram (here in after called "CLD"), that represents schematically the cause and effect relationships among the key variables of the considered system (Sterman, 2000). The development of such a diagram is particularly effective in understanding how some company variables may affect other elements of the system that would not have been possible to be detected just maintaining the managers' mental model as an abstract idea. The schematisation of such a system is also effective in understanding how such variables may affect the system behaviours over time, considering the delays that can characterise the causal relationships between some company variables as well.

A third phase consisted in analysing statistical data stemming from the monitoring system and some measurements made *ad hoc* for developing such project. In particular, the company disposes of a good information system but most of the data available are not processed and elaborated. Consequently, no relevant performance indicators were immediately available.

The last phase of the project focused on providing a stock and flow model built through the System Dynamics methodology that provided to the company a model of business intelligence or decision support system (DSS) able to support decision makers in the policy adoption process (Forrester, 1997, Sterman, 2000).

Rapid changes in technology, population, and economic activity are transforming our world. If some changes are positive and extraordinary as the effects produced by information technology, others are less so, such as climate change that may result from these transformations. The goal of the System Dynamics methodology is to support decision makers in the adoption of a policy to deal with a given phenomenon. Very often, the adoption of a policy does not lead to the expected results, due to, for instance delays and policy resistance neglected in the decision making process. Consequently, the policy could not allow the achievement of the desired target. Sterman (2000) states: "many times our best efforts to solve a problem actually make it worse".

The System Dynamics methodology improves the understanding process of complex systems; it assists managers and public decision makers by developing simulation models that allow them to understand the sources of resistance that policies face. Therefore, this methodology allows these individuals to learn how to deal with any issues in a learning environment.

In this context, the role of feedbacks is crucial. The system reacts every time somebody tries to change it by adopting strategies. The results that are obtained by the adoption of these strategies may not match the desired goals set. Hence, these resulting gaps obtained become the future problems to have to be solved through the adoption of remedial strategies based on the feedbacks that the system produces. Whenever decision makers establish a strategy aiming to alter the current system in order to achieve a given

goal, the other agents in the system try to alter the balance that decision makers intend to achieve through the adoption of further actions (Forrester, 1971, Wolstenholme, 2003).

The particular nature of the modelling activity carried out through the methodology of the System Dynamics is to identify and represent this data process by the interaction of feedbacks through which stocks and flows, delays and nonlinearity determine the dynamics of a system.

3. The Systemic Approach Applied to Fleet Management: the RAP S.p.A. Case

Rap S.p.A is a public-owned company that provides waste management services to the municipality of Palermo. This company in the last years have been experiencing a reduction in service quality and consequently a decrease in user's satisfaction. Reduction in service quality is concretely translated into waste piles around the city and in some cases degenerating in mini landfills in the sub urban areas.

According to the top management vision, a poor fleet and maintenance management that generates a daily lack of vehicles availability generates such discomfort. Consequently, the goal of this analysis is to provide an answer to the following questions:

- Is the low level of service quality provided by the company due to the lack of vehicles availability?
- Which are the causes that affect the availability and the reliability of such fleet?
- Are there any other hidden factors that negatively affect the company performance?

The company in the last twenty years have adopted an outsourcing policy for what regards maintenance and the repair of the fleet, reducing at the minimum level the personnel that in the past used to carry out the maintenance and repair indoor. Today the last few employees left in the workshop are entitled to check the breakdowns reported by the drivers, to open the request of repair and test the vehicles after that a third company repaired them. Moreover, looking at the administrative clerk body it seems to be under-dimensioned if compared to the mole of work they are supposed to carry out. This further problem negatively affects the quality of the fleet management. For a better understanding of the dynamics that characterise the company system, following the CLD representing the several causal-effect relationships is provided.

From the causal loop diagram, it is visible how complex is the organisational system that relates to the fleet management. The policy of vehicles acquisition P2, directly affect the finance department and the asset management department providing new and more reliable vehicles. In turn, the same policy affects the production department making available enough vehicles as required by the production managers. Of course, as effect of the utilisation of such vehicles, the preventive and the scheduled maintenance have to be provided generating cyclically the stops of vehicles.

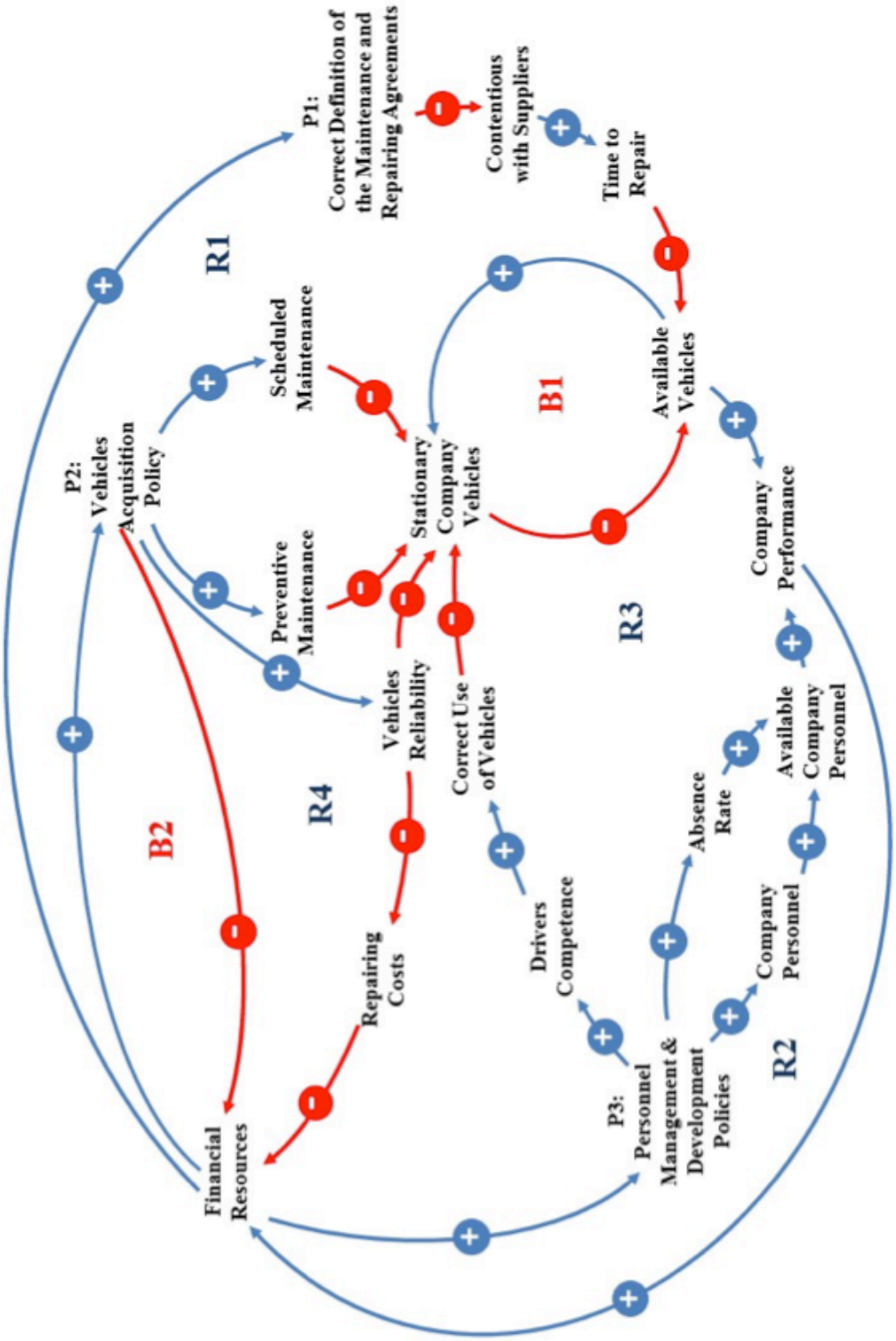

Figure 1. Causal Loop Diagram of the main cause and effect relationships of Fleet Management System

The time of stop depends both from the reliability of the company that provides the maintenance service in outsourcing and by the quality of the maintenance provided that prevents fatal breakdown. Clearly, a proper renewal policy would prevent to have an old aged fleet with higher rates of breakdowns. A good maintenance and fleet management would contain fixing and maintenance costs while increasing the level of company efficiency and the quality of the service provided.

Talking about assets it is important to refer to the personnel who are entitled to manage and drive vehicles. Personnel have to be considered as strategic resources as well as assets. Drivers can deeply affect the condition of the vehicles. It is easy to realise that a good driver, skilled and trained knows how to drive in any kind of conditions without damaging the vehicles. In particular, it has been discovered that within the company in object, many are those breakdowns that can be attributed to the negligence stemming from the low level of know how that drivers own. Indeed, strategic has to be seen the training process of drivers.

Another variable that affect the reliability and the availability of the fleet is the technology. It is clear that different brands are more reliable than others in providing equipment and engines more resilient and reliable than others producers do. In particular, this is the case of those vehicles belonging to special segment, sometimes customised *ad hoc* for a given service may show a higher breakdown rate than those standard ones. Yet, another important factor always related to the suppliers' brand quality that would foster the asset management and the fleet management is the additional service of repair and maintenance offered by the producer. This is related also to the financial capacity that affirmed producers have in anticipating the costs of spare parts and of the labour.

The boundaries of the system on which the analysis is focused are those that delineate the urban garbage collection department. The urban garbage collection service is mainly carried out by deploying vehicles characterised by different capacity of load and different kind of technology. Vehicles within the company system are classified in "families" and they are:

- Family 101, garbage trucks of small dimensions with rear loading;
- Family 102, garbage trucks of medium dimensions with side loading system. It is a strategic vehicle since it is the only technology that can handle recycling bins;
- Family 103, garbage trucks of medium dimension with rear loading system;
- Family 105, garbage trucks of small-medium dimensions particularly agile given their four steering wheels. It is considered strategic because it is employed to carry out the garbage collection in the old-central part of the city where streets are very narrow;
- Family 108, garbage trucks of big dimensions with rear loading system;
- Family 121, garbage trucks of extra-big dimensions;

To assess the availability, the reliability, the maintenance costs that every cluster shows a series of performance indicators have been calculated.

Table 1.Vehicles Fleet Management Technical Data

Vehicles Clusters	101	102	103	105	108	121	Tot
Number of Vehicles	70	7	14	23	28	5	**147**
Vehicles Downtime	112.5	216	122	140	127	142	**143**
Vehicles Available	48	3	9	14	18	3	**96**
Breakdowns Rate	30.82%	59.18%	33.42%	38.36%	34.79%	38.90%	
Average Age Fleet (Years)	7.00	11.00	9.00	8.00	9.00	7.00	8.50
Maintenance Annual Average Costs	14,195.37	7,074.91	14,810.72	17,721.57	9,374.09	1,488.39	
Annual Authorised Commissions Costs	3,366.96	7,621.23	792.18	5,258.68	2,060.86	820.55	
Total Average Costs (A+B)	16,099.30	11,253.02	13,703.01	20,667.00	9,508.03	1,385.55	
Annual Average Commissions	80.0	76.7	72.42	91.47	69.78	38.00	
Ensured Vehicles Value (Euros)	3,926,108.17	151,054.47	291,590.67	489,022.70	1,380,317.49	144,650.70	6,382,744.20

As shown in Table 1, the company department disposes of 147 garbage trucks in total. From the analysis carried out it is clearly visible that the fleet suffers of an excessive downtime, with an average of 143 days per year. In particular, it is noticeable that those trucks belonging to the 102 family reports 216 days of downtime per year. According to the breakdowns rate it is clear that all trucks show an inefficiency rate that range from 30% to 38%. Yet, worrying is the value of efficiency of the garbage trucks with side loading system that record a breakdown rate of 59%. As a result, the availability of trucks is of 96 trucks with an overall inefficiency rate of the 35%.

What are the causes of such fleet inefficiency? What are the causes of such elevated number of days of downtime?

Firstly, it is important to have a look to the average age of the fleet that is 8.5 years. However, if we look separately to the different family age we can see that the older truck family records the highest rate of breakdown. Then, it is possible to state that a first important factor that negatively contributes to increase the breakdown rate and the trucks downtime is the age of the fleet. Indeed, the following line graph shows how the breakdown rate varies over a time span of nineteen years.

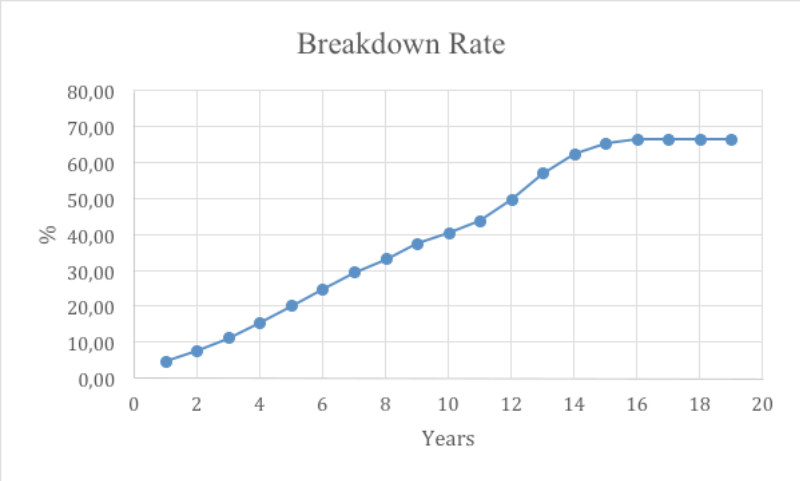

Figure 2. Average value for breakdown rate trend

The breakdown rate in Fig.2 shows a growing trend over the first fifteen years and it starts to stabilize at a rate of about 66% at the fifteenth year. Consequently, from the

analysis carried out it seems that the company should renew its fleet every five years allowing a 20% breakdown rate as maximum tolerance.

Surely, the company could improve its performance in terms of reducing the breakdown rate adopting a good maintenance management system that would respect all the deadlines that regard to both kinds of maintenance required by the vehicles producer: preventive and scheduled. As already discussed, if the maintenance is properly and promptly made, the number of breakdowns may sharply be reduced with consequent reduction in repair expenses a well. A further improvement for reducing the number of breakdowns can be achieved through the adoption of training programs that would enhance the driving qualities of the personnel in synergy with other expedients to empower personnel for the damage that they create to the asset. In that direction, for instance, a system of check-in and check-out at the garage can be an effective strategy of personnel empowerment.

Yet, the choice of a reliable brand, that would provide vehicles equipped with good quality chassis and reliable bins loading systems may further reduce the breakdown rate. So far, some solutions to solve the problem of the high breakdown rate recorded by Rap S.p.a have been provided. As we have already seen, the company records high vehicles downtime, that means that maintenance and the fixing activities are not quickly made. What are the cause of such delays between the time when the request of maintenance or of fixing is made and the day when the trucks become already operative?

The analysis of the company reports and the interviews carried out revealed that the causes of such long delays in repairing and operating the maintenance operations stem mainly from the relationships of Rap S.p.a. and its suppliers. The particular public nature of Rap S.p.a impose that suppliers must be chosen through a public tender that can be won by those companies that respect the minimum requirements and offer the lowest price to provide the service demanded by the company. This system works properly and guarantee efficiency and efficacy until when the minimum requirements are effective in selecting good quality suppliers. Indeed, significant is the impact that the selection of suppliers plays on the garbage collection company. The lack of clarity and of rigid clauses in the public tenders allows suppliers with weak financial structures to win these tenders just offering low prices. Considering that Rap S.p.a. adopts payment time policies that arrives also at six months, suppliers must anticipate significant amount of money to copy spare parts and labour costs to provide the maintenance and fixing service. Consequently, it happens that trucks are sent to the suppliers and rest inoperative until when the company commissioner does the payment or until when the supplier has enough liquidity to cope the costs of the service provision. The public tender provides a fine if the service is not provided within ten days, but often the supplier is willing to pay that fine so it can retain the truck for longer time to recover and collect liquidity.

Another issue that heavily affects the vehicles downtime are disputes between Rap S.p.a. and suppliers. The nature of these disputes is vary, many derive from the fact that some of the breakdowns are due to an incorrect maintenance that the supplier made in the past. Yet, it can be the case characterised by the uncertainty on whether to include a given breakdown in the contract of repair service provision, because it cannot be attributed to the drivers, or to make an extra-contract commission cause the breakdown has been provoked by the driver's negligence (e.g. engine breakdown for over-revving).

At the light of the results obtained, it has been suggested to the company to adopt a renewal policy that would replace its vehicles every five years, adopting an acquisition policy based on the long-term rental contract with the accessorial provision of full maintenance on vehicles. The adoption of such strategy would allow the company to streamline the administrative procedures stemming from the numerous relationships with the several suppliers entitled to provide the assets and the accessorial maintenance and repair services. The strategic analysis here suggested most probably would imply an additional increment of cost that it is significantly justified by an increase in the fleet management efficiency and efficacy with consequent enhancement of the company performance, service quality and final user's satisfaction.

Personnel

Investigating the causes of the company performance worsening, adopting a systemic view, we asked to ourselves whether there were other variables that would have been linked with the fleet management negatively affecting the overall performance. Conscious of the fact, the analysis has been extended to the personnel, in the case on the drivers. Then after having found that an average of 96 vehicles are annually available, we wondered: does the company department have enough drivers for making all the garbage trucks operatives?

Daily personnel and garbage trucks are arranged in a way to provide the urban garbage collection service on three main shifts. The following table provides data about the personnel ideally available and the personnel available at the net of the absence rate.

Production Department	Level	Qualification	Personnel 100% Efficiency	Personnel Net Abesence
Urban Garbage Collection	1	Worker	1	1
	1	Ecological Operator	7	5
	2	Ecological Operator	102	75
	2	Worker	53	39
	3	Ecological Operator	1	1
	3	Multiskilled Operator	121	90
	3	Driver	24	18
	4	Ecological Operator	1	1
	4	Mechanic	1	1
	4	Clerks	4	3
	4	Driver	62	46

Table 2. Urban Garbage Collection Dept. Personnel Data

The analysis revealed that the need of ecological operators (people who are entitled to carry out the operations of bins loading and of unloading with the truck) is 183 considering the trucks daily available. Applying the absence rate of 26.18% the company has about 218 ecological operators enough to satisfy the department need. Shifting the analysis on the drivers, the company at its level of fleet efficiency needs a minimum of 96 drivers meanwhile those available at the net of the absence rate are only 63. Then, a negative gap of 33 drivers between the desired level of drivers and the drivers available is contributing to worsening the company performance. Moreover, it is worth a note to remark that the company management have never thought that the company was suffering of a lack of drivers and that the negative performance is the result of interlinked issues.

4. System Dynamics Quantitative Model to Support Decision Making Process

The aim of this learning model is to provide a scenario that would allow to the company to increase its efficiency in providing its service. The company in object is a public owned company that has to provide garbage collection and hygiene service to the citizens of Palermo. Assuming that the company cannot hire new people, the only way for maintaining high quality of service, high level of efficiency and efficacy is to act on some performance drivers that relates to the fleet management and human resource management. In addition, it is assumed that the company would reach its total efficiency with one hundred operative vehicles.

The System Dynamics qualitative model provides a digital learning environment where the decision makers of such company could test the effects that the adoption of a given policy could have in the real context without incurring in the production of negative effects that would ruin the real company performance. Indeed, to that purpose, a quantitative model has been built for providing to the decision makers for possible scenarios stemming from the adoption of different strategies to manage vehicles and vehicles.

The SD model provides to decision makers a control panel where they can adopt decision mainly acting on four performance drivers: drivers and operators incompetency, maintenance and repairing agreement ambiguity, personnel absence rate and percentage of vehicles discarded to be purchased again.

5. Scenario Analysis

With the aim to make decision makers aware of what may be the effect of a mismanagement of the resources of the company, we have used the model to show managers four main scenarios that stem from the adoption of four different HR and fleet management strategies. The model provides the simulations of the strategy adopted over a time span of twenty years. In the realisation of such model it is assumed a minimum efficiency threshold of efficiency equal to 60%; it is assumed that the companies reaches a level of 100% of efficiency with 100 operative vehicles on the city territory.

5.1 Scenario S1: Vehicles Purchased 100%

The first scenario shows the behaviour that the company performance may have keeping the same fleet renewal strategy that the company is currently adopting. This scenario is characterised by the mere adoption of a renewal policy that aims at replacing the entire flow of discarded vehicles with new ones. The policies adopted do not regard to HR management. Following series of line charts provides the company performance behaviour of the first policy.

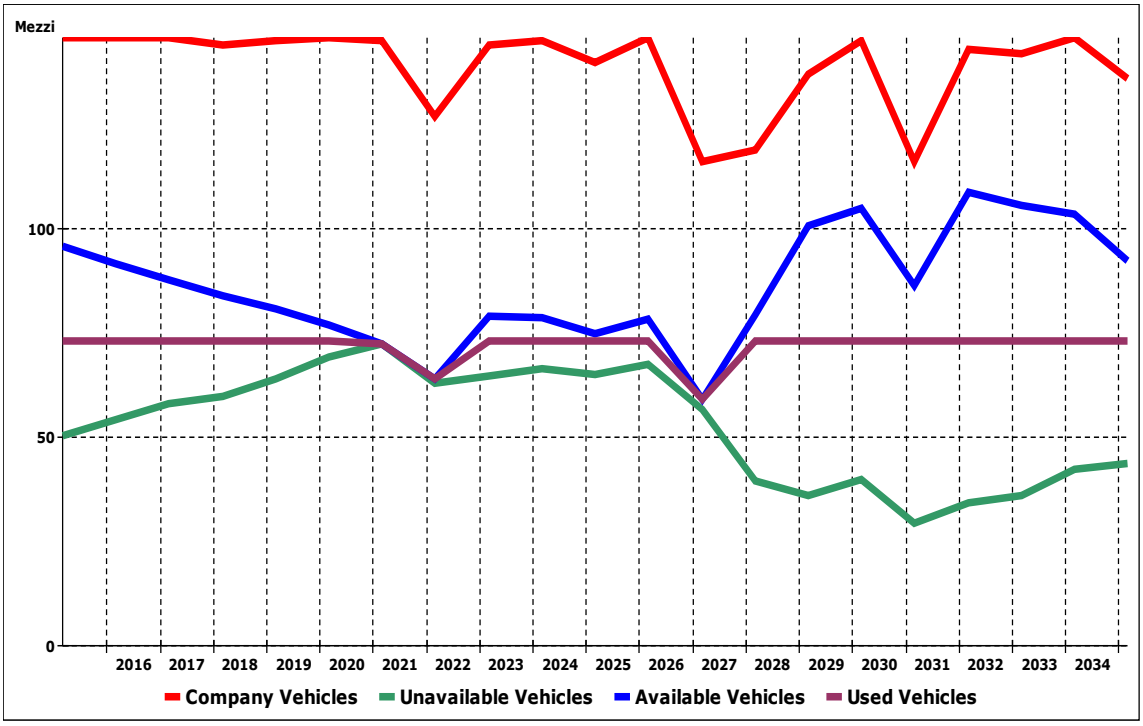

Figure 3. Scenario S1: Vehicles Purchased 100%

As noticeable from the line chart, the company adopting the previously mentioned strategy could maintain a good stable level of performance all along the time span. However, it is important to have a look to the red and green line representing the overall company vehicles and the unavailable vehicles (due to breakdowns) respectively. It is clear that the company is purchasing more vehicles than it should for maintaining the desired level of service quality without acting on others performance drivers that would improve the situation reducing the stock of broken vehicles through a better maintenance and HR management. The following line chart shows the service quality level behaviour compared to the minimum service quality threshold.

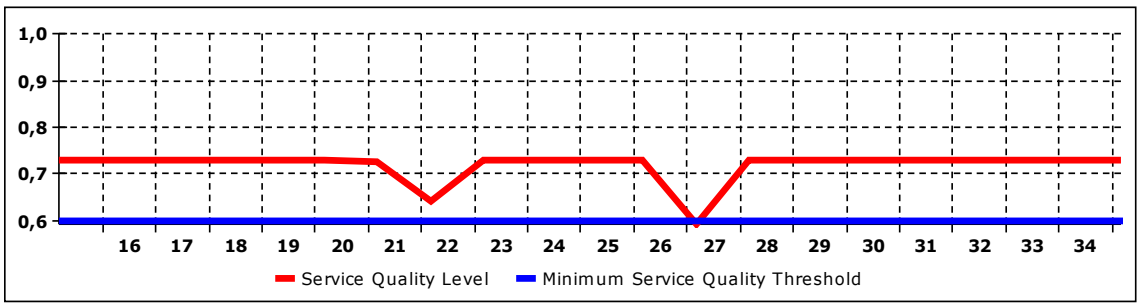

Figure 4. Scenario S1 Service Quality and Minimum Quality Service

As can be seen from Fig.4, the service quality level is quite stable and superior to the minimum threshold almost all over the time span, exception made for two negative peaks in correspondence of a lack of vehicles availability during the periods 2021-2022 and 2026-2027. These results are obtained considering the high rate of absence that is currently characterising the company.

Said that, the company strategy seems to work in terms of service quality level but not having regard to the financial efficiency as can be seen later when the attention is placed on the financial costs of such strategies. In addition, it is possible to state that a better HR management and fleet management may yield better performances to the company. However, only adopting a systemic view the situation of the company can be improved.

5.2 S2: Vehicles Purchase at 20%

The second scenario here discussed, starts from the assumption that the company may adopt a weak fleet renewal policy that limits the vehicles purchases at 20% of those previously discarded. Of course, it would be a saving-resources strategy but for sure, it would have drastic negative effect on the company performances. Following figure 4 provides the performance behaviour of the company with the adoption of such strategy. In this second scenario no HR policies are adopted.

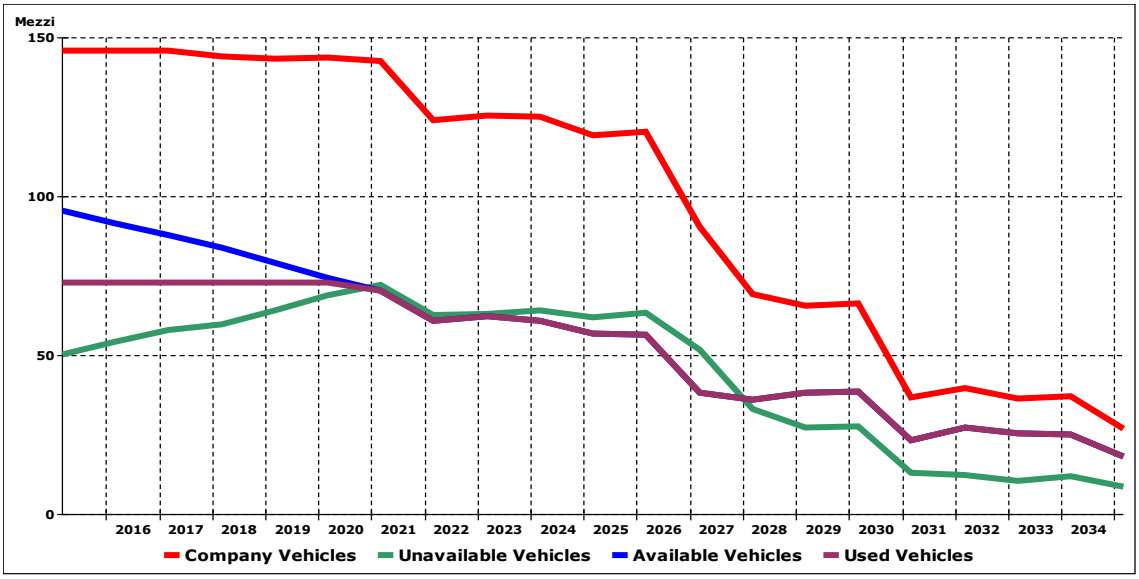

Figure 5. Scenario S2: Vehicles Purchase at 20%

It is undoubtedly clear that adopting such strategy that characterises this second scenario, the company would worsen its performance year after year for the shortage of vehicles. Indeed, if we have a look at figure 6, the level of service quality is sharply decreasing year after year reaching the zero level.

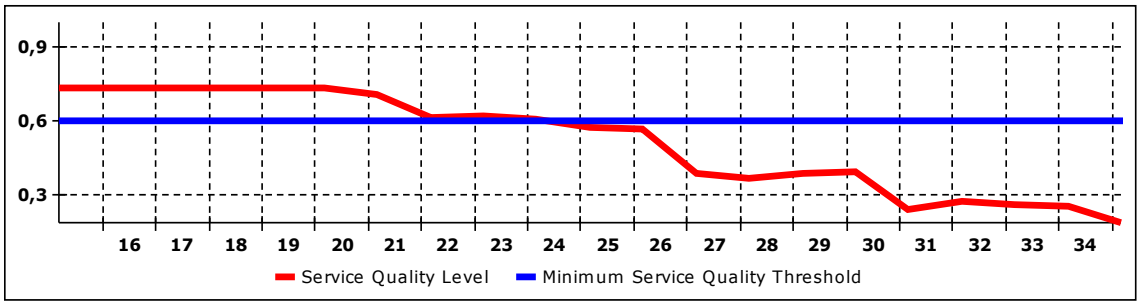

Figure 6. Scenario S2: Service Quality and Minimum Quality Service

As visible, the company service quality level decreases over time reaching the minimum service quality threshold after around five years to keep on decrease even more sharply in the long-term future. Indeed, it is clear that it is not possible to provide high quality services cutting sharply investments on fleet renewal and not adopting HR development policies at all.

5.3 Scenario S3: Reactive Purchase Policy and HR Policies

This third scenario represents the adoption of fleet renewal policies and of HR management policies acting reactively to the effects that past policies produced.

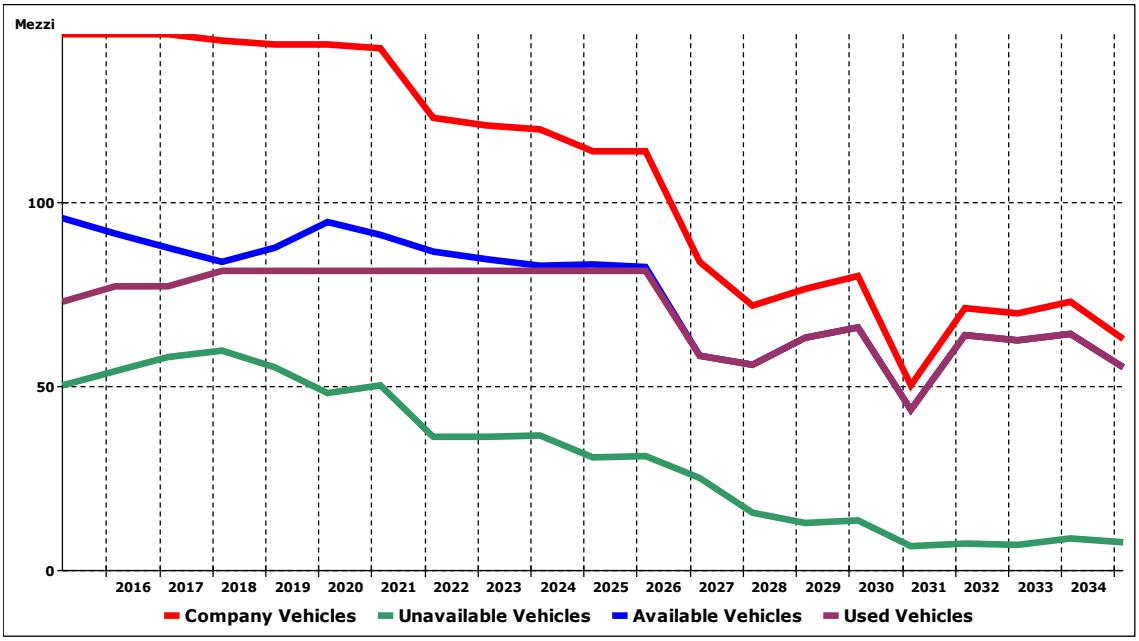

Figure 7. Scenario S3: Reactive Purchase Policy and HR Policies

As can be seen from the Fig. 7, it is assumed that the company reduces its personnel absence rate from 15% to 5% during the first three years of the simulation. Afterward, it mainly focuses on adopting HR management policies that would improve the competencies of the personnel in preventing or fixing breakdown in a way to decrease the number of unavailable vehicles in proportion to the overall vehicles that the company owns. In addition, the company does not purchase vehicles for the first eleven years. Without considering future discards, the company after having improved the

competency of the drivers and of the operators, after having reduced the ambiguity of the repair and maintenance agreements of 50% each, it decide to start purchasing 50% of the vehicles discarded every year. Maintaining that vehicles purchasing policy strategy, the company starts to decrease its performance because of an incorrect adoption of renewal policy that would not take into account proactively the dismissals of future vehicles.

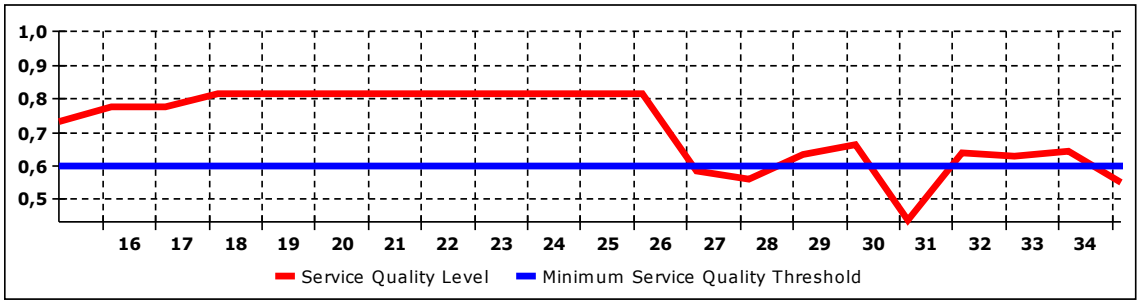

Figure 8. Scenario S3 Service Quality and Minimum Quality Service

Indeed, from figure 8, it is clear how despite the adoption of both HR and fleet management strategies are not enough for allowing to the company to maintain a good level of service quality. Then learning from this third scenario, it is following suggested to the company to apply the strategies that would produce the behaviour captured in the fourth scenario.

5.4 S4: Proactive Purchase Policy and HR Management

The scenario that is here discusses is the one that best guarantees the bests performance to the company in terms of service quality and financial efficiency. The aim of such strategy is to adopt a proactive policy adoption (forecasting future dismissals).

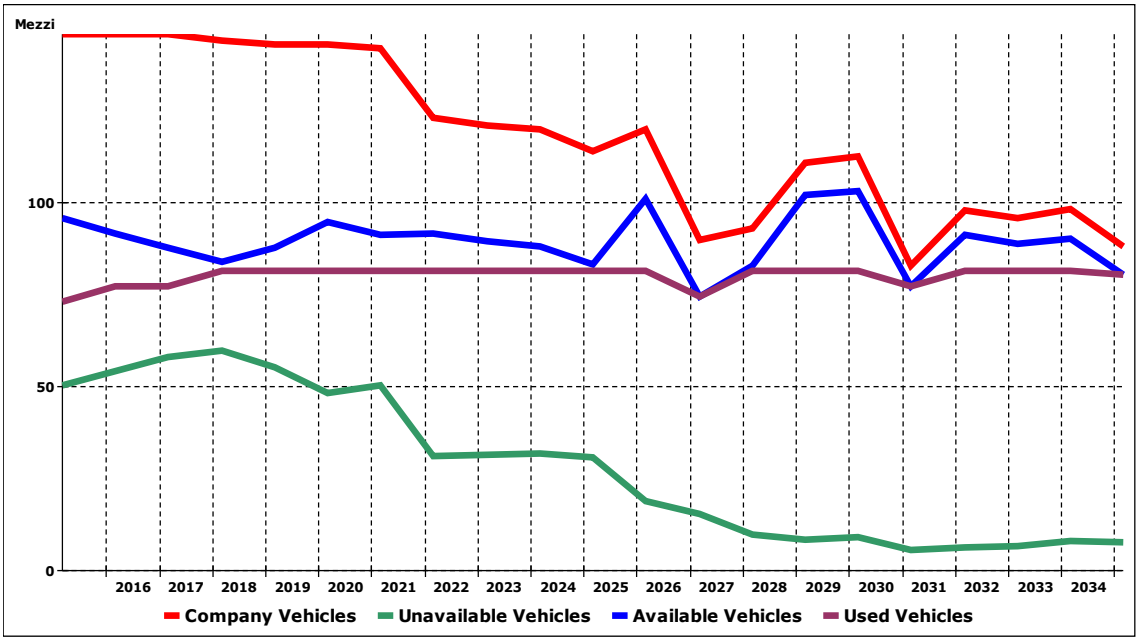

Figure 9. Scenario S4, Fleet Management Renewal Policy and HRM policies

The proactivity embodied in that scenario, makes possible to minimise the negative shocks allowing the company to maximize its efficiency and maintain it stable all over the time span of the simulation.

The strategy and policies adopted may allow the company to replicate the behaviour showed in Fig. 9. A better management of the fleet renewal, in synergy with the adoption of the HR management policies, would allow the company to save money through a proper purchase renewal policy, to reduce the number of unavailable vehicles to have a better maintenance and repairing management stemming from the improvement of the drivers and operators competencies. Moreover, the company may maintain a higher level of service efficiency using the personnel and the vehicles available.

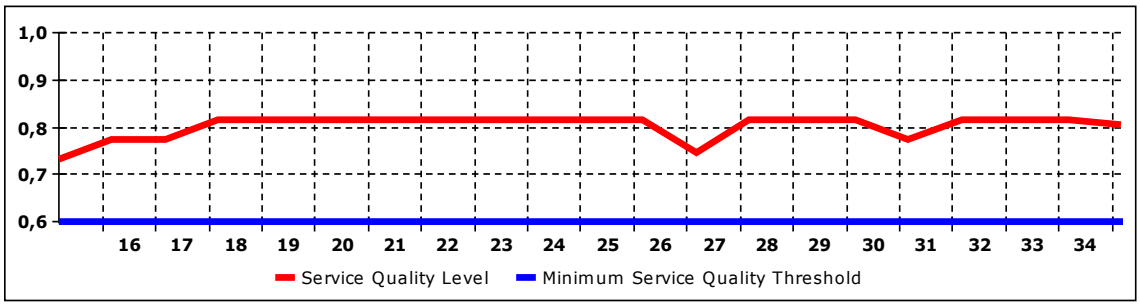

Figure 10. Scenario S4 Service Quality and Minimum Quality Service

Having a look at the Fig.10, it is noticeable that the service quality level is always higher than the minimum service quality threshold all over the time span.

6. Scenarios Benchmarking

To allow the company decision makers to adopt an effective fleet management policy, it is important to compare the previous different scenarios. More in details, we compared the following couples of Scenarios:

A. Scenario 1 vs. Scenario 4, to demonstrate that even though in the scenario 1 it is adopted a higher fleet renewal rate than in scenario 4, the performance in scenario 4 are higher than in the former one and it is achieved with less involvement of financial resources.

B. Scenario 3 vs. Scenario 4: to highlight how a proactive policy adoption is more effective than a reactive policy adoption.

Scenario 2 is not analysed since the level of the service quality achieved is not acceptable.

6.1 Comparison Scenario 1 vs. Scenario 4.

Fig. 11 shows how the service quality yield by the Scenario 4 (full line) is higher than the service quality yield by Scenario 1 where we had a full fleet renewal policy. Then as

it is clearly visible from figure 12, despite lower investments and costs bear by the company in the fourth scenario the performance recorded would be much higher.

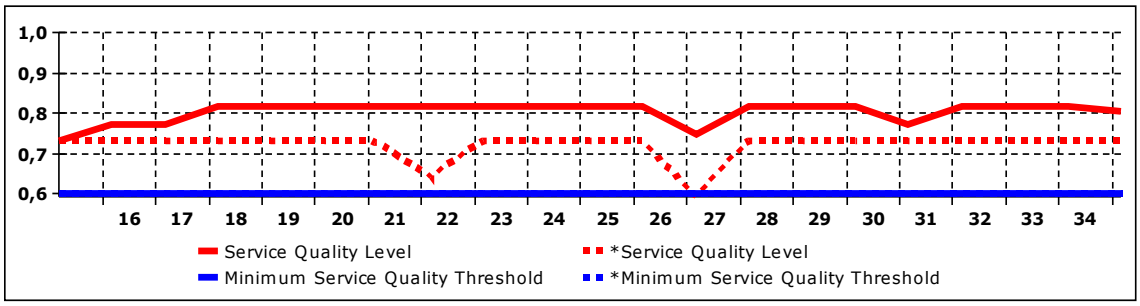

Figure 11. Service Quality Level and Service Quality Minimum Threshold Comparison Between Scenario 1 and Scenario 4

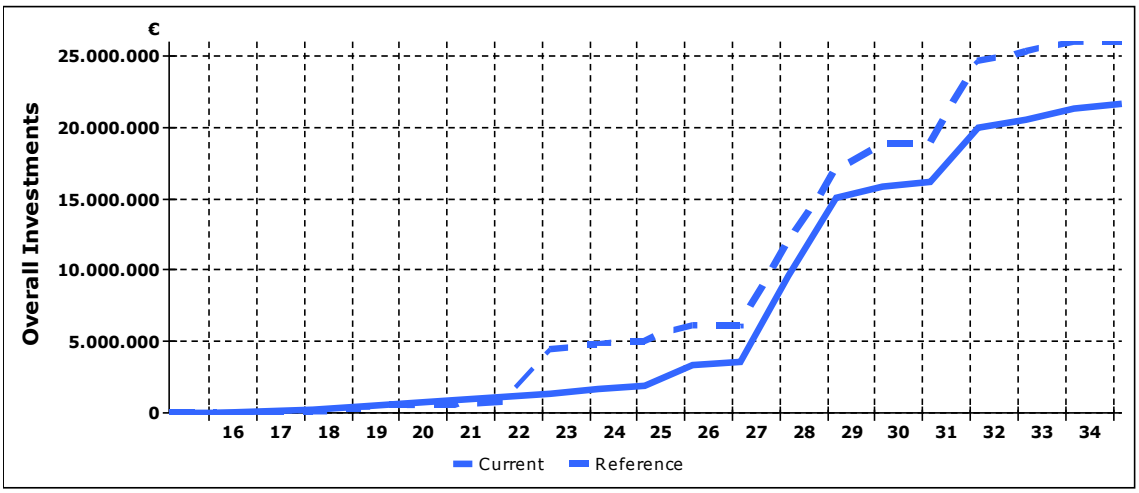

Figure 12. Comparison between Scenario 1 and Scenario 4 Overall Investments Trends

Indeed, it is clear how the company would save around five million at the end of the time span.

6.2 Comparison Scenario 3 vs. Scenario 4.

Yet, it is useful to compare the data stemming from the benchmark of Scenario 3 and Scenario 4 where in the latter (full line) it is adopted a proactive policy adoption approach differently from the former (dotted line), where instead, a reactive approach is adopted.

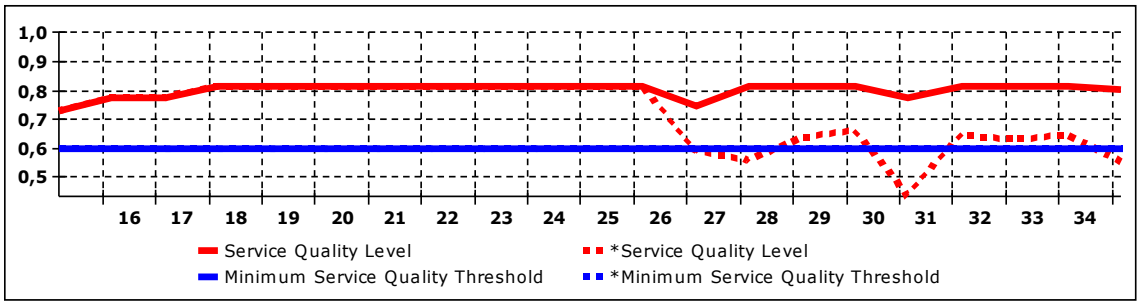

Figure 13. Service Quality Level and Service Quality Minimum Threshold Comparison Between Scenario 3 and Scenario 4

It is clear that through the adoption of a proactive approach in undertaking new strategies, better results can be achieved having regard to the service quality level and financial efficiency (Fig. 13). Indeed, the service quality recorded in the scenario four is much higher and stable than the one of the third scenario. Moreover, from the figure 14, it is possible to see that there is an improvement of the management of the financial resources.

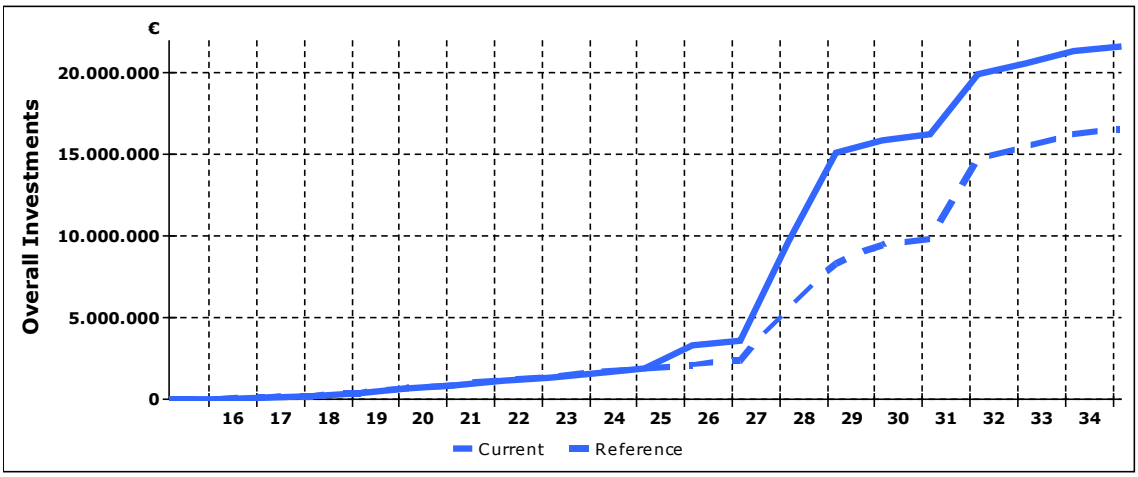

Figure 14. Comparison between Scenario 3 and Scenario 4 Overall Investments Trends

The fourth scenario imply a little bit higher investments and costs (€ 5M) bear in HR management and fleet renewal achieving better overall performances.

7. Conclusions

Organisations and their management are daily challenged by the increasing dynamic industrial complexities. The adoption of a systemic perspective cannot be left apart anymore otherwise; the company sustainability could be undermined by wrong decisions that may produce unexpected effect in long term. The case study previously provided has shown how effective can be adopting a system perspective for solving fleet management organisational issues. Indeed, the lack of a broader view, the lack of time consideration can make decision makers adopting a myopic perspective in detecting the symptoms, the illness and the care of an organisation. Indeed, the case study clarifies how the system thinking approach has been applied and highlighted how ineffective was the departmental, static and not time framed method of analysis that was

previously adopted by the company management. Moreover, the provision of a new business intelligence model for decision making process have helped managers to set the best renewal policy to adopt considering delays and system behaviours in long-term. The paper also has shown how maintenance issues belonging to the fleet management department may affect the financial department, the asset management department and yet, the production line.

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