

## **ABSTRACT**

**Title:** *Cost and execution term estimation in automated tunnelling projects.*

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A significant increase is taking place in the last years in the execution of tunnels worldwide, despite it has as a consequence a considerable improvement in the technological aspect, being built more and more complex tunnels and developing advanced and surer machinery, there is no success in the estimation of the cost and term of execution of the associate projects. Delays are common in the execution, as well as to exceed in great measure the bid budget. It is exactly this last statement that motivated this study that looks for a tool of simple and quick application, developing for that purpose a model that predicts not only the time but also the construction cost. Of the two basic excavation techniques that exist, the excavation based on conventional methods and the one that uses tunnelling boring machines, will focus this study in the second type, since it is the one that is motivating the great current growth of this structural typologies. The process followed to reach this objective, is reflected in the order in which the information is presented in this document.

Firstly it was necessary a process of documentation of the current state of the tunnelling technology, passing later to the search for information based on real cases. With the information available a database is generated, in which 99 cases are included which will serve not only as a tool in the search of relationships among parameters, but also to obtain medium advanced rates. It is concluded that these basic variables in the delimitation of the problem are: Diameter, emplacement, material type to dig, the presence or not of water, the tunnelling machine and finally it's shield. It is also studied the definition of the costs, beginning with the presentation of a tree that classifies them in 4 categories (time dependent, time independent, fixed and machinery) and in their subcategories giving a value for each type so they can be introduced in the program.

Arrived to this point we develop a model based on Monte Carlo's Simulation, thanks to it we can manage a great number of unknown variables in expressions that contain sums of products like it is in the case that occupies us, and to manage the inherent uncertainty in this field of knowledge. This model is applied by means of a program, in which there are also introduced the data of costs and advanced rates dependent on the work conditions, so that in a quick and simple way we get as a result not only the final cost and term in form of normal distributions, but also it will allow probabilistic studies of these variables and therefore be able to consider risks.

It has been proven in three different ways the final validity of the simulation. On the one hand, results of the database are compared with those resulting for the simulation. It is important to highlight that although we analyzed the relationship of the parameters with cost and advance rate, only these last ones are introduced in the program, and therefore, it is interesting to check out that the relationships related to the cost happen again using the same pattern. In second place, it is demonstrated, basing us on a paper written by the vice-president of the I.T.A., in which a typical distribution of costs is presented in a graphical form for a metro tunnel in soft ground, our exit result is adjusted to the pattern of this distribution of costs in a very precise way. Finally, the third path taken in the validation of the program is the applications of the model to three recent real cases for, once proven that the obtained results are adjusted to those of the case of study, give an additional strength to the results, once it is demonstrated that it also adjusts to the typical distribution cost mentioned before. Therefore we can affirm that a tool has been developed that completes the outlined objectives and that are no others than the formulation of a process of simple application that aids in the decision taking of the different agents of the construction sector, although this requires a deeper later study.