A virtual University campus on *Second Life* — the case of Instituto Superior Técnico

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The purpose of this work is to create a simulator that allows for the analysis and understanding of the behaviour of a Virtual University campus, independently of actual implementation constraints. In order to do so, the concept of *e-Learning* and Virtual University is first contextualized, enabling a better grasp of the different ways of utilizing the chosen platform — *Second Life* — as a teaching tool. The market attractivity and current state are also briefly evaluated.

The analysis is conducted with the aid of engineering project tools such as UML diagrams, which help to visualize the interactions between users and the encompassing system, as well as the information flows within this. Furthermore, a *Vensim* diagram was also developed, aiming at the transmission of the relevant connections present in the simulator. This was used in the final computation deployment of the simulator.

Two different working scenarios for the implementation of the Virtual University campus were conceived, both for the validation of the computational simulator as a tool, and the study of implementation constraints of this *e-Learning* initiative. The latter goal was complemented by a suitable sensitivity analysis.

Keywords: *e-Learning* , *Second Life*, *Virtual University, education, training, simulator*

I - Introduction

The way that knowledge spreads within a society has evolved over time: from a vision where the Professor carried this heavy load and was tasked with its transmition to willing students, one has arrived at a reality where everyone contributes to the creation and diffusion of knowledge. Teaching is no longer solely based on the individual, as was the case in the nineteen-fifties and sixties, and the student is now confronted with challenges that force him to use acquired skills in working groups: a shift based on the prospect that collective search for knowledge leads to the best results.

With the arisal of new techonological toals, this attempt to reconsider the role and mutual relation between teacher and student has been recast with the help of virtual environments and the use of electronic means of communication – the so-called e-learning (Ardizzone, 2003). The existing e-learning iniciatives try to implement one of several learning strategies: synchronous or assyncronous, blended or mixed.

The European community developed several programs with the objective of spreading *e-Learning* across Europe: starting with the programme *eLearning: Designing tomorrow's education*, and following with the *eContent* and *eContentPlus* initiatives and the *i2010* strategy, thus contributing greatly to the considerable growth of Internet usage and consolidation of *e-Learning* opportunities at the level of business and education.

The focus of the European Union was primarily set on the promotion of digital literacy, the twinning of higher and lower education schools and the creation of European virtual campuses. The latter is the most relevant for this work, and includes the encouragement development efforts towards new organizational models for European virtual universities (virtual campuses), the creation of European exchange and sharing schemes (virtual mobility) building on existing cooperation frameworks (Erasmus, Bologna process) to provide their operational tools (*e.g. European Credit Transfer System*, european Master programmes) with an *e-learning* component.

The purpose of this work is to put forward an initial analysis of the viability of establishing a virtual university campus of Instituto Superior Técnico (IST) in the *Second Life* platform, and to establish a computational simulator that could act as a validation and analysis tool for the understanding of scenarios facing the strategic planners and decisors.[1]

The Second-life platform

The *Second Life* platform was launched in July 2003 by Linden Lab, an American application software house based in San Francisco, California. It has experienced a considerable growth of user base since its inception, and today this universe already has millions of users worldwide.

Second Life can be interpreted as a "parallel life", it is a virtual reality that allows creation of virtual communities, where users can develop their imagination and act as both consumer and producer of content: allowing them to build, share information and interact with each other — some of the defining characteristics of the so-called *Web 2.0* environment: the second generation of community-based and Web platform services, where users are invited to participate in the creation of spaces, including *blogs*, *wikis* or complete virtual environments.

By allowing for the creation of new business models, *Second Life* has started a brand new market, with a strong dynamism and a novel set of requirements: creativity and imagination have a more proeminent importance in the search for new customers and their fidelization, as material constraints are less stringent than in the physical world (basically, dependent only on the current version of the *Second Life* platform and related hardware requirements). It is considered by many companies as a new form of entrepreneurship, allowing the user to acquire skills in management in a virtually environ.

Second Life has also been the subject of several studies regarding the implementation of educational projects, and many universities are currently using this platform as a teaching aid. Bransford and Gawel summarize the specifics of the *Second Life* platform by remarking that it is worthy of a deep exploration effort from the educational point of view, emphasizing “the sense of sharing between groups and communities, interoperability, ability to implement teaching situations viable in real life and underlying spirit of cooperation. "[2.3]

II - Description

Porter five forces competitive analysis

In this section an analysis of the market attractivity is performed, in order to better assess the viability of introducing a virtual campus of IST in the *Second Life* platform, following Porter five forces framework:

- Threat of new entrants: moderate/high. The deployment costs involved are low, but the required system know-how is key to the initiative’s success and recognition.
- Bargaining power of suppliers: very low. The initiative will be overwhelmingly developed in house by IST’s IT department, with external services required solely on very specific tasks. Also, built in tools in the *Second Life* platform serves to further reduce the need for outsourcing.
- Bargaining power of customers: moderate/high. If unsatisfied, students may opt to enroll in *e-Learning* courses from another virtual University. This manifests the loss of the physical bond with IST, as well as the added choices made available.
- Threat of substitute products: moderate. Although competing environments may be developed that allow for a better virtual university experience (either

in *Second Life* or on another platform), th established user base of the adopted platform ar large student pool available at IST should suffice t overcome any spurious trend effect that may arise.

- Competitive rivalry: moderate. Although mor demanding at an international level, loc competition is less concerning, given the insufficier presence of portuguese universities in *Second Lif* and the high notoriety enjoyed by IST nationwide.

SWOT analysis

The creation of a virtual university resorting to the *Second Life* platform sums up the advantages of an *e-Learning* application with those of a virtual environment. Following Marie Prat, I remark that it also enables for a much wider user base to share the same education package, as well as the diffusion of formative modules.

The deployment of IST's virtual university campus would capitalize on the already existing IT support, expertize and know-how of the local Computer Science Department; far from a purely self-centered effort, it would also yield several opportunities for the development of sinergies between university and companies. First and foremost, it would allow for IST to establish itself alongside those innovative universities worldwide that ground their *e-Learning* initiatives upon the *Second Life* platform.

The main advantages and disadvantages of this solution are tied to a possible reduction of the interaction between student ant teacher, which might lead to smaller commitment from the former and an increased risk of student abandonment. This said, the potential advantages far outweight these concerns, namely:

- The optional use of diverse teaching methodologies: synchronous or assynchronous, virtual classes, *etc.*
- Answers challenges arising from the professional and geographic mobility of students and teachers alike.
- Enhanced attractiveness, namely towards students from portuguese-speaking countries.
- More dynamic teaching opportunities, showcasing the inovative and entrepreneuring spirit of IST.

Notwithstanding the above list of advantages, some threats to the initiative should be acknowledged:

- Lack of domain of the required information technologies, leading to low motivation and risk of drop out.
- Mismatch between available user's hardware base and resource requirements of the *Second Life* platform may create technical constraints.
- Disregard for the need for mixed competences in pedagogy and multimedia could lead to an incomplete virtual experience.

UML diagrams

UML diagrams (namely the use case, sequence and activity types) are valuable resources to describe the way several intervenients interact with each other and the system, as well as information flows and alternatives in the temporal development of procedures. Amongst the several processes studied, two of the most relevant are shown in Figs. 1 and 2 (Dias, 2009).

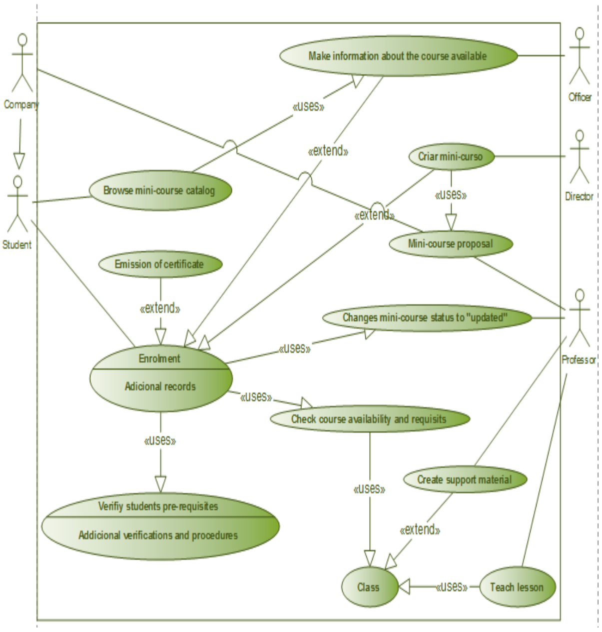

Fig. 1 – Use case diagram for enrolment procedure

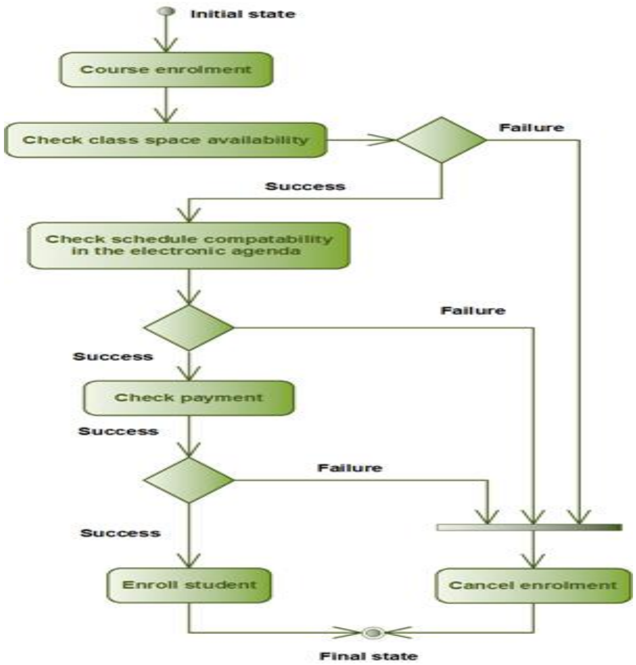

Fig. 2 – Sequence diagram for enrolment procedure

Phases of implementation

The proposed implementation assumes three separate deployment phases: firstly, the construction of virtual campus on *Second Life*: this phase includes initial test runs and acts as a launch ramp for further activities. Its main objectives are to start operations of the virtual campus and establish the initial interaction between teachers and students, as well as to publicize the initiave with prospective students and general audiences.

The second phase encompasses a more intense interaction between teachers and students, with an increase in the teaching dynamics and a more thorough use of the platform's teaching opportunities; error checking and correction will be crucial at this stage.

The third and final phase should arise after a firm grasp of the inner workings of a university campus in a virtual environment has been obtained; as such, it would aim at the deployment of projects that require an added degree of interaction between the physical and virtual spaces, *i.e.* an integrated learning experience. This phase would also include the progressive implementation of Fig. 3 – *Vensim* diagram of the simulator.

III – Simulator

Vensim model

This section deals with the creation of a coherent and adequate simulator of the working processes of an eventual virtual university campus of IST. With this purpose in mind, the *Vensim* diagram shown in Fig. 3 attempts to create a mental model that

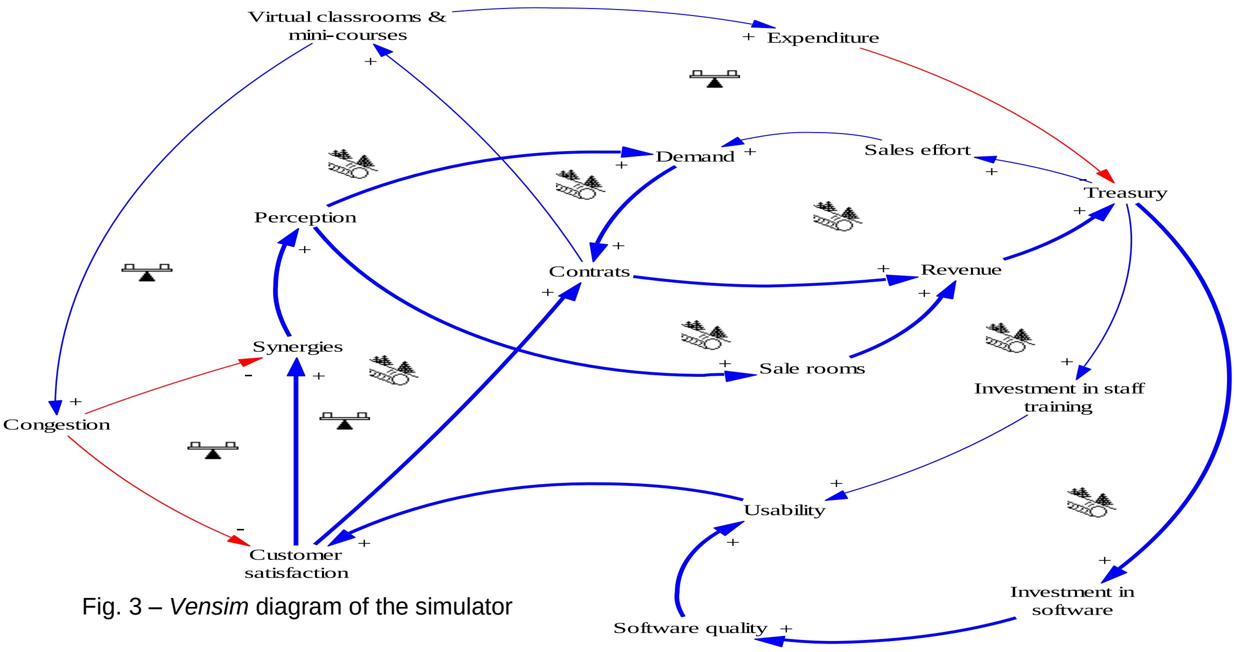

Fig. 3 – *Vensim* diagram of the simulator

synthetizes the main interconnections and cycles present in the simulator.

The model shown does not aim at a definitive ranking of variables according to relative importance, but simply their mutual interaction. However, the feasibility analysis one is ultimately searching for requires that a certain subset of indicators is chosen as representative of the state of the system at any given time: in this work, the cash level, contracts level and congestion are chosen.

Characterization

The simulator is composed of three main zones: the *treasury and contracts zone*, which includes variabes that affect the inward and outward flows of these levels; the *proportion zone*, which houses the decision variables concerning the relative distribution of investment to three separate funding categories: staff formation, software and sales efforts. These relative proportions are not assumed to be fixed parameters, but try to reflect the strategic decision making that the planner might opt to enforce (including changes of investment priority midway). This decision-making is highlighted by the promotion of these proportion variables to a suitable control panel.

Last but not least, the *demand zone* gathers variables such as congestion, perception and related logistic parameters, which have a strong impact on demand and, as a consequence, the contract level.

In order to validate the simulator and study the temporal evolution of the three main state indicators (as discussed on the previous paragraph), two distinct scenarios were established: the first assumes lower monetary values for several simulation parameters, with the second taking the opposite stance; both assume an equitative distribution of investment, as discussed in the previous section (the *proportion zone* of the simulator). Table 1 and 2 depict the parameters that differ between both scenarios (Dias 2009).

Table 1: Scenario 1

Cost_Class	11 €/mouth	Islands _init	10 Islands
Amount_contract	5 €/mouth	Percen_rooms_ sold	0.8
Base_value_naming	100 €/mouth	Prop_init_soft	0.33
Contrats_init	50 contrats	Prop_init_sales	0.33
Invest_per_mounth	100%		

Table 2: Scenario 2

Cost_Class	11 €/mouth	Islands _init	30 Islands
Amount_contract	25 €/mouth	Percen_rooms_ sold	0.8
Base_value_naming	200 €/mouth	Prop_init_soft	0.33
Contrats_init	50 contracts	Prop_init_sales	0.33
Invest_per_mounth	100%		

The reader should bear in mind that there is no claim of absolute rigour concerning the chosen values for the simulation parameters: although these were subject of preliminary research, as an attempt to model actual costs as close as possible, they are used here mainly to validate the diverse functions offered by the simulator, and to establish a qualitative grasp of the expected evolution of a future IST virtual university campus (although the actual quantitative results should lie within the same order of magnitude).

With the above caveat in mind, the comparison of the evolution of the three state indicators (treasury level, contracts level and congestion) is shown in Figs. 4-6: both scenarios display a clear trend towards an assymptotic behaviour, corresponding to an equilibrium state where income and expense are balanced. The initial transient regime quickly gives way to the mentioned equilibrium situation, with an approximately horizontal behaviour being achieved after the first semester.

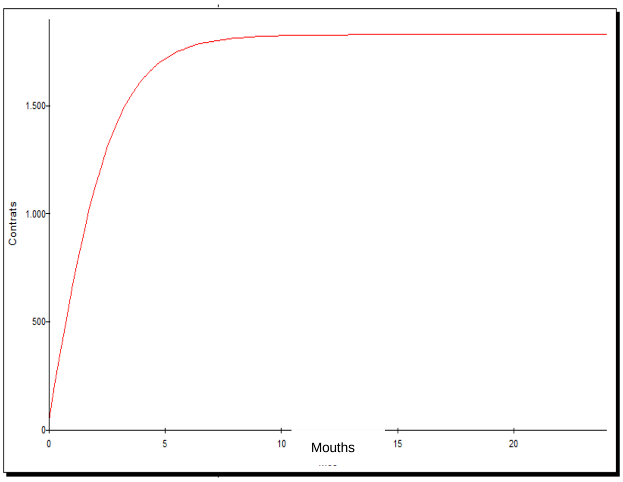

Fig. 4: Evolution of contract level
Scenario 1: average = 1831; standard deviation = 333

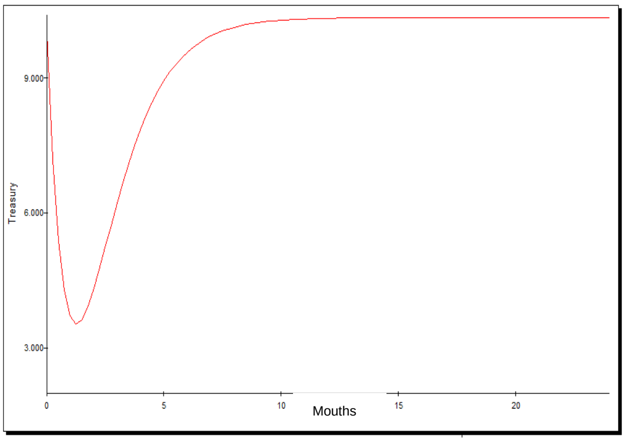

Fig. 5: Evolution of treasury level
Scenario 1: average = 10342; standard deviation = 1907

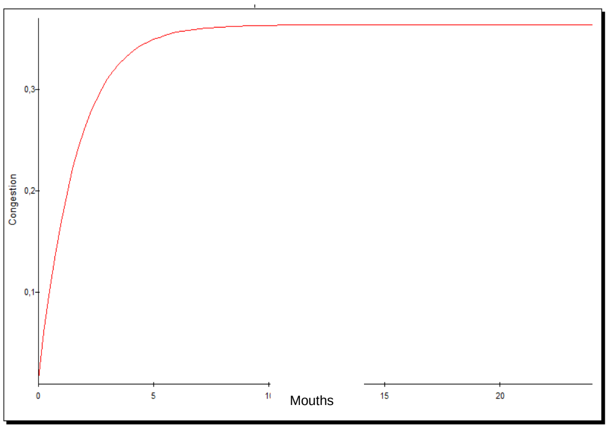

Fig. 6: Evolution of congestion
Scenario 1: average = 0,364; standard deviation = 0,056

Contrary to the contracts level and congestion (which rise steadily), the treasury level initially experiences a strong depletion, until the contracts (associated virtual classrooms and finantial support due to company naming) provide income at the require level and allow for steady growth. This reflects the usual requirement of strong initial finantial backing, and may be considered as a realistically modeled feature that validates the simulator.

Finally, one remarks that the evolution of congestion in the system is parallel to that of the contracts level. That is to be expected, as it reflects the low occupation rate of the initial virtual classrooms, with a rise towards an occupation level that is deemed acceptable, although incurring on a slight congestion penalty to users. This also serves to validate the simulator.

Sensitivity analysis

Following the simulations discussed, a sensitivity analysis was performed to ascertain if these equilibrium states were stable against a 10% relative change of several simulation parameters. Indeed, both scenarios yield stable equilibrium situations, since the three main state indicators (treasury, contracts and congestion) responded either linearly (with a 10% relative shift) or exhibited a damped response (with a relative change much lower than the 10% base level) for separate variations of each simulation parameters.

Only two parameters appear as exceptions to this rule: the *ilhas_inic* (initial islands in the campus) and *valor_contratos* (contract value paid by the student per month) parameters both provoked a slightly enhanced response of the three main state indicators, with relative changes slightly above the 10% baseline.

In order to ascertain if this could give rise to further complications, the full evolution of these indicators was plotted for larger variations of the *ilhas_inic* and *valor_contratos* parameters (±20% and ±30%), as depicted on Fig. 7. It was found that these increased modifications still yielded a linear response (even if at a slightly higher relative level), with no radical change of behaviour or end state. In particular, the transient regime still vanished within approximately half a year, with a steady rise of contracts level and congestion, and the decrease-increase bounce of the treasury level. Thus, this sensitivity analysis leads us to conclude that the system is stable, with no arbitrarily large fluctuations arising from minor disturbances.

Clearly, the above discussion helps to pave the way for future discussions: the chosen values for the simulation parameters are not accurate, and would always experience natural fluctuations (which are natural reflexes of changing economic conditions and unaccounted periodic or eventual occurences); as such, it is of the utmost importance that the obtained results are not restrained to a very specific range, and that they do not require an artificial (and probably inpractical) fine tuning of parameters, in order to shield the system from instabilities.

IV – Discussion

This study shows that the *Second Life* platform presents itself as an interesting médium to explore the possibilities of a virtual university campus of IST. The reduced implementation cost is clearly advantageous, serving to decrease the risk of the initiative and, simultaneously, the gathering of added experience and know-how.

The viability of *e-Learning*, initially addressed at a local and european level, allowed for the better understanding of the added value of the related initiatives, and the contextualization of the relations between the several agents and components involved in the implementation process.

The relations stemming from this initial survey were formalized in appropriate UML diagrams, which allow for a fast communication of the relevant interactions, temporal sequences and choices to an interested third-party. For this work, three types of UML diagrams were used: use case, sequence and activity diagrams, which exhibited the required complementarity and allowed for a full characterization of the relevant *e-Learning* processes.

Other standard management tools were deployed to analyse the project, including Porter five forces and SWOT analysis. The information embodied in these diagrams and tools was then gathered into a much more complex simulator of the whole system; its main operational components were first described graphically using a *Vensim* diagram, with the full simulator translated to a computational implementation. The adequate use of this computational model allowed for a in-depth analysis of the behaviour and interconnections between several components and phases of the virtual campus implementation project, culminating in the identification of the evolution and growth dynamics of key quantities and state identifiers.

The integrated understanding of the computational simulator also enabled the definition of two study scenarios, so that the comparative evolution arising from distinct choices could be observed. This served to gain further insight into the implementation opportunities that may be available, as well as to validade the computational simulator itself (mainly through a careful interpretation of the provided results and search for analog behaviour in other projects).

Having consolidated the computational simulator and interpreted the results arising in the two considered scenarios, a sensitivity analysis was performed; it yielded a measurement of the variability of the key state indicators as a response to small fluctuations of simulation parameters, and showed that the equilibrium states displayed in the temporal evolution of the simulator are stable, as required for any sustainable initiative.

As remarked before, only two simulation parameters gave rise to a slightly increased response from the state indicators (treasury level, contracts level and congestion): *valor_contrato* and *ilhas_inic*. The added sensitivity of the system to the latter poses no concern, since the cost of an extra initial "island" on *Second Life* is negligible when compared to the full implementation costs of the initiative — and hence any deviation from the expected behaviour due to an insufficient number of initial islands could be swiftly corrected by the purchase of an additional quantity.

The sensitivity of the system with respect to variations of the contract value (per month) *valor_contrato* is to be expected: the main source of project finanting lies (in most foreseenable implementations) in the monthly payments of enrolled students, and a fluctuation of the individual payment level should transmit itself to the whole system. However, it was found that this propagation is not supra-linear, *i.e.* the response of the three main state indicators did not rise significantly above the relative variation of this parameter (for ±10%, ±20% and ±30% relative shifts).

Although the above results could provide valuable insight for a future implementation of a virtual campus of IST on *Second Life*, it should be stressed that this work does not aim at establishing clear conclusions regarding the specific implementation path and strategic choices that will confront the deciding agents if and when such a project is embraced. Quite on the contrary, it is the declared purpose of this study to demonstrate the general feasibility of these type of *e-Learning* initiatives, and to establish a set of theoretical and computational tools — available for future research and the decision-maker.

This aim implies that the work here described should not be restricted to a particular time or implementation opportunity (*e.g.* as embodied in the two chosen simulation scenarios), but must endure as a valid tool for possibly a medium to long time span. For this reason, the conclusions stemming from the sensitivity analysis are of the utmost importance, as this has shown that the system displays an evolution towards a stable equilibrium state, with built-in flexibility concerning initial values and work scenarios. This, of course, could be further established through the exploration of additional scenarios and strategies (embodied in distinct choices of investment proportions

Recall that the two scenarios leading to the obtained equilibrium states and ensuing interpretations both rely on a equitative distribution of investment into staff formation, software and sales efforts; by the same token as the previous paragraph, this does not imply or suggest that the decision-maker should opt for such a strategy. Indeed, the focus of project investment could fall upon a particular área, or change at planned occasions or as response to unexpected incidents — depending, *e.g.*, on he treasury level and integration in the global strategy of IST as a whole.

V – Conclusion

As a final remark, I consider that the creation of IST's virtual university campus poses a great challenge and opportunity at the pedagogical, technical and leadership levels: it would concur to establish IST as an able player in a global education market, with a strong foothold on the realm of corporate and industrial collaboration.

Regarding the latter, not only does the use of a virtual university campus offers new opportunities for publicity and recruitment, but also for direct support of the initiative, via sponsorship or patronage protocols: a direct, preferential access to students "bred" in such a multidisciplinary and methodologically diverse environment would provide involved companies with a vital advantage in a world dominated by competition and new technologies.

By exploring these and other opportunities for financing, the long term sustainability of the project could be strongly established. With time, this would evolve from simply an interesting, albeit exotic, learning aid, to an integrated component of higher education — reinforcing the standards of excelence that have for very long delimited the path of IST, both in teaching as well as research; serving as an attractive force for the finest national and foreign students; and projecting IST as a reference university worldwide.

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