SIMULATION AS A SUPPORT TOOL IN SUPPLY CHAIN MANAGEMENT

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SANTIAGO DE CALI
2012

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Graduation project presented as a requirement to apply to the title of Industrial Engineer

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ACKNOWLEDGMENT

I would like to thank the cooperation and the guide of the people that helped for the successful development of this project.

Fernando Quintero Moreno: Professor of the University Icesi and thematic tutor, who advised, guided and supported me during the whole course of the investigation project. Also, was a key person for the successful development of the models bringing knowledge and accompaniment during the whole project.

Jairo Guerrero Bueno: Professor of the University Icesi and methodological tutor, who advised, guided and supported the whole development of the project.

Special acknowledgment to my family for their support and cooperation.

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1.1 TITLE OF THE PROJECT

Simulation as a support tool in supply chain management

1.2 DELIMITATION AND SCOPE

The project “Simulation as a Support Tool in Supply Chain Management” is a diagnostic project with a descriptive investigation method that covers the scope from 1998. During this period, simulation has acquired a large attention as a complementary technique in supply chain management research, due to complexities and uncertainties that rule it. The technological level involved in this field is the cornerstone to achieve a feasible application, considering a high number of agents and entities with several interrelationships among them. Meanwhile, methodologies have been developed to adapt previous types of simulation to current needs in the decision support process for designing and controlling supply chains. In fact, this project exposes different simulation approaches looking forward to understand how these apply and also to present the limitations still to overcome.

After presenting the main simulation approaches used in SCM, there will be a special focus on the discrete event simulation (DES), taking into account a case study where the complexity and benefits of simulations are proved, and integrating iterative models of optimization and simulation.

Its contribution to the sector and the university lies in wide and detailed information about the actual state of art of simulation as a support tool in the managing of the supply chain, remarking benefits and opportunities coming from its application. Also, the case study is created in order to apply the knowledge acquired through the whole investigation process. Conclusions are significant in a way to provide a deep understanding on how simulation could significantly influence the operative performance of the supply chain and to comprehend the enormous opportunities of applying it in an organization.

1.3 PROBLEM TO TREAT

1.3.1 Analysis of the problem

With the rise of global markets, new challenges appeared for all type of organizations. A competitive environment demands larger efficiency and response level to be more successful. That's a reason why concepts like lean management, and in general, added value chain, have gained more and more importance in SCM.

On the last twenty years, management processes have must been structured under faster and better decisions that respond to a dynamic market environment. In general, worldwide competence and better informed customers call for better products and faster responses from companies. That explains why organizations expend more effort everyday on finding the best way to meet customer needs and, at the same time, to minimize costs. With the simulation, virtual supply chain network emerged as a concept to symbolize the imitation of materials and information flows among several components and agents of distribution and manufacturing networks.

As modeling supply chain becomes an urgent requirement in decision support, proactive planning and control processes are specifically the main issues to be solved. "*Excellence in operational execution in manufacturing and logistics along the supply chain depends on the timely and effective translation of customer demand into material control decisions across the supply chain*"[1]. Supply chain networks are built of different products, processes and range of entities such as suppliers, distributors, customers and business policies as well as financial constraints, and all these factors set up a big challenge for successful modeling. However, as new technologies arise, more challenges are overcome and more opportunities emerge for simulation in supply chain management. This explains why is important to understand the actual state of art of the simulation in SCM and how it could play a vital role as a tool to manage more accurately the business.

[1] BANKS, Jerry. BUCKLEY Steve. JAIN Sanjay and LENDERMANN Peter. PANEL SESSION: OPPORTUNITIES FOR SIMULATION IN SUPPLY CHAIN MANAGEMENT. In: Proceedings of the 2002 Winter Simulation Conference. 2002, p. 1654.

1.3.2 Problem statement

Simulation as a support tool to manage the supply chain has become more attractive for the companies in the last years. It has helped to improve decision making process and to react better to customers demand. However there are still challenges and constraints to be overcome in order to obtain better models and more accurate simulations.

2 OBJECTIVES

2.1 GENERAL OBJECTIVE

Understand and analyze how the simulation it's been used in supply chain management.

2.2 OBJECTIVE OF THE PROJECT

Set up the actual state of the art of the simulation as a support tool for enterprises managing their supply chain networks through investigation and research.

2.3 SPECIFIC OBJECTIVES

1. Define the scope of the simulation in the structure and hierarchy of the decisions in a supply chain and the information requirements for modeling.

2. Identify major types of simulation that allow modeling of the supply chain, and specific issues to solve.

3. Elaborate a case study using a virtual supply chain to support decisions regarding a weekly production planning, taking into account, inventory levels, transportation modes and demand accomplishment. Benefits of simulation-based optimization approach to support the management of the supply chain are proved.

3 METHODOLOGY

3.1 METHODOLOGICAL STRATEGY

<table>
<tr><th>No.</th><th>Steps of the project</th><th>Critical activities</th><th>Specific methodologies</th></tr>
<tr><td>1</td><td>Filtering information</td><td>Read different sources of research and make a filter about the main information gathered.</td><td>Read and choose the more relevant and current information in order to set up a logical way to present it.</td></tr>
<tr><td>2</td><td>Input information and performance measures of the SC</td><td>Study the input data required to model and simulate a SC.</td><td>Describe the different types of input data and performance measures.</td></tr>
<tr><td>3</td><td>Understand the different types of simulation in SC</td><td>Research and understanding the main approaches of simulation in a SC.</td><td>Build up a table of the types of simulation and the way they can be applied in SCM, taking into account possible flaws.</td></tr>
<tr><td>4</td><td>Description of the use of Discrete Event Simulation in SC.</td><td>Disseminate and choose actual information about the state of art of DES in the supply chain modeling.</td><td>Describe carefully the applicability of DES in SC.</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Case study</td><td rowspan="2">Create an applied case of simulation in SCM, where complexities and iterative methodology are illustrated.</td><td>Statistics and performance measures</td></tr>
<tr><td>Use of a simulation and optimization approach to solve the case. Make use of both methodologies using software tools</td></tr>
</table>

Table 1 Methodological Strategy

Source: **The author**

4 FRAMEWORK

4.1 BACKGROUND

The need of modeling supply chains has had special interest of researchers since Japan taught the advantages of long term strategies between manufacturers and suppliers. They realized that internal control may not be enough to successfully respond to costumers. Instead, mutual coordination and support between the different entities involved were meaningful in delivering the product to the customers.

This worldwide interest has grown as long as IT developments turned theory into a possible and practical fact. However, despite of the latest advances, computational effort to solve real supply chain models is still the main barrier to beat in the way to achieve precise and reliable results for designing and controlling. So far, genetic algorithms, metaheuristics and several types of relaxations are the only feasible approaches but they do not accomplish the best performance yet when a wider range of relevant issues in SCM support needs to be included. In addition to the computational complexity (non-polynomial running times), uncertainty caused by many types of variability (demand, manufacturing performance, and transportation fulfillment) has become another matter to study, which makes more tough the goal of optimization and analytical as unique techniques.

On the other hand, stochastic nature is better involved, described and understood in a simulation model than another analytical method. When imitating a system is a reasonable thing to do, simulation covers difficult interrelationships and gives result samples that describe a better representation of happenings. At this point, IBM became the pioneer enterprise in supply chain simulation while realizing the main benefits to implement simulation in its own decision making process. IBM reengineered its global supply chain during the last 14 years to achieve quick responsiveness to its customers with minimal inventory[2]. They developed a supply chain analysis tool called Asset Management Tool or AMT. This tool integrated graphical modeling, optimization analysis, simulation and activity-based costing, and delivered quantitative methods that were useful for managers when analyzing supply chain decisions and performance. This tool was used in different IBM business units and the benefits of it included over $750 million in material costs and price-protection expenses saved in 1998[3]. As Steve Buckley said in the panel session “Opportunities for simulation in supply chain management”, such was the success of this tool that IBM turned AMT into a product of its own sales portfolio. It started to being commercialized by the name of SCA (Supply Chain Analyzer) and

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[2] BANKS, BUCKLEY, JAIN and LENDERMANN, Op. cit., p. 1652.
[3] Ibíd., p. 1653.

addressed among other issues: number and location of possible DC's, stock levels per product, lead times and demand variability.

Nevertheless, SCA as a first approach for SC simulation had its weaknesses. To make it work, to run SCA it was necessary to prepare a high number of flat files that in most of the cases where made by hand. Later, IBM started to improve it until SC simulators work together with the IT system of the company, which free the user to enter manually input data to the system. This also allows to have updated and reliable data (usually confirmed before by IT system). On the other hand, simulator is integrated into the enterprise business process, this means the simulator takes into account who does a task, where is done and different relationships and constraints between system agents. Also, new simulations have a high degree of customization with different interfaces and capable to display different type of data depending on user. Last but not least, new simulations are web-enabled and this allows reaching fast and almost unlimited access to real information.

Since recent years, more companies have recognized simulation and mathematical modeling as good allies when running their business tasks. They know that these tools bring over a good understanding of their business and provide guidelines for the decision making, concerning tactical and strategic levels and not only operational as simulation has done historically. As a result, IBM has shown a good use of simulation techniques that help to make better decisions, save money and improve customer service level. Beyond this experience, new opportunities in different fields appear for simulation everyday as a decision support tool in SCM, demanding high cooperation between SC members under expectations to accomplish big rewards.

4.2 THEORETICAL FRAMEWORK

When talking about SCM, it is necessary to understand that it differs from traditional material and manufacturing control forms. SCM focuses not only on the operational level of a single enterprise, but also the strategic level issues within a whole business network. Whereas the philosophy "Lean management" helps to find out roots and sources of wasting within a company, SCM aims at avoiding this all long the value chain[4].

Just like Oliver and Webber[5] said on their book, it is important to understand four essential aspects in SCM concepts:

- The SC should be viewed as a single entity rather than relegating fragmented responsibility for various segments in the SC.
- SCM stresses the need for strategic decision making.
- SCM provides a different perspective on inventories, which are used as the balancing mechanism of last, not first, resort.
- SCM requires a new approach to IS, based on integration instead of interfaces.

Following this ideas, key elements of SCM are identified. Under a search of efficient strategies and prioritizing resources policies, companies are requested to reduce levels of vertical integration. It means a moving to integration inside and outside the company as long as IS technology makes it possible, where SC must be understood as a single entity, with a close integration and collaboration policies and culture between members. This need of intra and inter-company collaboration is showed in the figure 1 remarking the main four flows of a typical SC: material (goods) flow, order (information) flow, information back loops flow, and of course, the financial flow.

[4] KNOLMAYER, Gerhard F. ZEIER, Alexander. MERTENS, Peter and DICKERSBACH Jörg Thomas. Supply Chain Management Based on SAP Systems. Architecture and Planning Process. Berlin: Springer, 2009, p. 1

[5] OLIVER, K. WEBBER, M. Supply-chain management: logistics catches up with strategy in: Logistics. The strategic issues. London: Chapman&Hall, 1992, p. 63-75

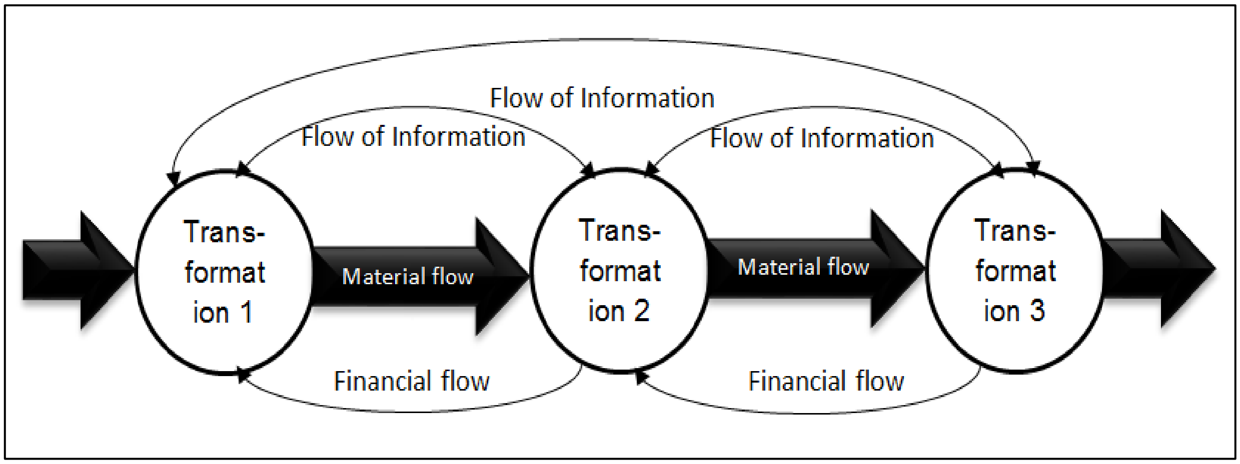

Figure 1 Material, information, and financial flows through the SC

Source: KNOLMAYER, Gerhard F. ZEIER, Alexander. MERTENS, Peter and DICKERSBACH Jörg Thomas. Supply Chain Management Based on SAP Systems. Architecture and Planning Process. Berlin: Springer, 2009, p. 3

Nowadays, a single company is frequently part of more than one SC like the figure 2 shows. At this point, one could start recognizing a first coordination problem: when an organization belongs to more than one single supply chain network, modeling problems arise.

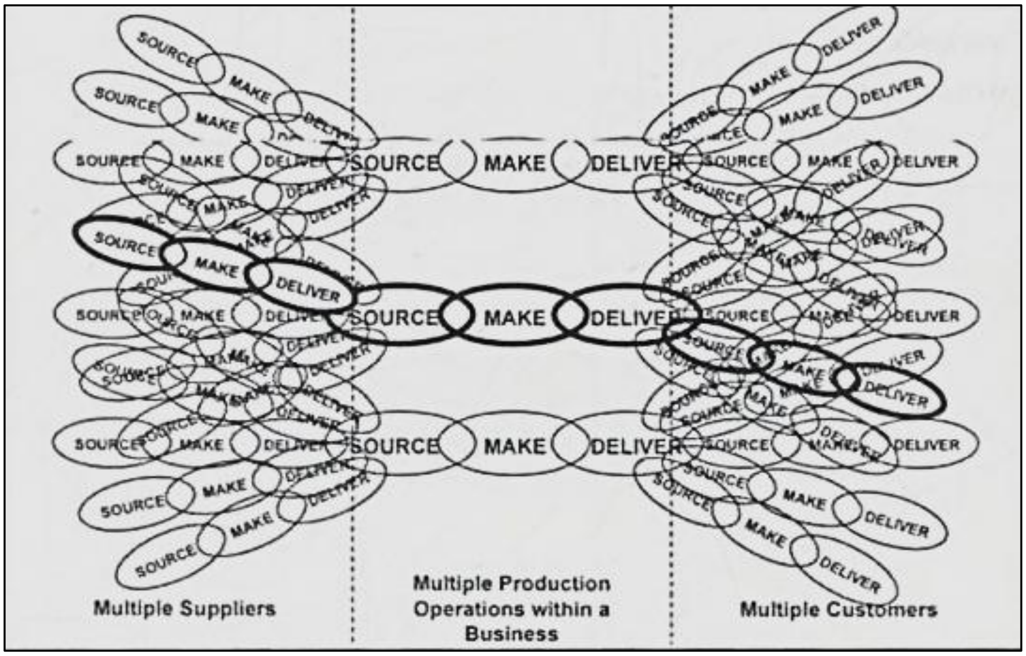

Figure 2 Supply Chain as part of a Supply Network

Source: KNOLMAYER, Gerhard F. ZEIER, Alexander. MERTENS, Peter and DICKERSBACH Jörg Thomas. Supply Chain Management Based on SAP Systems. Architecture and Planning Process. Berlin: Springer, 2009, p. 4

Here, is where modelers have to decide which entities are going to be part of the SC model. i.e.: when trying to apply a JiT (Just-in-Time) policy, only the most influent and significant members should be chosen, in order to make this intra-cooperative task. The less influence members could be omitted in the model because the performance of the SC will not be depending very close from them. This is known as mastery of complexity of supply chain. As mentioned before, supply chain models are not quite easy to model, due to the high number of entities, material and information flows and uncertainties that sometimes could not be controlled. Within this scope, there are two possible ways of mastering complexity; these are shown in figure 3.

Mastery of complexity is an important point when approaching SC simulation and modeling. One must understand that supply chain networks should be simplified wherever possible; either simplifying the reality and making a simplified IS that represents this reality or by making a complex IS with a high level of fidelity to the reality.

On this same direction one must understand that there is not one single kind of SC. Thus, two main viewpoints can be considered:

- The internal supply chain: Which focus on functional activities and processes and on material and information flows within enterprise.[6]

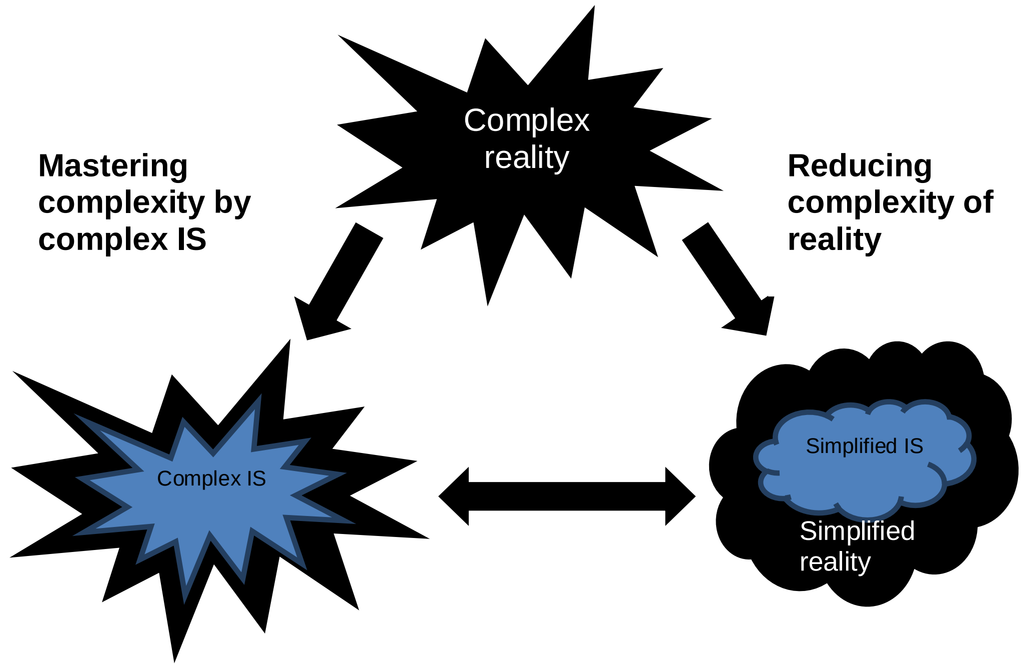

Figure 3 Possible ways of mastering complexity

Source: KNOLMAYER, Gerhard F. ZEIER, Alexander. MERTENS, Peter and DICKERSBACH Jörg Thomas. Supply Chain Management Based on SAP Systems. Architecture and Planning Process. Berlin: Springer, 2009, p. 14

- The external supply chain: includes the enterprise, the suppliers of the company and the suppliers' suppliers, the customers of company and the customers' customers.[7]

There is an important difference to be considered when modeling the SC: one single model to cover such a complex network could result in a non-feasible solution due to the large number of variables. Therefore, it is important that the modeler do not only have high skills in modeling, but also a deep understanding of the supply chain under study.

[6] THIERRY, Caroline. THOMAS André and BEL Gérard. Simulation for Supply Chain Management. Londen: ISTE, 2008, p. 2
[7] Ibíd., p. 2

4.2.1 Common inventory control in the supply chain

As seen before, a supply chain is more complex than a single supplier-manufacturer-distributor relationship. Nowadays, globalization has allowed companies to seek among a larger group of suppliers to fulfill their requirements. Deploying inventory under these possibilities has required a more dynamic inventory control, even more when a global network implies additional matters (taxation, exchange rates, etc.). To set up an optimal inventory level in a supply chain is still far from modeling scope and also to find out a common inventory control in multiple facilities is a complex issue despite collaborative policies. Indeed, a particular challenge for a common inventory control is the close relationship between stages. That is why commonly the different tiers have their own simple inventory control and use coordination between them to maintain those policies in the most efficient way.

About this dynamic control, many decades ago a special problem was identified and named analogically “the bullwhip effect”, which affects the decisions concerning inventory levels. It concerns about how small variations at the final demand are translated to an erratic demand downstream the SC, in other words, every tier responds with a larger variability than its successor regardless both are attending the same final demand rate. Due to the large number of entities that make part of a supply network there are difficulties for a common inventory control between them. Thus, members of the same supply chain should seek first of all for collaborative systems and policies that help them to minimize the “bullwhip effect”, information flow and trust are ways to start minimizing the effect. Some other strategies used to try to tame the bullwhip effect are:

- Improvement of the communication and information about the demand at the end of the chain (EDI).
- Maintenance of price stability to avoid large orders.
- Redesign of product that allows the centering of the inventory at a point for its subsequent conditioning to clients requirements (principle of form postponement)
- Consolidation of expensive items of slow movement in DC (Distribution center) where its variability is less than in the POS (Point of sale) among the chain[8].

[8] VIDAL Holguín, Carlos Julio. PLANEACIÓN, OPTMIACIÓN Y ADMINISTRACIÓN DE CADENAS DE ABASTECIMIENTO. FACULTAD DE INGENIERIA, Escuela de Ingeniería Industrial y Estadística. EDITORIAL: Programa Editorial – Universidad del Valle 2009, p. 268.

In this direction, simulation appears as a support tool in SC for common inventory control. It provides the opportunity to evaluate the behavior of certain policies in special conditions, considering the best decision to meet the requirements of the system. Nevertheless, as it is known, simulation is a descriptive technique but not a prescriptive one. In other words, it describes the behavior of a system under certain conditions but it does not find out an optimal solution right away. Instead, experimental design can be accomplished to attain efficient solutions.

4.3 INTELLECTUAL CONTRIBUTION OF THE RESEARCHER

The purpose of this project is to build the actual state of art of simulation as a support tool to manage the supply network. In the framework was shown the main considerations about the SC that a modeler should take into account when preparing a simulation. This addresses methodological ideas on how to use it in support decision making in supply chain management.

To have a better understanding on how simulation could work together with SCM, it will be developed a case study using a virtual supply chain and evaluating decisions under uncertainties that could occur in the SC. The case will be oriented to seek cost efficiency and response levels through specific performance measures showing the benefits of a collaborative approach to support the supply chain.

This case study is based on hypothetical small system of supplier, transformation facilities and customers for a set of components and products assembled in a weekly programming of production and transportation rates. It is an iterative process of simulation-based optimization making feasible and optimal decisions of procurement, manufacturing and deliveries of materials through whole network and under uncertainty conditions.

5 PROJECT DEVELOPMENT

5.1 SIMULATION SCOPE IN SUPPLY CHAIN MANAGEMENT

For the purpose of this project, it will be first analyzed the structure and hierarchy of the decisions in a supply chain in order to understand how modeling gives support to decision makers. After that, it is shown in a broad way the information requirements for modeling, as well as the performance measures used to evaluate the supply chain.

5.1.1 Structure and hierarchy of decisions in a SC

When analyzing the SC, there are involved a huge loads of information and decisions regarding several issues. At this point, it is important to make a clear distinction about the different planning levels concerning the SC. Table 2 shows a main scope of the HPP (Hierarchical production planning) approach presented by Miller[9]. Here, it is exposed three main planning and decision levels: strategic, tactical and operational. Within this approach, three levels remark the types of input information, the length and scope of decisions, organizational hierarchy in human decision makers involved and the degree of uncertainty of those decisions.

[9] MILLER, Tan C. Hierarchical Operations and Supply Chain Planning. London: Springer, 2002, p. 1 - 18

	Strategic Planning	Tactical Planning	Operational Planning
Types Of Information Inputs	Aggregated informational input in order to offer a broad perspective. Also competitors' capacity levels and forecast future total industry demand levels.	Also demands the construction of aggregate decision support inputs. Mostly internal information inputs.	Detailed and disaggregated data inputs in the decision making process.
Decision Period Term	Long term decision period (several years into the future: +2 years and more)	At least 12 months and sometimes up to 18 or 24 months. With seasonality demand patterns at least 1 season	Short planning horizon: from days to a few weeks.
Management Decision Makers	Senior Managers	Middle managers and lower level senior executives	Employees responsible of the successful daily operations
Uncertainty & Risks Levels	Higher degree of risk and uncertainty compared to the lower level decisions. (Higher time scope)	Do not carry as much risk as the Strategic Level Decisions, nevertheless they bear significant importance for the firm's success. They influence the medium term horizon of the firm.	Usually, do not have tremendous risk or uncertainty when judged individually, but maybe on the long term could affect the firm's success.

Samples Of Decisions	New plant locations and sizes Plant and warehouse location Order fulfillment approach (e.g. make-to-order, make-to-stock) Plant and warehouse capacity levels	Resource allocation and resource utilization Planning manufacturing capacity utilization rates, by plant and network wide Workforce requirements (regular and overtime levels) Transportation mode and carrier selections.	Daily and weekly production scheduling at the item level including item sequencing decisions. Short term inventory balancing Warehouse operations scheduling Vehicle scheduling

Table 2 Hierarchical planning framework with three broad categories

Source: The author

Having understood all decision categories, it is relevant to start thinking about the limitations of building a “one” single model to provide support to all decision levels. However, operational research techniques such as mathematical optimization have restrictions that affect the efficiency of the model. Up to the system dimension, such a complex model couldn’t even find a feasible solution in a considerable time running, better known as “np-hard”: Non-Deterministic polynomid-time hard, means in a few words complex mathematical models or systems which cannot be solved in a polynomial time. Up to now, it has been difficult to design one decision support model to address a whole complex hierarchical decision processes, it still seems to be out of the scope of the operations research techniques.

On the other hand, within this approach the existence of linkages among the decision levels are seen. Each level should performance in order to effectively provide restrictions and feedback to the other levels. In this way, the strategic level place constraints on the tactical level and ultimately to the operational level[10], also decisions made on the tactical level also place constraints on the operational level. But as a close-loop system, decisions made at the operational and tactical levels should provide feedback to evaluate tactical and strategic levels decision,

[10] Ibíd., page 8.

respectively. Some bottom level decision could force later decisions on the upper levels.

Another approach suggests the use of linked models which provide inputs and/or outputs to each other: TPS (Transaction processing systems), MIS (Management information systems), DSS (Decision-support systems) and executive support systems. The relationship between those different systems can be seen in the figure 4 where the IS pyramid is presented with the major systems used in the organizations in order to provide support to different decision levels. Each hierarchy has its own support system, even though these systems are aimed to work together.

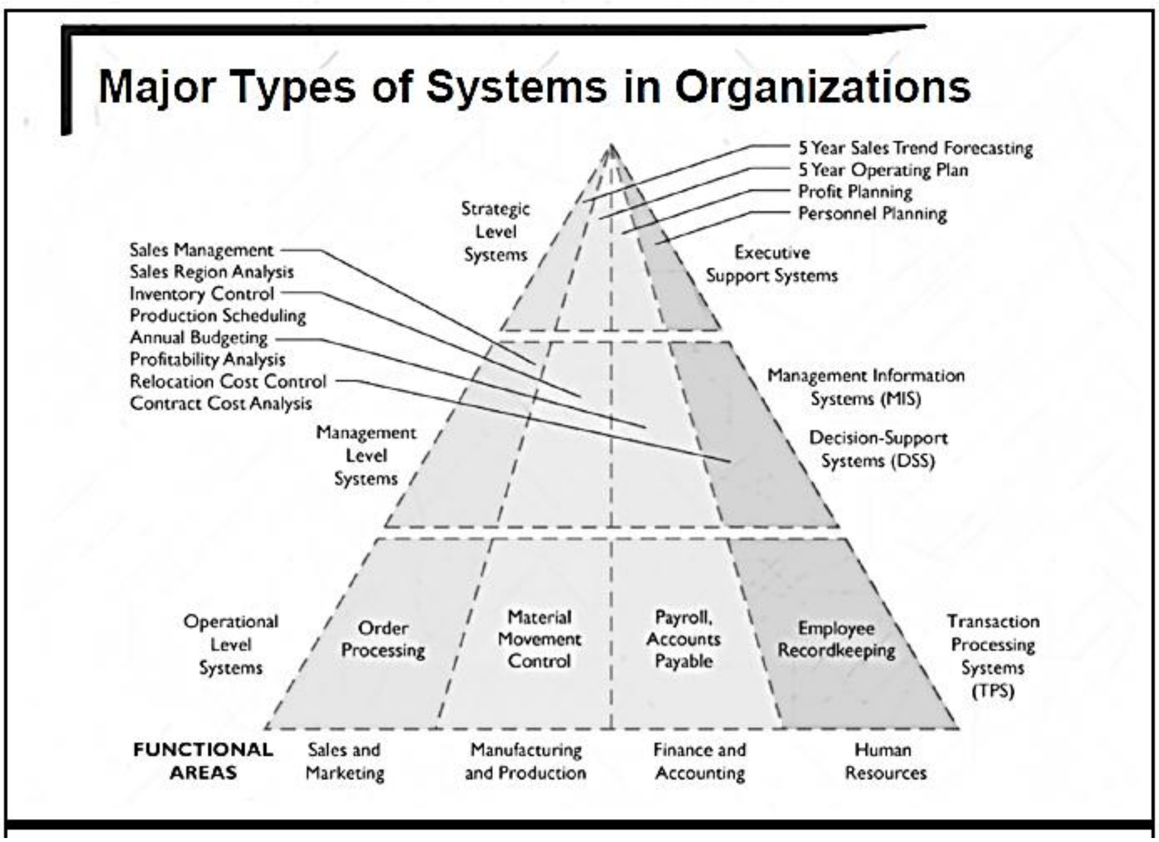

Figure 4 Major Types of Systems in Organizations and Hierarchy of Decisions

Source: THIMM, H. HOCHSCHULE PFORZHEIM. Lecture Slides, SoSe 11. 2011. Slide 6.

In this case, the challenge of working with different support systems to manage the supply chain network would be on aliening the IS landscape with the business operation landscape. If IS landscape is not designed properly and do not represent correctly the way the company does business, modeling won't provide effective support regarding decisions and strategies about how company would be willing to direction processes.

5.1.2 Information requirements and input data for modeling the SC

Before going deeper into different simulation approaches, it is reasonable to start considering the information and the data required building an effective supply chain model. It is critical to understand that without accurate input and data, a model won't be useful for decision making and won't represent a real support management tool.

About supply chain modeling, there are a large number of disciplines that works together to reach a single objective: improve the performance of the business through the seeking of the maximization of the net revenues. The most important ones are:

- Managerial accounting: In order to develop costs and cost relationships among different entities of the SC.
- Forecasting methods: Useful to generate demand projections and study patterns that could lead to an improvement regarding customer service.
- Transportation science: Helpful to understand the influence of transportation as a key factor when considering different decisions through the SC.
- Operations management: Support the management of the inventory and to describe manufacturing rules and relationships[11].

In upcoming pages, it will be discussed how these disciplines work together in order to set up the input basis for an effective and accurate SC model. As a starting point, input information for decisions concerning the operational level is

[11] SHAPIRO, Jeremy F. Modeling the Supply Chain. Stamford: Cengage Learning, 2009, p. 225-226

mainly expected to be specific and disaggregated. On the other hand, input information for tactical and strategic level is expected to be aggregated in order to have a global view of the performance of the company's supply chain. The main variables considered to be aggregated are:

- Finished Products: The best way is to aggregate by product families, this means products that contain similar manufacturing and distribution costs and activities throughout the supply chain.[12] Product aggregation is important to support an evaluation of scenarios. For example, some families could be used to analyze a possible new manufacturing facility whereas other families could be necessary to evaluate a tactical plan across the same company.

- Customers and Markets: Just as products, the complexity of a model would be too high if one tries to manage each costumer as a single entity. Furthermore, aggregation is expected to simplify the reality. In this case, customers should be aggregated into markets, taking into account similar demand characteristics in a close geographical region. Although customers with a close proximity may be candidates for aggregation, their demand characteristics may suggest treating them separately. The marginal costs of delivering full shipments for a big customer are significantly different from those for a small customer. Therefore, not all customers have the same importance in terms of sales volume or participations. Therefore, it is recommended to do an ABC classification to visualize which customers represent larger percentages of sales in the SC. Those customers with a high percentage representation should be treated as a single market. Other considerations about customer service and policies also play a role when considering aggregation at this point.

- Suppliers: Just as customers, suppliers should be also aggregated using as parameter close geographical location. Also, the form a supplier is shipping could be used as a way of aggregation, because it provides a transportation cost relationship that could be easier analyzed in an optimization problem.

As a general fact for modeling manufacturing facilities, it is primordial to include all of products such as raw material, intermediate products and finished products. These materials flow through certain processes of consumption in the facility where are transformed by using resources (e.g. labor hours and machines) to finally deliver them. This is covered into a tactical modeling requirement.

[12] Ibíd., p. 229

About estimating costs, before creating and designing a model it is really important to understand how several types of costs are carried in different stages of the SC. Table 3 shows some typical costs that are identified in the facility. After identifying the costs more important is to establish the "*cost relationships that describe how these costs are incurred as a function of independent factors called cost drivers or activities*".[13]

Product Costs	DIRECT COST: Associated with handling and manufacturing a product
Process Costs	DIRECT COST: Associated with processes (physical) used in manufacturing and distribution products.
Facility resource Costs	INDIRECT COST: Associated with resource consumption by different processes.
Facility overhead Costs	INDIRECT COST: Associated with maintaining the facility.
Flow Costs	DIRECT COST: Associated with product flows between facilities. Depends on the mode of transportation and the volume.
Transportation resource costs	INDIRECT COSTS: Associated with managing flows

Table 3 Main facility and transportation costs to be consider when modeling

Source: The author

In order to have a broader scope and establish cost relationships it is recommended to make use of management accounting. To seek causal cost relationships means that there are cost drivers influencing directly the total cost. For direct costs, cost drivers are in certain degree easy to identify because

[13] Ibíd., p. 234

activities usually depends on machines, people, equipment and raw materials. This type of cost relationship is visualized in figure 5. However, in some cases there could be more than one single driver influencing a total cost, for this issue other elements as binary variables ought to be applied. The task of developing cost relationships in a supply chain model is one of the most difficult tasks. Further techniques and methods as activity-based costing could be required when considering indirect costs.

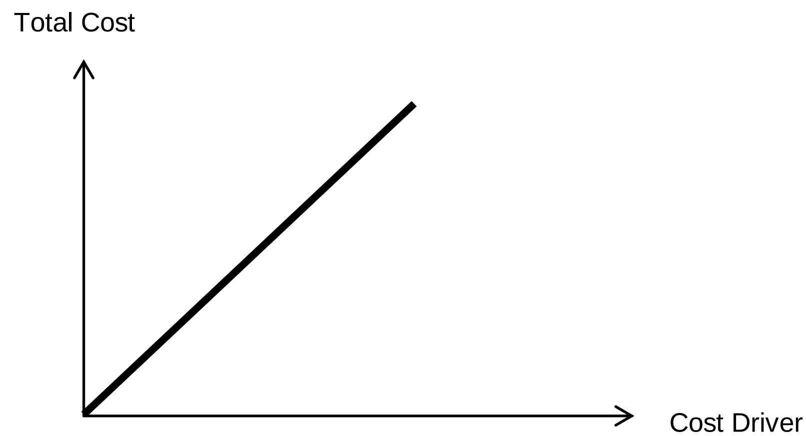

Figure 5 Simple cost relationship

Source: SHAPIRO, Jeremy F. Modeling the Supply Chain. Stamford: Cengage Learning, 2009, p. 235

Decisions regarding inventories of raw materials, intermediate and finished products have an important influence in the efficiency exploration of supply chain planning[14]. Inventory costs as out-of-stock and holding costs influence significantly the total cost of the supply chain. However, classical inventory models (different inventory policies for single products) are useful in an operational level but they do not match the main objective of supply chain cost minimization.

As a submodel of the whole supply chain is the transportation network. The structure of this submodel is simply the connection of an origin (supplier or facility)

[14] Ibíd., p. 235

to a destination (facility or market) with the way a product should flow.[15] The typical components of a transportation model are:

a. Inbound transportation network: “Linking the company’s supplier to its facilities”.[16] The tactical planning decisions are complicated and have to balance the costs of transportation against the inventory costs. These decisions are concerning: shipment capacities, shipment sizes and timing of the arrivals.
b. Interfacility Transportation Network: Describing the connection of facilities between them. This kind of transportation is useful in order to minimize total production and inventory costs. It is a key element for enterprises that produce portion of the entire products line in different plants, and then through cross-docking consolidate the whole shipments.
c. Outbound Transportation Network: Connecting facilities with customers and markets. It is important to deliver the right product at the right time in the right quantity to the right customer. At this level the main goal is to minimize the total cost and maximize the customer service.

When considering the transportation cost for a family of products, one must make a weighted average of the unit costs of the individual SKUs in the family[17]. Also regarding the tactical decisions, the most relevant are regarding the mode of transportation and the size of the shipments. This is known as modal choice and for this issue is required the use of mixed integer programming in order to find the optimal solution under normal circumstances.

A supply chain model has a variety of possible input data, the challenge for the modeler lies on deciding which decision level he wants to aim. The complexity and the data to support an operational decision won’t be the same as the information needed for tactical and strategic decisions. There is no such thing a “generic model” for every SC, that is why before designing a model one must have clear the expected reach of this one and decide the input data needed to support the expected decisions. Within this scope, the input data needed for a model supporting the internal supply chain of a company should include in the majority, information concerning flow of material and information inside the enterprise. On

[15] Ibíd., p. 237
[16] Ibíd., p. 237
[17] Ibíd., p. 241

the other hand, modeling an external supply chain of a company, demands further information regarding suppliers, customers and transportation.

5.1.3 Performance measures

Before modeling a SC it is important to have clearness of what one wants to reach with it. Also, about which decisions we want to analyze. As a matter of fact, one should understand that there is not a generic set of performance measures for all the supply chains models, the number and the depth of the measures will depend on the specific problem and decision to analyze.

To start, it is required to consider the three levels for decision making in a SC: operational, tactical and strategic. If a measure fits into a specific level it depends not on the planning horizon but on the scale of the activity we want to measure. Within each of the three levels it is found different possible performance measures, but in a general way those could be further categorized as: external measures and internal measures. External measures focus on the effectiveness of flows and links across the supply chain. A measure could be classified as external because the accuracy of this activity will impact the next stage of the supply chain. For example, an external measure could be the order and line item fill rates on customer orders. The calculations for these measures will tell whether the supplier delivers the total order and the individual line items on time and completed as ordered. On the other hand, internal measures evaluate the cost of efficiency of an organization in producing its outputs and services.[18]

In figure 6 shows an example of some typical measures for each level. Employing a hierarchical performance measurement framework offers a number of important benefits. It helps a firm to organize its existing and future key performance measurements into a structure that leads to a relatively few, high level, strategic measures. It also allows large and small functional areas to: develop and maintain their own measures and to contribute and be part of the overall measurement system. In few words, it permits to keep measures simple and meaningful. Each level function and sub-function can focus on a few key performance measures.19 Last but not least this approach allows having feedback loops in order to see if an

[18] MILLER, op. cit., p.214.
[19] MILLER, op. cit., p.219.

overall objective is achievable, that means, that lower level goals should be align with overall organizational goals and performance

MEASURES Level:	Type:	
		Distribution
Strategic	External	*Percent of customer shipments delivered on-time
		*Order cycle lead tiem: from release to distribution to customer delivery -time in days -variability
	Internal	*Total distribution cost per unit delivered
		Warehouse Operation
Tactical	External	*Percent of lines/orders picked correctly
		*Percent of orders picked on scheduled day
	Internal	*Total warehouse costs per unit of throughput
		Receiving
Operational	External	*Percent of cases/lines received correclty
	Internal	*Total receiving costs per unit

Figure 6 Some SC measures for the different decision levels of a SC

Source: MILLER, Tan C. Hierarchical Operations and Supply Chain Planning. London: Springer, 2002, p.217

5.1.3.1 Logistics and SC performance

In this subsection it will be provide a set of common performance measures employed to monitor and evaluate the supply chain of an enterprise. The table 4 show a list of logistic performance measures grouped into major categories.

Asset Management	**Productivity**
Inventory levels	Warehouse labor productivity
Return on net assets	Units shipped per employee
Return on investment	Productivity index
Cost	Units per labor dollars
Comparison of actual versus budget	Order entry productivity
Cost as a percent of sales	Equipment downtime
Total cost (logistics)	Orders per sales representative
Direct labor	Transportation labor productivity
Cost per unit	**Customer Service**
Cost of damage	On-time delivery
Warehouse order processing	Stockouts
Inventory carrying cost	Shipping erros
Cost of returned goods	Fill rate
Direct product profitability	Delivery consistency
Cost of backorder	Backorders
Logistics quality	Complete orders
Picking/shipping accuracy	Customer complaints
Damage frequency	Response time to inquiries

Table 4 Common logistics performance measures

Source: MILLER, Tan C. Hierarchical Operations and Supply Chain Planning. London: Springer, 2002, p.217

These measures are not the only ones that could be used to evaluate a SC, of course the number of measures and the depth of them will depend on the decision we want to support with the simulation.

5.2 SIMULATION APPROACHES TO MODEL A SUPPLY CHAIN

From here on it will be covered main simulation approaches to model a supply chain network. Those methods will be explained in a broad way in order to understand when they could be applied for a certain decision problem and their opportunities in SCM.

"Simulation can be defined as the process of designing a model of a real system and conducting experiments with this model in order to understand the behavior of the system and evaluating various strategies for its operation".[20] In supply chain management, simulation appears as a way to evaluate supply chain performance and to achieve goals. Within this scope, and as seen before there are several decisions that could be supported by simulation, nevertheless it is important to understand if the problem to analyze is part of the internal or of the external supply chain of a business. "*For internal supply chain is understood activities, processes, material and information flows within the enterprise. On the other hand external supply chain includes the enterprise, the suppliers of the company and the suppliers' suppliers, the customers of the company and the customers' customers. In this case supply chain management mainly focuses on integration of operation and cooperation between the enterprise and the other actors of the supply chain.* [21]

There are three main ways of analyzing a supply chain: analytical methods, such as queuing theory. Monte-Carlo methods, such as simulation or emulation. Physical experimentations, such as lab platforms or industrial pilot implementations.[22] The analytical methods could be seen as impractical because as explained before the reality of a supply chain network is too complex to be solved with a single mathematical model. Concerning physical experimentations, not all the enterprises are willing to do this mainly because of the technical and cost limitations. In this direction, simulation appears as a strong resource to model and analyze the performance of a supply chain.

Building a simulation model is not an easy task, there are many considerations and difficulties to be overcome. The two main issues to be considered for simulation on SC are:

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[20] SHANNON, Robert. Introduction to the art and science of simulation. Texas: Texas A&M University, 1998. p. 1

[21] THIERRY, Caroline. THOMAS André, BEL Gérard. Simulation for supply chain management. Toulouse: Wiley, 2008, p. 2

[22] Ibíd., p. 6

1. Size of the system: A supply chain is a network buildup of a large number of entities, because of that, there could be a large number of decision variables which could make a very complex system.

2. Complexity of the production management system: A model is a virtual representation of a reality, within this scope, one must take into account how the real system behaves. In the real world a system could have a large number of flows: material and information. Because of that it could be a challenge to model all the specific and possible flows in the network, therefore that reduction of the complexity is required but without changing the main structure of the system.

It is important to understand that SC simulation models can be built in a centralized way or in a distributed way. In an internal SC, the same ERP software could be used, but in an external one, often different information and decision systems ERP must be connected, leading to interoperability problems and/or synchronization problems. "*In opposite of distributed simulation, in a centralized approach, one single simulation model reproduces all the supply chain structures (entities and links).*"[23]

Nowadays, organizations have recognized that working by their selves it is not enough when trying to improve the whole performance of a SC. As a result of that, cooperation between the different members of the network is critical. To reach the expected performance multiagents system (MAS) can be used. "*MAS are composed of a group of agents that can take specific roles within the organizational structure. Different agents may represent different objects belonging to the studied network.*"[24] MAS simulation requires a distributed approach where there is not a centralized control rather a certain degree of autonomy from the different members but at the same time they are working together to reach a global objective. As said before trying to run a single model for an entire SC could lead to data problems or to unrealistic results. Therefore, there is a strong need for using distributed simulation in supply chain management. Nevertheless there is the question about if there are several simulators running separately how they could work together. For this purpose, HLA (High Level Architecture) appears as a feasible solution. HLA is a software that provides a general framework to combin different simulators that have been working separately, and join them together to reach a common simulation objective. These concepts would be explained in a broader way in the upcoming chapters.

[23] Ibíd., p. 24
[24] Ibíd., p. 25

To make it clear, a simulation model is made of a set of *objects* and relations between them. Those objects have *attributes* that describe them. These *attributes* could be fixed or be changing during the time. The two main modeling approaches according how state variations are considered are: continuous approach and discrete event approach.[25] In the following subsections these methods are described.

5.2.1 Continuous simulation approach in supply chain management

In a continuous approach one should understand that the states of the entities that build the model vary continuously, that is why there is a strong requirement of a closed loop between the output of the model and the input. The purpose of this feedback is to analyze the behavior and performance of the system through causality relationships between the entities. In other words, this refers to the concept of *system dynamics* where a system is analyzed in order to find relationships between the different entities. For this purpose, mental models are used as a tool to represent all those possible interactions. As just said, the construction of relationships within a system depends on the knowledge and fidelity that the modeler has of it, that is why in order to avoid possible subjective mental models, an extensive analysis between different members with high knowledge of the system is recommended with the purpose of having a more realistic casual diagram that allows the modeling of the system. In supply chain management, system dynamic methods have been applied to analyze the behavior according to demand fluctuations, also to model the integration of the supply chain and to possible approaches for a global control of the SCM. On the other hand system dynamic have been related with the control of inventory levels. Figure 7, illustrates an example of a system dynamics model where it is analyzed the evolution of a level in accordance with the variation of the input and output rates[26]. Variations in the output rate change the stock level variable which sends a feedback to another variable that increases or decreases the input rate in order to cover the gap of the actual stock.

[25] Ibíd., p. 12
[26] Ibíd., p. 40

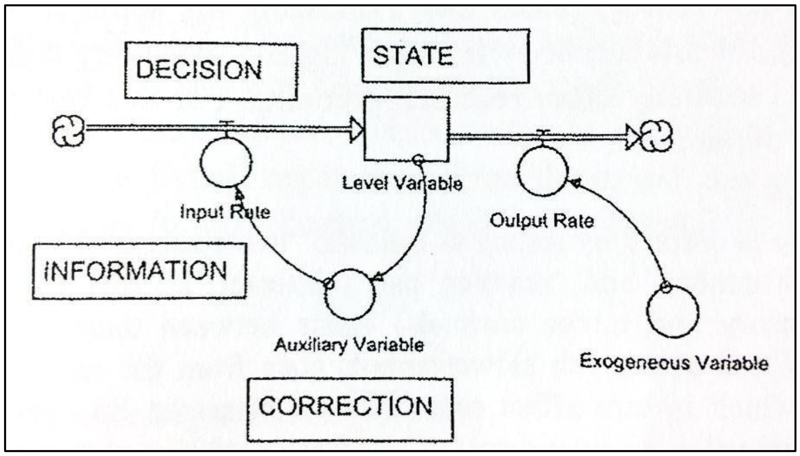

Figure 7 An example of a stock-and-flow model

Source: THIERRY, Caroline. THOMAS André, BEL Gérard. Simulation for supply chain management. Toulouse: Wiley, 2008.

Recent applications of system dynamic in SCM are oriented to understand the bullwhip effect, a problem that is produced by the inherent uncertainty of the demand that generates perturbation of the demand downstream the chain. In order to analyze the BE (bullwhip effect) one should first distinguish which are the possible perturbations that could lead to a disequilibrium of the chain. After that, identify the BE causes and establish the causational relationships. Fill up the model with the rates of material flow (related with the distributions that are observed) between the different echelons. Possible reductions of the BE within a SC are: better information sharing, reduction in the lead-time, EDI, reduction in sporadic rebates.

For a last approach table 5 summarizes the continuous simulation applied for supply chain management.

Continuous Simulation Approach	1. *System Dynamics:* Flow system orientation. The models are design on the basics of rates. Levels as stock are integrated to the time variation using the rates. This type of model uses a closed loop effect, were the manager or simulator is evaluating and comparing the performance with the expected values in order to take possible decisions. In few words objects are seen as continuous flows. The behavior of these flows is represented by a differential which is integrated using a time sampling. 2. *Production Management Models:* Objects are not changing, they have attributes that change only at specific periodic dates. It is a well-adapted method to simulate a SC.

Table 5 Continous approach in the SCM.

Source: THIERRY, Caroline. THOMAS André, BEL Gérard. Simulation for supply chain management. Toulouse: Wiley, 2008.

5.2.2 Discrete event simulation in supply chain management

"As a result of a survey made of relevant application papers from 2006 Winter Simulation Conference, it was found that the main use of discrete-event simulation has been in the manufacturing logistics: design, planning and control of material flows in manufacturing companies."[27] In figure 8 it is shown the main decision areas supported by DES models that were found when analyzing 52 papers in the survey made on the 2006 Winter Simulation Conference.

[27] SEMINI, Marco. FAUSKE Hakon. STRANDHAGEN Jan Ola. APPLICATIONS OF DESCRETE-EVENT SIMULATION TO SUPPORT MANUFACTURING LOGISTICS DECISION-MAKING: A SURVEY. In: Proceedings of the 2006 Winter Simulation Conference. 2006, p. 1946

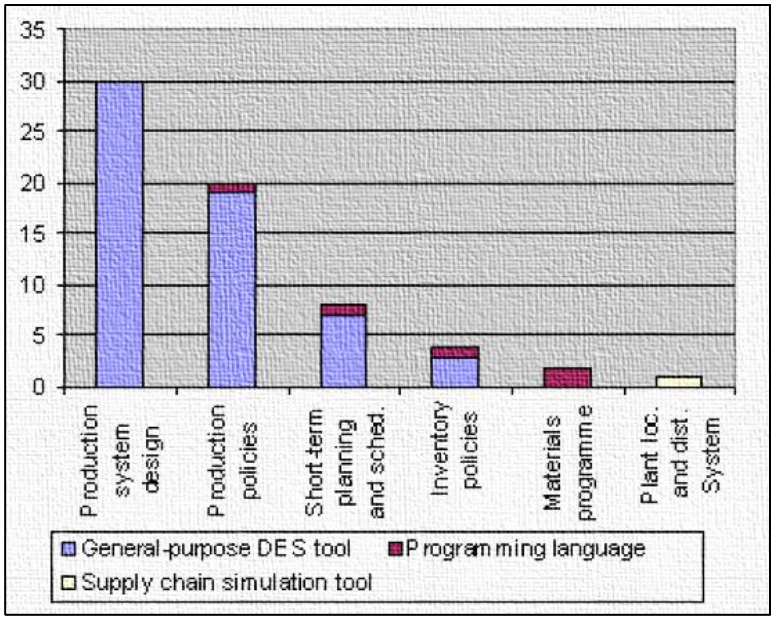

Figure 8 Decision areas supported and software types used in applications

Source: SEMINI, Marco. FAUSKE Hakon. STRANDHAGEN Jan Ola. APPLICATIONS OF DESCRETE-EVENT SIMULATION TO SUPPORT MANUFACTURING LOGISTICS DECISION-MAKING: A SURVEY. In: Proceedings of the 2006 Winter Simulation Conference. 2006.

Even though the survey was made with 52 papers in figure 9 one recognizes that the total of DES models sum up to more of the papers, this is because some DES models could be supporting decisions concerning different areas. Table 6 shows a main approach to the different types of DES.

Discrete Event Approach	1. *Time bucket driven:* • Time is divided in periods of same length • Events occur at each beginning of the period (change of state). States are calculated with model equations at these points. • Main States are the states of resources: quantities of items processed by a

	certain activity on a certain period. • Simulation determines all the states of all the resources at each period of time. 2. *Event Driven:* • Main States are the states of items (or set of them) • The state variation is linked with an specific date when the event occurs. • Each state is characterized by the resource utilized by a given item at a given time.

Table 6 Discrete event approach in the SCM.

Source: THIERRY, Caroline. THOMAS André, BEL Gérard. Simulation for supply chain management. Toulouse: Wiley, 2008.

Both event-driven and time bucket-driven simulation for supply chain look forward to analyze the evolution along the time of a system. When the model is created, it expresses the transformation of objects in order to make activities. The principles of these techniques are:

- There are objects whose attributes change in a specific moment of the simulation. Those could be:
    - Static: Do not change along the time.
    - Variable: They are changing during the simulation.
- The happening of an event characterizes the start of an activity, which at the same time involves the way the state of the objects changes when it happens.

The simulation algorithm in a broad way is:

1. Initialize the system with objects. Those objects have an initial attribute value, also define a list of events to be consider.
2. Select the next event in the list.

3. Update the system state (generate new object, change obejets' attributes) considering the consequences of the selected event.

4. Post into the list, the events generated by the selected event. Go to 2 until the simulation final date is achieved.[28]

As said before, simulation can support manufacturing logistics because it gives a wide understanding of how the real system is working, furthermore it provides the opportunity for decision makers to work with "what-if" scenarios without changing the real system. It is important to remark that the application of DES is kind of limited to discrete manufacturing enterprises. This means, it would be ineffective to use this technic to model and simulate continuous production systems like petroleum industry.

Complexity places a big challenge for supply chain modeling that is why an important skill of the modeler is to make the right assumption to reduce the complexity without making the model unreal. In this direction table 7 shows the concepts of systemic and enterprise modeling as possible approaches for model reduction.

Systemic Approach	Enterprise Modeling
• Physical, informational and decisional sub-system are distinguished from the environment. • Main focus on one of the sub-system and the others interact as macro-activities. • Characterizing the environment is a problem for the modeler: how demand is generated and the predictability of it during simulation. • Assumed that tactical and strategic decisions do not change during the simulation.	• *Functional Point of View:* Select the functions of the system to be modeled and the level of detailed when describing the entities that take part of it. • *Organizational Point of View:* Organizational decomposition of the system. It takes into account which point of view does each organizational unit (department) has about the state of the system.

Table 7 Systemic and Enterprise Modling

Source: THIERRY, Caroline. THOMAS André, BEL Gérard. Simulation for supply chain management. Toulouse: Wiley, 2008.

[28] THIERRY, THOMAS, BEL, op. cit., p.71.

As a matter of fact DES modeling has been traditionally used in a production system that is why there are some challenges that still have to be overcome to use it in the analysis of supply chains. For example, existing DES software need adjustment in order to meet the necessities of a whole supply chain system analysis. "*Also moving from a single manufacturing plant to a multi echelon supply chain adds a number of new requirements, including the alignment of network strategies and interest, mutual trust and openness among actors, high intensity of information sharing, collaborative planning decisions and shared IT tools.*"[29]

5.2.2.1 Software tools in DES

In this subsection it will be named the types of software tools that are mainly recognized in DES for supporting manufacturing enterprises and decisions most of them in the internal supply chain. In figure 8 it was shown that the most common decisions were about: production design, production policies and schedules. In table 8 one sees the main software that were found in the survey of the 2006 Winter Simulation Conference. As a result, Arena and Automod/Autosched were the most common tools applied in DES problems.

Name	Number
Arena	13
Automod/Autosched	11
Quest	6
ProModel	5
Sigma	4
Extend	3
DSOL	1
SLAM II	1
Supply Chain Builder	1

Table 8 Software used in DES

Source: SEMINI, Marco. FAUSKE Hakon. STRANDHAGEN Jan Ola. APPLICATIONS OF DESCRETE-EVENT SIMULATION TO SUPPORT MANUFACTURING LOGISTICS DECISION-MAKING: A SURVEY. In: Proceedings of the 2006 Winter Simulation Conference. 2006.

[29] Ibíd., p. 1949

5.2.3 Agent-based simulation

Global competition places new challenges for companies that have to be more efficient and effective in order to respond to customer demands. That is why, the concept of virtual enterprise network is taking a bigger role to overcome these challenges.

"*Multi-agent supply chain simulation makes it possible to represent and evaluate the behavior of the entities composing the chain, as well as the existing interactions*"[30]. Agent-based modeling allows the modeler to capture the dynamic nature of the supply chain, organizations have objectives and constraints. However, they are independent and impact in a certain way for the global system performance.

MAS (Multi-agent system) nature makes it a very suitable for supply chain management. In Table 9 it is shown the similarities between supply chain management and MAS.

Supply Chain Management	**Multi-agent System**
It consist of multiple parties working on multi-stage tasks	It consist of different types of agents with different roles and functions
There is no single authority: knowledge is distributed among members in the supply chain. Decision making through multiparty negotiation and coordination.	Agents are autonomous: They are responsive to monitor changing environment, proactive to take self-initiated action, and social and interact with humans and other agents.
The structure of the SC is flexible; it can be organized differently to implement different strategies.	The agent system is flexible: agents can be organized according to different control and connection structures.
SC is dynamic: entities may join or leave a supply chain.	Agents can be created or discarded from a multi-agent system.

Table 9 SCM & MAS

Source: THIERRY, Caroline. THOMAS André, BEL Gérard. Simulation for supply chain management. Toulouse: Wiley, 2008.

[30] THIERRY, THOMAS, BEL, op. cit., p.71.

Decision making process, control and data are commonly spread among the different agents of the supply chain that is why MAS propose a method of autonomous agents with different capabilities and resources interacting with the environment and with each other. MAS reduces the centralization of the decisions among the supply chain giving the possibility to the different agents to react in the better way they can to support the global performance of the system.

5.2.4 Simulation games

Simulation or business games are useful when trying to understand the human behavior in a specific environment, for the purpose of the project: how managers make decisions in a supply chain.

In a broad way, there are strategic and operational games:

- Stretegic games: Are the ones that include teams of players, which interact with each order in certain simulated environment. Players in a certain number of rounds, taking into account the constraints placed by the model. It is useful to understand, how managers make decisions and the effects of those decisions in the performance of the supply chain.

- Operational games: Rather than several teams, here exists one single team (one or multiple players) that interacts with the simulation model. These are games that face decisions regarding interruptions in the supply chain and look forward to give a scope on how the player react in certain situations.

Business games are a powerful tool to analyze the dynamic of the supply chain. Sometimes, it is very challenging to simplify the reality of the system in a single model. In this direction, business games give an interesting approach for decision making, when not only considering processes but also the human behavior.

5.2.5 HLA and distributed simulation approach for supply chain

Before, it has been said that a unique simulation model is a big challenge to reduce a whole supply chain. A unique model could drive to a very simplified environment that could lead to an unrealistic reality. On the other hand, a monolithic model requires full data sharing (even when there are certain data that the companies handle in a confidential way), therefore a distributed simulation (DS) in SCM is required: large number of data located in different echelons of the chain. *"Distributed simulation refers to technologies enabling a simulation program to be executed on multiple and geographically distributed computing systems, interconnected by a communication network, such as a computer network"*[31]. In this direction, appears the question about the interaction of several simulators running separately and how could make them work together. For this purpose, HLA (High Level Architecture) appears as a feasible solution. HLA is a software that provides a general framework to combined different simulators that have been working separately and join them together to reach a common simulation objective.

There are some technologies that enable and facilitate the data interchange between companies in order to make distributed simulation feasible; table 10 shows some of them.

Technology	**Comment**
EDI (Electronic Data Interchange)	Characterized by the speed and reliability which include the safety of transmitted information. It also has a drawback linked to its difficulty of implementation.
XML (eXtensible Markup Lenguage)	Is a description language that associated with EDI enables full engagement of companies in in electronic processes.
Contract-Net	Is an interaction protocol, it enables the identification of each partner, and the forwarding of structured data. It checks that no transmission error exists.

Table 10 Model Interaction Protocols

Source: THIERRY, Caroline. THOMAS André, BEL Gérard. Simulation for supply chain management. Toulouse: Wiley, 2008.

In HLA the participants of the DS are called a federate, and interact sharing information. A HLA federate is a distributed simulation system using federate information that is nothing more than simulation interchange. HLA is entirely standardized, the way the communications between models are carried out is ruled by the standard IEEE P1516.2.2000. In a broader way the principles rules defining the operation of the federate and the federations are in the standard IEEE

[31] THIERRY, THOMAS, BEL, op. cit., p.261

P1516.2.2000[32]. HLA standards allow the reusability and the interoperability of simulation without requiring re-coding. Reusability refers that the models of the simulation could be used several time in different applications without the need of re-coding. On the other hand, interoperability refers to the capacity of interconnect and combine distributed platforms. In few words, HLA enables the work of DS in supply chain which give the opportunity to manage multiple simulation models in a standard way that interact with each other looking forward to collaborate in the best way to improve the decisions among the different echelons.

5.3 LIMITS AND OBJECTIVES OF SIMULATION IN SCM

Simulation is a powerful tool to support decisions in the organization; it gives a deep understanding of the possible consequences of taking a certain path. Nevertheless, there are some limitations one must take into account when using this tool. Table 11 shows the scope and the limitations of simulation applied in SCM.

CAN DO	**CANNOT DO**
Regarding design: justify and quantify necessary investments, to define the global characteristics of the system, to choose between different projects or to identify bottlenecks.	Cannot optimize the performance of a system it only reproduces the behavior of the modeled system. Thus, it could answer questions of the type: “What happens if…?”
Regarding improvement: identify existing problems, evaluate various drafts (scenarios), to choose between several improvement solutions, to study the influence of the disturbances or to determine the capacities of the resources.	They cannot give correct results if the data are inaccurate. This means they do not check the validity of the input data, if it is not correct we won’t have a model that correctly represents the reality.
Regarding exploitation: anticipate deadlines or to help make control decisions.	The simulation tools always make it possible to obtain a result, but do not bring anything for its validity compared to the real system which we simulate

Table 11 Limits and objectives of simulations tools

Source: THIERRY, Caroline. THOMAS André, BEL Gérard. Simulation for supply chain management. Toulouse: Wiley, 2008.

[32] THIERRY, THOMAS, BEL, op. cit., p.263

6. CASE STUDY

Until this point, the main approaches has been analyzed and also presented considerations, limitations and objectives of the simulation in SCM. As follows, the case study is described in its dynamic and interrelationships between entities. The goal is to experience the synergy of simulation and optimization techniques, from transferring data from each to other, and analyzing how optimal solutions are tested under uncertainty environment about delivery times for transportation and end times of manufacturing for daily production orders. Despite of capacities constraints added in optimization model, discrete event simulation model brings feasible fulfillments when downtimes and stochastic time processes are involved in a shared conversion line.

Having remarked that simulation does not guarantee an optimal solution, there is a framework with optimization and discrete-event simulation combined, running one after other in an iterative way. Figure 9 shows how this framework works, once the mathematical model has been created and run, the optimal values of decision variables are read as input data by simulator and under decision rules (control system), the supply chain model runs, coming out with duration times of activities and processes, which become parameters for one more optimization problem running. After the parameters have been defined, they will be the input for the optimization model. Clearly, the optimization model and variables will also depend on the decision to support. After solving the optimization model the results will be transformed into decision rules that will be used in the discrete-event model. Finally, it starts again with further simulation experiments and repeats the same process. To successfully connect the simulation model with the optimization model, it is required a database, where information from both models is stored and retrieved.

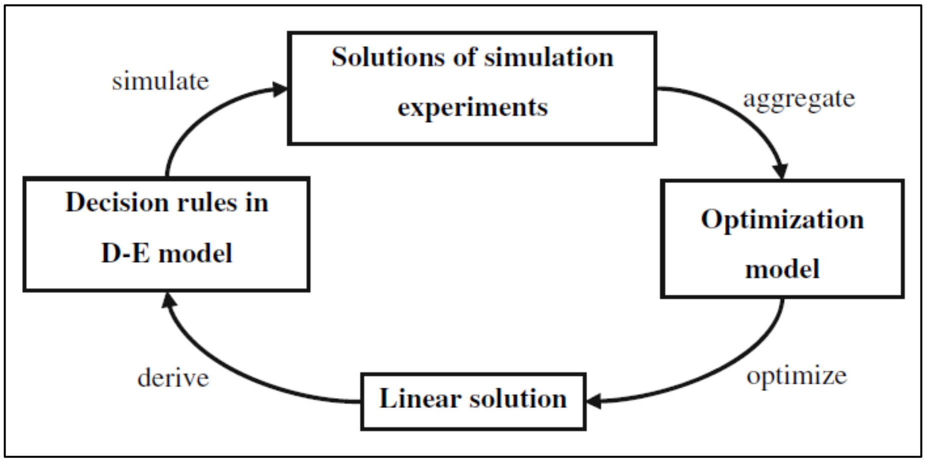

Figure 9 Interaction between simulation and optimization

Source: ALMEDER, Christian. PREUSSER Margaretha. HARTL, Richard F. Simulation and optimization of supply chains: alternative or complementary approaches? Vienna: Springer, 2009.

In few words, it has been decided to use a discrete event simulation approach combined with (mixed-integer) linear programming to analyze and solve the case. Even though the input data do not pertain to a real system, it does provide a realistic environment of a virtual supply chain and decisions that could commonly face organizations in the real world.

6.1 Considerations

The model has 4 modules: supplier, production, customer and transportation. Each module has its own constraints and at the same time places other restrictions to the other modules. The goal of the approach is to provide an optimal operation for the supply chain, taking into account cost efficiency and service levels.

As said before, it starts with the simulation model, running it several times and getting the input values that will be sued in the optimization model. More detailed:

Results of the optimization model (parameters for the simulation): production quantities, flow of materials between entities (supplier-facilities, facilities-customers).

Results of the simulation model (parameters for the optimization model): production times, transportation times between entities (supplier-facilities, facilities-customers).

The case is based on the paper “Simulation and optimization of supply chains: alternative or complementary approaches?” by Christian Almeder, Margaretha Preusser and Richard F. Hartl. The model consist of one supplier, two facilities, three customers, two products, two raw materials, two transportation modes and it will be evaluated in a horizon of five days (weekly planning). The objective is to minimize the costs of the whole supply chain, looking forward to satisfy the demand with the capacity the different entities have.

6.2 Case and model

The SC for the case consists of a single supplier that supplies two different facilities with two different types of raw material. The facilities have a main capacity that it is spread between the two final products (not perishable products). Also, the production times have a stochastic behavior and are determined by the simulator. The objective function of the complementary approach is to try to optimize a weekly production plan (5 days) based on the minimum cost for the whole supply chain satisfying the orders placed by the customers. In this supply chain there are three different clients that are connected with the facilities via two possible transportation modes (the same for the case of the supplier and the facilities). The two transportation modes are accessible for both levels of the supply chain, but they have different costs, lead times (determined by the stochastic behavior modeled in the simulator) and limited capacity. Other options as outsourcing of production are not considered, due to the fact that our time horizon is a weekly planning where decisions are usually made based on the actual performance and capabilities of the supply chain.

The optimization model decides on the variables on the amounts of each product to be produced and the flow of materials (raw material, finished products) between entities. The simulation model provides the lead times for the different transportation modes and the production times for each facility. Figure 10 summarizes the supply chain model. Inventory handling costs are calculated based on the unit cost of the product (raw materials and finished products) multiplied by the annual storage rate as a percentage of the unit prices. For the input and output inventory of raw material the annual storage rates are of 25% and 20%. For the output inventory of finished products the annual storage rate is 30%.

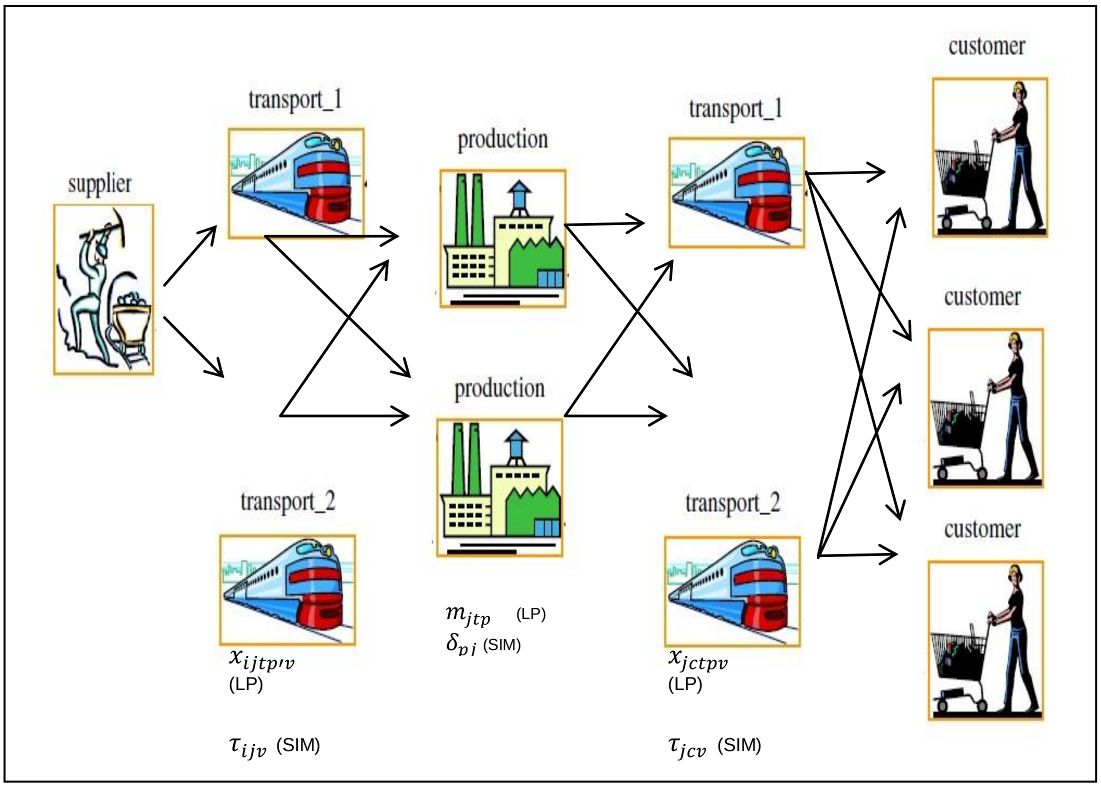

Figure 10 Supply chain used for the model

Source: The author

For the optimization-simulation methodology two different tools have been chosen. First of all, one must consider the limitations of the software available (in terms of variables, restrictions and entities) and after that choose the proper tool. For the development of the case, it has been used as optimization tool the Microsoft Excel complement: OpenSolver. This complement is an open tool and allows working with a large number of variables and constraints. As Microsoft Excel has been chosen to optimize, this vary same tool will work as data base to allow the interface between the optimization tool and the simulator. In several Spreadsheets will be storage the results of each interaction in order to analyze them. Both, the optimization and the simulation model could be viewed in the appendix 1.

6.2.1 Optimization model

Notation used:

$i \in \{1\}$	Suppliers
$t \in \{1,2,3,4,5\}$	Time periods
$j \in \{1,2\}$	Facilities (production and storage)
$c \in \{1,2,3\}$	Customers
$p \in \{1,2\}$	Products
$p' \in \{1,2\}$	Raw material
$v \in \{1,2\}$	Transportation mode

Decision variables:

m_{jtp}	Amount of product p that starts to be produced at facility j in period t
$x_{ijtp'v}$	Flow of raw material p' from supplier i to facility j with transportation mode v in time period t
x_{jctpv}	Flow of product p from facility j to customer c with transportation mode v in time period t

Parameters:

a_{jp}	Factor indicating the amount of capacity (units required) to produce one unit of product p at facility j
$\propto_{jpp'}$	Amount of raw material p' required to produce one unit of product p at facility j
b_{pct}^{in}	Amount of backorders of product p at customer c at period t
C_{ijtv}	Maximum transportation capacity of transportation mode v on the way from supplier i to facility j at period t
C_{jctv}	Maximum transportation capacity of transportation mode v on the way from facility j to customer c at period t
C_{jt}^{prod}	Maximum production capacity at facility j in period t
$c_{ijp'v}$	Cost for deliveries of raw material p' between supplier i and facility j with transportation mode v
c_{jcpv}	Cost for deliveries of product p between facility j and customer c with transportation mode v
D_{pct}	Demand for product p at customer c in period t
δ_{pj}	Amount of periods required to produce product p at facility j
$f_{jp't}^{in}$	Amount of raw material p' arriving at facility j in time period t
f_{cpt}^{in}	Amount of product p arriving at customer c in time period t
$f_{ip't}^{out}$	Amount of raw material p' sent away from supplier i in time period t
f_{jpt}^{out}	Amount of product p sent away at facility j in time period t

g_{pv}	Factor indicating the amount of capacity units required to transport one unit of product p with transportation mode v
$g_{p'v}$	Factor indicating the amount of capacity units required to transport one unit of raw material p' with transportation mode v
$h_{ip't}^{out}$	Outbound inventory cost of raw material p' at supplier i in time period t
h_{jpt}^{out}	Outbound inventory cost of product p at facility j in time period t
$h_{jp't}^{in}$	Inbound inventory cost of raw material p' at facility j in time period t
L_{jt}^{inraw}	Maximum capacity of inbound inventory of raw material at facility j in time period t
$L_{jt}^{outprod}$	Maximum capacity of outbound inventory of product at facility j in time period t
$l_{jp't}^{inraw}$	Inbound inventory of raw material p' at facility j in time period t
$l_{ip't}^{outraw}$	Outbound inventory of raw material p' at supplier i in time period t
l_{cpt}^{inprod}	Inbound inventory of product p at customer c in time period t
$l_{jpt}^{outprod}$	Outbound inventory of product p at facility j in time period t
$q_{p'j}$	Factor indicating the amount of capacity units required to hold one unit of raw material p' at the inventory in facility j
q_{pj}	Factor indicating the amount of capacity units required to hold one unit of product p at the inventory in facility j

$r_{jp't}$	Amount of raw material p' which is already transported at period 0 an will arrive at facility j in period t (external increase of inventory)
r_{cpt}	Amount of product p which is already transported at period 0 an will arrive at customer c in period t (external increase of inventory)
ρ_{cp}	Penalty cost at customer c for product p
$S_{ip't}$	Supply of raw material p' at supplier i in period t
s_{jpt}	Amount of product p which is already in production process in period 0 and will be finished in period t (external increase of inventory)
τ_{ijv}	Amount of periods that transportation mode v requires to go from supplier i to facility j
τ_{jcv}	Amount of periods that transportation mode v requires to go from facility j to customer c
w_{jp}	Production cost of product p at facility j

Objective function:

$$MIN: \sum_{t=1}\sum_{v=1}\sum_{p'=1}\sum_{j=1}\sum_{i=1} c_{ijp'v} * x_{ijtp'v} + \sum_{t=1}\sum_{v=1}\sum_{p=1}\sum_{j=1}\sum_{c=1} c_{jcpv} * x_{jctpv} + \sum_{t=1}\sum_{j=1}\sum_{p=1} w_{jp} * m_{jtp} + \sum_{t=1}\sum_{p'=1}\sum_{j=1} h_{jp't}^{in} * l_{jp't}^{inraw} + \sum_{t=1}\sum_{p=1}\sum_{j=1} h_{jpt}^{out} * l_{jpt}^{outprod} + \sum_{t=1}\sum_{p'=1}\sum_{i=1} h_{ip't}^{out} * l_{ip't}^{outraw} + \sum_{t=1}\sum_{p=1}\sum_{c=1} \rho_{cp} * b_{pct}^{in}$$

Constraints:

$$l_{ip't}^{outraw} = l_{ip'(t-1)}^{outraw} - f_{ip't}^{out} + S_{ip't} \quad \forall\, i, p', t \quad (1)$$

(1) Inventory balance equation for the suppliers and the raw material

$$l_{ip't}^{outraw} \geq 0 \quad \forall\, i, p', t \quad (2)$$

(2) Guarantees that the inventory level cannot be negative

$\sum_{p=1} \frac{m_{jtp}}{C_{jt}^{prod}} \leq 1 \quad \forall j,t$ (3)

(3) Restrict the total production capacity in each facility

$l_{jp't}^{inraw} = l_{jp'(t-1)}^{inraw} + f_{jp't}^{in} - \sum_{p'=1} \propto_{jpp'} * m_{jtp} + r_{jp't} \quad \forall j,p,p',t$ (4)

(4) Inventory balance equation for the input inventory of raw material at each facility

$l_{jpt}^{outprod} = l_{jp(t-1)}^{outprod} - f_{jpt}^{out} + \chi_{t>\delta_{pj}} * m_{jp(t-\delta_{pj})} + s_{jpt} \quad \forall j,p,t$ (5)

(5) Inventory balance equation for the output inventory of products at each facility. The function $\chi_{t>\delta_{pj}}$ is used to avoid the use of production amounts for negative periods.

$\sum_{p'=1} q_{p'j} * l_{jp't}^{inraw} \leq L_{jt}^{inraw} \quad \forall j,t$ (6)

(6) Restrict the total inventory capacity of raw material in each facility

$\sum_{p=1} q_{pj} * l_{jpt}^{outprod} \leq L_{jt}^{outprod} \quad \forall j,t$ (7)

(7) Restrict the total inventory capacity of product in each facility

$m_{jtp} \geq 0 \;, \quad l_{jp't}^{inraw} \geq 0 \;, \quad l_{jpt}^{outprod} \geq 0 \qquad \forall j,t,p,p'$ (8)

(8) Guarantees that the inventory levels cannot be negative as well as the amounts produced

$l_{cpt}^{inprod} = b_{pct}^{in} - b_{pc(t-1)}^{in} + f_{cpt}^{in} - D_{pct} + r_{cpt} \quad \forall c,t,p$ (9)

(9) Inventory balance equations taking into account the demand of the customer. Considering all customers are served JiT.

$l_{cpt}^{inprod} = 0 \quad \forall c,t,p$ (10)

(10) Ensure that no oversupply (positive stock level) is possible. Not possible to send more products than demanded.

$\sum_{p'=1} g_{p'v} * x_{ijtp'v} \leq C_{ijtv} \quad \forall i,j,v,t$ (11)

(11) Limit the overall transportation capacity between supplier and facilities

$\sum_{p=1} g_{pv} * x_{jctpv} \leq C_{jctv} \quad \forall j,c,v,t$ (12)

(12) Limit the overall transportation capacity between facilities and customers

$f^{in}_{jp't} = \chi_{t>\tau_{ijv}} * \sum_{i=1}\sum_{v=1} x_{ijp'v(t-\tau_{ijv})} \quad \forall j,p',t$ (13)

(13) Inflow of raw material to each facility

$f^{in}_{cpt} = \chi_{t>\tau_{jcv}} * \sum_{j=1}\sum_{v=1} x_{jcpv(t-\tau_{jcv})} \quad \forall c,p,t$ (14)

(14) Inflow of product to each customer

$f^{out}_{ip't} = \sum_{j=1}\sum_{v=1} x_{ijtp'v} \quad \forall i,p',t$ (15)

(15) Outflow of raw material

$f^{out}_{jpt} = \sum_{c=1}\sum_{v=1} x_{jctpv} \quad \forall j,p,t$ (16)

(16) Outflow of products

$x_{ijtp'v} \geq 0$, $x_{jctpv} \geq 0 \quad \forall j,t,p,p',v$ (17)

(17) Guarantees that the flow of materials cannot be negative

6.2.2 Simulation model

As said before, the simulator chosen is ProModel® 2010. Figure 11 shows the layout of the model. One can easily identify the only supplier, the two facilities and the three different clients. Each production facility was made up of three work stations, each one with different capacities and production times. Also, two different path networks were created in order to represent the two different transportation modes. The transportation times between entities are defined by different uniform distributions that give us an important stochastic element for the supply chain. On the other hand, the processing times for each facility are also stochastic variables. The main output of the model are both stochastic elements (transportation and production times) for the time horizon of five work days.

The model read the results from the optimization model in the spreadsheet of Excel and uses them as input data for the simulation. After the model has run for the horizon of 5 days the data is exported to another spreadsheet of Excel that have been already linked with the optimization model. This loop is done several times until we find a minimum cost for the weekly operation of our supply chain.

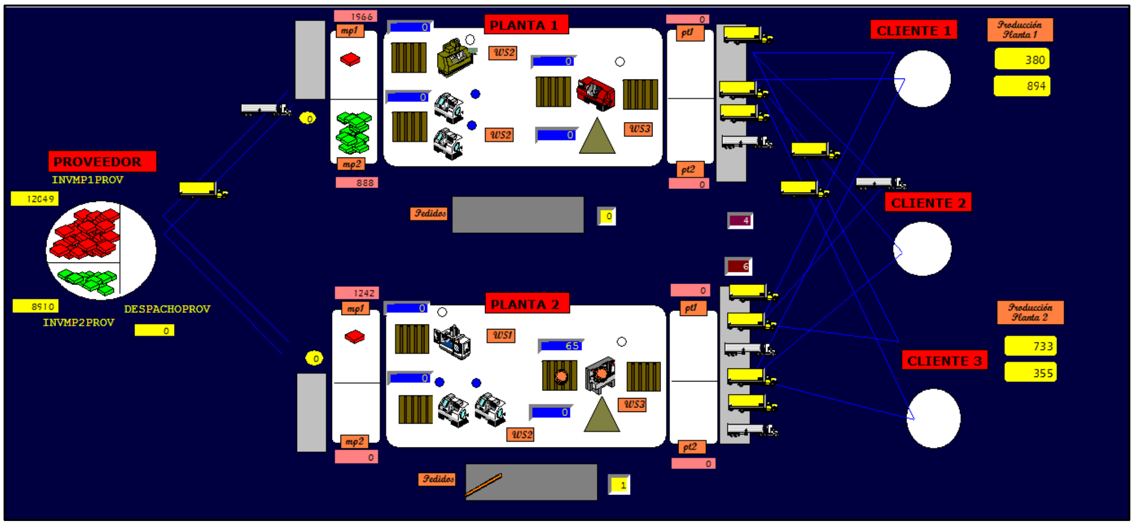

Figure 11 Supply chain model layout using ProModel

Source: The author

6.2.3 Results

For the first results of the optimization model, production and transportation times were assumed as one day. After running both models and making a total of ten interactions the main results of this approach are shown both in figure 12 and in table 12, where one could see, how the weekly costs of this supply chain could be minimized meanwhile the demand of the customers is satisfied.

During the process of simulating and optimizing, it was perceived the variation of the production and transportation times. One could recognize the influence of stochastic elements on the values of the decision variables of the model (production quantities and flow of materials between entities). In few words, when non stochastic parameter was consider the result was an overestimated weekly cost of managing the supply chain.

Significant changes were also found on the inventory levels in the production facilities during the interactions. One could see how integrating inventory levels and inventory holding costs in the model, could give us a feedback about the inventory policies taken by a company.

On the other hand, this approach allows generating a weekly planning to accomplish the demand of the set of customers meeting the constraints of the system at a minimum cost (inventory, production, transportation and backorders cost).

The results of this approach are overwhelming, while simulation takes into consideration stochastic elements of the supply chain, the optimization model takes those results and look for the best way to accomplish the demand while minimizing the whole cost of the network. One could clearly identify that after the sixth interaction the reduction of the cost is no longer significant, due to the fact that within those conditions the models have met the “best” way to meet the weekly planning of the supply network.

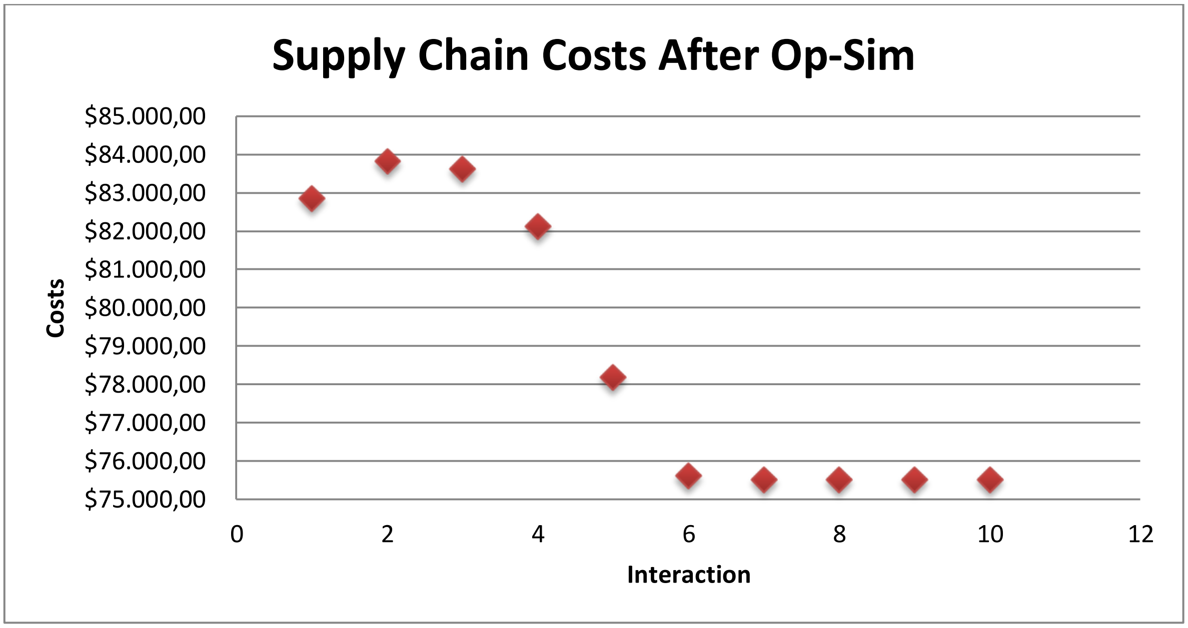

Figure 12 Supply chain cost reduction using optimization and simulation

Source: The author

Interaction	Costs
1	$ 82.861,21
2	$ 83.833,44
3	$ 83.632,44
4	$ 82.123,33
5	$ 78.191,18
6	$ 75.610,51
7	$ 75.520,04
8	$ 75.520,05
9	$ 75.514,72
10	$ 75.514,56

Table 12 Supply chain cost reduction

Source: The author

CONCLUSIONS

- Robustness of supply networks (number of entities, relationships, flow of information and material) primary places restrictions for simulation. Do to this fact, a distributed simulation approach (with integration of several simulators and models) is more attractive and could be more effective in terms of representing the whole supply chain.

- There is not a final word about the use of a certain simulation approach when modeling and simulating a supply chain. Nevertheless, the use of a certain simulation approach is related to the decision (regarding hierarchical level: operational, tactical and strategic) one wants to support. Do to this fact, certain approaches could be more accurate for each decision level.

- Creating a virtual supply chain model based on theoretical input data has some problems that should be overcome. The modeler may not only have to decide on the structure of the system (flow of information and goods), but also validate the coherence of the input data in order to have a realistic representation of the chain.

- Simulation may not only be useful for decision process, it is also a useful tool in terms of evaluating the performance of the supply network. Within this scope, a hierarchical performance measurement framework helps a firm to organize its existing and future key performance measurements into a structure that leads to a relatively few, high level, strategic measures.

- Concerning supply chain modeling, one must consider that it is fundamental the cooperation of several disciplines trying to reach a single objective: improve the performance of the business through the seeking of the maximization of the net revenues. Within the most important disciplines we found: managerial accounting, forecasting methods, transportation science, and operations management.

- Simulating a supply chain network is not an easy task. For such interconnected systems, the modeler should consider the two possible ways of mastering complexity: either simplifying the reality and making a simplified IS that represents this reality or by making a complex IS with a high level of fidelity to the reality. Neither one of the approaches is better than the other one, it depends on the expertise of the modeler and the decision problem one wants to support.

- A simulation-optimization approach requires a high technological level, there are involved a large number of variables and relations (material and information relations) that build up a complex environment to model. Not only expertise of the model is required, but also a powerful tool for simulating, optimizing and saving the results (data bases).

GLOSSARY

ASSET MANAGEMENT TOOL (AMT): tool developed by IBM, which integrated graphical process modeling, analytical performance optimization, simulation, and activity-based costing into a system that supported quantitative analysis of extended supply chains.

ASSEMBLE TO ORDER (ATO): a business production strategy where products ordered by customers are produced quickly and are customizable to a certain degree. The assemble-to-order (ATO) strategy requires that the basic parts for the product are already manufactured but not yet assembled. Once an order is received, the parts are assembled quickly and sent to the customer[33].

BUILD TO ORDER (BTO): production approach in which once an order is received and confirmed, the products are built.

CONTINUOUS REPLENISHMENT (CRP): products are replenished only for the sold amount as needed in real time, and there is no specific order point or expression for calculating the order batch size. CRP is also referred to as a water supply method in the way that water will be supplied from a tank when needed and for the amount you need if you turn on a faucet[34].

DISCRETE EVENT SIMULATION (DES): utilizes a mathematical/logical model of a physical system that portrays state changes at precise points in simulated time. Both the nature of the state change and the time at which the change occurs mandate precise description[35].

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[33] HUSDAL, Jan. A new supply chain perspective. [Online]. Available in: http://www.husdal.com/2008/10/09/a-new-supply-chain-perspective-the-supply-chain-life-cycle. Access 14 December 2011.

[34] IMAOKA, Zenjiro. Understand Supply Chain Management through 100 words. [Online]. Available in: http://www.lean-manufacturing-japan.com/scm-terminology/crp-continuous-replenishment-program.html. Access 14 December 2011.

[35] NANCE, Richard E. A History of Discrete Event Simulation Programming Languages. Technical Report TR-93-21, Computer Science, Virginia Polytechnic Institute and State University. Quoted by ALBRECHT, Mike. Introduction to Discrete Event Simulation. [Online]. Available in: http://www.albrechts.com/mike/DES/index.html. Access 14 December 2011.

SUPPLY CHAIN ANALYZER (SCA): product developed by IBM from the original version used on their own (AMT), used in consulting engagements.

SUPPLY CHAIN LIFE CYCLE: it is told that it usually has 3 Stages: initiation, operation and cessation. The first part brings the system into being and deals with questions of how to design structure and develop the system. The second stage deals with operational issues, how to manage, maintain, support and upgrade the system, and so on. The third part steps in when the system is no longer needed or obsolete, and deals with how to retire, replace or deplete the system[36].

SUPPLY CHAIN MANAGEMENT (SMC): it's the management of the network of enterprises and business that work together in order to deliver a finished product or service to a target costumer.

SUPPLY CHAIN PLANNING (SCP): supply chain planning (SCP) is the component of supply chain management (SCM) involved with predicting future requirements to balance supply and demand[37].

VIRTUAL SUPPLY CHAIN: a simulation model that includes integrated models of material and information flows. Usually integrating Virtual Logistics and Virtual Factory. It may also include the flow of money transactions through the supply chain.

[36] HUSDAL, Op. cit., page 6.

[37] TECHTARGET. Supply Chain Planning (SCP). [Online]. Available in http://searchmanufacturingerp.techtarget.com/definition/supply-chain-planning-SCP. Access 14 December 2011.

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APPENDIX

APPENDIX 1. SETS & PARAMETERS

Sets	
i= Suppliers	1
t= Time periods	5
j= Facilities	2
c= Customers	3
p= Products	2
p'= Raw material	2
v= Transportation modes	2

a_{jp}		
	j=1	j=2
p=1	2	3
P=2	3	4

$\alpha_{jpp'}$			
		j=1	j=2
p'=1	p=1	3	3
	P=2	1	1
p'=2	p=1	4	4
	P=2	3	3

b^{in}_{pct}			
	c=1	c=2	c=3
	t=0	t=0	t=0
p=1	100	100	100
p=2	100	100	100

C_{ijtv}											
		j=1					j=2				
		t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
i =1	v=1	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	v=2	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000

C_{jctv}											
		j=1					j=2				
		t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
c=1	v=1	500	500	500	500	500	500	500	500	500	500
	v=2	700	700	700	700	700	700	700	700	700	700
c=2	v=1	500	500	500	500	500	500	500	500	500	500
	v=2	700	700	700	700	700	700	700	700	700	700
c=3	v=1	500	500	500	500	500	500	500	500	500	500
	v=2	700	700	700	700	700	700	700	700	700	700

	C^{prod}_{jt}									
	j=1					j=2				
	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
p=1	1350	1350	1350	1350	1350	1450	1450	1450	1450	1450
p=2	950	950	950	950	950	1400	1400	1400	1400	1400

$c_{ijp'v}$												
			j=1					j=2				
			t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
i=1	v=1	p'=1	$ 0,20	$ 0,20	$ 0,20	$ 0,20	$ 0,20	$ 0,50	$ 0,50	$ 0,50	$ 0,50	$ 0,50
		p'=2	$ 0,20	$ 0,20	$ 0,20	$ 0,20	$ 0,20	$ 0,50	$ 0,50	$ 0,50	$ 0,50	$ 0,50
	v=2	p'=1	$ 0,20	$ 0,20	$ 0,20	$ 0,20	$ 0,20	$ 0,50	$ 0,50	$ 0,50	$ 0,50	$ 0,50
		p'=2	$ 0,20	$ 0,20	$ 0,20	$ 0,20	$ 0,20	$ 0,50	$ 0,50	$ 0,50	$ 0,50	$ 0,50

c_{cjpv}												
			j=1					j=2				
			t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
c=1	v=1	p=1	$ 1,00	$ 1,00	$ 1,00	$ 1,00	$ 1,00	$ 1,00	$ 1,00	$ 1,00	$ 1,00	$ 1,00
		p=2	$ 2,00	$ 2,00	$ 2,00	$ 2,00	$ 2,00	$ 2,00	$ 2,00	$ 2,00	$ 2,00	$ 2,00
	v=2	p=1	$ 3,00	$ 3,00	$ 3,00	$ 3,00	$ 3,00	$ 3,00	$ 3,00	$ 3,00	$ 3,00	$ 3,00
		p=2	$ 4,00	$ 4,00	$ 4,00	$ 4,00	$ 4,00	$ 4,00	$ 4,00	$ 4,00	$ 4,00	$ 4,00
c=2	v=1	p=1	$ 5,00	$ 5,00	$ 5,00	$ 5,00	$ 5,00	$ 5,00	$ 5,00	$ 5,00	$ 5,00	$ 5,00
		p=2	$ 6,00	$ 6,00	$ 6,00	$ 6,00	$ 6,00	$ 6,00	$ 6,00	$ 6,00	$ 6,00	$ 6,00
	v=2	p=1	$ 7,00	$ 7,00	$ 7,00	$ 7,00	$ 7,00	$ 7,00	$ 7,00	$ 7,00	$ 7,00	$ 7,00

		p=2	$ 8,00	$ 8,00	$ 8,00	$ 8,00	$ 8,00	$ 8,00	$ 8,00	$ 8,00	$ 8,00	$ 8,00
c=3	v=1	p=1	$ 9,00	$ 9,00	$ 9,00	$ 9,00	$ 9,00	$ 9,00	$ 9,00	$ 9,00	$ 9,00	$ 9,00
		p=2	$ 10,00	$ 10,00	$ 10,00	$ 10,00	$ 10,00	$ 10,00	$ 10,00	$ 10,00	$ 10,00	$ 10,00
	v=2	p=1	$ 11,00	$ 11,00	$ 11,00	$ 11,00	$ 11,00	$ 11,00	$ 11,00	$ 11,00	$ 11,00	$ 11,00
		p=2	$ 12,00	$ 12,00	$ 12,00	$ 12,00	$ 12,00	$ 12,00	$ 12,00	$ 12,00	$ 12,00	$ 12,00

$c_{ijp'v}$				
			j=1	j=2
i=1	v=1	p'=1	$ 0,20	$ 0,50
		P'=2	$ 0,20	$ 0,50
	v=2	p'=1	$ 0,20	$ 0,50
		P'=2	$ 0,20	$ 0,50

C_{cjpv}				
			j=1	j=2
c=1	v=1	p=1	$ 1,00	$ 1,00
		p=2	$ 2,00	$ 2,00
	v=2	p=1	$ 3,00	$ 3,00
		p=2	$ 4,00	$ 4,00
c=2	v=1	p=1	$ 5,00	$ 5,00
		p=2	$ 6,00	$ 6,00
	v=2	p=1	$ 7,00	$ 7,00
		p=2	$ 8,00	$ 8,00
c=3	v=1	p=1	$ 9,00	$ 9,00
		p=2	$ 10,00	$ 10,00
	v=2	p=1	$ 11,00	$ 11,00
		p=2	$ 12,00	$ 12,00

D_{pct}															
	c=1					c=2					c=3				
	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
p=1	200	200	200	200	200	140	140	140	140	140	180	180	180	180	180
p=2	170	170	170	170	170	210	210	210	210	210	135	135	135	135	135

g_{pv}		
	v=1	v=2
p=1	2	2
P=2	2	2

$g_{p'v}$		
	v=1	v=2
p'=1	8	8
p'=2	8	8

$h^{out}_{ip't}$					
	i=1				
	t=1	t=2	t=3	t=4	t=5
p'=1	$ 0,000	$ 0,000	$ 0,000	$ 0,000	$ 0,000
p'=2	$ 0,001	$ 0,001	$ 0,001	$ 0,001	$ 0,001

		Annual	Daily
	r=	20%	0,050%
p'=1	$ 1,00		
p'=2	$ 2,00		

h^{out}_{jpt}										
	j=1					j=2				
	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
p=1	$ 10,006	$ 10,006	$ 10,006	$ 10,006	$ 10,006	$ 18,006	$ 18,006	$ 18,006	$ 18,006	$ 18,006
p=2	$ 13,007	$ 13,007	$ 13,007	$ 13,007	$ 13,007	$ 17,007	$ 17,007	$ 17,007	$ 17,007	$ 17,007

		Annual	Daily
	r=	30%	0,072%
p=1	$ 8,00		
p=2	$ 10,00		

$h^{in}_{jp't}$										
	j=1					j=2				
	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
p'=1	$ 0,201	$ 0,201	$ 0,201	$ 0,201	$ 0,201	$ 0,501	$ 0,501	$ 0,501	$ 0,501	$ 0,501
p'=2	$ 0,201	$ 0,201	$ 0,201	$ 0,201	$ 0,201	$ 0,501	$ 0,501	$ 0,501	$ 0,501	$ 0,501

		Annual	Daily
	r=	25%	0,061%
p'=1	$ 1,00		

p'=2	$ 2,00

L^{inraw}_{jt}									
j=1					j=2				
t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
8000	8000	8000	8000	8000	8000	8000	8000	8000	8000

$L^{outprod}_{jt}$									
j=1					j=2				
t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
350	350	350	350	350	350	350	350	350	350

$I^{inraw}_{jp't}$		
	j=1	j=2
	t=0	t=0
p'=1	4000	4000
p'=2	4000	4000

$I^{outraw}_{ip't}$	
	i=1
	t=0
p'=1	0
p'=2	0

$I^{outprod}_{jpt}$		
	j=1	j=2
	t=0	t=0
p=1	50	50
p=2	50	50

$q_{p'j}$		
	j=1	j=2
p'=1	0,1	0,1
p'=2	0,1	0,1

q_{pj}		
	j=1	j=2
p=1	2	2
p=2	2	2

$r_{jp't}$										
	j=1					j=2				
	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
p'=1	800	800	800	800	800	600	600	600	600	600
p'=2	1000	1000	1000	1000	1000	1000	2000	2000	2000	2000

r_{cpt}															
	c=1					c=2					c=3				
	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
p=1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
p=2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ρ_{cp}			
	c=1	c=2	c=3
p=1	$ 8,00	$ 8,00	$ 8,00
p=2	$ 12,00	$ 12,00	$ 12,00

$S_{ip't}$					
	i=1				
	t=1	t=2	t=3	t=4	t=5
p'=1	3000	3000	3000	3000	3000
p'=2	3000	3000	3000	3000	3000

s_{jpt}										
	j=1					j=2				
	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
p=1	0	0	0	0	0	0	0	0	0	0
p=2	0	0	0	0	0	0	0	0	0	0

w_{jp}		
	j=1	j=2
p=1	$ 4,00	$ 12,00
P=2	$ 6,00	$ 10,00

w_{jp}										
	j=1					j=2				
	t=1	t=2	t=3	t=4	t=5	t=1	t=2	t=3	t=4	t=5
p=1	$ 4,00	$ 4,00	$ 4,00	$ 4,00	$ 4,00	$ 12,00	$ 12,00	$ 12,00	$ 12,00	$ 12,00
p=2	$ 6,00	$ 6,00	$ 6,00	$ 6,00	$ 6,00	$ 10,00	$ 10,00	$ 10,00	$ 10,00	$ 10,00

APPENDIX 2. RESULTS FROM THE RUNS OF THE MODEL

INPUT	FIRST RUN				
	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	4020	6020	8020	11020
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	2097	1597	2397	3197
INV PLA1 MP2	4000	3623	5143	7143	9143
INV PLA2 MP1	4000	2914	3154	3754	4354
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	175	0	0	0	0
INV PLA1 PT2	0	50	0	0	0
INV PLA2 PT1	65	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	730	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	1250	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	0	250	71	80	0
FLUJO PLA1 CLI1 PT2 MODO 1	200	0	170	170	0
FLUJO PLA1 CLI2 PT1 MODO 1	190	41	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 1	60	210	210	210	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI3 PT2 MODO 1	63	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	0	80	250	120	0
FLUJO PLA2 CLI1 PT2 MODO 1	21	170	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	240		0
FLUJO PLA2 CLI2 PT2 MODO 1	200	1	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	63	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	63	63	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	250	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	0	0	0	0	0

FLUJO PLA1 CLI2 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	230	180	0	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	60	10	73	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	0	0	118	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	0	0	0
PDN PLA1 PT1	545	71	80	0	0
PDN PLA1 PT2	332	465	380	0	0
PDN PLA2 PT1	15	670	120	0	0
PDN PLA2 PT2	234	0	0	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	1	1	1	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	1	1	1	1
T. FINAL PDN PLA2 PT2	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	1	1	1	1	1

T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	1	1	1	1	1

SECOND RUN

INPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	5220	7220	9220	12220
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	4050	3710	4510	5310
INV PLA1 MP2	4000	4430	5070	7070	9070
INV PLA2 MP1	4000	2568	2148	2748	3348
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	780	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0

FLUJO PLA1 CLI1 PT1 MODO 1	0	250	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 1	0	0	0	170	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	35	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 1	0	0	0	210	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	63	0	0	0
FLUJO PLA1 CLI3 PT2 MODO 1	0	0	0	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	250	0	80	200	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	0	170	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	105		0
FLUJO PLA2 CLI2 PT2 MODO 1	0	0	145	0	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	0	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	63	0	63	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	45	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	220	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	190	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	160	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	5	0	0	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	155	120	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	0	170	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	0	0	35	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	100	65	65	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	228	0	0	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	123	0	208	0	0
PDN PLA1 PT1	145	393	0	0	0
PDN PLA1 PT2	330	0	380	0	0
PDN PLA2 PT1	428	155	340	0	0
PDN PLA2 PT2	235	650	0	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	4	1	1
T. FINAL PDN PLA1 PT2	1	4	4	1	1
T. FINAL PDN PLA2 PT1	1	2	3	1	1
T. FINAL PDN PLA2 PT2	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	4	1	5	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	4	1	5	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1

T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	1	3	4	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	1	3	4	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	4	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	3	4	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	3	3	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	3	3	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	1	5	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	2	1	3	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	2	1	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	1	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	1	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	3	1	5	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	3	1	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	1	1	4	1	1

THIRD RUN

INPUT	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	6000	8000	10000	13000
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	3455	3800	4600	5400
INV PLA1 MP2	4000	5059	5364	7364	9364

INV PLA2 MP1	4000	3057	2558	3158	3758
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	0	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	250	0	120	200	0
FLUJO PLA1 CLI1 PT2 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 1	35	0	107	72	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	40	0
FLUJO PLA1 CLI3 PT2 MODO 1	20	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	50	80	0	250	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	170	170	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	140		0
FLUJO PLA2 CLI2 PT2 MODO 1	0	104	104	139	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	63	63	0
FLUJO PLA2 CLI3 PT2 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	170	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	40	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	310	72	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	0	350	145	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	200	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	100	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	114	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	214	0	118	15	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	0	0	0
PDN PLA1 PT1	240	0	120	0	0
PDN PLA1 PT2	485	314	72	0	0

PDN PLA2 PT1	327	280	320	0	0
PDN PLA2 PT2	50	274	139	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	3	3	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	2	3	3	1
T. FINAL PDN PLA2 PT2	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	2	1	5	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	2	1	5	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	2	1	3	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	3	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	3	3	4	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	3	1	2	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	3	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	4	1	2	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	3	3	1	2	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	2	2
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	2	5	2	2
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	2	2	3	1	2
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	2	2	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	2	2	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	3	1	5	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	3	2	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	2	2	1	1	1

T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	2	1	4	1	1

FOURTH RUN

INPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	4750	6750	8750	11750
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	3737	3602	4402	5202
INV PLA1 MP2	4000	5219	5989	7989	9989
INV PLA2 MP1	4000	2948	2725	3325	3925
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	1250	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	250	5	120	120	0
FLUJO PLA1 CLI1 PT2 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	0	120	120	0
FLUJO PLA1 CLI2 PT2 MODO 1	48	0	48	130	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI3 PT2 MODO 1	63	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	55	0	80	248	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	170	170	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	20		0
FLUJO PLA2 CLI2 PT2 MODO 1	0	163	163	80	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	63	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	0	0	0	0	0

FLUJO PLA1 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	40	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	310	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	0	0	33	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	0	308	145	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	196	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	270	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	154	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	214	0	85	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	0	0	0
PDN PLA1 PT1	240	5	273	0	0
PDN PLA1 PT2	370	255	130	0	0
PDN PLA2 PT1	371	196	248	0	0
PDN PLA2 PT2	220	333	80	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	3	3	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	2	3	1	1
T. FINAL PDN PLA2 PT2	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	3	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	3	3	4	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	3	1	2	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	3	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	4	1	2	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	3	3	1	2	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	1	2
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	2	1	2	2

T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	2	1	3	1	2
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	2	2	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	2	2	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	3	1	5	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	3	2	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	2	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	2	1	4	1	1

	FIFTH RUN				
INPUT	**DAY1**	**DAY2**	**DAY3**	**DAY4**	**DAY5**
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	2955	4705	6705	8705	11705
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	3860	3136	3936	4736
INV PLA1 MP2	4000	5273	6397	8397	10397
INV PLA2 MP1	4000	2653	2596	3196	3796
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	45	1250	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0

FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	50	0	153	153	0
FLUJO PLA1 CLI1 PT2 MODO 1	200	0	0	98	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 1	210	0	210	210	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	18	0
FLUJO PLA1 CLI3 PT2 MODO 1	0	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	250	80	48	220	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	170	73	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	140		0
FLUJO PLA2 CLI2 PT2 MODO 1	0	48	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	32	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	20	0	31	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	170	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	53	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	0	0	149	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	0	350	0	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	200	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	70	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	70	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	214	0	0	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	115	0	0
PDN PLA1 PT1	170	0	301	0	0
PDN PLA1 PT2	413	273	308	0	0
PDN PLA2 PT1	484	280	220	0	0
PDN PLA2 PT2	40	218	0	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	3	3	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	2	3	1	1
T. FINAL PDN PLA2 PT2	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	1	1	1	1

T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	3	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	3	3	3	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	3	1	2	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	1	1	2	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	3	3	1	2	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	1	2
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	2	1	2	2
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	2	1	3	1	2
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	2	2	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	2	2	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	3	1	5	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	3	2	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	2	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	2	1	4	1	1

SIXTH RUN

INPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	4750	6750	8750	11750
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000

INV PLA1 MP1	4000	3643	3037	3837	4637
INV PLA1 MP2	4000	5183	6385	8385	10385
INV PLA2 MP1	4000	2912	2914	3514	4114
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	1250	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	165	0	200	200	0
FLUJO PLA1 CLI1 PT2 MODO 1	85	0	0	45	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	0	15	15	0
FLUJO PLA1 CLI2 PT2 MODO 1	210	0	210	210	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	63	0
FLUJO PLA1 CLI3 PT2 MODO 1	63	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	135	52	0	200	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	170	125	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	125		0
FLUJO PLA2 CLI2 PT2 MODO 1	0	100	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	63	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	163	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	0	0	106	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	0	245	0	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	200	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	185	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	78	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	214	0	12	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	145	0	0

PDN PLA1 PT1	278	0	321	0	0
PDN PLA1 PT2	308	273	255	0	0
PDN PLA2 PT1	376	252	200	0	0
PDN PLA2 PT2	135	270	0	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	3	3	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	2	3	1	1
T. FINAL PDN PLA2 PT2	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	3	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	3	3	3	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	3	1	2	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	1	1	2	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	1	3	1	2	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	1	2
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	2	1	2	2
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	2	1	3	1	2
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	2	2	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	2	2	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	3	1	5	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	3	2	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	2	1	1	1

T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	2	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	2	1	4	1	1

SEVENTH RUN

INPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	4750	6750	8750	11750
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	3643	3037	3837	4637
INV PLA1 MP2	4000	5183	6385	8385	10385
INV PLA2 MP1	4000	2912	2914	3514	4114
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	1250	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	165	0	200	200	0
FLUJO PLA1 CLI1 PT2 MODO 1	85	0	0	45	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	0	15	15	0
FLUJO PLA1 CLI2 PT2 MODO 1	210	0	210	210	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	63	0
FLUJO PLA1 CLI3 PT2 MODO 1	63	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	135	52	0	200	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	170	125	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	125		0
FLUJO PLA2 CLI2 PT2 MODO 1	0	100	0	0	0

FLUJO PLA2 CLI3 PT1 MODO 1	0	0	63	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	163	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	0	0	106	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	0	245	0	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	200	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	185	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	78	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	214	0	12	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	145	0	0
PDN PLA1 PT1	278	0	321	0	0
PDN PLA1 PT2	308	273	255	0	0
PDN PLA2 PT1	376	252	200	0	0
PDN PLA2 PT2	135	270	0	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	3	3	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	2	3	1	1
T. FINAL PDN PLA2 PT2	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	3	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	3	3	3	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	3	1	2	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	1	1	2	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	1	3	1	2	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	1	1	1	1	1

T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	1	2
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	2	1	2	2
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	2	1	3	1	2
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	2	2	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	2	2	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	2	1	5	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	3	2	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	2	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	2	1	4	1	1

EIGHT RUN

INPUT	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	4750	6750	8750	11750
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	3610	3004	3804	4604
INV PLA1 MP2	4000	5183	6385	8385	10385
INV PLA2 MP1	4000	2902	2904	3504	4104
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	1250	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0

FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	203	0	200	200	0
FLUJO PLA1 CLI1 PT2 MODO 1	0	0	0	45	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	0	40	40	0
FLUJO PLA1 CLI2 PT2 MODO 1	210	0	210	210	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	63	0
FLUJO PLA1 CLI3 PT2 MODO 1	63	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	98	52	0	200	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	170	125	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	100		0
FLUJO PLA2 CLI2 PT2 MODO 1	0	100	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	63	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	150	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	0	0	81	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	43	203	0	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	200	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	270	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	90	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	214	0	37	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	145	0	0
PDN PLA1 PT1	303	0	321	0	0
PDN PLA1 PT2	265	273	255	0	0
PDN PLA2 PT1	351	252	200	0	0
PDN PLA2 PT2	220	270	0	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	3	3	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	2	3	1	1
T. FINAL PDN PLA2 PT2	1	2	1	1	1

T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	3	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	1	3	3	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	3	1	2	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	1	1	2	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	1	3	1	2	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	1	2
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	2	1	2	2
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	2	1	3	1	2
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	2	2	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	2	2	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	2	1	5	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	1	2	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	2	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	2	1	4	1	1

NINTH RUN

INPUT	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	4750	6750	8750	11750

CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	3244	2739	3539	4339
INV PLA1 MP2	4000	4859	6129	8129	10129
INV PLA2 MP1	4000	2677	2729	3329	3929
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	1250	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	203	0	200	200	0
FLUJO PLA1 CLI1 PT2 MODO 1	23	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	0	40	40	0
FLUJO PLA1 CLI2 PT2 MODO 1	210	0	210	210	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	63	0
FLUJO PLA1 CLI3 PT2 MODO 1	63	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	98	0	0	183	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	170	170	0	0
FLUJO PLA2 CLI2 PT1 MODO 1	0	0	100		0
FLUJO PLA2 CLI2 PT2 MODO 1	0	38	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	63	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	150	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	63	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	0	0	98	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	0	245	108	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	200	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	124	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	90	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0

FLUJO PLA2 CLI3 PT1 MODO 2	230	180	20	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	38	0	0
PDN PLA1 PT1	303	0	338	0	0
PDN PLA1 PT2	308	381	210	0	0
PDN PLA2 PT1	368	380	183	0	0
PDN PLA2 PT2	74	208	0	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	3	3	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	2	3	1	1
T. FINAL PDN PLA2 PT2	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	3	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	1	3	3	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	3	1	2	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	1	1	2	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	1	3	1	2	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	1	2
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	2	1	2	2
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	2	1	3	1	2
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	2	2	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	2	2	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	2	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	1	2	5	1	1

T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	2	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	2	1	4	1	1

TENTH RUN

INPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
INV PROV MP1	3000	6000	9000	12000	15000
INV PROV MP2	3000	4911	6911	8911	11911
CANT APROV PROV MP1	3000	3000	3000	3000	3000
CANT APROV PROV MP2	3000	3000	3000	3000	3000
INV PLA1 MP1	4000	3304	3214	4014	4814
INV PLA1 MP2	4000	4809	6809	8809	10809
INV PLA2 MP1	4000	2444	3044	3644	4244
INV PLA2 MP2	4000	0	0	0	0
INV PLA1 PT1	0	0	0	0	0
INV PLA1 PT2	0	0	0	0	0
INV PLA2 PT1	0	0	0	0	0
INV PLA2 PT2	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 1	0	1090	0	1000	0
FLUJO PROV PLA2 MP1 MODO 1	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 1	0	0	0	0	0
FLUJO PROV PLA1 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA1 MP2 MODO 2	0	0	1000	0	0
FLUJO PROV PLA2 MP1 MODO 2	0	0	0	0	0
FLUJO PROV PLA2 MP2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 1	250	0	100	100	0
FLUJO PLA1 CLI1 PT2 MODO 1	0	0	0	21	0
FLUJO PLA1 CLI2 PT1 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 1	210	0	210	210	0
FLUJO PLA1 CLI3 PT1 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI3 PT2 MODO 1	63	63	63	0	0
FLUJO PLA2 CLI1 PT1 MODO 1	50	41	101	0	0
FLUJO PLA2 CLI1 PT2 MODO 1	0	170	150	0	0

FLUJO PLA2 CLI2 PT1 MODO 1	150	0	140		0
FLUJO PLA2 CLI2 PT2 MODO 1	100	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 1	0	0	63	0	0
FLUJO PLA2 CLI3 PT2 MODO 1	0	0	0	0	0
FLUJO PLA1 CLI1 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI1 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI2 PT1 MODO 2	80	0	0	0	0
FLUJO PLA1 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI3 PT1 MODO 2	0	0	0	0	0
FLUJO PLA1 CLI3 PT2 MODO 2	43	203	125	0	0
FLUJO PLA2 CLI1 PT1 MODO 2	0	200	0	0	0
FLUJO PLA2 CLI1 PT2 MODO 2	135	0	0	0	0
FLUJO PLA2 CLI2 PT1 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI2 PT2 MODO 2	0	0	0	0	0
FLUJO PLA2 CLI3 PT1 MODO 2	230	180	118	0	0
FLUJO PLA2 CLI3 PT2 MODO 2	0	0	21	0	0
PDN PLA1 PT1	280	0	100	0	0
PDN PLA1 PT2	265	398	231	0	0
PDN PLA2 PT1	380	421	0	0	0
PDN PLA2 PT2	185	170	0	0	0

OUTPUT

	DAY1	DAY2	DAY3	DAY4	DAY5
T. FINAL PDN PLA1 PT1	1	2	3	1	1
T. FINAL PDN PLA1 PT2	1	1	1	1	1
T. FINAL PDN PLA2 PT1	1	2	1	1	1
T. FINAL PDN PLA2 PT2	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP1 MODO 2	3	1	1	1	1
T. ARRIBO FLUJO PROV PLA1 MP2 MODO 2	1	3	3	1	1
T. ARRIBO FLUJO PROV PLA2 MP1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PROV PLA2 MP2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 1	3	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 1	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 1	4	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 1	1	1	2	1	1

T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 1	1	3	1	2	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 1	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 1	2	1	5	1	2
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 1	2	2	1	2	2
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 1	1	1	3	1	2
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 1	1	2	3	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 1	2	1	4	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI1 PT2 MODO 2	1	2	2	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI2 PT2 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT1 MODO 2	2	1	1	1	1
T. ARRIBO FLUJO PLA1 CLI3 PT2 MODO 2	1	2	5	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT1 MODO 2	1	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI1 PT2 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT1 MODO 2	1	1	2	1	1
T. ARRIBO FLUJO PLA2 CLI2 PT2 MODO 2	2	2	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT1 MODO 2	1	1	1	1	1
T. ARRIBO FLUJO PLA2 CLI3 PT2 MODO 2	2	1	4	1	1