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A dynamic simulation game (UNIGAME) for strategic university management

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The authors present an interactive simulation model on which the academic aspects of university management can be analyzed and alternative management strategies tested. The model focuses specifically on long-term, dynamic, strategic management problems, such as growing student/faculty ratios, poor teaching quality, and low research productivity. It yields numerous performance measures about the fundamental activities in a university: teaching, research, and professional project activities. Results suggest that the university management game (UNIGAME) promises to be a useful technology to support strategic decision making and a laboratory for theoretical research on how to best deal with strategic university management problems.

KEYWORDS: management games; simulation game; strategic management; system dynamics; university management.

Contemporary universities worldwide face challenging management problems such as unbalanced growth in student body in state (public) universities, infrastructures that cannot keep up with the enrollment growth, increased student/faculty ratios, concerns about quality of instruction, heavy competition for limited funding for research, and heavy competition among private universities for limited student demand. Such problems have been studied on both macro and micro levels by many researchers (Benjamin, 1995; Boğaziçi University, 1994; Gürüz et al., 1994). Whereas some of these studies have made use of certain quantitative methods (e.g., Galbraith, 1998; Mahmoud & Genta, 1993; Saeed, 1993; Sinuany-Stern, 1984; Vemuri, 1982), a great portion of the existing research on university problems does not have a quantitative foundation, primarily because such problems involve qualitative (human) elements.

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that are difficult to quantify and model. Thus, there seems to be a need for research that can handle simultaneously the quantitative and the qualitative aspects of the university management problems. In this research, we build an interactive simulation model/game (UNIGAME) that focuses on those university problems that are dynamic and long term in nature and as such must be addressed by high-level, strategic policy-making mechanisms (the president, the deans, and the main policy-making councils) within the university.

**Model Overview**

The model focuses on those academic management problems that are dynamic and persistent in nature, such as growing student/faculty ratios, poor teaching quality, and low research productivity. As such, the model represents faculty members’ time allocation among the main activity groups, the factors that determine this allocation, and various performance measures that result from these often-conflicting allocations. The major activities of faculty members are (a) graduate instruction, (b) undergraduate instruction, (c) graduate instruction overhead, (d) undergraduate instruction overhead, (e) unsponsored research, (f) sponsored research, (g) income-generating projects, and (h) unofficial projects. With respect to these activities, faculty members are classified into two groups: graduate faculty members, who are primarily involved in graduate instruction and research (but also involved in some undergraduate instruction), and undergraduate faculty members, who are involved only in undergraduate instruction and have limited interest in (and background for) research. Thus, graduate instruction and graduate instruction overhead loads apply only to the graduate faculty members.

The instruction activities are divided into two groups: (a) in-class instruction and (b) instruction overhead, which includes all out-of-class activities related to instruction. The second main activity group is research activities. Research activities are represented in two categories as (a) unsponsored research activities, which are not sponsored financially except for the university’s own resources, and (b) sponsored research activities, which are supported by government or private organizations. The last activity group is project (consulting) activities, which are divided into (a) income-generating projects, which are activities such as seminars, courses, or consulting realized through university channels and generate income to the university, and (b) unofficial projects, which are activities such as seminars or consulting realized through nonuniversity (“unofficial”) channels and do not generate any income to the university.

The model is constructed on sector basis (see Figure 1). The sectors of the model are determined so as to represent the dynamics of major activity groups defined above. The model is constructed using Vensim software (Eberlein & Peterson, 1994). The basic time unit is one semester, and the time step used in the simulation is also one (the model is discrete).
In this sector, the graduate faculty full-time equivalent (FTE) that is available for instruction and the need for graduate instruction are calculated, and the faculty FTE is assigned to graduate instruction (see Figure 2). If the graduate faculty FTE is not enough to meet all the need, the discrepancy is eliminated with some other strategies, such as hiring part-time faculty, increasing the class sizes, and so on. On the other hand, if the graduate faculty FTE for instruction is more than the need for graduate instruction, the surplus is transferred to the undergraduate instruction sector.

The main stock variables in this sector are "number of graduate faculty" and "number of graduate students." "Number of graduate faculty" decreases through "graduate faculty that leave" and increases through "new graduate faculty." "New graduate faculty" is determined by "graduate faculty hiring decision" under the constraints of "vacant faculty positions" and "indicated graduate faculty supply." "Graduate faculty hiring decision" is a user decision variable in the interactive game version, but in the simulation version, it is computed so as to eliminate the discrepancy between the need for graduate faculty and the existing graduate faculty FTE. "Graduate faculty supply" depends on "instruction load per graduate faculty" and "historical average graduate
FIGURE 2: Stock-Flow Diagram of the Graduate Instruction Sector
faculty salary.” These variables affect “graduate faculty that leave” as well (see Figure 2). (It is impossible to discuss all the variables and equations within the scope of this article; for a more thorough review, see Diker, 1995.)

**Undergraduate Instruction Sector**

In this sector, the need for undergraduate instruction is determined and met by the “undergraduate faculty time” that can be assigned to instruction and the surplus graduate FTE for instruction, if any, from the graduate instruction sector. If the need is more than the total available FTE, some strategies such as hiring part-time faculty and increasing class sizes are used to eliminate the discrepancy. This sector is very similar to the graduate instruction sector in many aspects (see Diker, 1995).

**Graduate Instruction Quality Sector**

This is the sector in which the graduate instruction quality indicators are calculated (see Figure 3). The main instruction quality indicators are “graduate students/graduate faculty ratio,” “actual graduate instruction overhead per graduate student,” “actual average graduate class size,” and “lab facilities for graduate instruction per graduate student.” The graduate instruction quality index in a semester is given by $f$ (“actual graduate instruction overhead per graduate student,” “actual average graduate class size,” “lab facilities for graduate instruction per graduate student,” and “historical average research papers per graduate faculty”).

Each of these factors is a function of other related variables. The instruction quality indexes are important for determining the teaching commitments of different faculty members, which are indicators of the long-term attitude of the faculty members about instruction quality. Teaching Commitments of graduate and undergraduate faculty are used as inputs to graduate and undergraduate instruction overhead sectors, respectively. For space considerations, we will not discuss the variables and equations (see Figure 3 for the other variables and Diker, 1995, for all equations).

**Undergraduate Instruction Quality Sector**

The indicators of undergraduate instruction quality are calculated in this sector. The structures of the undergraduate and graduate instruction quality sectors are very similar. For space considerations, the undergraduate sector will not be discussed further. (Interested readers are referred to Diker, 1995.)
FIGURE 3: Graduate Instruction Quality Sector
Graduate Faculty
Instruction Overhead Sector

In this sector, the instruction overhead loads of graduate faculty members are first calculated. Instruction overhead load is defined as all out-of-classroom yet instruction-related work. Two different instruction overhead loads are calculated separately for graduate faculty members: graduate instruction overhead and undergraduate instruction overhead (see Figure 4). The total “noninstruction graduate FTE” is found by subtracting the sum of “graduate faculty instruction total overhead” and “graduate faculty total in-class FTE” from the “total graduate faculty FTE.” This “noninstruction graduate FTE” yields, after some fine adjustments, the “graduate FTE for research and projects.” Finally, this FTE is divided between research and project activities (“graduate FTE for projects” and “graduate FTE for research”) according to the relative motivations of each (“graduate faculty financial pressure” and “graduate faculty research commitment”). It is unnecessary to discuss all the variables and computations. (Interested readers are referred to Diker, 1995.)

Undergraduate Faculty
Instruction Overhead Sector

This is the sector in which the instruction overhead loads of undergraduate faculty members are calculated and the undergraduate FTE for research activities and for project activities is determined. This sector resembles the graduate faculty overhead sector discussed above. The dynamics in both sectors are similar. The main difference is that only undergraduate (no graduate) instruction overhead is assigned to undergraduate faculty because those faculty members are not involved in graduate instruction. For space considerations, the undergraduate instruction overhead sector diagram is not included. (Interested readers are referred to Diker, 1995.)

Graduate Faculty Research Sector

In this sector, the graduate faculty FTE dedicated to sponsored and unsponsored research activities is determined, as are the motivations behind and the outcomes of those activities. “Actual FTE graduate faculty for research” is divided among “actual FTE graduate faculty for unsponsored research” and “actual FTE graduate faculty for sponsored research” according to the relative weights of “graduate faculty unsponsored research commitment” and “graduate faculty sponsored research commitment.” These two indicators of commitment are the historical averages of “graduate faculty unsponsored research commitment” and “graduate faculty sponsored research commitment” and take values of between zero and one. The variables that determine the values of these commitments are “graduate faculty desired/realized research papers published,” “graduate faculty research culture,” and the
FIGURE 4: Graduate Faculty Overhead Sector
corresponding research recognitions. “Graduate faculty desired/realized research papers published” is the ratio between the current historical average of research papers published each semester and the target average papers published. “Graduate faculty research culture” is the long-term attitude of graduate faculty members toward research and takes values of between zero and one. Higher research culture causes higher research commitment. Research recognition represents the long-term attitude of the administration toward the related research activities and takes values of between zero and one. Administration expresses its recognition by rewards, which increases the research commitment. “Unsponsored research recognition” depends on unsponsored research paper productivity on the part of faculty members, namely, “unsponsored research papers published current term” and “total FTE for unsponsored research.” On the other hand, “sponsored research recognition” depends on the financial productivity or projects, and on research paper productivity.

After “actual FTE graduate faculty for unsponsored research” and “actual FTE graduate faculty for sponsored research” are determined, the outcomes of research activities are calculated. These outcomes depend on the relevant faculty FTE and productivity indexes.

**Undergraduate Faculty Research Sector**

This sector is similar to the graduate faculty research sector except that it is less important because by definition, a small portion of research is carried out by undergraduate faculty. In this sector, the undergraduate faculty FTE dedicated to sponsored and unsponsored research activities and the motivations behind and the outcomes of those activities are determined.

**Graduate Faculty Projects Sector**

This is the sector in which the portions of the graduate faculty FTE dedicated to official projects and unofficial projects and the motivations behind and the outcomes of those official projects are determined (see Figure 5). “Actual FTE graduate faculty for projects” is divided among “actual FTE graduate faculty for official projects [OP]” and “actual FTE graduate faculty for unofficial projects [UP]” according to the relative weights of “graduate faculty official projects motivation” and “graduate faculty unofficial projects motivation.” “Graduate faculty official projects motivation” depends on the ratio of incomes realized through official projects and unofficial projects and “official projects-unofficial projects mentality.” “Official projects-unofficial projects mentality” is an index of the long-term attitude of the faculty members toward doing projects through nonuniversity channels to earn extra income. “Official projects-unofficial projects mentality,” for graduate and undergraduate faculty members, takes a value of between zero and one. Higher official projects-unofficial projects mentality indicates a lower tendency for doing unofficial projects. “Graduate faculty unofficial projects
FIGURE 5: Graduate Faculty Projects Sector
motivation” is determined by “official projects-unofficial projects income ratio” and “official projects-unofficial projects mentality graduate faculty.”

After “actual FTE graduate faculty for official projects” is determined, “gross income generated by official projects” is calculated as a function of graduate and undergraduate faculty FTE and the related official projects productivity levels. “Net funds/grants gotten by official projects” is calculated by “gross income generated by official projects” – [“income share for graduate faculty on official projects” + “income share for undergraduate faculty on official projects”]. “Official projects share per FTE per semester” is calculated by “official projects income level” × “weekly hours per faculty” × “weeks per semester.” “Official projects income level” represents the amount of money paid per man-hour of faculty workforce for official projects. The number of active weeks per faculty member per semester is 23. Total official projects share for faculty members for the current semester is calculated by “official projects share per FTE per semester” × “total FTE for official projects.”

An important subsystem of this sector consists of “graduate faculty financial pressure” and the variables that affect it. “Graduate faculty financial pressure” is an index of the financial concern of the graduate faculty members. It depends on the ratio between the historical average of the actual salary and the “salary desired” by faculty members (which in turn, is a function of the average market salary).

Undergraduate Faculty Projects Sector

This sector is similar to graduate faculty projects sector. In this sector, the portion of undergraduate faculty FTE dedicated to official projects and unofficial projects and the motivations behind and the funds obtained by official projects are determined. For space considerations, this sector is not described further. (Interested readers are referred to Diker, 1995.)

Laboratory and Facilities Sector

In this sector, the laboratory facilities are updated and then assigned to instruction, research, and project activities. The criteria for assigning the facilities are the relative amounts of faculty FTE allocated to each activity. For space considerations, this sector is not described further. (Interested readers are referred to Diker, 1995.)

Assistants Sector

This is the sector in which the number of assistants, available assistant hours per week, and the instruction overhead assigned to assistants are calculated. “Number of assistants” is a function of “number of graduate students” and “assistants/graduate
students ratio.” This value is limited by “assistant positions,” which is a function of the total number of faculty positions and “faculty/assistant positions ratio.”

“FTE assistants for instruction overhead” is first converted to “faculty FTE” units by dividing the total assistant hours by weekly hours per faculty. After the “FTE assistants for instruction overhead” is computed this way, the total available assistant FTE is distributed among “FTE assistants for graduate instruction overhead” and “FTE assistants for undergraduate instruction overhead.” According to these values, instruction overhead loads for graduate and undergraduate faculty members are updated. These values are used as inputs to the graduate faculty overhead sector and the undergraduate faculty overhead sector.

**Base Run of the Model**

The base run of the model is the simulation run made under the typical expected set of parameters and input values taken from Bogaziçi University (1985-1995). In the stand-alone simulation version of the model, there are no interactive player inputs; all decisions are represented by proper behavioral formulations. The dynamics of the variables obtained in this run are used as a reference when interpreting the behaviors of the same variables in validation and sensitivity runs.

Base dynamic behaviors of some important variables are shown in Figures 6 through 11. Figure 6 depicts the dynamic behavior of “number of undergraduate students” and “number of graduate students.” The values of both variables increase through time, but whereas “number of undergraduate students” increases at a steady pace, the rate of increase in “number of graduate students” decreases as time passes. In Figure 7, both “number of graduate faculty” and “number of undergraduate faculty” increase at a steady pace.

Figure 8 shows the dynamic behaviors of the instruction loads in the base run. The total instruction loads on graduate and undergraduate faculty members are at their operating maximums (6 and 9 hours/week, respectively) until Period 15. After that period, instruction loads increase gradually toward absolute maximum values (9 and 12 hours/week, respectively) due to high student body.

Figure 9 shows the weekly hours spent on research and projects by each graduate faculty member. Whereas the weekly hours spent on research activities do not change substantially, weekly hours spent on official projects decrease and weekly hours spent on unofficial projects increase considerably. These behaviors are caused by the increase in “graduate faculty official projects motivation” and the decrease in “graduate faculty unofficial projects motivation.” The dynamic behaviors of “graduate faculty official projects motivation” and “graduate faculty unofficial projects motivation” and “graduate faculty research commitment” are shown in Figure 10. The increase in “graduate faculty unofficial projects motivation” and the decrease in “graduate faculty official projects motivation” are caused by the relative values of income obtained from

*(text continues on p. 346)*
Number of Students

FIGURE 6: Number of Students in the Base Run

Number of Faculty Members

FIGURE 7: Number of Faculty Members in the Base Run
FIGURE 8: Dynamic Behaviors of Instruction Loads in the Base Run

FIGURE 9: Graduate Faculty Research and Project Loads in the Base Run
FIGURE 10: Graduate Faculty Motivations in the Base Run

FIGURE 11: Research Papers per Semester in the Base Run
official projects and unofficial projects, as well as the “official projects-unofficial projects mentality” of the faculty members.

The dynamic behaviors of “research papers published current term,” “unsponsored research papers published current term,” and “sponsored research papers published current term” are shown in Figure 11. Here, all the variables increase steadily.

Validity of the Model

A crucial step in system dynamics methodology is model validation. Model validity has to do with the degree of realism and relevance of the model with respect to the real problem. Although it is a philosophically deep issue, validation practically means demonstrating that the model is an adequate and useful description of the real system with respect to the problem(s) of concern (Barlas & Carpenter, 1990).

Validation tests are divided into two groups: (a) structure validation tests, which determine whether the model has an adequate, meaningful structure, and (b) behavior validation tests, which determine whether the behavior of the model resembles the behavior exhibited by the real system that was modeled (Barlas, 1989, 1996).

Structural Validity

To test the structural validity of UNIGAME, the built-in unit consistency checking feature of the Vensim environment, which checks the equivalence of units on both sides of the equations, was first used to eliminate any errors that might be in the equations. After all the sectors were individually verified, the unit equivalence check was repeated for the model as a whole.

Finally, extreme condition and sensitivity tests were applied to complete the structural validation. Extreme condition tests are based on the idea that the behaviors of a given model are far more predictable under extreme conditions than they are under normal conditions. Extreme condition tests are done by simulating the model after setting a certain variable to an extremely high or extremely low value and examining the behavior of key variables. The extreme value of the chosen variable implies certain predictable behaviors by other variables. If the behaviors of one or more key variables are not as they are expected to be, the validity of the model is questioned and the cause of the problematic behavior is traced to the equations, which are revised accordingly. Otherwise, that is, if the behaviors of all the key variables are as they were expected to be, the model passes the extreme condition tests. Numerous extreme-condition simulation runs were done on the model, including no undergraduate admission, extremely high undergraduate admission, no undergraduate faculty, extremely low faculty salary, and extremely high instruction overhead ratio. Results of these tests reveal evidence of high structural validity. For space considerations, the results of these tests are not shown. (Interested readers are referred to Diker 1995.)

After the extreme-condition tests, a series of sensitivity runs were made to determine whether the sensitivity of the base model was within acceptable limits.
Sensitivity tests were done on numerous parameters, such as different values of “graduate faculty official projects-unofficial projects mentality,” different values of “average hours per graduate student,” and various undergraduate and graduate class sizes. The results (not shown) indicate that the model has a meaningful and reasonable level of sensitivity to these parameters. (Interested readers are referred to Diker 1995.)

Behavioral Validity

After the structural validity tests were completed, the behavior of the model was compared with the data from Bogazici University (see Figures 12 through 17). Most of the real data are taken from the 1994 edition of the yearly document Bogaziçi University in Numbers (Bogaziçi University, 1994). This document includes a wide range of data on many aspects of Bogaziçi University, such as students, faculty members, publications, and financial figures. Some other data about other aspects of the model, such as official projects and available faculty and assistant positions, are gathered by interviews and used for calibrating the model.

An exact matching between real data and model data points is not required for model validity because a system dynamics model is not designed to include the internal and external details and random factors that are required in short-term forecasting (Barlas, 1989). The purpose of a system dynamics model is to generate the major dynamic behavior patterns of the system, in the long term. Thus, what is required is the matching of the major patterns of behavior of the model and the real system, rather than individual data points.

All the data on Bogaziçi University that could be used for behavior validation are compared with the behavior of the model, and a broad resemblance between the model behavior and the behavior of the real system was obtained (see Figures 12 through 17). Thus, it is concluded that the model is behaviorally acceptable.

UNIGAME


The university management simulation model is converted into an interactive dynamic game (UNIGAME) using the Venapp feature of Vensim software (Eberlein & Peterson, 1994). In UNIGAME, the player assumes the role of a university policy
FIGURE 12: Dynamic Behavior of Number of Students in the Base Run

FIGURE 13: Dynamic Behavior of Number of Faculty Members in the Base Run
FIGURE 14: Dynamic Behavior of Number of Research Papers per Faculty Member in the Base Run

FIGURE 15: Dynamic Behavior of Number of Students According to Data From Bogazici University
FIGURE 16: Dynamic Behavior of Number of Faculty Members According to Data From Bogazici University

FIGURE 17: Dynamic Behavior of Number of Research Papers per Faculty Member According to Data From Bogazici University
maker who is trying to seek a delicate balance among the main academic functions of the university to get better output from these activities, in terms of both quality and quantity. The player does not have too many decision opportunities, as most of the factors are imposed by the environment in which the university exists. The objective of the player is to make six decisions that will improve the performance indicators of the university, within the limitations imposed by outside factors. These decisions are new graduate students, new undergraduate students, graduate faculty hiring decision, undergraduate faculty hiring decision, share from income-generating projects per faculty member, and weekly release time per graduate faculty member (see Figure 18). Sixty different performance indicators are displayed after each decision period. There is also detailed information option that the player can use to carry out more detailed causal analysis of the dynamics of the model (see Figure 18).

UNIGAME consists of a series of screens that are linked in-between themselves. One screen can be observed (active) at a time. Some of these screens are just query screens that ask players what name they want to give to the current game file, whether they want to end the game, whether they want to exit the simulation environment, and so on. The main game screen is divided into four display boxes (see Figure 18). The Game Controls box includes buttons to be used to end the game, exit the simulation environment, or see the game conditions. Two display objects in this box show final time and current time.
The Decisions box includes the player decision entries and the Advance button. The user enters his or her decisions on "new graduate students," “new undergraduate students,” “graduate faculty hiring,” and “undergraduate faculty hiring” (which represent the number of new graduate and undergraduate faculty members to be hired in the current semester); “share of income-generating projects per faculty member” (which indicates the amount of money that will be paid to each person-hour of faculty workforce from income-generating projects); and “weekly release time per graduate faculty member” (any load reduction from the maximum weekly instruction hours of graduate faculty members). When the Advance button is pressed, the simulation proceeds one period (semester) and the new values are calculated and displayed. The Help button calls a small frame that includes information about the decision variables.

The Main Indicators box displays the values of the 60 variables in the current time period. The buttons with the names of the various decision and indicator variables display the behavior patterns of the related variables when pressed. The button More Indicators is pressed to call another set of 30 variables.

The main button in the Detailed Analysis box executes the link to the Detailed Analysis Screen, which includes certain analysis tools. The Causes Tree tool displays the causal tree diagram of all variables that affect a certain (selected) variable. The Uses Tree tool displays the tree of all variables that are affected by the selected variable. Loops is another tool that displays the causal loops that include the selected variable. The Graph tool plots the time graph of any selected variable, and the Causes Graph tool plots the graphs of all the variables that affect it. Finally, the Causes Table tool yields a table that includes the time values of the selected variable and all the variables that affect it.

A series of verification and validation tests are done on the interactive simulation game. The behavior of the variables under “extreme player decisions” are tested, and several sensitivity tests are done (results not shown; see Diker, 1995). The necessary improvements both in the model and the in game are made according to the results of these tests. The resulting game is believed to be a valid and robust interactive simulation gaming environment.

A group of players with different academic degrees and different orientations were invited to play UNIGAME. Among the players were graduate students, teaching and research assistants, faculty members, and managers. Some selected results are presented for illustration.

### Game Results of a Research-Oriented Faculty Member

The first player was a faculty member who has high research interests and little interest in income-generating projects, even if they are realized through official university channels. During the game, except for period 6, he consistently hired more graduate faculty than undergraduate faculty. He gave considerable release time to graduate faculty (2 hours/week on average). He decreased official projects share for
faculty members gradually (see Figure 19). As a result of his emphasis on graduate study and research, he obtained a remarkable increase in the number of research papers per semester. The average research papers per faculty member increased as well (see Figure 20). On the other hand, decreasing the official projects share for faculty members caused official projects motivations of the faculty members to decrease and unofficial projects motivations to increase. These in turn caused the weekly hours dedicated to official projects by faculty members to decrease and the hours dedicated to unofficial projects to increase. (A counterintuitive result certainly not intended by the “research-oriented” player.) In Figure 21, the behaviors of project loads of graduate faculty members and total FTE for official projects are shown; the patterns for undergraduate faculty members are similar.

### Game Results of a Balanced Faculty Member

Another player was a faculty member who tried to strike a balance between instruction, research, and project activities. He put some emphasis on research by giving release time to graduate faculty, but also encouraged official projects by giving a considerable official projects income share to faculty members (see Figure 22).

The balanced faculty member obtained an increase in the number of research papers published per semester and average research papers per faculty member (see...
FIGURE 20: Dynamics of Research Papers in the Game Played by the Research-Oriented Faculty Member

FIGURE 21: Dynamics of Project Loads of Graduate Faculty Members in the Game Played by the Research-Oriented Faculty Member
FIGURE 22: Decisions of the Balanced Faculty Member

FIGURE 23: Dynamics of Research Papers in the Game Played by the Balanced Faculty Member
Although these levels are somewhat lower than those obtained by the first player, the differences are not very significant.

The important difference between the decisions of the research-oriented faculty member and the balanced faculty member is that the latter put the necessary emphasis on official projects activities, which the former neglected. This factor causes significant differences in the two games, between the number of FTE faculty working on official projects, as well as differences in the distribution of the project workloads among official and unofficial projects (see Figures 21 and 24).

Conclusions

An interactive simulation model for the academic aspects of university management is presented. The model focuses specifically on the long-term, dynamic, strategic management problems, such as growing student/faculty ratios, poor teaching quality, and low research productivity. The system dynamics simulation model (the “engine” behind the game) is built first. Numerous verification, validation, and sensitivity tests were carried out on the model. The parameters are calibrated using data from Bogazici University, and the dynamic behavior patterns generated by the model are found to be consistent with the major historical time patterns obtained from Bogazici University.

Next, the simulation model was converted into an interactive simulation game. The interface was built using the Venapp facility of Vensim software. Players with different
academic degrees, backgrounds, and orientations played and tested the game. A comparative analysis of the game results of different subjects reveals that players with different orientations emphasize different performance measures of the university. Furthermore, game results show that players do not always act consistent with their stated objectives and preferences. For instance, a self-declared research-oriented player may indirectly cause a greater percentage of faculty members to do outside consulting. Such results demonstrate the complex and counterintuitive nature of such systemic, dynamic games. Research results suggest that UNIGAME promises to be a useful technology to support strategic management and a laboratory for theoretical research on how to best deal with strategic university problems. We are currently carrying out further research on the existing model and the gaming interface. The model will be extended to include more aspects of the university system, such as budget considerations and support staff. The model will provide more detailed representations of variables such as facilities, infrastructure, and projects. Also, the gaming interface will be enhanced to include various user-friendly features.

**References**


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