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Mining Engineering Postgraduate Education by Distance Learning through the Internet

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ABSTRACT: This work considers different schemes to assist the need of mining engineers for advanced postgraduate education. The work is conducted İn two stages. In the first stage, a modified Delphi approach is applied to determine the teaching modules that mining engineers consider the most important and useful. Using statistical analysts tools, it İs found that the market that the course addresses can be enlarged to include chemical engineers, metallurgists and industrial chemists, who display similar demand patterns. The second stage consists of an economic/technical analysis of five suggested alternative teaching modes. These scenarios include the options of distance learning (DL), studio-on-line and tutor-on-line DL using the Internet, experts delivering lectures in situ, and a traditional university course. The best option is identified by means of the cost benefit, while a sensitivity analysis is carried out to show the dependence of the expenditures on the cost variables.

1 INTRODUCTION

The establishment and operation of institutions of learning with high accessibility, course diversity and appropriate facilities scattered over a large area is an extremely expensive task. This is particularly true in countries with the topology and geography of Greece, with remote communities in small islands or in mountain regions. Students have to spend a great deal of time and money on their education if they decide to pursue a university degree by means of conventional education schemes (Croy, 1998).

Distance education presents an interesting alternative. The idea of DL has been around for a long time, while advances in information technology provide new modalities to assist the delivery of knowledge to anyone interested, regardless of place or time. Especially nowadays, the concept of delivering course material is shifting from the physical classroom to the virtual classroom, where there is a lack of direct face-to-face contact. Since 1969, the Open University (OU) in the UK has offered undergraduate degrees via a "virtual classroom" (Educom Staff, 1996). In the USA, the California Virtual University (listing 1000 distance education courses) and the Western Governor's University (a consortium of 18 states) are two of the most successful examples of partnerships formed to promote distance education as a viable alternative to classroom instruction (Koss-Feder, 1998). Computer-mediated communication (CMC) schemes appear as substitutes to direct student-tutor interaction, and create the social presence that lacks in traditional distance learning courses (Tu, 2000). In these applications, the Internet presents the twin advantages of a powerful development platform in a familiar and user-friendly environment (Butler, 2000; Yanarella et al., 2000).

At the moment, the European Union is creating a network of European open universities and is providing substantial financial assistance. This situation brings immense opportunities for the development of DL schemes, while the recently established Hellenic Open University (HOU) can administrate such courses.

This paper considers the postgraduate education of mining engineers in high-managerial positions who have typically graduated over 20 years previously. Having left the classroom so long ago, they need to enrich and update their knowledge, while the nature of their job (which locates them away from the big cities where most universities are) has probably deprived them of a postgraduate degree. It is not the purpose of this paper to stress the importance of continuing education in an era of global information and competition (see Harrod and Townsend, 1998).

The work first applies a modified Delphi approach in order to determine the teaching modules that appear to be of great importance and use to a sample of mining engineers. Using statistical analysis tools, it is found that the course target audience can be enlarged to include chemical engineers, metallurgists and industrial chemists, who display similar demand patterns. Based on the suggested course modules, the study continues with an economic/technical analysis of five suggested alternative teaching modes. These scenarios include the options of distance learning (DL), studio-on-line and tutor-on-line DL using the Internet, experts delivering lectures in situ, and a traditional university course. The best option is identified by means of the cost benefit, while a sensitivity analysis is carried out to show the dependence of the expenditures on the cost variables.

The paper presents the first attempt in the field of postgraduate education opportunities for mining engineers in Greece, and thus features elements of a forecasting activity. For this reason, the Delphi method is suggested, suitably modified to address the needs and practicalities of the present study.

2 METHODOLOGY

The Delphi method was initially developed at the RAND Corporation in 1950 by Dalkey and his colleagues so as to eliminate several negative effects produced by interacting individuals and groups in die process of decision making. Traditionally, tiiis method has employed the use of advisers/experts in order to arrive at a consensus on the determination of the necessity of plans/actions and their consequences in the near future, as well as on the likelihood and timing of possible future events. These advisers/experts are queried independently on iterative questionnaires with feedback supplied between rounds by the group in charge for the whole project.

There are many versions, modifications and extensions of the Delphi method. One of these, called SEER (System for Event Evaluation and Review), introduces preliminary work for constructing an initial list of alternative scenarios to reduce the number of questionnaire rounds, thus saving effort, economic resources and time. According to this modification, the advisers/experts are asked to answer questions only in their area of expertise İn order to obtain answers of approximately equal importance/reliability, thus avoiding the otherwise necessary setting of weights on opinions according to the specialty of each expert (Fusfeld and Foster, 1971).

The three-stage Delphi version adopted here employs the use of a different set of advisers / experts at each stage in order to increase reliability and reduce the required time, cost and resources. For this last reason, the first two questionnaires were answered orally, while some preliminary work,which should be performed by the experts during the first round, was actually done by one research group. The whole project lasted about 45 days, not including the background work done previously. It can be divided into the following nine steps:

1. Problem definition. Retrieval of information available. Determination of expertise required. Selection of advisers/experts. Preparation of the first questionnaire with the objective of selecting the topics that must be taught to the professionals whom the program is addressed to.
2. Personal communication with advisers/experts. Classification and processing of answers. Unification of topics into formal entities, corresponding to similar entities found in the teaching material provided by universities on Internet sites which are considered international leaders in the field.
3. Intermediate restructuring of the initial problem on the basis of these formal-teaching entities. Preparation of the second questionnaire with the objective of investigating ways of teaching/learning these entities by modern educational means.
4. Personal communication with advisers/experts other than those mentioned above (mainly tutors of HOU). Categorization and processing of answers.
5. Final restructuring of the problem on the basis of the relation between teaching entities and teaching modes. Formulation of teaching modules with the corresponding syllabuses. Preparation of the* third questionnaire with the objectives of (i) ranking the modules according to their importance for the potential postgraduate professionals, and (ii) obtaining feedback as regards topics probably not included in the initial list of modules (or topics incorporated within wide-ranging instead of stand-alone modules).
6. Circulation of the written questionnaire. Collection and processing of answers. Decision making on the final structure of the teaching program.
7. Design of alternative ways to realize the program.
8. Cost benefit analysis of the alternatives. Further investigation of each alternative solution by means of break-even point and parameter sensitivity analysis.
9. Decision making on the most beneficial alternative. Simulation of application aided by a specimen group of professionals exhibiting the characteristics of expected or possible candidates. Further improvement of the proposed solution.

Subsequently, we present the quantitative parts of tbis work, namely, the statistical processing of answers to the third questionnaire and the cost benefit analysis (included in steps 6 and 8, respectively).

Table 1: Statistical analysis for assessing agreement of the rankings within the sample of 14 mining engineers.

Module	R_i	R_i/m	s.d.	rank
Engineering economics	32	2.29	2.15	10
Environmental management	47	3 36	2.81	9
Human resourses management	89	6.36	1 99	4
New technology & methods	59	4.21	2.06	7
Occupational health	115	8.21	1 64	2
Operations management	80	5.71	2.00	5
Reliability & risk analysis	49	3.50	1.89	8
Safety	117	8.36	1.95	1
Statistical process control	103	7.36	2.28	3
Total quality management	79	5 64	1.81	6

$n = 10$, $m = 14$, $w = 0.4892$, $x^2_r = 61.64$

top-down: $C_T = 0.4701$, $x^2_T = 59\ 23$

bottom-up: $C_T = 0\ 4569$, $x^2_T = 57.57$

Table 2: Statistical analysis for assessing agreement of the rankings within the sample of 23 CEMICs.

Module	R_i	R_i/m	s.d.	rank
Engineering economics	67	2.91	1.51	10
Environmental management	82	3.57	2 45	9
Human resourses management	143	6 22	2.32	4
New technology & methods	124	5.39	2.12	5
Occupational health	199	8 65	2.22	1
Operations management	101	4.39	2.86	8
Reliability & risk analysis	113	4.91	2.06	7
Safety	170	7.39	2.00	2
Statistical process control	146	6.35	0.84	3
Total quality management	120	5 22	2.39	6

$n = 10$, $m = 23$, $w = 0.3254$, $x^2_r = 67.36$

top-down: $C_T = 0.2874$, $x^2_T = 59.49$

bottom-up: $C_T = 0.3425$, $x^2_T = 70.89$

Table 3: Statistical analysis for assessing agreement of the rankings in the joined sample of 37 professionals.

Module	R_i	R_i/m	s.d.	rank
Engineering economics	99	2 68	1.51	10
Environmental management	129	3.49	2.45	9
Human resourses management	232	6.27	2.32	4
New technology & methods	183	4.95	2.12	6
Occupational health	314	8.49	2.22	1
Operations management	181	4.89	2.86	7
Reliability & risk analysis	162	4.38	2 06	8
Safety	287	7.76	2.00	2
Statistical process control	249	6.73	0.84	3
Total quality management	199	5.38	2.39	5

$n = 10$, $m = 37$, $w = 0.3648$, $x^2_r = 121.5$

top-down: $C_T = 0.3305$, $x^2_T = 110.1$

bottom-up: $C_T = 0.3654$, $x^2_T = 122.3$

3 STATISTICAL PROCESSING

The ten modules included within the third questionnaire are listed alphabetically in the first column of Table 1. Fourteen professionals, all mining engineers, were asked to give marks in the form of ranks in descending order from 10 to 1. The ranking is according to the subjective judgment of each of them separately, and refers to the importance/usefulness of the modules. The Kendall coefficient of concordance was used to determine the degree of agreement among these rankings. The next columns indicate the sum of the ranks *R, (i=\,..,n),* the mean, the standard deviation (s.d.) and the overall ranking. The Kendall coefficient for this sample is 0.4892; the significance of this value is checked through the relationship between this coefficient and the Friedman chi-square, x^2_r, i.e. $x^2_r = m(n-1)w$, which gives $x^2_r = 61.64 >$ jr$_{r>CJ}$ where $xr_{r,L}$ are the tabulated critical values for confidence levels of 90% and 95% according to the chi-square distribution (*m*=*samp\e* size, »=number of teaching modules). Consequently, the null hypothesis that there is no agreement among the 14 rankings is rejected.

We also use a weighted rank correlation (after Quade and Salama, J 992) to put emphasis on those modules ranked high or low, performing a top-down or bottom-up examination, respectively In the bottom-up examination, each original rank k is replaced by its Savage score (Iman and Conover, 1987), i.e., the sum of reciprocals 5, -£"$_{=J}$1/&. For the top-down examination, the Savage scores are assigned in reverse order, since the reference is expressed in descending order. The corresponding test statistic CT, for assessing the degree of agreement among the professionals, is used to calculate $x^2_T = m(n-1)C_T$. The resulting x"> İs compared to the tabulated critical values of chi-square distribution for confidence levels of 90% and 95%.

Since the number of mining engineers in Greece İs rather limited, i.e., 2,000 (only a small percentage of these work in mines, while this figure includes metallurgists), we decided to extend our study to chemical engineers, metallurgists and industrial chemists (CEM1C) in order to mcrease decisively the possible demand. It is worthwhile noting that the number of chemical engineers is about 7,200 and the number of industrial chemists is about 1,800 (out of a total of 8,200 chemists). Tables 2 and 3 correspond to the new sample of 23 CEMICs and the joined sample of 14 + 23 = 37 professionals, respectively. In both cases, as well in the top-down and bottom-up analytical examination, we find the rankings to be in agreement. We can, therefore, proceed to cost benefit analysis based on an enlarged market which exhibits significant uniformity as regards the demand for educational services (priority and intensity/emphasis on teaching modules).

4 ALTERNATIVES UNDER CONSIDERATION

The suggested postgraduate studies program is based on taught courses, examinations, projects and a dissertation. The course length is one and a half years, divided into three semesters. There are ten available modules, as discussed previously. Within the first two semesters of the course, each participant is entitled to take either the ten modules described, or a selection of five of his/her choice. In the latter case. die participant allocates the remaining course time to the thesis project, which is continued and concluded within the third semester of the course. The participants selecting the former option should spend the third semester on four small-size projects.

The following economic/technical analysis assumes a number of 120 participants scattered over many small and medium-size mining sites and industrial units in Greece. Our survey has yielded that 40% of the potential participants are mining engineers and the rest are CEMICs. To accommodate for the slightly different interest areas and educational backgrounds of the above categories, it is assumed that each module's material consists of a theoretical part, which is common to both categories, and an application part, which is tailored lo the category in question. Note that this should increase the figures in some parts of the expenditures (for instance, the development of the course material).

Clearly, the average student (having graduated 20 years previously) should have particular difficulty in complying with the university's expectations. In this sense, the course design allows flexibility so that the length can vary according to the needs of the individual participant. Indeed, the student can attend the courses over a longer time than the prescribed one year or spend longer time on the project work. Accordingly, the analysis presented here is based on the average course length, which is expected to be two years.

The scenarios for continuing education consist of five distance and face-to-face schemes, including conventional and novel alternatives. The different cases considered here are:

1. Distance learning course.
2. Studio-on-line distance learning course.
3. Tutor-on-line distance learning course.
4. Experts deliver lectures in situ.
5. Traditional university course.

An economic/technical evaluation is performed so as to indicate the best options based on strictly economic criteria.

Scenario 1 assumes conventional DL, as in the case of the British OU or the recently founded HOU. In this scheme, the student, who may reside in a remote location, receives a package with the course material (carefully put together to assist the self-learning process). A personal tutor is assigned to each student, and student-tutor communication is mainly over the phone, e-mail, or the Internet course forum. The next two scenarios resemble scenario 1, but they allow synchronous on-line communication between the participants and their tutors. The participant should have access to a studio near the place of his/her residence (scenario 2) or acquire a personal computer (scenario 3). The tutor İs found at the central studio and he/she can be contacted via an Internet connection at predetermined times according to the course schedule. Apart from the interactive option in scenarios 2 and 3, the students in scenarios 1-3 should be able to:

- have e-access to the course material (found on a web page in the course site),
- communicate (synchronously or asynchronously) with other students and his/her tutor via a specially allocated course forum,
- submit his/her assignments electronically, etc.

A number of courses have nowadays adopted similar schemes, developed on an Internet platform (for instance me on-line quality assessment pilot course at:
http://mirnix.europace.be/quality/index.php3).

The last scenario (5) considers the traditional option of attending a conventional university course. This obviously requires that the student reside close to a university that supports the course and find a course time-schedule conforming with his/her professional or personal commitments. Scenario 4 follows the classroom instruction schemes of scenario 5, but the lectures are delivered in situ. Consequently, the tutors have to travel and possibly stay over a period of time at the various remote places where the students reside.

5 COST BENEFIT ANALYSIS

The total annual expenditures are estimated for each one of the five scenarios. The students attending the course are divided into a number of smaller groups that share the same tutors, facilities, etc. The number of persons per group is fixed according to the nature of the student-to-tutor interactions. In the OU scenario, each tutor supervises 30 students, while scenario 5 accommodates up to 25 students in the same university classroom. Note that these numbers are in agreement with common practice in Greek universities. Scenario 4 assumes 20 students on average. The number is lower than scenario 5, to address the possible difficulty in finding 25 students in each remote site. For the studio-on-line case, one has to account for various practicalities, e.g., that the tutor cannot communicate synchronously with more than 8 students sharing the same studio. The tutor-on-line scenario accommodates up to 15 students per tutor since we do not expect all the students of the group to be logged on at the same time.

Accordingly, each education scheme assumes a different number of hours annually for synchronous student-to-tutor interaction. Based again on common practice, the OU hours are set at 20 though the lectures taking place in scenarios 4 and 5 require 350 hours annually. For scenarios 2 and 3, the number of hours available on line is 300 annually. Since it is up to the student to what extent this availability will be exploited, it is estimated that only 40% of this time will be used.

As an example, Table 4 presents ihe detailed calculations for the OU option. The total costs per annum consider the depreciation of the original investment (over a period of 3 years), the annual Fixed costs to support the course, and the annual running costs depending on the participants In terms of the imtial investment, the development of the course material is of crucial importance in a distance course with minimal contact between the student and his/her tutor (Hunt, 1998) According to the scenario, it is possible that this material should be sidelined with software that assists the learning process or enables the on-line communication. The latter, though, does not apply in scenario 1 The annual fixed expenditures relate to the costs of administering and coordinating the course, regardless of the demand. Each student presents an additional expenditure m terms of reproducing the course material, providing personal supervision, etc However, it is the groups of students one needs to take into consideration when estimating the total course bours per annum. Each hour yields different expenditures according to the nature of the student-to-tutor contact and the facilities required to establish it. According to the scenario, one might include traveling and accommodation expenses or charges for the ISDN line. In addition, the tutors receive a fixed amount per group to cover for the expenses of familiarizing themselves with the course material and/or the way the course is conducted.

Table 4 Total and itemized expenditures for Scenario

	cost (EU)	annual cost (EU/yr)	annual cost per student (EU/yr)
fixed expenditure per course		**125,000**	**694**
depreciation time (yrs) = 3			
development of reading material	150,000	50,000	278
administration, in course development	60,000	20,000	111
development of software	45,000	15,000	83
pilot runs	30,000	10,000	56
consultancy	90,000	30,000	167
annual fixed expenditure per course		**195,000**	**1,083**
communication	15,000	15,000	83
administration	90,000	90,000	500
academic staff (course coordinators)	60,000	60,000	333
rent of central building	30,000	30,000	167
annual running expenditure per student		**121,500**	**675**
reprint of reading material	180	32,400	180
reprint of software	45	8,100	45
administration	150	27,000	150
personal tutor (supervision)	300	54,000	300
hourly running expenditure per group		**7,200**	**40**
hours in meetings/year = 20			
rent of meeting place	27	3,240	18
tutor in situ	15	1,800	10
tutor traveling expenses	18	2,160	12
annual running expenditure per group		**4,500**	**25**
tutor responsible for group	750	4,500	25
total annual cost		**453,200**	**2,518**

Table 5 presents the final and itemized course expenditure estimations for all five scenarios. The best solution is the OU scheme. The studio on line is 60% higher than the best solution, while the option of sending experts in situ leads to more than twice the OU expenditures. Somewhat near the OU is the tutor-on-line alternative, closely followed by the traditional university scheme. If one considers the practicalities of either moving to a different city to attend a university course, or lacking substantial supervision and tutor support, then scenario 3 probably presents the most attractive alternative seen from the viewpoint of the student. These figures can be reduced if one takes into account subsidies from the government or the European Umon (EU) as financial support for postgraduate education.

Table 5.Total and itemized expenditures for the 5 scenarios

	scenario 1 *(EU/yr)*	scenario 2 *(EU/yr)*	scenario 3 *(EWyç)*	scenario 4	scenario 5 *(EV/yr)*
FIXED EXPENDITURE	**125,000**	**184,400**	**160,250**	**81,000**	**129,000**
course development	**125,000**	**155,000**	**155,000**	**81,000**	**129,000**
development of reading material	50,000	50,000	50,000	24,000	24,000
administration, in development	20,000	20,000	20,000	20,000	12,000
development of software	15,000	45,000	45,000	9,000	9.000
pilot runs	10,000	10,000	10,000	10,000	10,000
consultancy	30,000	30,000	30,000	18,000	14,000
facilities	0	0	0	0	60,000
remote studios	**0**	**19,200**	0	**0**	**0**
studio equipment (4 PC's, printers, peripherals)	0	17.500	0	0	0
studio facilities (furniture, carpet, lighting, etc)	0	1,700	0	0	0
central studio	**0**	**10,200**	**5,250**	**0**	**0**
studio equipment (6 PC's, printers, peripherals)	0	9,300	4,800	0	0
studio facilities (furniture, carpet, lighting, etc)	0	900	450	0	0
ANNUAL **FIXED EXPENDITURE**	**195,000**	**249,000**	**249,000**	**195,000**	**186,000**
communication	15,000	15,000	15,000	15,000	6,000
administration	90,000	90,000	90,000	90,000	90,000
academic staff (coordinators)	60,000	60,000	60,000	60,000	60,000
rent of central building	30.000	30,000	30,000	30,000	30,000
technical support (central studio)	0	54,000	54,000	0	0
ANNUAL RUNNING EXPENDITURE	**133,200**	**286,875**	**139,680**	**573,750**	**248,625**
students	**121,500**	**102,600**	**102,600**	**64,800**	**48,600**
reprint of reading material	32,400	32,400	32,400	16,200	16,200
reprint of software	8,100	16,200	16,200	5,400	5,400
administration	27,000	27,000	27,000	43,200	27,000
personal tutor (supervision)	54,000	27,000	27,000	0	0
meetings	**7,200**	**153,900**	**28,080**	**388,800**	**194,400**
tutor on line	0	40,500	21,600	0	0
ISDN call charges	0	24300	6480	0	0
anchor person at remote studio	0	40500	0	0	0
technician at remote studio	0	48600	0	0	0
rent of meeting place	3,240	0	0	87480	72900
tutor in situ	1,800	0	0	243000	121500
tutor traveling expenses	2,160	0	0	58320	0
groups	**4,500**	**30,375**	**9,000**	**120,150**	**5,625**
tutor accommodation & maintainance	0	0	0	113,400	0
tutor responsible for group	4,500	16,875	9,000	6,750	5,625
remote studio rent and mise expences	0	13500	0	0	0
TOTAL ANNUAL EXPENDITURE	**453,200**	**720,275**	**548,930**	**849,750**	**563,625**

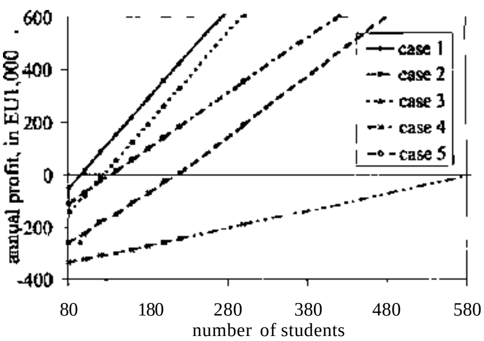

Figure 1. Break-even point analysis on the number of students.

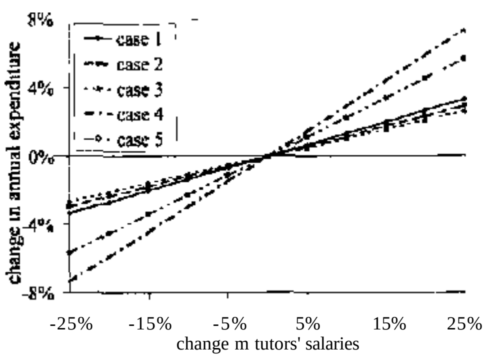

Figure 2. Sensitivity analysis on the expenditure for tutors.

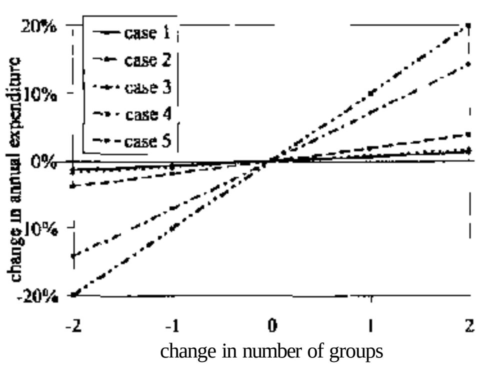

Figure 3 Sensitivity analysis on the number of groups.

6 BREAK-EVEN POINT AND SENSITIVITY ANALYSIS

The previous sections discussed the results of the economic/technical analysis in terms of - the expenditures, without considering the revenue resulting from the tuition fees paid by the students. A fixed fees platform of EU4.500 is assumed for all the scenarios, leading to EU3,000 annually per student.

Based on the fees, the number of participants is varied so as to identify the break-even points for each scenario. The results are shown in Figure 1. Scenarios 1, 3 and 5 present reasonable break-even points at 95, 123, and 131 participants, respectively. Scenarios 2 and 5 present break-even points at 215 and 587 participants, respectively. The last numbers are way off the course analysis and design standards, rendering the respective scenarios unfeasible (at least without some sort of financial or other support). Of the feasible cases, scenario 1 is always the most economical regardless of the number of participants. With the expected demand of 120 students, scenarios 3 and 5 appear economically unfeasible. However, the EU allocates special budgets to the financial support of distance education courses, and thus the expenditures for scenarios 1-3 can be reduced.

Figures 2 and 3 illustrate results from the sensitivity analysis. The former considers changes in the salary of the tutors and how these affect the total annual expenditures. Note that the tutors are temporary staff with annual contracts and their number follows the course demand fluctuations. With respect to Table 5, the costs appearing in the tutors' salary refer to the supervision of students and groups, and in-situ or on-line hourly meetings. Clearly, an increase in the tutors' salaries brings an increase in the overall annual costs, but the extent of the change differs for each scenario. The slope is similar for the first three scenarios, i.e., the distance education alternatives. Scenarios 4 and 5, however, require many hours of lecturing in situ, and this increases the contribution of the tutor salary to the total expenses.

A similar trend can be seen in Figure 3. By increasing the number of groups, we impose an incremental change in the total annual expenditures. Again, the extent of the change depends on the scenario, with scenarios 5 and 4 being the most affected. However, the distance learning schemes are insensitive to the number of groups of students. Consider scenario 1: if we increase the groups from 4 (base case, assuming 30 students per group) to 6 {i.e., by 50%), the overall cost increases by less than 3%. Similarly, in scenario 2, an increase of 25% in the groups (from 8 to 10) results in an additional 2% in the annual costs. This is an important observation, since the number of groups can indeed vary based on course demand in the local communities.

7 DISCUSSION AND CONCLUSIONS

This paper presented a study of possible education schemes for mining as well as other engineers working in mining sites in Greece. Because of the nature of their job, they usually reside in remote areas scattered across relatively inaccessible rural regions. The location issue, along with the wish of these professionals to pursue postgraduate degrees, makes them an ideal target group for DL courses.

Using a modified three-stage Delphi approach, a course often modules is proposed. In the last stage, a survey is conducted with two samples, one of mining engineers, and another of chemical engineers, metallurgists and industrial chemists working in mining sites. The survey has proved that there is a high statistical agreement between the samples as regards the demands for educational services. As a result, the suggested course applies to a wider market, with an estimated demand of 120 participants annually.

Five different course implementation scenarios are considered in order to examine the economic viability of the course. The scenarios include traditional in-situ classroom instruction schemes as well as DL alternatives. The former appear as reference cases, while the case of full-time attendance in a university is obviously in conflict with the professional commitments of mine employees. The other options include conventional and on-line DL. The on-line schemes include synchronous interaction with the course tutor through an Internet connection. The conventional and the tutor-on-line schemes are economically feasible over the break-even point and sensitivity analyses carried out here. If criteria other than the cost are considered, the tutor-on-line option appears more promising, since it provides the opportunity for further communication between the student and his/her tutor on a synchronous, visual and vocal basis.

It is further suggested that the implementation is carried out mainly by the Department of Mining & Metallurgy Engineering of NÏTJA. In effect, NTUA has a suitable infrastructure to support continuous (as well as under- and postgraduate) education, while open universities avoid issuing degrees in chartered professions (e.g., in law, medicine, and engineering). The above scheme will also include as board members/consultants the Union of Hellenic Industries, the Ministry of Industry, Energy and Technology, and the Technical Chamber of Greece, as well as HOU.

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