Selection of Graduate School for Masters of Science in Engineering using Hierarchal Decision Modeling (HDM)

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EMGT 630 / 530 : Decision Making in ETM
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Winter 2009

Contents

Abstract

The decision to select an appropriate graduate school is a very critical decision for a student seeking this opportunity. This paper uses a Hierarchical Decision Model for the selection of an engineering graduate program from five graduate schools in Oregon. The paper includes a brief overview of each criterion that was used in the model as the main factor that students think about when they try to select the appropriate graduate school for a master in an engineering program. In addition, there is a brief description of the five universities which are considered as alternatives in this paper. Additionally, the project report shows how the HDM was used to prioritize the alternatives. A Judgment Quantification Instrument (JQI) was developed to obtain pair-wise comparisons from various experts. Twelve experts responded to the instrument and their judgments were analyzed. Then, the paper explains how the calculations were made and final weights are then calculated. Finally, this project report also suggests the future work that can be done to further expand the model and include other universities from the northwest and other states. Further modification of this model could allow it to be used for all different types of schools and programs not just engineering or graduate programs.

1. Introduction

Each year, thousands of prospective graduate students decide on where to further their studies in terms of college institutions. Many factors are considered when deciding, including the perceived image or academic reputation of the school, campus life facets, cultural diversity of the student body, quality of housing options, availability of research grants, and overall cost of the program. Many publications are available to obtain about each school in terms of faculty-teacher ratio, average classroom size, demographic breakdown, and so on. You can also find many publications which use different methods to rank schools in the U.S. in terms of academic excellence, which are sorted by undergraduate and graduate schools and by program. Among the most popular of these rankings are U.S. News and World Report magazine, and Kaplan's, Inc. However, in our research, no decision models were found incorporating several criteria so that one school could be chosen. The intent of this study is to develop a model that can weigh these criteria for a prospective student to make a decision suited to his/her needs.

In choosing the mission for our model, we decided to decide the best engineering graduate school for a particular person surveyed based on several criteria, and how important each criterion was for that person. We decided to use engineering schools partially because all the members of this study are currently enrolled in engineering graduate school and could bring insight into selecting criteria. Also, the number of engineering schools is limited when compared to MBA or Masters in Education programs, so to simplify the model. We also choose to limit the schools to within the state of Oregon. This gave us a total of five schools, which would present a manageable number of comparisons a surveyed person would have to make. Also, by keeping the schools in state, we don't have to consider the resident/non-resident tuitions, and assume all respondents are residents of Oregon.

Choosing the wrong graduate school can be a costly mistake for a graduate student. Often, without a campus visit, one may not get the right idea if a school is right for them. A student may put too much weight on cost alone, and then end up attending a school without the program or research area that they are searching for. Additionally, they may realize once they get there that housing is not available for students that are not undergrads, and they want to live on campus. An oversight like this could lead to a college experience lacking many facets the student had hoped for. A model like the one we're proposing would help a student give weights to each important criterion and could better serve as a tool for deciding where to continue their studies. It also could serve as a framework for other graduate or professional programs, such as business, medical or law schools, and can even help high school seniors select an undergraduate program.

2. Decision Making Methodologies

Some methods used for selecting an engineering graduation school can be based on financial and social aspects, the perceived image of the school, and mathematical modeling. There are many different companies that profit from making ranking systems that rank various schools based on different criteria, and these systems are for students to use when making a decision about what graduate school to go to or all schools in general. But there is not currently a model that will filter through this information, so that the person using this program can find the best school based on their own ratings of various criteria.

If this decision is purely based on financial matters, a model could be made using a cost/benefit ratio. The model would likely favor the school which costs the least after financial aid and scholarships are included. But this model would be very limited because it would only give information based on the cost and would not include other valued information like the perceived ranking of the school.

A more advanced method of a decision making model could use a string predicting program that would filter through a database [1]. An example of how this model would work is that a query would be set up to ask for records that satisfy tow predicates "tuition cost of graduation school per quarter ≥ $4,000 & that the engineering graduation school is located in Portland". This model would filter through the data to find out that the only engineering graduation school that fits these constraints would be PSU. The problem with this type of model is that it is limited to the number of constraints that the user can use. Another problem is that it does not give weights to the criteria to help the decision maker make a decision.

Decision trees would also be another way to model this decision [2]. The way that this model would work is that a decision tree would be made based on certain criteria that are important to the user and the different schools that the user is interested in. The user could then give weights to the criteria and these could then be calculated back to figure out what the best school was. The problem with this type of model is that the more criteria and sub-criteria the model has the more complicated it will get for the end user to follow. This is a very important factor to consider because the model will not get used as much if it is too complicated for the user to get the necessary information they need to make a final decision.

Another way to model this problem would be to use a Hierarchical Decision Model (HDM) that will formulate an expert consensus through [3, 4]. This model assigns the relative values to the various decision criteria. The user puts in values on a ratio scales by a series of multiple pair-wise comparisons. These comparisons are allocated 100 points between the two points in each individual series. This is done in such a way that the allocation of points reflects their judgment based on each element versus one the other with respect to a certain criterion. It was decided that HDM was the best way to model this program because it gives weights to each criterion and the model does not have to be modified for each user.

In formulating the HDM for choosing an engineering graduate school in Oregon, there where several instances where the criteria had to be ultimately weeded out due to they're being considered constraints. The problem with these constraints is that they are either a "Yes" or "No" answer. Among these was the question of "do you want to go to the school you received your bachelors from?" It is a popular choice for graduates of an undergraduate program to attend their alma mater for graduate studies. This may because of familiarity with the facility, convenience of not having to relocate, staying near friends and generally easier admissions standards. No decision would be made and the model would not work for these people. Another criterion that was later deemed a constraint was admissions standards. Both of these criteria where considered constrains because other colleges would have effectively been eliminated if they did not meet these requirements. If Oregon State had admissions standards, for instance GRE exam scores, that Portland State did not, and the student did not take the GRE, OSU would be eliminated from consideration. PSU would receive a pairwise comparison score of 100 to 0 (or 99 to 1) compared to OSU. Other criterion where taken out because it was later noted that these criterion where not necessary because they would not influence the user into selecting a graduation school. An example of this would be "Faculty Ratio". While this is an important criterion it was taken out because it was assumed that this would be a relatively constant number for most graduation schools.

3.0 HDM Model

A Hierarchical Decision Model (HDM) was used to for deciding the appropriate graduate school for masters in engineering in Oregon. The model consists of these three tiers: objective, criteria and alternatives. The criteria were developed after some literature review, discussion with faculty, feedback from students, and brainstorming within the project team. The objective, criteria and alternatives are described in detail in the subsequent sections of this paper.

3.1 Objective & Model

The objective of the model is to select a Master of Science in Engineering program in Oregon. The model is shown in the diagram below:

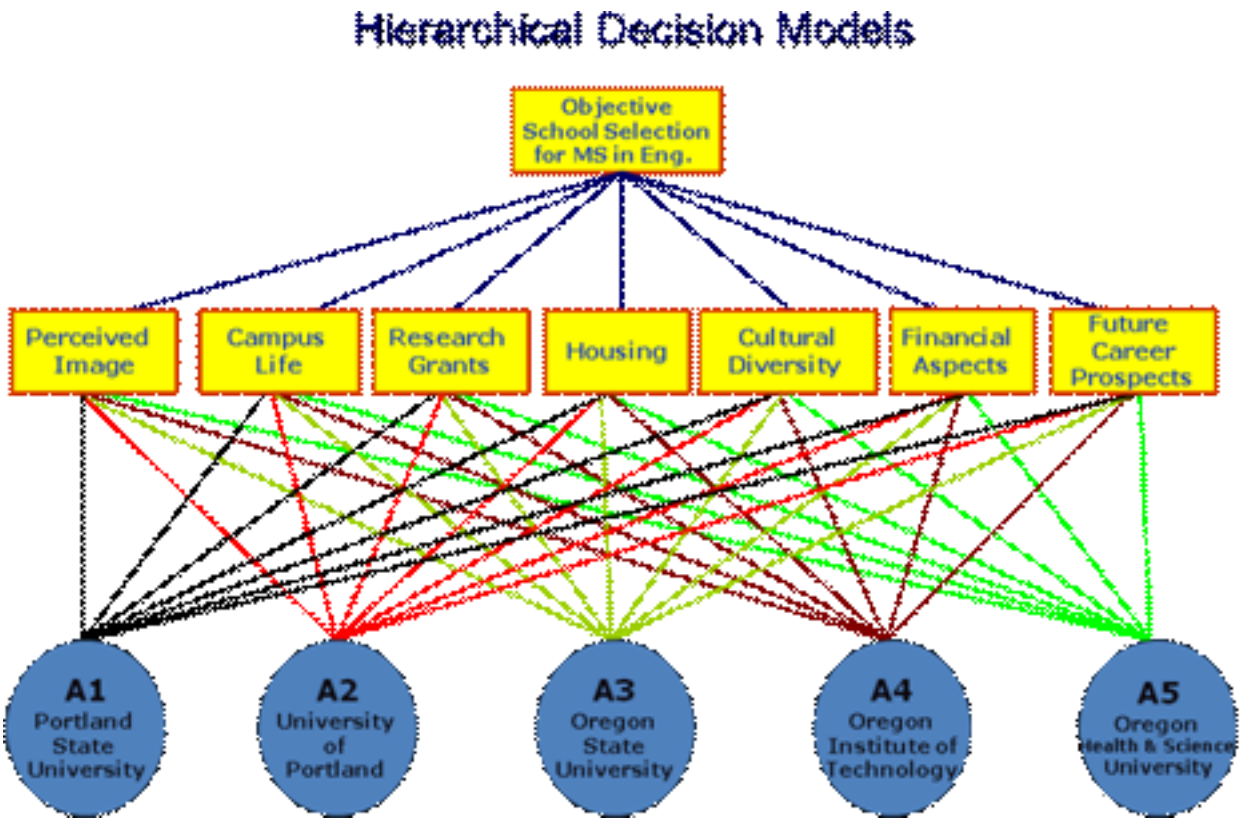


Fig 1: HDM Model

3.2 Criteria

The HDM criteria consist of seven elements. These elements were determined the most critical factors in choosing a graduate engineering school. A description of each element is given below:

Perceived Image:

Perceived image is the overall image of graduate engineering program, the university, faculty and the quality of the education that students. In other words, It is their academic reputations. Ranking and accreditation are two of the most important elements when students consider which school they are going to. Reputation is implemented through surveys that students make frequently, so more surveys lead to more clear and complete picture of a specific school. According to the U.S. News and World Report website, Oregon State University was ranked 80th in 2008, while the others weren't on the list [33]. However, Oregon Institute of Technology was ranked at 4th place as one of top public schools in the west for baccalaureate schools [34]. OHSU was not ranked due to their lack of an undergraduate program. In general, the ranking of the five universities among those in Oregon are shown in table below:

Rank	Name of School
3	UP
8	OSU
12	OIT
14	PSU

Table 1: Ranking of the five universities among Oregon's universities [7]
(Source: http://www.stateuniversity.com/rank_by_state/score_rank/OR/position/14)

In table 2, there are some characteristics that students consider for their potential graduate schools:

School	Ration of student to faculty	Full time faculty	Total grad. Eng. enrollment	Total enrollment	Student Retention	Fall 2007 Acceptance rate
PSU	22 : 1	67	550	24,254	67%	90.7 %
UP	15 : 1	23	*	3,478	86%	58.8 %
OSU	24 : 1	123	564	19,352	81%	85.5 %
OIT	14 : 1	6	*	3,290	67%	93.7 %
OHSU	5:1	47	*	2,418	**	**

Table.2 important characteristics for graduate schools [6, 7]

(Source: US News Rankings &
http://www.stateuniversity.com/rank_by_state/score_rank/OR/position/14)
* No of graduate engineering enrolment is very low
** Student retention / student acceptance rate for OHSU is not available

Campus Life:

Campus life is all about the student life outside the classroom (or outside the academic world). It includes the opportunities available to take part in, such as multiple extracurricular activities, leadership roles, artistic endeavors, intercollegiate athletics, intramural sporting events, recreation, and volunteer service opportunities. Moreover, different clubs and societies provide learning opportunities for students to enhance their overall educational experience. Campus life significantly depends upon how life in the residence halls is, how many clubs and organizations are available on campus, what kind of student events are offered and how many opportunities are available to the students to build a bridge to their future through career-related choices. These activities give an opportunity to the students to contribute their time and talents to life outside the classroom.

Various campus resources and facilities including fitness centers, gyms, sports facilities, cafeterias, union buildings, various student clubs and organizations are the main focus of this criterion. In our informal interviews with many students before finalizing the criteria it was revealed that student give importance to the campus recreation facilities and students programs, because satisfaction with these services has a positive effect on the academic, social and emotional life of the students.

Portland State University being the largest university in the Oregon is located in downtown Portland and offer vibrant and cosmopolitan campus life to the students. It has more than 100 active student programs and organizations designed to enrich the university experience [8]. These clubs offer recreation, fun and other activities to the students. Portland State differs from the other universities in Oregon partially because as an urban institution it attracts a student body older than other rural universities. There are good sports facilities and other campus resources. Portland State offers Division I sports including football and basketball, the latter of which recently won the Big Sky conference and competed in the NCAA Championship Tournament.

University of Portland has a conservative environment and offers diverse opportunities to the students. There is good infrastructure of various campus resources, including the Chiles Center indoor athletic arena [9]. This is the only private school among the choices, and the only one with a religious presence. Catholic services are offered but not required, and theology classes are available to take. It is set in an urban neighborhood of north Portland, and offers views of downtown and Forest Park. Athletics compete at the highest collegiate level, with its woman's soccer team winning 2 recent national championships, and men's soccer and cross country teams regularly in the top of the nation.

Oregon State University offers many of the elements associated with larger American universities, including Division I football, fraternities, and has a reputation for having a "party atmosphere". The university organizes good sporting events and its teams are well ranked, with the men's baseball winning the nations championships in both 2006 and 2007. OSU is a part of Pacific-10 Conference (Pac-10). The PAC 10 is a college athletic conference which operates in the western United States. There are many student clubs and organizations and campus life is very vibrant. Situated in the Willamette Valley, there are a lot of opportunities for outdoor adventure [10]. However since OSU is not located in a big city, there is not an active city life for the students.

Oregon Institute of Technology has limited enrollment of about 3,300 students which creates an intimate campus environment [11]. There more than 30 campus clubs and organizations for the students. Lot of campus activities take place ranging from game nights to sports and cultural events. OIT is situated in Klamath Falls, which has a modest population of fewer than 20,000 inhabitants. This virtually eliminates any element of a city life.

OHSU is a professional university and offers many interest groups to the students [12]. The campus is nontraditional, for it's predominately a medical school and houses 3 major hospitals and a couple hundred medical offices, and research labs. This makes traditional elements of campus life like athletics obsolete, yet it is teaming with volunteer and service-oriented activities. Its main campus is situated on Markham Hill in Portland, with stunning views of Mt. Hood, downtown and east Portland. The Engineering department is located at the smaller Hillsboro campus, about 12 miles west, but it is in the process of moving to the main campus.

Research Grants [10, 12, 22, 23, 35]

This criterion illustrates the amount of funds or budget available at the University for Research Grants. These research projects are done by the graduate students, faculty and staff, and there are many research projects in a departments or programs at any university. Universities allocate a budget for research project and professors also get direct funding from the industry if they (industry people) have interest in a particular research. Universities also develop their laboratories to facilitate research projects in a creative and comfortable environment. For a student who wants to apply for a graduate study program and pursue research opportunities, this criterion is very important. It also indicates research culture at the university / programs. In addition, it shows the opportunities that universities offer to the students as research grants and scholarships. The funding for research projects can be made by internal or external sources. Internal funding can be from the university and external funding is from a company, government organization or foundation.

At Portland State University (PSU), the college of engineering and computer science provides an inspiring and creative environment to develop research projects. The percentage of external funded research in PSU has increased annually by 35 %. In addition, research partnerships with regional industries and government agencies have

been continuously expanded over time. In civil and environmental engineering, PSU is the first among the Pacific Northwest universities in research project by faculty and graduate students in several areas such as structural and transportation engineering. Faculty and students in PSU have received many awards for their research projects; for example, in 2006, Associate Professor David Jay and his research group received over $ 1 Million of newly awarded research grants and in 2007 Assistant Professors Gwynn Johnson and Hamid Moradkhani each received multi-year research grants of about $400k. In short during last three years many professors got research grants [22].

Oregon State University (OSU) is the only university in Oregon that was specified in the Carnegie Foundation's top tier for research institutions [10]. Also, more than 60% of the total federal and private research funding was gathered by OSU in the university system of Oregon. In 2007-08, OSU scholars earned more than $ 231 million in external research funding and during the past five years [10], OSU's research funding has been increased by 75 million dollar. Moreover, OSU's researchers (from faculty and students) have received many awards, and by 2007-08 they have obtained 1,279 awards [10]. Research grants were also given to OSU by different government agencies like U.S. Army Corps of Engineers. The College of Engineering and several other departments at OSU have shown more growth in the research funding [10].

Oregon Health and Science University (OHSU) also receives many funding grants for research & development projects. Most research grants OHSU are funded by a single source [12]. OHSU is launching a strategic plan for its Department of Science and Engineering for an effective research programs that will help solving human and health problems. Many awards have been earned by OHSU researchers and departments which indicates good standard of research at OHSU [12]. In 2005, the Department of Science and Engineering has received a total of awards for approximately 13 Million dollar [12].

The other two universities, University of Portland (UP) and Oregon Institute of Technology (OIT), also give importance to the research grants and research projects but have limited funds for research. OIT have research funding of about $100k per year [35]. UP also offer some fellowships and grants to the students for overseas study; for example, in 2008, UP provided scholarships and grants to some graduate students to teach or conduct research in Europe and South America [23].

Housing:

The intent of university housing is not merely to provide students with a convenient place to sleep and store belongings; rather residence hall facilities and programs are an important resource that enhances academic learning and fosters maturation and progression toward effectiveness in life after graduation. Living on campus is a big part of the college experience. Research shows that living on campus is an important ingredient for academic success and graduation [13]. Universities with safe, clean, and well-maintained residence halls support the academic success of residents.

You are not only making decision of where to study but you are also making decisions that affect academic success, including how to stay healthy, manage a busy schedule, and have time for recreation. Well organized housing services help students develop relationships with roommates, friends, faculty, and staff members.

This criterion emphasizes how important the comfort in housing is important for the person filling this survey. Research over the past 40 years indicates that college students who live on campus are more likely to:

- Take full advantage of campus resources
- Be more involved in campus activities and educational programs
- Take more credits per quarter
- Achieve greater academic success
- Persist to graduate at a higher rate
- Be more satisfied with their overall university experience [13]

PSU Housing

All housing is coed, and there are accessibility accommodations for disabled students. Campus housing is university owned and is managed by a third party. Freshman campus housing is guaranteed, and roommate selection is optional. Total number of on campus residents is approximately 1,400. On-campus residence required for freshman year [25].

First year students in the First Year Experience program are required to take part in one of the meal plans [26]. All students residing on campus must read and sign the housing contract before taking occupancy of their room. The contract can be for the entire academic year or a quarter.

University of Portland Housing

All housing is coed. Men-only and women-only residences are available. Campus housing is university owned, and freshman campus housing is guaranteed. Residence options for students who choose to live on or near campus including traditional residence halls, apartment style buildings, and university owned apartments. Number of on campus residents is approximately 1450 [27].

Room and board rates are based on the combination of a double occupancy room and the chosen meal plan. Meal plans are mandatory in the traditional residence halls. Off campus students can purchase commuter meal plans through cafes.
The contract is for the entire academic year [28].

Oregon State University Housing

Twelve residence halls offer modern college student living arrangement that satisfy a range of different individual requirements. The total resident population of students, spouses, partners, and children is approximately 4,400. The apartments are smoke free. Freshman applicants are given priority for college housing [29].

Dining services are provided by university. They offer menu selections that will meet dietary and budgetary needs of any guest. In addition to residential meal plans they also accept, Visa and Master Card, OSU Card Cash, checks and cash [30]. The contract can be for the entire academic year or a quarter.

OIT Housing

All housing is coed and campus housing is university owned. On campus housing is optional for freshman applicants. Dorm capacity is 450. Each new resident is required to have a meal account [31]. There are three cafes on campus. There are yearly or quarterly contract options available.

OHSU Housing

OHSU is a commuter campus with no on-campus housing available [32]. Students and staff are directed to Portland City to find housing.

Cultural Diversity

Cultural diversity has a great importance to many prospective graduate students. Engineering has an especially high percentage of international students, due to the resources available in the U.S. as opposed some foreign countries. Often, students will want to attend a school which is more culturally diverse, or has a high population from their native country. This can lead to friendships and help with the adjustment of living abroad. Also, many enjoy the opportunity of meeting people from other countries and learn more about other cultures. In any case, a higher level of cultural diversity, or a larger distribution of nationalities would be considered positive.

School [14]	African American	Asian American & Pacific Islander	Hispanic	American Indian/Alaskan	White Non-Hispanic
OSU	272	1532	731	242	13960
OIT	36	171	128	60	2471
PSU	728	2079	1003	323	15705
UP	50	343	110	24	2536
OHSU	42	246	67	23	1849

Table 3: Cultural Diversity in Oregon universities [14]

From the data above, all five schools show little variation in cultural diversity. The greatest diversity was at Portland State University, the least was at Oregon Institute of Technology. The table gives raw numbers of each ethnic population, and the pie charts illustrate percentages. Some races were unknown, and were not included in the table or charts. Pie charts showing cultural diversity in engineering schools are attached as Appendix B.

Financial Aspects of Engineering Graduate Programs (2008-09)

Financial aspects include out-of-pocket expenses for attending graduate school. This includes tuition, fees, room and board, and financial assistance received. If everybody had unlimited resources, then the financial aspects would not be an issue. For most of us, however, it is a dominating issue when deciding what graduate school to attend. Everyone is going to have differing financial assistance based on need and scholastic merit, and will have to factor in expenses like families, etc. These factors, however, will not change regardless of school chosen. There is no benefit to spending more for school, and therefore the lowest cost of a school is considered to be the best.

School	Resident Tuition + Fees	Non-Resident Tuition + Fees	Room and Board Costs	Average Financial Aid Disbursement [6]	Total Cost of Program (Resident)
Oregon State University [15] (4 quarters)	$3,658 (Full Time)/Quarter $14,632 Total Program	$5,602 (Full time)/Quarter $22,408 Total Program	$7,566/yr [20]	$8,030/yr	$14,015
Oregon Institute of Technology [16] (4 quarters)	$3,507 (FT-12 credits)/Quarter $14,028 Total Program	$5,763 (FT-12 credits)/Quarter $23,042 Total Program	$7,325/yr [20]	$10,609/yr	$9,660
Portland State University [17](4 quarters)	$3,754 (FT-12 credits)/Quarter $15,016 Total Program	$5,629 (FT-12 credits)/Quarter $22,516 Total Program	$9,486/yr [21]	$5,860/yr	$19,839
University of Portland [18] (3 semesters)	$820 per credit $24,600 Total Program	$820 per credit $24,600 Total Program	$8,300/yr [20]	$13,878/yr	$16,233
OHSU [19] (4 quarters)	$7,140 (Full Time) $28,560 Total Program	$7,140 (Full Time) $28,560 Total Program	$8,893/yr*	$9,594/yr**	$27,627

Table 4: Fee structure in different universities [6, 15, 16, 17, 18, 19 20, 21]

Table 4 breaks down the estimated costs of each of the five schools being considered. It's important to note the person choosing a school may not look exclusively at total cost of program. The prospective student may be planning to live off campus, and has decided not to exceed $650 a month on housing. Students may find that they can get a one-bedroom apartment for this amount in Corvallis, or a small studio in Portland. In this case, the trade off will be quality of living conditions, but will still be driven by cost of attendance. It was also assumed this student is very ambitious and will finish the program as fast as possible. Again, if they decide to go part time and take more terms to complete, the increase in cost will all be relative and the model would not change.

*Room and board is not offered at OHSU, so the amount is an average of Portland State University and University of Portland, due to the three schools being within 20 miles of each other

**Financial aid disbursement data was not available for OHSU, so the amount is an average of the other four universities.

Future Career Prospects

Future Career Prospects is the relationships between the business and schools that will benefit the graduate student. This can be finding a job now while the graduate student is going to school, i.e. part time job or an internship. Another example would be for when the graduate student has finished their schooling, and is looking for a job in their new carrier. More job opportunities are considered to be to be better. PSU, OSU, and OIT are all a part of the MECOP/CECOP program for finding internships and jobs for students. See appendix C for a list of companies that work with the MECOP/CECOP program. While University of Portland and OHSU both have their own internship and job placement programs. Figure 2 shows how big the work force industries are for the different cities.

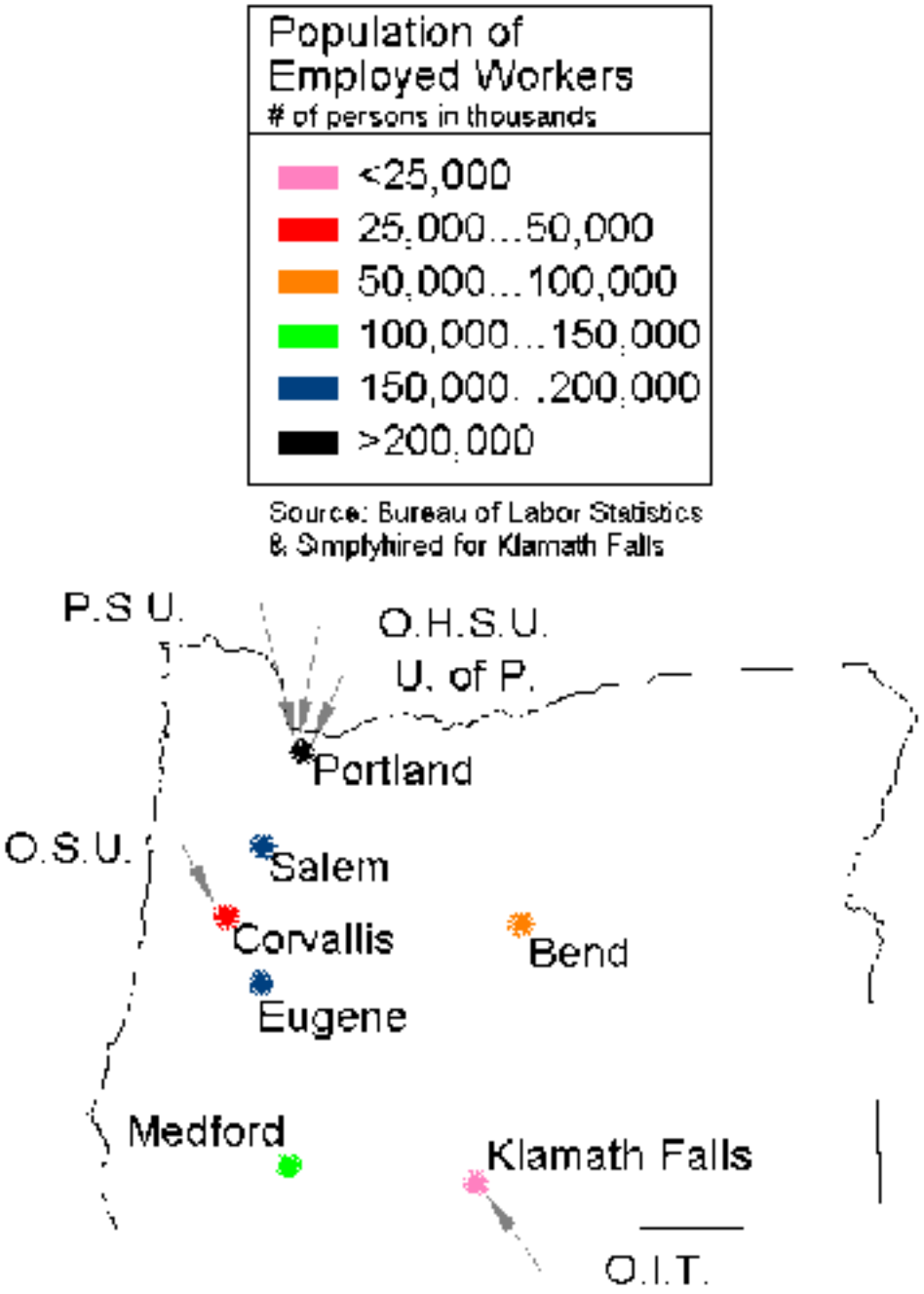


Figure 2: Population of employed workers (Bureau of Labor and Statistics) [5]

3.3 Alternatives

There are five universities in Oregon offering Master of Sciences in Engineering programs. So these are our five alternatives. Brief description of each alternative is given below:

Portland State University (PSU) [22]:

Portland State University is a part of the Oregon University System. PSU is a public state urban university located in downtown Portland, Oregon. It was founded in 1946 and has the largest overall enrollment of students in the state of Oregon. PSU's vision is to enhance recognition of the value of higher education by continually strengthening the metropolitan environment and utilizing that strength for its own growth toward standards of excellence in accessible high quality research, teaching and outreach programs. Schools at PSU include the Maseeh College of Engineering and Computer Science, School of Business Administration, Graduate School of Education, School of Fine and Performing Arts, School of Social Work, College of Urban and Public Affairs, and the College of Liberal Arts and Sciences

Maseeh College of Engineering and Computer Science is well-equipped research laboratories to train students for the fast-changing technology and engineering marketplace. Its students can take advantage of PSU's proximity and access to technology-oriented companies in the Portland metropolitan area. College consists of Civil and Environmental Engineering, Computer Science, Electrical and Computer Engineering, Engineering and Technology Management, Mechanical and Material Engineering departments. The focus of research work ranges from nanoscale medical devices to jet engines; from wireless networks to hydroelectric dams. The Maseeh Foundation donated $8 million to the College of Engineering and Computer Science and college was renamed as the Maseeh College of Engineering and Computer Science.

University of Portland [23]:

Thu University of Portland opened in September 1901. Since then, the university has been grown and has 3500 students and 316 professors. According to the U.S. News and World Report, this university has been ranked in the top 10 schools in the west area of the states. Moreover, it has been ranked 2nd among Pacific Northwest four-year higher education institutions by Seattle Metropolitan magazine. The publication listed a total of 39 public and private universities and colleges from Oregon and Washington based on different variables such as students satisfaction with academics, student satisfaction ratings of campus social life, and alumni giving. According to The Washington Monthly magazine, University of Portland was ranked first among US universities for national service.

UP offers engineering programs which are fully accredited. The graduate program in engineering school has many features for their students. It develops decision making and problem solving skills. Furthermore, this degree enhances your

opportunities to communicate with the outside companies through its local corporate internships. It also improves your engineering, communication, and fundamentals business qualities.

Oregon State University (OSU) [10]:

OSU's main campus is located in the heart of Corvallis, Oregon. This campus features over 400-acres of beautiful park like features for areas of playing, relaxing, and studding. OSU's roots go all the way back to 1858 when it was established as a private academy. During these years OSU has had a three-folded mission of teaching, research, and services to the people of Oregon and the world. The College of Engineering was formally founded in 1889, since then there have been over 28,000 engineers that have graduated from this program. Currently, this program enrolls about 3,100 undergraduates and about 500 graduate students yearly. There are also about 125 faculty members in this program as well. O.S.U. offers more engineering majors than any other university along the west cost and is ranked 22nd largest engineering program in the nation in terms of undergraduate enrollment. OSU takes great pride in the fact that many of its graduates are responsible for many advances in the world we live into day.

Oregon Institute of Technology (OIT) [11, 16]:

Oregon Institute of Technology is the only public, accredited polytechnic university in the Pacific Northwest, and is a member institution of the Oregon University System. The university was founded in 1947 to educate servicemen returning from World War II. Throughout its history, OIT has maintained vital relationships with industry partners to be responsive to workforce needs. Most classroom experiences are balanced between theory lecture and immediate laboratory application. The university's main campus is in Klamath Falls, with two satellite campuses in the Portland-metropolitan area and specific degree programs delivered in Seattle, Medford and La Grande. The graduate placement rate is 98 percent, with an average starting salary of $54,000. The university's overall enrollment is 3,318. OIT is ranked among the US News & World Report Top 10 Baccalaureate Colleges in the West, and is home to the national champion Hustlin' Owls Men's Basketball Team. OIT was the first university in the United States to offer a Renewable Energy Systems bachelor's degree, graduating its first student in June 2008.

OIT currently offers a variety of degrees in engineering and engineering technology, including a well-established program in Civil Engineering, as well as the more recent addition of undergraduate curricula in Mechanical and Electrical Engineering. A study of Civil Engineering graduates revealed 92% were successfully employed within 6 months of earning their degree, with a further 6% enrolled in graduate school. The school of engineering is recognized for producing graduates with a more comprehensive knowledge of practical design principles than many other institutions, and has seen extensive recruitment by top corporations and design firms as well as state and federal agencies. Starting salaries for OIT engineering grads have

exceeded the national average in each of the last 5 years. Additionally, OIT has acquired a solid record of placing students in highly ranked graduate programs at schools such as Stanford, University of California, Berkeley and The University of Washington . They offer a Master of Science in Manufacturing Engineering Technology (MET) at OIT campuses in Portland and Klamath Falls and at The Boeing Company in Washington.

Oregon Health & Sciences University (OHSU) [12]:

In 2001, OHSU merged with OGI (Oregon Graduate Institute of Science and Engineering) renaming it the OHSU Department of Engineering. Within the School of Medicine, OGI was started in the 1960's in Hillsboro, Oregon, located near the "Silicon Forest" as a public university aimed at research. Currently, there are 330 graduate students, a third of which are PhD students. Oregon Health & Sciences University is a public university, and its main campus is located on Markham Hill in Portland, Oregon (12 miles west of the Department of Engineering/OGI campus). This campus has three hospitals – the OHSU Hospital, Doernbecher Children's Hospital, and the Portland Veterans Affairs Medical Center (run by the U.S. Dept. of Veterans Affairs, not OHSU). OHSU is perhaps most well known for being a medical school, and also has professional programs in Nursing, Dentistry, and Pharmacy. It does not take on the traditional characteristics of a University, having no undergraduate programs, athletics, or on-campus housing,

OHSU is widely considered the state of Oregon's leading medical education and research center, and the Engineering Department follows this trend. It is divided into three divisions: Biomedical Engineering, Biomedical Computer Science, and Environmental & Bimolecular Systems. Degrees are offered include Electrical Engineering, Biomedical Engineering, Environmental Engineering, and Computer Sciences Engineering. OHSU offers both at the Masters and PhD levels. Each of these programs is medical in nature, for instance the Electrical Engineering program has tracks in Speech and Language Technologies and Machine Learning and Adaptive Systems, specially geared to the medical field. Additionally, research programs and grants are closely tied to the medical community.

4. Analysis and Discussion

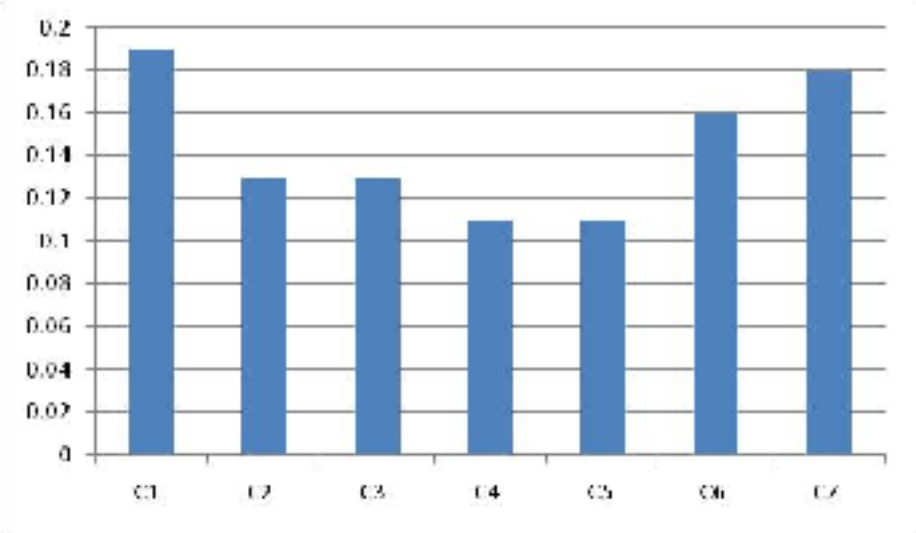
In the HDM model, pairwise comparisons were made to access importance (relative weights) of criteria and alternatives. A Judgment Quantification Instrument (JQI) was developed and filled JQIs were obtained from twelve experts. A brief overview of criteria and alternatives was also given to the experts so that they can understand the model. Each expert expressed the importance of criteria to the objective and importance of alternatives to each criterion using the pair wise comparisons. The PCM software provided by ETM department was used to calculate relative weights of criteria against the objective and alternatives against each criterion. Complete analysis of the various criteria with respect to the objective, and various alternatives (universities) with respect to each criterion was performed. The results of PCM software (relative weights of criteria to the objective) are shown in the table No. 5 below:

Experts	**Grad School Selection Criteria for Master of Science in Engineering**						
	C1: Perceived Image	C2: Campus Life	C3: Research Grants	C4: Housing	C5: Cultural Diversity	C6: Financial Aspects	C7: Future Career Prospects
Faisal	**0.24**	**0.12**	**0.16**	**0.11**	**0.08**	**0.07**	**0.24**
Paul	**0.26**	**0.13**	**0.12**	**0.03**	**0.05**	**0.24**	**0.18**
Maher	**0.14**	**0.19**	**0.09**	**0.2**	**0.12**	**0.17**	**0.11**
Turgut	**0.22**	**0.13**	**0.13**	**0.1**	**0.06**	**0.17**	**0.2**
Muhamma d	**0.26**	**0.07**	**0.13**	**0.07**	**0.09**	**0.15**	**0.25**
Stuart	**0.15**	**0.17**	**0.16**	**0.17**	**0.09**	**0.14**	**0.12**
Expert 1	**0.16**	**0.08**	**0.16**	**0.06**	**0.21**	**0.16**	**0.18**
Expert 2	**0.19**	**0.13**	**0.12**	**0.11**	**0.11**	**0.18**	**0.18**
Expert 3	**0.11**	**0.18**	**0.11**	**0.18**	**0.16**	**0.13**	**0.13**
Expert 4	**0.24**	**0.07**	**0.13**	**0.07**	**0.09**	**0.17**	**0.24**
Expert 5	**0.24**	**0.07**	**0.12**	**0.09**	**0.07**	**0.2**	**0.21**
Expert 6	**0.12**	**0.17**	**0.12**	**0.16**	**0.14**	**0.12**	**0.17**
Mean	**0.19**	**0.13**	**0.13**	**0.11**	**0.11**	**0.16**	**0.18**
Maximum	**0.26**	**0.19**	**0.16**	**0.2**	**0.21**	**0.24**	**0.25**
Minimum	**0.11**	**0.07**	**0.09**	**0.03**	**0.05**	**0.07**	**0.11**

Table 5: Relative weights of criteria with respect to the objective
(Snap shots of PCM software screen are attached as Appendix D)

It was obvious from the result (as shown in the table) that Perceived Image, Future Career Prospects and Financial Aspects are more important to students and they give more importance to these factors while deciding about the graduate school /

university for any MS engineering program. Availability of Research Grants and better campus life both got equal importance (relative weights) and emerged as the fourth most important factor for decision making. The overall disagreement was observed to be 0.046. The chart below graphically represents the importance (relative weight) of each criterion to the overall objective.

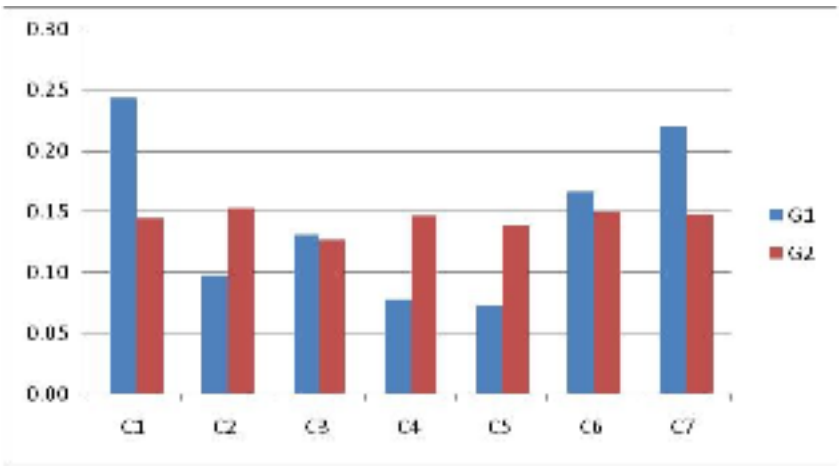


Graphs 1: Relative weight of each criterion to the overall objective

It can be observed that there is difference in the judgments of the experts and two groups of experts can be made based upon their judgments. Each group of experts consists of 6 people. Group 1 consists of 5 international students and 1 resident. Group 2 consists of 2 international students and 4 residents.

Experts Groups	Grad School Selection Criteria for Master of Science in Engineering						
	C1: Perceived Image	C2: Campus Life	C3: Research Grants	C4: Housing	C5: Cultural Diversity	C6: Financial Aspects	C7: Future Career Prospectus
G:1 (6)	0.24	0.10	0.13	0.08	0.07	0.17	0.22
G:2 (6)	0.15	0.15	0.13	0.15	0.14	0.15	0.15

Table 6: Relative weights of criteria with respect to the objective by group of experts



Graphs 2: Relative weight of each criterion to the overall objective by each group

After dividing the experts' judgments into two groups, it's obvious that first group gave much higher importance to Perceived Image, Future Career Prospects, Financial Aspects and Research Grants respectively. Whereas the second group of experts gave almost equal importance to each criterion. Moreover, further analysis of both groups revealed some interesting facts given below:

Group 1	Group 2
Experts from this group are concerned about the financial situation, tuition fees etc. therefore, they emphasized more on Financial Aspects and Research Grants	They are financially sound, they have scholarships or they are willing to take loans for higher education
Experts from group 1 are not interested as mush as living on campus and they are not much involved in various campus activities, sports events, clubs and other cultural activities	Experts from group 2 want to be more involved in campus life and have the full college life experience. Therefore they gave more importance (relative weights) to Campus Life, Housing and Cultural Diversity.
Experts from group 1 are part time working or they have prior working experience and more exposure to the professional life. Therefore they gave more importance to the Perceived Image of the program and Future Career Prospects.	Experts from group 2 have no or less work experience and low exposure to the professional life.
Group 1 consists of 5 international students and 1 residents	Group 2 consists of 2 international students and 4 residents

Table 7: Comparison of both groups of experts

The next step was to calculate the relative importance weights of various alternatives (grad schools / universities) with respect to each criterion by using the PCM software. The results are shown in the table below:

Criteria	Alternatives Grad School offering MS Engineering				
	A1: PSU	C2: UP	C3: OSU	C4: OIT	C5: OHSU
C1: Perceived Image	0.19	0.19	0.22	0.15	0.25
C2: Campus Life	0.23	0.22	0.26	0.12	0.16
C3: Research Grants	0.23	0.17	0.24	0.12	0.24
C4: Housing	0.19	0.27	0.30	0.15	0.09
C5: Cultural Diversity	0.37	0.15	0.18	0.13	0.17
C6: Financial Aspects	0.22	0.16	0.23	0.21	0.18
C7: Future Career Prospects	0.24	0.15	0.25	0.14	0.22

Table 8: Relative weights of alternatives with respect to each criterion
(Snap shots of PCM software, result screens are attached as Appendix D)

After calculating all the relative weights, final weights of each alternative was calculated by using the matrices of criteria weights and schools weights as described below:

C_i = Criteria i
C_1 = Perceived Image
C_2 = Campus Life
C_3 = Research Grants
C_4 = Housing
C_5 = Cultural Diversity
C_6 = Financial Aspects
C_7 = Future Career Prospects

A_j = Alternative (university) j
A_1 = PSU
A_2 = UP
A_3 = OSU
A_4 = OIT
A_5 = OHSU

WC_i = Priority weight value of criteria i with respect to objective
A_jC_i = Weight of Alternative j with respect to criteria i

Priority Weight of each Alternative

$$= \begin{vmatrix} WC1 & WC2 & WC3 & WC4 & WC5 & WC6 & WC7 \end{vmatrix} \begin{vmatrix} A1C1 & A2C1 & A3C1 & A4C1 & A5C1 \\ A1C2 & A2C2 & A3C2 & A4C2 & A5C2 \\ A1C3 & A2C3 & A3C3 & A4C3 & A5C3 \\ A1C4 & A2C4 & A3C4 & A4C4 & A5C4 \\ A1C5 & A2C5 & A3C5 & A4C5 & A5C5 \\ A1C6 & A2C6 & A3C6 & A4C6 & A5C6 \\ A1C7 & A2C7 & A3C7 & A4C7 & A5C7 \end{vmatrix}$$

$$= \begin{vmatrix} 0.19 & 0.13 & 0.13 & 0.11 & 0.11 & 0.16 & 0.18 \end{vmatrix} \begin{vmatrix} 0.19 & 0.19 & 0.22 & 0.15 & 0.25 \\ 0.23 & 0.22 & 0.26 & 0.12 & 0.16 \\ 0.23 & 0.17 & 0.24 & 0.12 & 0.24 \\ 0.19 & 0.27 & 0.30 & 0.15 & 0.09 \\ 0.37 & 0.15 & 0.18 & 0.13 & 0.17 \\ 0.22 & 0.16 & 0.23 & 0.21 & 0.18 \\ 0.24 & 0.15 & 0.25 & 0.14 & 0.22 \end{vmatrix}$$

$$= \begin{bmatrix} 0.23 & 0.19 & 0.24 & 0.15 & 0.20 \end{bmatrix}$$

Thus this study finds that the Oregon State University (A_3), has the highest priority weight (0.24) and Portland State University (A_1) has the second highest priority weight (0.23). OHSU and UP have priority weight 0.20 and 0.19 respectively. OIT has the lowest priority weight (0.15).

5. Conclusion

This research report proposes a Hierarchal Decision Model (HDM) that can be used to select a school for a Masters of Engineering program in Oregon. In this model, several criteria were identified and considered as important factors for the selection of the best alternative. According to the survey that was distributed to several students from different background and experience, everyone gave his/her personal judgment, opinions and priority between all the alternatives and criteria.

As a result, the data from the surveys collected shows that Oregon State University (OSU) and Portland State University (PSU) were the best alternatives. Regarding the criteria, perceived image, financial aspects, and future career prospects were the most important factors for selecting these universities. All of these results might have been different if the survey were given to students with other opinions and priorities. Therefore, these results reflect the point of views from the students who have participated in the survey.

5.2 Future Research

In the future, the scope of this decision model can be expanded. First of all, other universities might be considered as alternatives. The research report could have included other universities from the Northwest area; such as Washington State University and the University of Washington. In addition, the universities with the best ranking in engineering from the west coast could have also been included into the model.

Secondly, more detailed criteria can have been developed for selecting the best university. For example, program duration, options for distance learning, etc. could be added into the criteria. Finally, in addition to the usage of this model for selecting engineering graduate study program, it may also be used for other fields such as physics, science, and management.

Moreover, experts can be classified into different categories for conducting the separate surveys. The classification of an expert can depend upon their demographic backgrounds, professional experience and opinions about college life. This would help us to understand that certain groups of people give more importance to certain factors for selecting a graduate school and further comparison can be made between the results of opinions between the different groups of people. Data can also be collected to show where people from a certain demographic backgrounds are going so that a user can choose this school to be with like minded classmates. Research can also be conducted to find selection preference of Master's and Ph.D. students.

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