

# “University management challenges: Unanticipated consequences of commercialization in Iranian higher education”

## AUTHORS

Aryan Gholipour  
Badri Abbasi

## ARTICLE INFO

Aryan Gholipour and Badri Abbasi (2009). University management challenges: Unanticipated consequences of commercialization in Iranian higher education. *Problems and Perspectives in Management*, 7(2)

## RELEASED ON

Tuesday, 16 June 2009

## JOURNAL

"Problems and Perspectives in Management"

## FOUNDER

LLC “Consulting Publishing Company “Business Perspectives”



NUMBER OF REFERENCES

0



NUMBER OF FIGURES

0



NUMBER OF TABLES

0

© The author(s) 2019. This publication is an open access article.

Aryan Gholipour (Iran), Badri Abbasi (Iran)

## University management challenges: unanticipated consequences of commercialization in Iranian higher education

### Abstract

Any major social action entails both intended and unintended consequences. Commercialization of academic products brings about simultaneously, along with numerous advantages for universities and society, probable manifest and latent drawbacks and negative consequences for academic values. In this article, six academic values, in terms of science values, shared governance, academic prestige, academic freedom, active teaching-learning process and liberal approach to education, all in relation to commercialization, are examined and then some measures of commercialization to be taken by universities are presented. Awareness about these points enables universities to benefit from opportunities in commercialization and to avoid its threats.

**Keywords:** higher education, academic values, commercialization, unintended consequences, university and industry collaboration.

**JEL Classification:** M13.

### Introduction

In recent years universities have increasingly pursued a commercialization agenda. The reasons behind this emergent mission are manifold (Ylijoki, 2003, p. 307). On the one hand, in order to remain competitive in the global market, corporations are increasingly seeking for new knowledge and science-based productions and processes from universities (Slaughter and Leslie, 1997, p. 7). On the other hand, the need for new sources of academic research funding created by budgetary stringency, has motivated universities to collaborate with external customers (Bercovitz and Feldman, 2006, p. 175). Correspondingly, according to triple helix model, dynamic elements are incorporated in cross-institutional activities. Close relationships between universities, government and industry have brought about "a second academic revolution": whereas in the first academic revolution research was incorporated in a primarily educational institution, now a "new third mission" contributing to the economy, is added to core functions of higher education institutions (Etzkowitz and Leydesdorff, 1999).

A close look at modifications in Iranian universities is suggestive of commercialization and orientation of educational institutions toward market-based economic organizations. At policy making level, one of the tasks of Iran Supreme Council of Science, Research and Technology in policymaking and macro-programming phase is to establish necessary policies for commercialization of research findings and for expanding and transferring modern technologies and inventions to industrial partners. Additionally, one of the policies and missions of higher education, specified in the Fourth Development Program of Iran, is to pass and to communicate regulations in connection with the methods of involving researchers in the profits of commer-

cialization of research findings (Higher education national report, 1380). As a result, such a trend will increasingly lead universities and researchers (faculty members) toward commercial activities as a part of larger free-market methodologies (Sanders, 2007, p. 3). In Iran commercial activities constitute information of university owned for profit companies, co-ventures with private proprietary, non-university institution framing, pretty trade on campus and admission of full fee-paying students (Higher Education's national report, 1383). Certainly, the entrance of higher education into commerce and marketing of its products and its attention to the market demands and customer's criteria, have some positive opportunities and consequences, among which are enhancement of revenues, benefiting from scientific research and the correlation between education and training with economic and social objectives (Meyer & Evanse, 2005).

Changes in the commercialization of academic products could also be interpreted as components of a broader "shock wave" that tends to transform the professoriate status and other academic values (Crespo and Dridi, 2007, p. 67).

A review of critical studies about Iran's higher education institutions clarifies the intervention of market values in scientific research process (Mansuri, 2001), that has led to intervention of personal interest and connection with specific individuals in market and university, evaluation of faculty members in light of their income obtained from profitable research contracts (Arasteh, 2003; Shafiee, 2002) and a decline in research, educational, professional and administrative values. Therefore, deeper reflection on universities' commercial activities based on economic rationality and its impact on the predominant values of this institution, academic rationality, seems to be necessary. Regarding the impact of this emerging paradigm on academic values in Iranian higher education, this article intends to study the effect of

commercial activities of universities on their values so that more care could be taken of the commercialization of universities and finally a new trend is introduced for taking further steps in making policies.

There must be a critical thought and care about launching commercialization, particularly under macro policy-making in a society where there is the expectation that university must supply at least 40% of the civil service costs. In such conditions, in order to examine the trends in macro-policies of higher education as well as to analyze a significant role of values and norms that dominated universities in all-round social development, it seems necessary that we inspect the interactions between university and market. This research has its roots in the fact that we must discover to what extent universities are able to create a cultural shield to protect their identity and to respect the values of different parts of our system and to defend practically this trend by recognizing threatening factors of market and commerce and eliminating them. Researchers believe that this trend can have positive effects if it is recognized and dealt with appropriately (Iran Higher Education's National Report). This is so because besides presenting the policy of commercialization of academically scientific results, ministry of science, research and technology must scientifically explain cultural, political and social issues in universities as it is one of the responsibilities of this ministry highlighted in objectives of the *20-year Vision* and the *Fourth Development Programme* and the *Law of Objectives, Responsibilities and Organizations*. Otherwise, as Richardson interprets, it could clearly be said that government and higher education institutes will be acting in a situation void of policymaking that leads to nothing, and negative and unanticipated consequences are expected to emerge which are the fruits of political oppressions from social macro policy-makers. Therefore, a close study of variables in this research as consequences of commercialization in universities seems necessary to help policy-makers and officials.

### 1. Commercialization and academic values

Recently, the commercialization of university technologies has attracted significant attentions. This trend enables universities to obtain sole ownership of the patent rights to technologies developed partially or wholly with public funds and to exploit technological knowledge (Grandi and Grimaldi, 2005, p. 822). The dominant mode, through which these entities have participated in commercialization, is through licensing intellectual property rights to establish spin-off companies, starts-up, and faculty-conducted ventures (Tijssen, 2005, p. 710). Commercialization is a process through which ideas, findings or university products are converted into

products, services and processes capable of being presented to market. Therefore, from a funding perspective, it refers to the archetypical mode of generating revenue for many public universities (Ouma-Wangenge, 2008, p. 56). It is a means to bring findings resulted from research to market and then new ideas or findings develop to be new products and services or technologies which can be sold all around the world. In other words, commercialization is believed to be the attempts to sell university works with the purpose of acquiring profit (Glazer, 2004, p. 112; Bok, 2003, p. 1). Production and marketing of university products are new domains in which university principles and core educational and research values are overshadowed by principles and values of commerce (Gieger, 2004, p. 392). Many authors claim that there is a new role for universities in society with respect to commercialization of research results, "entrepreneurial science" (Rasmussen et al., 2006; Muller, 2006). In this new paradigm, science has entered marketing literature as a service or a university product, consequently such issues as customer satisfaction and marketing of university products have entered academic domains (Brooks, 2005; Plewa & Quester, 2005; Nowtony, 2006).

According to Willmott (1995), "the commodification of academic knowledge production which is increasingly judged in terms of its exchange value, is represented in research funding and position in university league tables, rather than in terms of its intrinsic value. As an original contribution to knowledge it is also seeing, "McDonaldization" of its dissemination, where delivery is increasingly judged in terms of efficiency, value for money, and ability to attract large number of fee-paying students, who are being duly re-constituted customer – the results, it is said, of academic work and proletarianization of academic worker" (Harely, 2006).

As universities increasingly rely on external funding to support their research programs, and as individual faculty members find that their professional advancement increasingly relies on grantsmanship and the generation of a constant flow of external funding, observers have begun to raise questions about the impact of these changes on the academic values (Fajen, 2006, p. 1). Nevertheless, despite the increasing orientation towards commercialization of research results and education, in the current literature of universities, certain alarming issues, such as their impact on predominant scientific values in universities, are raised (Behrens & Gray, 2001; Nowtony, 2006; Robins, 2007). Some scholars believe that after echoing the ring of secularism in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, we now hear another echo against fundamental values of universities, values such as academic freedom and normative

structure of science (Bok, 2003; Kutinlahti, 2005; Nowotony, 2006). An anxiety is being formed about commercial activities of universities, due to prevailing strong motive towards money-making activities and generating more revenue and consequently more legitimacy. This trend will normally affect the commitment of universities to pursue the active teaching-learning process objectively (Domino, 2006, pp. 1-3; Danaeefard, 2004, p. 183). Some faculty charged that as market forces had increased at universities, it enabled trustees and administrators to circumvent the normal channels of governance, leaving faculty "out of the governance loop", bypassed in the decision-making process (Bleak, 2003, p. 9). Some asserted that values, like academic collectivism and self-governance of departments, are diminished (Hellstrom, 2004, p. 512). Others focused on the lack of social significance of strongly institutionalized forms of academic conduction (Ziman, 2000) and social justice in university as a public good (Cunningham, 2007).

Additionally, the effect of increasing number of practical courses based on tuition fee, and paying more attention to practical disciplines, where commercial contracts in their research areas are more feasible, will not only influence graduates' perceptions, but also will lead to the withdrawal of some educational domains and despair self-efficacy of faculty members (Bok, 2003, p. 6). This condition leads to decline of social prestige of faculty member (Faber, 1987). Analyzing the commercial activities of universities, many scholars have discussed "the abuse of universities rational borders" or aiming at "academic rationality" (Behrens & Gray, 1999, pp. 180-183; Kutinlahti, 2005, p. 18). Some discuss the damages to institutional integrity and identity (Henkel, 2005), social cohesion of universities (Heuser, 2007), academic honesty (Choong, 2007, p. 91), and others point at directed threats that are posed against liberal education (Reed, 2004; Magnell, 2005) as well as fundamental values of higher education such as academic freedom (Furres, 2005; French, 2005, p. 1). In spite of the fact that these activities' mutual benefits are approved by scientific sources, and at the same time the commercial activities influence university education and training, some potentials of conflict and resistance are being formed (Rusmussen and Gulbrandsen, 2006, p. 518).

In literature, presenting an introduction from both optimistic and pessimistic perspectives, it is written that pessimistic ideas about commercialization are responsible for a decrease in research studies in long-term, a tension between open science culture and commercialization or commoditization and finally increasing pressure on university education

and appointed responsibilities of basic research (Gulbrandsen and Smeby, 2005). Bok, the former Harvard president, in his analysis of the impact of the pressure of commercialization on higher education through obtaining more benefits from science, points out that the conflict between the above-mentioned phenomenon and the ideals of university ought to be entirely reflected upon limitless pursuit of new knowledge; and transferring it to the next generation via education should be considered. Additionally, receiving scientific awards which are basically rational and thoughtfully based on the prestigious status and development of science, is now based on other criteria such as larger number of enrollment, transfer of technology and commercialization of intellectual capitals (Bok, 2003, p. 6). From another point of view, challenges of commercialization, particularly for faculty members, have brought about a change in role expectations and functions (Luanna & Evanse, 2005, p. 1). In a study entitled *Interrogating the Crisis in Higher Education Marketing: the CORD Model* three crises have been taken into account:

- ◆ there continues to be sizeable resistance towards the marketing idea in the academy of many universities across the world;
- ◆ higher education itself has failed to identify its core business without which the sector can not have a firm marketing foundation;
- ◆ higher education marketing has not adequately domesticated itself and continues to rely on imported wisdom from the business sector (Maringe, 2005: 564).

Literature review of the higher education in Iran has shown that ethical standards in Iranian scientific community are very weak and, therefore, cooperation between university and industry is mainly based on the personal taste of and connection to specific individuals. Some argue that faculty members are no longer at universities and see this as unfavorable for training future experts and liberal citizens. Moreover, the relationship between universities and society which is a positive phenomenon, eventually leading to the localization of university, has not yet been balanced. Instead, the criteria for genuine science and research have strongly been muddied and conditions for pseudo-scientist are clearly highlighted. A study of destructive effects of this unhealthy trend in the development process of the countries has evidently demonstrated the emergence of crisis in the academic rationality and social role of Iranian universities (Mansuri, 2001, pp. 21-22).

Jacob also views universities' commercial activities as a threat to the authority of science and believes that commercialization modifies culture of research

(Jacob, 2003, p. 133). Commercialization weakens ethical standards in research, and reduces joint studies between university and industry. Besides, it shakes people's trust in research findings. What's more, commercial purposes create conflicts between university research groups and their sponsors. These conflicts naturally affect the research results. Jacob believes that intervention in choosing a research plan, its analysis method and interpreting its results is influenced by commercialization of research. Regarding the above-mentioned notions, in this article, six concepts in terms of academic values (Kreber and Mhina, 2005; Pasiokine, 2002; Scott, 2004; Kutinlahti, 2005) are specifically considered and the impact of commercialization on them is analyzed.

## 2. Science values

Merton presented four values that define science: "universalism", "communism", "disinterestedness" and "organized skepticism" (Triggle, 2005, p. 141).

In communism, scientific findings result from social cooperation and these findings are a type of shared heritage in which individual's role in making science is limited and insignificant. Findings are the product of social cooperation and are assigned to the community. The concern is that increased industry sponsorship of research will result in an increase of secrecy and concealing in academic science (Fajen, 2006, p. 70). Disinterestedness is the term Merton (1957) used for the idea that scientists are motivated to adhere to the norms of science, not by the financial gain but rather by the desire for priority in discovery and peer recognition that follows from such discovery. The counter norm to disinterestedness is self-interestedness, which describes the situation in which scientists are motivated by competition with each other to obtain grants, publication and other rewards (Macfarlane and Cheng, 2008, p. 69). Universalism conveys the idea that scientists evaluate research by considering only its merit, rather than by judging it based on the reputation or past work of the researcher. The counter norm associated with universalism is particularism, which means that researchers would judge the value of new research based on its source (Fajen, 2006, p. 78). Finally, organized skepticism is the idea that all new research evidence should be considered, even if it contradicts one's own work. The corresponding alternative norm, organized dogmatism, suggests that scientists are focused on promoting their own theories or discoveries (Behrens and Gray, 1999, p. 183). Hence, we formulate the first hypothesis as follows:

*H1: Commercial activities of university affect science values in Iranian higher education.*

## 3. University shared governance

Birnbaum (1988) contended that governance answers the question "Who is in charge here?" Similarly some defined "university governance as the distribution of legitimate authority for the purposes of making decisions and taking actions. Indeed, decision-making is at the very heart of governance". Yet, it is here that the academy and corporation perhaps differ most markedly. Characterized by diffused authority and de-centralized decision-making, academic governance is typically," shared "by faculty, administrators and board of trustees and is considered one of the core values of the academy. In academic governance, inactivity prevails, participation is fluid, and interest group behavior and conflict often dominate discourse among governing structures Bleak, 2003, pp. 62-63).

Besides emphasis on the role of universities' managers in the process of commercialization, Gieger believes that the main task of managers is to inject economical rationality to academic tasks and activities. This economical rationality considers the maintenance of economical autonomy through university control on revenues and expenditures as the responsibility of a university (Gieger, 2004). With such an interpretation, higher education administration in this process for getting more sources, has a penchant towards producing marketing intelligence and imposing it on picking out more students (enrollment management) and getting more sources (marketing) and regulating coherent structures with it (Greek et al., 2005).

Some believed that the growth of the so-called managerialism, suggested that differences between academic institutions and other forms of organizations, in a knowledge-based society are being reduced (Scott, 2003, p. 304). Today administrations are regarding academic members, as a source to facilitate the works and bring funds. This reversal is altering academics' positions and relationships (Polster, 2007, p. 604).

According to adaptation theory, in order to cope with the changes in the remote and commercial environment of higher education institutions, many university administrations incorporated proven private sector management tools such as top-down management, market mission statements, corporate lexicon and incorporating words like efficiency, accountability, the bottom line, value added, cost-benefit, output and consumer (Feldman, 2007, p. 60; Zilwa, 2007). Opponents argue that adaptation to market-driven realities, is antithetical to the shared governance value in higher education (Kennedy, 2003, p. 57). Hence, we formulated the second hypothesis as follows:

*H2: Commercial activities of university affect university shared governance in Iranian higher education.*

#### 4. Academic prestige of faculty members

Every organization belongs to an organizational set which is defined as consisting of two or more organizations of the same type, each of which is continuously visible to one another. Furthermore, comparison is the essential function of an organizational set, and every set creates a prestige order that is recognized by members and usually by an outside audience as well. The prestige order serves the primary functions of facilitating communication among the organizations in the set and with the outside audiences, providing regulating cooperation and conflict among the members of organization. Prestige is not a direct measure of productivity, but a composite of subjective opinion. "What is important in the discipline is what others, think of him and how good he is" (Faber, 1978, p. 13).

Traditionally, universities have been collegial communities that have enjoyed professional autonomy, their members having the freedom to select their own interests, priorities and goals according to criteria, set by their discipline values. The scholarly ideal prestige, generated a thirst for knowledge and love for learning, uncontaminated by material considerations. "Indeed, academia has given more symbolic than material rewards to its members. Their advancement, particularly to the higher ranks, has been due less to their contribution to their employing organization than to their academic discipline within a reputational system judged by peer review" (Harely, 2006, p. 330).

It has been argued, that commercial activities of universities, particularly their relationship with industry, influence faculty members' perceptions toward them (Behrens & Gray, 1999, p. 182). A study done on the process of changes in Iranian higher education is suggestive of launching commercial processes and coordination between university and industry in commercial university – industry projects. Results have shown that these activities, resulted in entrance of non-academic individuals into academic environment, changing the promotion criteria for faculty members, the lack of self-efficacy and authority feeling across faculty members and lack of social trust toward them (Arasteh, 2003, p. 63). Faber also stated that commercialization orientation of academic members toward higher education, can alter two main prestige factors, in terms of tenure and authority (Faber, 1978).

Passing and exercising laws concerning different ways of involving researchers in the profits obtained from commercializing research results are an in-

stance of this policy making in a large scale in Iran (Higher Education National Report, 1384). In a smaller scale, we may point at Amir Kabir Industrial University as a point in case. As a result of this plan, a contract's credit can be measured in terms of publishing commercially usable research articles. For instance, a faculty member who has dealt a contract worth 500000 dollars, gets 8 research points (Arasteh, 2003, p. 72). While reviewing conflicts in connection with the launching of higher education commercial activities in Iran, we come across a spectrum of attention to the effect of these activities on not involved academic member and also its threats to promotion of them, and their academic prestige, when comparing themselves with well-known researchers at university. Hence, we formulate the third hypothesis as follows:

*H3: Commercial activities of university affect faculty members perception toward their own academic prestige.*

#### 5. Academic freedom

Academic freedom refers to the freedom of faculty members to study, teach, research and publish without being subject to, or causing undue interference (Altbach, 2001, p. 206). Academic freedom is granted in the belief that it enhances the pursuit and application of worthwhile knowledge, and as much is supported by society through the funding of academics and their institution. Academic freedom embodies an acceptance by academics of the need to encourage openness and flexibility in academic work, and of their accountability to each other and to society in general. Academic freedom is an aspect of academic autonomy on whose basis faculty members enjoy the following freedom: freedom from imposing ideology, freedom from being evaluated by customers and freedom from external pressure (Michael, 1997, p. 129; Kayrooz, Kinnear & Preston, 2005; Taylor et al., 2006). Supplying supportive research facilities as much and as fast as possible is one of the most important principles of manifestation of academic freedom that means all necessities and tasks of this institution ought to be fulfilled and performed by the institution itself (Mansuri, 2001, p. 17).

A study focusing on unintended consequences of cooperative research and the impact of industry sponsorship on climate for academic freedom and its relevant consequences has been conducted. Besides giving reference to numerous studies about collaborative research done by university and industry, it discusses lack of experimental studies on expenditures or on university graduates and their impact on academic freedom. This study intends to measure advantages of collaborative research done by univer-

sity and industry against its drawbacks. To do this, the impacts of the source of capital (industry or government) on type of investment (one source, consortium or without investment), on research process and its consequences, particularly among vulnerable academic graduates, were taken into account. Despite some small differences in this regard, results of this study are indicative of negative effects of industry or government financial support on academic research and of graduates' experience. Nevertheless, further analyses in this study show various variables that affect academic freedom in university (Behrens & Gray, 2001). In an exploratory research entitled *Academic Freedom and Commercialization of Australian Universities*, the impact of commercial activities of universities (presenting courses based on tuition fee, collaborative research between university and industry and academic consultation) on academic freedom principles is analyzed and the assumption is made that in the new millennium, universities in an environment with financial characteristics and values are explored in three levels: individual, collegial and institutional. Ninety-two percent of respondents who provided answers said that the most important principle in academic freedom is freedom to define the title of research, choosing its methodology and publishing the results. Modification in research time and in research title for financial reasons is the most important consequence of research commercialization. Those who provided us with answers along with declaring satisfaction in individual level, declared their concerns of some systematic side effects of commercialization on academic freedom in both collegial and institutional levels (Kayrooz et al., 2001). Hence, we formulate the fourth hypothesis:

*H4: Commercial activities of university affect academic freedom in Iranian higher education.*

## 6. Teaching-learning

Scholars stressed on values such as actions, communication, participation and experience in the teaching-learning as a social practice; the end goal being the continual process of individual growth directed toward social aims (Monahan, 2004, p. 286). The process of teaching-learning is also influenced by university commercial activities (Bok, 2003). The combination of certain rationalities, both neo-liberal (academic capitalism, privatization, vouchers, flexible and docile students, IT pedagogies) and neo-conservative (standards and accountability) leading to overall, proscribes not only teaching-learning as a social act, but also insidiously eliminates democracy by denying legitimate public space for free discussion and critique and active relationships between students and academic members (Monahan, 2004, p. 286). The effects of commercialization, in their turn,

have had devastating effects on the morale of faculty and devaluing the teaching-learning profession, warned of institutional decay (Feldman, 2007, p. 64). In an effort to be competitive with other universities, and therefore increase national ranking, universities have neglected their teaching values. Shifting curricula to reflect trends focusing more on research (because research can generate income), and less on teaching has become common practice (Feldman, 2007, p. 61). In this regard, a university might be tempted to increase the direct tuition fee for the courses it presents. Additionally, involvement of faculty members in commercial activity, lack of the time for direct interactions between professors and students (Powers, 2000). Therefore, the fifth hypothesis has been formulated as follows:

*H5: Commercial activities of university affect teaching-learning process in Iran higher education.*

## 7. Liberal education

A liberal education in the sense of one that frees the mind, is, ideally, as integrated to a scientific and methodological education as it is to an education in the arts and humanities. It aims to educate students who can "think autonomously, critically and dialogically" within a university that is responsible for upholding norms of freedom and democracy, and for activity as a source of independent criticism in the area of its competencies (Tasker and Packham, 1993, p. 131).

Because of the demands of the economy, higher education soon placed an extraordinary value on offering courses based on a quantitative or revenue generating basis (Bok, 2003). This has led to the demise of many traditional humanities and social science courses, new disciplines and programs became plentiful in higher education curricula. Additionally, the traditional academic value of educating students to be productive citizens in a democratic society changed to the idea of training students for jobs in the marketplaces (Feldman, 2007, p. 65).

Paying attention to university commercial activities and their focus on profitability, some scholars say that higher education with an increase in pragmatic aspect will change its trend in liberal education as core values shared as fundamental basis of university (Magyar, 2006: 392), and pay more attention to applied disciplines (Scott, 2004; Bok, 2003; Taylor & Braddock, 2006). Production and sale for profit are anti-thesis for the ideals that Newman defined in his book "ideal of university and lovely process of dedicating science". He, by presenting a concept so-called "Lure of profit" consider commercialization in higher education a threatening trend (Gieger, 2004: 389, Greek et al., 2005). So we can formulate the sixth hypothesis as follows:

*H6: Commercial activities of university affect the liberal education in Iranian higher education.*

## 8. Methodology

This practical field study is a descriptive survey looking for a causative relation between the variables. The results can be comfortably generalized to similar situations.

The data base for this study consisted of public higher education institutions, taken from Iranian Higher Education Report (2006). This directory contains a compilation of all higher education institutions in the special data base maintained by the science, research and technology ministry. The guide was arranged in alphabetical order, by geographical area, and provided institutional characteristics and the names and titles of academic members for 82 public universities in Iran. The population for our research consisted of faculty members of all 8 public universities in Tehran city. We stratified faculty members of these universities into 4 fields of studies of humanities, engineering, medicine and basic sciences. Selection of faculties was done by means of stratified random sampling. The study sample consisted of a total of 352 individuals, among which 107 individuals from humanities, 60 individuals from medicine, 130 individuals from engineering, and 55 individuals from basic sciences. The majority of faculty members consists of males (83.8 percent), and females (16.2 percent). Over 81.8 percent of the professors has obtained a doctorate degree and is predominantly employed as an assistant professor (51.4 percent). The mean age of respondents was 49 (Table 1).

Within the domain of higher education in Iran, public higher education is widely represented. The sampling frame of public institutions was selected, because such institutions face extreme external pressure for commercialization of university products, specially, university research results. The public institutions in this sampling frame also face higher degree of external controls (state, religious, etc.) and increased pressure for external adaptation.

Finally, it has been accepted that cultural norms across scientific fields of faculty members may also be critical in shaping faculty involvement in commercial activities.

Disciplines differ in cognitive dimensions. Some of them deal with discoveries and explaining phenomena (basic science), the others are pragmatic in nature (engineering), the third, like history, are concerned with understanding and interpreting the phenomena (Ylijoki, 2000, p. 340).

Faculty members from the same scientific discipline, have a set of common perceptions and practices that are likely to influence their degree of engagements in knowledge transfer activities (Este and Patel, 2007). Hence in this paper we entered and focused on the fields, along with other demographic characteristics.

Table 1. Demographics of participants

Demographics	Total number	%
Gender		
Male	295	83.8
Female	57	16.2
Age		
Less than 30	9	2.6
30-39 years old	51	14.5
40-49 years old	177	50.3
50-59 years old	99	28.1
Over 60 years old	16	4.5
Time at university		
Less than 6 years	45	12.8
6-15 years	103	29.3
16-25 years	123	34.9
26-35 years	53	15.1
Over 35 years	28	8.0
Rank		
Lecture	64	18.2
Assistant	181	51.4
Associate	81	23.0
Full	26	7.4
Fields		
Engineering	130	36.93
Humanities	107	30.39
Medicine	60	17.4
Basic sciences	55	15.6

**8.1. Data collection.** A questionnaire was the main instrument with 48 questions. The questions were divided among variables in the following way: 18 questions (1 to 18) for analyzing the commercialization variable, 4 questions (19 to 22) for analyzing science values variable, 6 questions (23 to 28) for analyzing university shared governance, 6 questions (29 to 34) for analyzing academic prestige of faculty member variable, 6 questions (35 to 40) for analyzing academic freedom variable, 4 questions (41 to 44) for analyzing liberal education variable, and 4 questions (45 to 48) for analyzing teaching-learning variable.

As many authors have noted, commercial activities can be categorized according to resource deployment, length and formalization of agreements (Este and Patel, 2007). Building on this, we categorized commercial activities according to the formalization of agreements, and asked respondents about the frequency of commercial activities, across five groups (See Table 2).



Table 2. Grouping commercial activities in five categories

Groups	
◆	Meeting conferences
◆	Consultancy and contract research
◆	Creation of physical facilities
◆	Training
◆	Joint research

Our research was conducted in the first half of 2008, and resulted in 342 valid returned questionnaires, a response rate of 70.1 percent. There were no statistical differences in the response rates across scientific disciplines, which ranged from 86 percent for humanities, to 57 percent for engineering. The collection of questionnaires continued 56 days with the help of 2 questioners (that is 2/85 questionnaires for each questioner per day). Of course, gathering 3 questionnaires a day shows the reluctance of respondents. The questionnaire was based on Likert scale, ranged from 1 as totally opposed to 5 as completely agreed.

**8.2. Measures and instruments.** In designing the questionnaire questions it has been noticed to perform the required precision in order to have simple but clear questions. In order to determine the questionnaire reliability, 30 questionnaires were distributed among universities assistants. The Cronbach Alpha coefficient of the independent variable scale (commercialization) with 18 questions was about 0.89 and that for the dependent variables scale (6 variables) with 30 questions was 0.91 which proved the reliability of research instruments. The independent variable scale had 20 questions and each dependent variable scale had 6 questions. After determination of validity, 2 questions were deleted from the first and 6 questions were deleted from the second one.

Also in order to answer the question of validity, factor analysis and content validity tests were performed. Experts' views were used for the determination of content validity of the questionnaire and required changes were made to make sure those questionnaires meet the desired specifications of researchers.

Content validity test of questionnaire along with confirmatory factor analysis were performed using the 8/53 LISREL software. It is worth mentioning that in order to confirm the measurement model or factor analysis, first of all, its indicators should be included goodness of fit, and secondly, t-value and its standard coefficients should be significant. If the amount of  $\chi^2$  is less and the ratio of  $\chi^2/DF$  is less than 3, and RMSE<sup>1</sup> is less than 0.05 and GFI<sup>2</sup> and

AGFA<sup>3</sup> are higher than 90 percent it can be concluded that the model enjoys a very suitable goodness of fit. If the amounts are more than 2 or less than -2 they would be significant in 99 percent of confidence level.

By looking at the external results of LISREL, it can be seen that independent variable (commercialization) measurement model is regarded as a suitable model because  $\chi^2$  amount, RMSEA amount and the ratio of  $\chi^2/DF$  are low and its GFI and AGFA amounts are higher than 90 percent. Also, all of the t-values are significant at the confidence level of 99 percent. Also dependent variables measurement model is regarded as a suitable model because the amount of  $\chi^2$ , RMSEA and the ratio of  $\chi^2/DF$  is low and the amount of GFI and AGFA is more than 90 percent. All of the t-values in 99 percent of certainty level are significant. These results express that the questionnaires used in this study enjoy high level of validity and reliability.

## 9. Analysis and results

In order to investigate the causal relation in hypothesis, structural equations modeling was used. This is the last step for confirmatory factor analysis which has been performed before on research analyzing scale which also shows the suggested validity of conceptual model, through model fitting indicators.

Causal relation between dependent and independent research variables, through using structural equations modeling method (process analysis) was tested by the use of LISREL 18.53 software. Seven models were totally performed of which the first model, the relation between academic values, was analyzed with 6 dependent variables. Diagram 2 shows the results of the first model (general) which is structural equation modeling. Table 3 is the summary of the next 6 models results for 1 to 6 hypotheses test with structural modeling.

Commercialization has shown negative relation with science values ( $t = -3.49, -0.16$ ), that means respondents believe that commercialization process has negative effect on science values. Also, there is a positive relation between commercialization and shared governance ( $t = 8.36, 0.40$ ); it means that commercialization process has led to the managerial optimization in universities. Some of these issues are because of effectiveness that resulted from effective private management prototypes which have had positive effects on universities.

There also exists a positive relation between commercialization and professors academic prestige ( $t =$

<sup>1</sup> Root Mean Square Error of Approximation.

<sup>2</sup> Goodness of Fit Index.

<sup>3</sup> Adjusted Goodness of Fit Index.

3.74, 119) that means, when professors have a productive relation with industry and government, they improve their own social prestige. Additionally, economic condition improvement will lead to the improvement of their academic prestige. This issue is also affected by the present social values that money plays a vital role in shaping them. There is a negative relation between academic freedom and commercialization (t = -8.06, -0.36). It means, as participants believe, commercialization will restrict the academic freedom. Some parts of this issue relate to the definition of research preferences of universities by market, industry and government. Therefore, university has no freedom in this act. There is a negative relation between commercialization and active teaching-learning process between faculty members and students (t = 3.75, -0.16). It means that university lecturers' participation in commercial activities will damage education quality

and quantity. Also, results have shown that commercialization has negative impact on liberal education (t = 5.36, -0.25), which means that the curriculums of universities tend toward the market and industry preferences and the non-practical and pure science will be overridden.

As it is shown, considering those significant t-values in 99 percent confidence level, all of the hypotheses are confirmed and the validity and fitting of models are confirmed because RMSE has low value and the ratio of  $\chi^2/DF$  is less than 3 in all models and also in all models the AGFI and GFI value is more than 90 percent. Considering correlation between the dependent variable (commercialization) and the independent variables (6 variables), Spearman ranking test was used and the results are reflected in Table 4 (All coefficients are significant at 99 percent confidence level).

Table 3. Hypotheses test results

Model	Hypothesis	Standard coefficient	t-values	X <sup>2</sup> /DF	RMSE	GFI	AGFI	Results
1	Commercialization → academic freedom	-0.36	-8.06	2.34	0.037	0.96	0.94	Accepted
2	Commercialization → scientific values	-0.16	-3.49	2.37	0.047	0.94	0.92	Accepted
3	Commercialization → social prestige	0.19	3.74	2.37	0.041	0.93	0.91	Accepted
4	Commercialization → shared university governance	0.40	8.36	2.37	0.033	0.92	0.90	Accepted
5	Commercialization → liberal education	-0.25	-5.36	2.37	0.053	0.94	0.92	Accepted
6	Commercialization → learning process	-0.16	-3.72	2.37	0.043	0.95		Accepted

Table 4. Correlation matrix

	Commercialization	Academic freedom	Normative structure	Social prestige	Managers orientation	Curriculum	Learning process
Commercialization	1						
Academic freedom	-0.193	1					
Science values	-0.140	0.164	1				
Academic prestige	0.162	0.323	0.022	1			
University shared governance	0.175	0.314	0.206	0.675	1		
Liberal education	-0.121	0.354	0.278	0.674	0.648	1	
Active teaching-learning	-0.480	0.545	0.288	0.220	0.310	0.574	1

As it is shown in Table 4, there are relations between commercialization and academic freedom (-0.194), commercialization and science values (-0.140), commercialization and academic prestige (0.162), commercialization and university shared governance (0.175), commercialization and liberal education (-.121), commercialization and active teaching-learning process (-0.480), academic freedom and science values (0/164), academic freedom and academic prestige (0.323), academic freedom and university shared governance (0.314), academic freedom and liberal education (0.354), academic freedom and active teaching-learning process (0.545), science values and academic prestige (0.022), science values and university shared governance (0.206), science values and liberal education (0.278), science values and active teaching-

learning process (0.288), academic prestige and shared governance (0.675), academic prestige and liberal education (0.674), academic prestige and active teaching-learning process (0.220), shared governance and liberal education (0.648), shared governance and active teaching-learning process (0.310), and finally liberal education and active teaching-learning process (0.574).

Coefficients show that in spite of negative correlation between commercialization and 4 components (academic freedom, science values, liberal education and active teaching-learning process), those components together with professors' academic prestige and university share governance have positive correlations. Therefore, they should be taken into consideration as a whole.

The results also showed that as could be expected, the most widespread form of commercial activity among faculty members is meeting and conferences, which is a reflection of the extent to which faculty members, are involved in any of these two informal commercial activities. Also, about 52 percent of faculty members was engaged in contract research and consultancy. Establishment of physical facilities (starts up and spin off companies) was the least frequent form of commercial activities, and joint research and training were moderately important. Among the fields, the majority (85 percent) of faculty members in humanities, stated that commercialization at university can affect academic values. Overall, only 22 percent of faculty members in other disciplines (practical fields) indicated that commercial activities can affect academic values. However, each academic member from the same scientific discipline has a set of common perceptions and practices that are likely to influence their degree of attitude toward commercialization.

Within each of the five commercial activities, there were significant differences in the level of involvement across fields, with humanities faculty members showing much lower levels than those other three fields. Another prominent finding of this research is that among the faculty members, the majority of them with junior rank (lecturers and assistant professors) experience and respond to academic commercialization, differently than senior faculty (full professors). The majority (76 percent) of them reported that academic commercial activities haven't any negative effects on academic values. Overall, it seems that junior faculty members take a less judgmental approach to being commercial or market like.

### **Discussion and conclusion**

The main purpose of this research is the consideration of commercialization impact on academic values (science values, academic freedom, liberal education, active teaching-learning process, perception of academic members toward own academic prestige and university shared governance). This article, through presenting the critical and vulnerable variables in universities, which form their academic rationality, can be illuminating for higher education administration in order to take more informed actions for modern commercialization approach and university valuable products marketing. It also addresses a number of wise and useful strategies in this regard to utilize the commercialization advantage and prevent its probable damages.

Historical trends in management show that whenever the institutional management took action to compile the related strategies for any issue without considering sociological considerations, cultural

norms of fields, faculty members' priorities, and without awareness about possible destructive dimensions, after confronting some crisis, became uncertain and doubtful whether to continue the action.

This process has been started in Iranian university community by higher education macro-policy makers in the field of research results. Commercialization and related policies in research and education are relatively novel and do not enjoy the required balance in the view of university researchers and managers. It has also seen a lot of opposing and personal policies so it necessitates more reflection and more profound studies about the effects and dimensions of commercialization in Iranian universities in order to find proper strategies to link commercialization to the university to make the former a positive contribution rather than a load or damaging factor on the system.

The study of global trends in higher education confirms increasing university orientation toward market. The result of this tendency is the formation of a wisdom based on market and business as is evident in the commercial activities of universities. In fact, from the functionalistic perspective, university is now confronting three new functions: to increase the extent of commercialization, to visualize the contribution to economic development and to manage the relationship between commercialization and its core values. Therefore, it tries to conform to different market culture. Undoubtedly these new functions have a potential for conflict and resistance in this system. In its real sense, university is recognized with two functions: knowledge production and socialization (i.e., a kind of re-socialization in which some experts are trained to explore the reality with scientific tools and methods). In such conditions, because of the essential critical role of universities in policy-makers' acts and the vital role of values and norms and their impacts on these institutions, the analysis of mutual action process between university and market (commercialization processes) will be important.

This study has its roots in the issue that to what extent universities would be able to defend the identity and integrity of their own system components and values through establishing a cultural shield and performing scientific defense, through recognizing market and business threatening factors and eliminating them. The results of this investigation show that market and university interaction brings threats for some university values such as academic freedom, active teaching-learning processes, academic prestige of academic members, liberal education, basic research studies, scientific values and academic share governance.

Generally, in spite of market and business with autocratic specification, universities hold a normative entity and their nature does not accept employee-employer behaviors, so restricting scientific and professional conditions for whatever reason other than competence, will be regarded as an aggression to knowledge authority. Emotional responses to these threats are completely anticipated. From researchers' viewpoints, this thesis and anti-thesis solvency can produce a safe relation in increasing interference of some opposing identities of market and university culture, so that science will have the final word.

So universities heads should pay attention to the following comments:

1. Turning scientific norms into transparent statements and providing professors and students with them so that these norms will become institutionalized at university.
2. They should emphasize and legalize academic freedom in commercialization of scientific researches so that university priorities will become intrinsic and priorities will not be determined merely by industry and government. Otherwise, university will become a puppet for government and industry.
3. Re-vitalization and empowerment of science ethical norms, together with the preservation of academic members' respect. Paying attention to this point is so important that in spite of the existence of various academic disciplines and national system effects, there are values and beliefs that integrate the professors of all fields. Academic members in spite of variety in higher education are committed to several academic beliefs that define the meaning and value of academic works, for themselves and others. These values affect professors, their self-belief and their expectations of faculty and higher education policies. So, naturally, the reward giving system and validity acquiring in society and university depend on these values.
4. Establishing balance in scientific community ideas toward different research activities and scientific courses. Mere admiration of certain methods or scientific courses will be threatening to other scientific investigations and educational fields as valuable social activities. Tendency toward externally ordered researches should not decrease the value of internal origin of university researches.
5. Evaluation and meta-evaluation of market and university interactions and re-engineering of institutional processes are very important, because these actions will lead universities toward being more powerful and will bring about the institutionalization of its fundamental values.
6. The necessity of entrepreneurship, creating a variety of financial resources and income generating and cost-benefit considerations in management should not be interpreted as neglecting the main mission of universities as cultural and social critics, university enlightenment, and academic life on campus and academic norms.

## References

1. Altbach, P. G. (2001). Academic freedom: International realities and challenges, *Higher Education*, Vol. 41, pp. 205-219.
2. Arasteh, H. (2004). University and industry cooperation, *Higher Education Research and Planning Quarterly*, Vol. 10/3, pp. 57-92.
3. Arasteh, H. and Shafiee, M. (2003). University and Industry cooperation. Higher Education Encyclopedia. Audited by: Ghurchiyan, N. Arasteh, H. Jaafari, P. Published by: Persian Foundation. – p. 1292.
4. Behrens, T.R and Gray D.O. (2001). Unintended consequences of cooperative research: Impact of industry sponsorship on climate for academic freedom and other graduate student outcome., *Research Policy*, Vol. 30, No. 2, pp. 113-126.
5. Bercowitz, J., Feldman, M. (2006). Entrepreneurial universities and technology transfer: A conceptual framework for understanding knowledge-based economy, *Journal of Technology Transfer*, Vol. 31, pp. 175-188.
6. Bleak, J.L. (2003). Integrated or Isolated: The Governance of For-Profit Subsidiaries of Nonprofit University. Doctoral dissertation. Harvard University.
7. Bok, D. (2003). *University in Marketplace*. Princeton University Press.
8. Choong, P. (2007). The future of academic honesty, *Academy of Educational Leadership Journal*, Vol. 11, pp. 91-102.
9. Crespo, M. Dridi, H. (2007). Intensification of university-industry relationships and its impact on academic research, *Higher Education*, Vol. 54, pp. 61-81.
10. Cunningham, F. (2007). The university and social justice, *Journal of Academic Ethics*, Vol. 5, pp. 153-162.
11. Danaeefard, H. (2004). Knowledge-Based Economy and maintenance of institutional integrity of university, *Higher Education Research and Planning Quarterly*, Vol. 10, No. 3, pp. 163-191.
12. Domino, S. Libraire, T. Lutwiller, D. Superczynski, Sh. And Tian, R. (2006). Higher education marketing concerns: factors influence student's choice of colleges. *The Business Review*, Vol 6, No. 2, pp. 157-163.
13. Etzkowitz, H. Leydesdroff, L. (1999). The future location of research and technology transfer, *Journal of Technology Transfer*, Vol. 24, pp. 111-123.
14. Faber, A.F (2000). The creation and maintenance of prestige in the Irgal sector of the academic marketplace. Doc-

- toral Dissertation. Department of sociology at University of Virginia.
15. Feldman K.S. (2007). The commercialization of public Higher Education: Balancing Academic, Fiscal and Market Values. Doctoral dissertation: Educational Leadership. University of New Mexico.
  16. French, P.D. (2005). Is academic freedom a threat to teaching introductory science? *Journal of college science teaching*, Vol. 35/3, pp. 132-145.
  17. Geiger, R.I. (2004). Commercialization of the university, *American journal of education*, Vol. 110, No. 4, 56-78.
  18. Glazer, N. (2004). "The University for Sale", *Public interest*, Vol. 154, Pp.112-118.
  19. Grandi, A. and Grimaldi, R. (2005). Academics organizational characteristics and the generation of successful business ideas, *Journal of Business Venturing*, Vol. 20, pp. 821-845.
  20. Greek, K.W. Inman, R.A. Brown, G. (2005). Market orientation: relation to structure and performance, *Journal of business and industrial marketing* Vol. 20, No. 6, pp. 276-284.
  21. Gulbrandsen, M. Smeby, C.J. (2005). Industry funding and university professors research performance, *Journal of research policy*, Vol. 34, pp. 932-950.
  22. Harely, S. et al (2004). From academic community to managed organization: the implication for academic careers in UK and German universities, *Journal of Vocational Behavior*, Vol. 64, pp. 329-354.
  23. Hellstrom, T. (2004). Between a rock and a hard place: Academic institutional change and the problem of collectivism action, *Higher Education*, Vol. 48, pp. 511-528.
  24. Henkel, M. (2005). Academic identity and autonomy in a changing policy environment, *Higher Education*, Vol. 49, pp. 155-176.
  25. Heuser, B. L. (2007). Academic social cohesion within higher education, *Prospectives*, Vol. 37, pp. 293-303.
  26. Kennedy, K.J. (2003). Higher Education Governance as a key policy issue in the 21 century, *Educational research for policy and practice*, Vol. 2, pp. 55-70.
  27. Kutinalahti, P. (2005). University approaching market: intertwining scientific and entrepreneurial goal. VTT publication. No 589.
  28. Macfarlane, B. Cheng, M. (2008). Communism, universalism and disinterestedness: Re- examining contemporary support among academics for Mertons scientific norms, *Journal of Academic Ethics*, Vol. 6, pp. 67-78.
  29. Magnell, T. (2005). Privilege, responsibility and dimensions of value with liberal education, *The Journal of Value Inquiry*. Vol. 39, pp. 1-9.
  30. Magyar, B. (2006). Humanistic and academic core values: The responsible reform of the European University, *Higher Education in Europe*, Vol. 31, No. 4, pp. 391-394.
  31. Mansuri, R. (1380). Definition of University, *Journal of Rahyafi*, Vol. 24, pp. 16-29.
  32. Maringe, F. (2005). Interrogation the crisis in HE marketing: The CORD model, *International journal of educational management*, Vol. 19, No. 7, pp. 564-578.
  33. Meyer, L. and Evans, T. (2005). Supporting academic staff: Meeting new expectations in HE without compromising traditional faculty values, *Journal of higher education policy*, pp. 243-255.
  34. Michael, S.O. (1997). American Higher education system: Consumerism versus professorialism, *International journal of educational management*, Vol. 77, No. 3.
  35. Monahan, T. (2005). Just another tool? IT pedagogy and the commodification of education, *The Urban Review*, Vol. 36, pp. 271-293.
  36. Muller, P. (2006). Exploring the knowledge filter: How entrepreneurship and university-industry relationships drive economic growth, *Research policy*. Vol. 35, pp. 1499-1508.
  37. National Report of Iran Higher Education (2005). Published by: Research and Planning Institution of Higher Education.
  38. Nowotny, H. (2006). Real science is excellent – how to interpret post-academic science, mode 2 and ERC, *Journal of science communication*, Vol. 5, No. 4, pp. 1-4.
  39. Ouama-Wangenge, G. (2008). Higher Education marketisation an its discontents: the case of quality in Kenya, *High Education*, Vol. 56, pp. 457-471.
  40. Patel, P., Este, P.D. (2007). University- Industry linkage in the UK: What are the factors underlying the variety of interactions with industry, *Research Policy*, pp. 1-19.
  41. Plewa, C. and Quester, P. (2005). Marketing orientation in university Industry Linkages, Australian & New Zealand Marketing Academy Conference, Wellington, New Zealand, 29.11-01.12.
  42. Polster, C. (2000). The future of liberal university in the era of the global knowledge grab, *Higher Education*, Vol. 39, pp. 19-41.
  43. Polster, C. (2007). The nature and implications of growing importance of research grants to Canadian universities and academics, *Higher Education*, Vol. 53, pp. 599-622.
  44. Rajabzadeh, A. (1379). University, Religious and Policy: Assessment of Intellectual and cultural Attitudes of Students. Office of cultural and social studies: Science, Research and Technology Ministry. Published by: research and planning institution of Higher Education.
  45. Rasmussen, E. Moen, Q. Gulbrandsen, M. (2006). Initiatives to promote commercialization of university knowledge, *Technovation*, Vol. 26, pp. 518-533.
  46. Reed, D. (2004). Universities and promotion of corporate responsibilities: Reinterpreting the liberal arts traditions, *Journal of Academic Ethics*, Vol. 2, pp. 3-41.
  47. Richardson, C. Bracco, K. Patrick, M. Finney, J. (1998). Higher education governance: Balancing institutional and market influence, *National center for public policy and higher education*, pp.1-26.

48. Sanders, D.(2007). The impact of neo-liberalism on college students, *Journal of College& character*, Vol. 5, pp. 1-9.
49. Scott, P. (2003). Challenges to academic values and the organization of academic work in a time of globalization, *Higher Education in Europe*, Vol. 3, pp. 295-306.
50. Scott, P. (2004). Ethics "in" and "for" Higher Education international. Conference on Ethical and moral Dimensions for Higher Education and Science in Europe.
51. Slauther, S. and Leslie, L. (1997). *Academic capitalism*. John Hopkins University Press.
52. Tasker, M. and Packham, D. (1993). Industry and Higher Education, *Journal of Studies in Higher Education*, Vol. 18/2, pp. 127-136.
53. Taylor, P. and Braddock, R. (2006). Commercialization and the function of the university, *The international journal of learning*, Vol. 12, pp. 1-10.
54. Tijssen, R.J.W (2004). Is the commercialization of scientific research affecting the production of public knowledge? Global trends in the output of corporate research articles, *Journal of Research Policy*, Vol. 33, pp. 709-733.
55. Trigg, David. J. (2005). Patenting the sun: Enclosing the scientific commons and transforming the university ethical concerns, *Drug Development Research*, Vol. 63, pp. 139-149.
56. Willmott, H. (1995). Managing the Academics: commodification and control in the development of university education in the United Kingdom, *Human Relations*, Vol. 48, pp. 993-1027.
57. Ylijoki, O.-H. (2000). Disciplinary cultures and the moral order of study- a case study of four Finnish university departments. *Higher Education*, 39, p 339-362.
58. Ylijoki, O.-H. (2003). Entangled in academic capitalism? A case study on changing ideals and practices of university research, *Higher Education*, Vol. 45, pp. 307-335.
59. Zilwa, D. (2007). "Organizational culture and values and the adaptation of academic units in Australian universities". *High Education*. 54, pp. 557- 574.
60. Ziman, J. (2002). Real science, what it is and what it means, *Science and engineering Ethics*, Vol. 8, pp. 1-17.