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The attitude of Egyptian SET academics towards innovation

Universities and innovation in a factor-driven economy

Hala El Hadidi and David A. Kirby

Abstract: *In the modern knowledge economy universities are being required to operate more entrepreneurially, commercializing the results of their research and spinning out new ventures. The literature on the Triple Helix model (of academic–industry–government relations) is outlined, emphasizing – as does the model – the enhanced role that the modern entrepreneurial university plays in technological innovation. The study then examines the situation in Egypt where, as an earlier study demonstrated, innovation and the role of higher education in the innovation process are only weakly developed. Four hundred science, engineering and technology academics from eight of Egypt's private and public universities were surveyed to identify why this is the case. The results reveal that while there is considerable uncertainty amongst academics in both the private and public sectors about the role of Egyptian universities in the innovation process, there is recognition of the need for government intervention and support if the country's universities are to adopt this Third Mission function. The possible types of intervention and support are considered, which will be of relevance to both academics and policy makers in Egypt and other factor-driven economies.*

Keywords: *Egypt; entrepreneurial university; factor-driven economies; innovation; knowledge economy; Triple Helix*

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In the modern knowledge economy that characterizes the 21st century, innovation is based increasingly on a Triple Helix of university–industry–government interactions (Etzkowitz, 2003) and the incubation of

university-based new technology firms. This has given the university a more prominent place in the modern innovation process. With it the concept of the entrepreneurial university has emerged, which takes a

positive stance in putting knowledge to use and broadening the input to the creation of new knowledge. Thus the innovation process now operates according to an interactive rather than a linear model. As firms raise their technological level, they move closer to an academic model, engaging in higher levels of training and in the sharing of knowledge, while government acts as a public entrepreneur and venture capitalist, in addition to its traditional regulatory role in setting the rules (Mustar and Laredo, 2002). As previous research (Academy of Scientific Research and Technology, 2014; El Hadidi and Kirby, 2015) has shown, this does not appear to be the case in Egypt, where innovation, and the role of universities in the innovation process, are only weakly developed.

This article examines the attitudes of Egyptian science, engineering and technology (SET) academics to innovation in an attempt to understand why and identify any interventions that might be needed, both in Egypt and elsewhere.

Theoretical framework

Academia has been changing, to become an active economic engine, spinning out new companies, licensing technology to the private sector and even developing their own ventures to facilitate commercial development. The Bayh–Dole Act of 1980 in the USA created an incentive for US universities to translate academic research discoveries into innovative commercial products by granting them ownership of patents.¹ Other countries have struggled to match the capacity of US universities to capitalize on their discoveries (Nelson, 1994). In Germany, although university academics were allowed to own patents, the external environment was not conducive to commercialization of these patents and, as a result, many innovations stagnated until new incentives were introduced. Similarly, French inventors had little incentive to commercialize; however, changes in the French system have removed these disincentives, enabling technology transfer to be funded (Nelson, 1994). The UK government has provided fiscal incentives to its universities to encourage both the transfer and commercialization of intellectual property resulting from research (Kirby, 2006).

Thus research universities are now positioning themselves to move from basic research into more applied research, and are taking equity in new spin-out companies as part of a diversified technology transfer licence structure. In addition, the ties between industry and universities have strengthened (Mehta, 2004) and commercial awareness in universities is increasing, with many academics no longer opposing business

opportunities. Such changes in attitude are particularly striking in departments of science and engineering; but increasingly universities are hiring entrepreneurs from the commercial world to lead their institutions (McKelvey, 1997).

Thus the 21st century university appears to be arriving at a common entrepreneurial format. The modern entrepreneurial university encompasses a ‘Third Mission’ of economic development in addition to research and teaching. This shift has arisen from both the internal development of the university and external influences on academic structures, associated with the emergence of ‘knowledge-based’ innovation. Entrepreneurial activities are undertaken with the objective of improving regional or national economic performance as well as the university’s financial advantage. However, many academics and others still view the entrepreneurial paradigm as a threat to the traditional integrity of the university (Pelikan, 1992; Kirby, 2006). Some critics believe entrepreneurship should be resisted, or at least ‘encapsulated in a special class of institution, fearing that an intensive pecuniary interest will cause the university to lose its role as independent critic of society’ (Dasgupta, 1994, p 500).

Similarly, the publication of research and production of graduates are held by many to be the most appropriate roles for an institution dedicated to the public good. Some companies, concerned about competition from new firms emerging from academia, adopt a similar position, arguing that universities should confine themselves to traditional academic–industrial relationships. Despite such claims, the momentum towards the emergence of an ‘entrepreneurial university’ is exceptionally strong. The concept of the entrepreneurial university envisions an academic structure and function that is revised through the alignment of economic development with research and teaching as academic missions.

Nevertheless, universities have not found it easy to construct new regimes that can handle the commercialization of research, and an in-depth study of university industrial liaison offices found policies for intellectual property rights confused and often ignored by academics (Ranga and Etzkowitz, 2012). As is the case in the UK, for example, it is possible that privately funded contract research will form the primary links between academia and industry. However, as elsewhere in Europe, the growth in the UK of university spin-off firms has increased steadily in response to the pressure towards commercializing the science base or developing knowledge-based services for larger firms that subcontract R&D activities, such as experimental testing (Ranga and Etzkowitz, 2010).

As the UK case indicates, the entrepreneurial university can emerge in academic systems with little or no previous history of, and even a strongly antagonistic attitude toward, the capitalization of knowledge. New policies on intellectual property rights that mirror similar shifts in the USA are important, and in both the UK and USA the relative independence of the university sector from the state meant that the capacity for a flexible response to the new circumstances was high (Ranga and Etzkowitz, 2010).

In Europe, academic institutions were traditionally state institutions. Under such conditions, part of the process of creating entrepreneurial academic institutions has been their attaining a significant degree of independence from controlling bureaucratic institutions such as a Ministry of Education, Culture or Science (Mello *et al*, 1998). A gradual shift can be identified in Continental Europe and Latin America towards, on the one hand, an increasing autonomy and independence of the university from the state and, on the other, closer engagement with industry while the transition to an entrepreneurial university is encouraged by European Union funding programmes. These programmes provide resources for creating intermediary mechanisms such as industrial liaison offices to interface with SMEs (small and medium-sized firms). Protectionism is being abandoned, and associated plans to develop entirely new industrial sectors based on government R&D have been downscaled to more modest, less costly programmes in order to subsidize Latin American universities to take up the task of enhancing industrial technology. Should these trends continue, European and Latin American universities would find a new balance in their relationship with government and industry, moving apart from the former and closer to the latter (Leydesdorff and Van Den Besselaar, 1998).

Thus the evidence from the literature suggests that a pattern of transformation into the entrepreneurial university is emerging, from different bases, in the USA, Latin America, Europe and Asia. At least two major trends can be identified that affect the future role of the entrepreneurial university: one is the shift to ever-greater dependence of the economy on knowledge production (Ranga and Etzkowitz, 2013), and the second is the attempt to identify and guide future trends in knowledge production and their implications for society.

The Egyptian context

As a 'factor-driven' economy, Egypt has a low level of economic development, competes on the basis of factor endowments (primarily unskilled labour and natural resources) and is characterized by low wages and low

productivity. Its economic competitiveness appears to be deteriorating and the Global Competitiveness Report, 2010, attributes this to the decline in its capacity for innovation. Overall, the country's rank for innovation has deteriorated from 59th of 114 countries in 2005/2006 to 83rd of 139 countries in 2010/2011 (CAPMAS 2012), while The Global Innovation Index (GII, 2011) ranked Egypt 108th of 142 countries in terms of progress and innovation and the World Economic Forum's Global Competitiveness Report 2011–2012 ranked Egypt 83rd on its capacity for innovation.

In terms of education, the country is characterized by a weak university sector that is highly centralized and governed by the Ministry of Higher Education and the Egyptian Supreme Council, with the result that institutions have little autonomy or independence. There are 20 public universities (with approximately two million students) and 23 private sector universities (with some 60,000 students). However, the country's rank in terms of the quality of higher education and training has been deteriorating, from 80th of 114 countries in 2005/2006 to 128th of 139 in 2010/2012, while spending on higher education has also been declining (Reda, 2012).

Transformations in the purpose and scope of Egyptian higher education have taken place in recent decades and education is now perceived as a means by which to foster economic growth and one of the country's top priorities. However, earlier research by El Hadidi and Kirby (2015) revealed that Egypt's universities are neither producing creative graduates who can innovate nor transferring and commercializing knowledge, while few universities have strong links with industry.

Aims and methodology

Against this academic and contextual background, the aim of this research is to identify why Egyptian universities are not contributing to the competitiveness of the country, particularly by generating new innovations and transferring and commercializing new knowledge. The study also focuses on the challenges the universities face when attempting to do so and to transform their role to that of a modern Triple Helix institution.

Given the developments that have occurred in Egypt since 2011, it is even more important than before that the country relies on its own indigenous development to compete in a rapidly changing global knowledge economy. Egypt, as with other factor-driven economies, will need to create businesses that innovate and can compete internationally and not merely within the local market. The research is thus both timely and relevant.

Table 1. Descriptive statistics and reliability coefficients for study variables.

Variable	Mean	Standard deviation	Cronbach's alpha
Innovation	23.61	4.69	0.777
Teaching	31.56	3.87	0.753
Research and R&D	23.53	5.32	0.780
Commercialization of knowledge	41.37	7.23	0.739
Knowledge transfer	57.64	7.01	0.830
Ecosystem	41.12	6.55	0.707
Support needed	65.85	5.93	0.853

Apart from contributing to the body of understanding in what is a newly emerging field, the study has practical relevance and the potential to aid policy formulation in both Egypt and elsewhere.

In accordance with the contextual stepwise approach to research (Kirby, 2007), the study adopts a three-phase strategy, whereby each phase contributes to greater understanding. Phase One (El Hadidi and Kirby, 2015) is a qualitative analysis of the views of a panel of experts, based on in-depth interviews. Together with the literature, it provides the basis for Phase Two, the focus of this study. This is a contextual investigation based on a self-administered questionnaire survey of 560 science, engineering technology (SET) academics in 8 private and public universities in Egypt. Phase Three, not reported here, will be a set of illustrative case studies selected purposively from the Phase Two survey.

The questionnaire comprised 86 Likert-style questions, in which respondents were required to indicate the strength of their agreement or disagreement with each of 86 statements, using a five-point scale to indicate whether they were opposed to, in favour of, or neutral about the concepts. The statements were divided into seven sub-sections: Table 1 reveals that these

sub-components have reasonable reliability. The content validity was estimated through the agreement of a panel of 10 experts on the items representing each component. Considerably large agreement coefficients among the experts were obtained, ranging from between 75% to 95% for all questionnaire items. This indicates reasonable validity of the survey.

The questionnaire was distributed in eight of the country's 43 universities (including three of the 20 state universities – Cairo, Alexandria and Assiut Universities – and five of the 23 private universities – the American University in Cairo, the British University in Egypt, Misr International University, the Modern Science and Arts University and Nile University). In total, these universities engaged some 2,890 SET academics (2,059 in the public sector and 831 in the private sector). The participants were selected randomly and in total 400 responded, representing a 13.8% sample or a 71.4% response rate. However, only 240 responses (11.7% of the population) were from the state sector, compared with 160 (19.2%) from the private sector. The reasons for this are unclear, but it means that the state universities are somewhat under-represented in the study, as they appear to be in the innovation process nationally. This might be a reflection of the importance the state academics place on both innovation and the study, but it means that the results for the state universities are not necessarily representative of the sector. The data were processed and analysed using SPSS and the differences in responses between the public and private universities were analysed using a *T*-Test (Table 2).

Findings

As mentioned above, the respondents were asked to indicate their agreement or disagreement with 86 statements, using a five point Likert Scale ranging from 'Strongly Disagree' (1) to 'Strongly Agree' (5). The statements were derived either from the literature or the

Table 2. Comparison of average scores between public and private universities.

Variable	Public (n=240)		Private (n=160)		T-value
	μ	σ	μ	σ	
Innovation	23.72	3.90	23.43	5.67	0.601
Teaching	31.66	2.76	31.41	5.11	0.675
Research and R&D	24.78	3.31	21.65	6.97	6.02 [*]
Commercialization of knowledge	41.76	4.66	40.77	9.91	1.34
Knowledge transfer	57.89	4.11	57.26	9.89	0.878
Ecosystem	42.30	5.48	39.35	7.58	4.51 [*]
Support needed	64.59	5.19	67.73	6.46	5.37 [*]

Note: ^{*}Difference is significant at $p < 0.001$.

earlier study of Egyptian experts (El Hadidi and Kirby, 2015). Averages were calculated for each of the statements for both public and private universities and the total sample population (Table 2).

Attitudes towards innovation

From the data in Table 3 it would appear that the population did not oppose universities being involved in the innovation process; rather, they neither agreed nor disagreed with the statements relating to innovation and the role of the country’s universities. On average, the respondents neither supported nor refuted the idea that universities are the creators of new ideas, have a major or minor role to play in innovation, or promote innovation through their teaching, research or community service activities (the Third Mission). Similarly, the respondents neither agreed nor disagreed with the view that the quality of higher education in Egypt was conducive to innovation, which is in contrast to the earlier views of Egyptian experts (El Hadidi and Kirby, 2015). This indecision possibly reflects the fact that innovation is not something which, to date, either the public or the more recent private universities have traditionally been required to engage with, suggesting a need to raise awareness.

Attitudes towards teaching

Table 4 reveals again that on average the respondents were undecided about the contribution that teaching makes to innovation, although it is noticeable that the private sector average of 2.91 suggests that academics in the private universities disagree with the statement that Egyptian universities ‘... are not producing graduates who can innovate’. This would imply that this is a more common objective for the more modern and smaller private universities than it is for the state sector. Similarly, with an average of 4.06, the private sector

Table 3. Innovation.

Statement	Public	Private	Total
Universities are the creators of new ideas	3.34	3.30	3.33
Universities have an important role to play in innovation	3.45	3.66	3.54
Universities make only a minor contribution to innovation	3.15	3.25	3.19
The quality of higher education is conducive to innovation	3.39	3.36	3.38
Universities promote innovation through: teaching/research/ community service	3.53	3.63	3.57

Table 4. Teaching.

Statement	Public	Private	Total
Universities teach innovation and entrepreneurship as part of the curriculum	3.18	3.11	3.15
Universities equip students with: knowledge to innovate/skill to innovate	3.34	3.11	3.25
Universities are not producing creative graduates who can innovate	3.24	2.91	3.11
The curriculum depends: on rote memorization/ dated teaching methods	3.49	3.30	3.42
Universities have too many students	3.78	3.83	3.80
There is the ability to increase the pool of innovative students	3.60	3.74	3.66
Teaching in universities needs to be geared more towards industry needs in terms of problems faced and new developments	3.61	4.06	3.79
Universities can and do produce creative graduates who can innovate but not in all specialties and on a very small scale as this is only a recent development	3.38	3.18	3.30
Universities produce graduates that are not fit for the labour market	3.49	3.35	3.44

seems to appreciate better that ‘Teaching in universities needs to be geared more towards industry needs, in terms of problems faced and new developments’.

Attitudes towards research and development

A statistically significant difference of opinion (significant at the 0.001 significance level) appears to exist between the country’s private and public universities with respect to R&D (Table 5). Essentially, the respondents from the private universities disagreed that universities have R&D activities, that university R&D has a strong effect on innovation, that there is collaboration between universities and industry, that university budgets allow for R&D, or that universities have strong R&D environments. While the respondents from the public universities, on average, neither agreed nor disagreed with these statements, it would appear that there is a difference between the two types of institutions and the roles they play with respect to R&D.

Table 5. Research and development.

Statement	Public	Private	Total
Universities have R&D activities	3.35	2.88	3.16
University R&D impacts strongly on innovation	3.47	2.85	3.22
There is collaboration in research between universities and industry	3.25	2.66	3.02
There are cost pressures in universities that impede R&D	3.49	3.64	3.55
Universities constitute an important input to industry R&D	3.34	3.06	3.23
University budgets allow for R&D	3.32	2.90	3.15
Research in the university needs to be geared more towards industry needs in terms of problems faced and new developments	3.86	3.96	3.9
Universities have strong research environments	3.41	2.90	3.21

Attitudes towards commercialization of knowledge

The concept of commercializing the knowledge generated from academic research is somewhat new to Egypt and, according to the earlier survey of experts (El Hadidi and Kirby, 2015), not permitted by law. Hence it is perhaps not surprising that both samples neither agreed nor disagreed with any of the statements relating to knowledge commercialization (Table 6): this is not something that is widely considered in Egyptian academia, nor is it seen as an important role for the country's universities. If the country is to benefit from the new knowledge created by its universities through the research undertaken, particularly in the state sector, clearly this needs to change. Academics need to recognize the importance of the commercialization of knowledge to the functioning of a modern 21st century university in the contemporary global knowledge economy, and to be permitted to do so.

Table 6. Knowledge commercialization.

Statement	Public	Private	Total
There are too few university start-up and spin-out companies based on innovative ideas coming from university research and laboratories	3.62	3.14	3.43
The mechanisms that allow universities to create links with companies are missing	3.63	3.60	3.62
Universities have to avoid moving towards a profit company	3.41	3.30	3.37
Universities do not understand the needs of the economy	3.20	3.49	3.32
Business is considered to be a shameful word by most academics	3.11	3.01	3.07
Universities have an important role to play in knowledge commercialization	3.42	3.79	3.57
The involvement of Egyptian universities in knowledge commercialization is limited	3.37	3.90	3.58
University research is not sufficiently innovative to commercialize	3.43	3.68	3.53
Universities have very few patents due to ignorance of the patents law and weak information about IP which leads to no encouragement for inventive ideas and no governmental regulations to govern knowledge commercialization	3.41	3.68	3.52
The current universities law does not allow commercialization	3.31	3.18	3.26
State university staff are not allowed to become part or full partners in enterprises (spin-offs)	3.25	3.48	3.34
Egypt's universities are not involved in knowledge commercialization: it is the role of start-up firms and entrepreneurs: that's why collaboration with industry is important	3.35	3.58	3.44
Universities are not involved in knowledge commercialization because there is no expert database	3.36	3.40	3.38
No risk taking is allowed in universities	3.57	3.50	3.54
Industry benefits from university research	3.53	3.30	3.44

Table 7. Knowledge transfer.

Statement	Public	Private	Total
Universities have a role to play in knowledge transfer	3.78	3.49	3.67
Scientific publication is a way to transfer academic knowledge to industry	3.81	3.55	3.71
Seminars are a way to transfer academic knowledge to industry	3.88	3.65	3.79
Workshops are a way to transfer academic knowledge to industry	3.76	3.66	3.72
Knowledge spill-overs from universities benefit industry	3.74	3.26	3.55
The transfer of knowledge from university to industry is affected by geographical distance	3.33	3.16	3.26
Revenue generation is the main goal of universities in knowledge transfer	3.6	3.26	3.47
The cost of knowledge transfer affects the innovation process	3.64	3.44	3.56
Some universities are involved in knowledge transfer through joint programmes with international universities and guest lecturers	3.59	3.56	3.58
There is a lack of trust between university and industry	3.39	3.31	3.36
Universities lack the organizing mechanisms for the proper management of formal relationships with industry	3.53	3.55	3.54
University and industry are on a different wavelength	3.35	3.58	3.44
Currently, universities are not working effectively with industry	3.48	3.66	3.55
There is a mutual link between industry and university	3.45	3.51	3.48
Universities give consultancy to industry to solve problems	3.44	3.33	3.40
Industry does not value the impact of scientific research from universities	3.43	3.24	3.35
Universities often work with industry because according to the law of scientific research, taxes are decreased for scientific research and there is the training of personnel	3.31	3.19	3.26
Sometimes there are centres inside universities dealing with industry but the link is weak	3.59	3.34	3.49
Universities are not oriented to the needs of industry	3.53	3.40	3.48

Attitudes towards knowledge transfer

Traditionally there has been very little formal knowledge transfer between most Egyptian universities and industry. While the state universities in Egypt have traditionally had a role in community service, the formal transfer of knowledge between university and industry has not been extensive. This may well explain why the average response to all of the statements in both sectors is 'neither agree nor disagree' (Table 7). The respondents, on average, were insufficiently well informed to reach a decision. Again, as with the commercialization of knowledge, this needs to change if the country's universities are to fulfil their role in helping Egypt to compete more effectively in the global market place.

Attitudes towards the ecosystem

Critical to the successful transformation of a country's universities is a supportive ecosystem. As the literature demonstrates, the Triple Helix of university–

industry–government relations is important. In Egypt, however, it would appear – on the basis of the responses – that either the respondents were not aware of the support available from industry and government, or it is not readily available (see Table 8). Interestingly, the respondents from both the state and the private universities were agreed that '... there needs to be a national policy that encourages universities to get involved with the "Third Mission"', while there was recognition, particularly in the private sector, that 'Cooperation between universities and industry promotes innovation'. This needs to be capitalized on and encouraged. If the Egyptian government '... has a policy towards increasing the capacity for innovation and university–industry research' it would seem that, with an average score of 3.54, the respondents in both sectors were not aware of it. Particularly in the private sector, the infrastructure of universities does not appear to encourage innovation.

Table 8. Ecosystem.

Statement	Public	Private	Total
The infrastructure of universities encourages innovation	3.45	2.95	3.25
There are too few incentives to universities to encourage innovation	3.67	3.26	3.51
There are people in universities who can help raise funding for innovation	3.86	3.59	3.75
Universities compete in terms of innovation	3.69	3.04	3.43
Universities are part of an ecosystem that encourages innovation	3.81	3.30	3.61
Universities should concentrate on 'market pull' not 'technology push'	3.65	3.30	3.51
Cooperation between universities and industry promotes innovation	3.93	4.04	3.97
Size affects the capacity of universities to innovate	3.90	3.73	3.83
The location of a university helps promote innovation	3.88	3.69	3.81
The government has a policy towards increasing the capacity for innovation and university–industry research	3.79	3.15	3.54
There are mechanisms that have been in place for several years which support university–industry collaboration	3.77	3.23	3.55
There needs to be a national policy that encourages universities to get involved with the 'Third Mission'	4.04	4.06	4.05

Attitudes towards support needed

From Table 9 it is clear that the respondents agreed that support was needed if Egypt's universities are to play a more central role in the innovation process. The respondents agreed with 10 of 14 suggestions for support. Somewhat surprisingly, perhaps, given the control exerted by the Government, the state universities did not agree that universities should be more autonomous. This not only contrasts with the views of those from the private sector but it also contradicts the view expressed by Naghizadeh *et al* (2014) and others that in order to optimize their entrepreneurial capability universities need to move away from close government regulation and sector standardization. However, both sectors recognized the need to capacity build (4.37) and to reward those academics who innovate (4.38)

Discussion

The results of the first phase of this project (El Hadidi and Kirby, 2015, pp 156–157) concluded that:

'Egyptian universities do already contribute, but that, they generally lag behind those of other competitor countries. Although support exists, there are numerous factors that contribute to this situation, including the nature, quality and amount of research being conducted in Egyptian universities, the mistrust between industry and academia and the lack of resources, both human and physical.'

Having reviewed the attitudes of Egyptian SET academics, this second phase of the study suggests a further, significant and major factor, namely that there is little apparent understanding of the concept of the contribution of the modern university to the innovation process. This would further suggest a need for raising awareness through capacity building and staff development, ensuring the researchers have both the knowledge and skills to innovate and bring their ideas to market. As one respondent stated, however,

'The most important [thing] is that staff with industrial research achievements should be recognized and selected for leadership positions.'

This is important. Those academics who do innovate and commercialize their innovations need to be rewarded and recognized as role models. Accordingly, the systems by which academics are rewarded and promoted need to be adapted and modified to reflect the country's emerging priorities and requirements. Recognition should not be given solely for the publication of research findings, as is traditional, but for their application, implementation and commercialization. Indeed, in order to protect the intellectual property, the researchers may need to be prevented from journal and/or conference publication of their findings. This will certainly require changes in university policy, both at the level of the institution and, probably, nationally, a point recognized in Phase One by the panel of experts. They suggested that '... if the

Table 9. The support needed in Egypt.

Statement	Public	Private	Total
More needs to be done if universities are to fulfil their potential in the innovation process	4.14	4.15	4.15
It needs to be clear why universities should be involved	4.03	4.28	4.13
The promotions laws need to recognize applied research and patent application	3.92	4.16	4.02
There is a need for training	4.06	4.36	4.18
Universities need to be permitted to be more autonomous	3.74	4.11	3.89
Egypt has weak policies to increase the capacity to innovate from the part of the university and research institutes	3.93	3.79	3.88
The funding for research and innovatory projects needs to be increased	4.06	4.43	4.21
Universities must be encouraged to solve problems relevant to the needs of the market through their research	3.95	4.51	4.18
The government needs to have a coherent policy towards increasing the capacity for innovation and university–industry research	4.07	3.85	3.98
Innovators must be supported and rewarded	4.30	4.50	4.38
Part or complete tax exemptions need to be introduced for innovatory projects in order to motivate industry to activate their R&D departments or/and link with universities	3.94	4.20	4.05
The bureaucratic rules that discourage the registration of IPR need to be reduced	3.90	4.01	3.95
Bureaucracy needs to be kept to a minimum	4.02	4.15	4.07
Universities need to be encouraged to work with business	4.00	4.44	4.18
Universities should be required to conduct leading edge research	4.03	4.50	4.22
Academics should be encouraged and supported to bring main findings to market	4.04	4.44	4.20
A ‘can do’ culture needs to be fostered in universities to encourage staff to try new things	4.13	4.49	4.27
There needs to be a programme for capacity building	4.25	4.55	4.37

promotion laws recognized applied research and patent applications, the situation would improve’ (El Hadidi and Kirby, 2015, p 156). In addition, and importantly, policies will need to be introduced that enable and support the transfer and commercialization of knowledge by universities and their academic staff.

Conclusions

The aim of this article was to build on earlier research by El Hadidi and Kirby (2015) to identify why Egyptian universities do not participate in the innovation process in the country and to identify any support that might be needed. To achieve this, the study surveyed some 400 SET academics drawn from eight universities in Egypt.

It revealed that it was a case less of there being opposition to the concept of universities contributing to the innovation process than to there being an apparent lack of understanding of, or commitment to, it. Hence, there was recognition of the need for intervention on the part of government, confirming developments that have occurred elsewhere. While the role of government should not be over-estimated, it does play an integral role in the transformation process, in accordance with the Triple Helix model. Interestingly, though, it was not felt by the respondents that there needs to be ‘a coherent policy towards increasing the capacity for innovation and university–industry research’ nor any reduction of the control of government, especially in the state sector. This would suggest that the Egyptian government perhaps needs to work with the private and public universities to produce policies which create an

environment conducive to the transformation process, and encourage industry to collaborate with higher education. As elsewhere, the Government might provide fiscal incentives to encourage university–industry research collaboration in the innovation process. To do so it may use some or all of the instruments provided by external sources such as the EU, USAID and the UK in order to promote quality innovative science and technological research and its commercial exploitation.^{2,3,4} This is already happening. Between 2007 and 2011 the country received €11 million from the European Union to fund the Research Development and Innovation Programme and from 2011 to 2018 it will receive a further €20 million. The intention is to use the funding to foster a science and innovation culture in the country and to expand research collaboration with business. However, more is needed and, as one respondent recognized, ‘there are mechanisms for supporting university and industry collaboration but they are not effective or applied’. Hence support is needed to ensure that both industry and academia are aware of the measures and have the ability and networks to use them. While this will involve awareness-raising events and capacity-building programmes, the government might usefully consider creating a permanent national academic–industry–government forum in which members can explore areas of mutual interest and benefit, together with opportunities for collaboration. This body could then encourage and spawn replication at the local level.

Clearly, the present research contributes to the growing body of literature on the topic and focuses attention on a factor-driven economy rather than the more advanced economies that have been the subject of most other studies. Further research is needed, however, not just in Egypt but in other economies attempting to transform and compete in the global knowledge economy. Meanwhile, the next and final phase of this research will focus on providing exemplars of how Egyptian universities and academics are already responding to the challenge and the problems encountered in so doing.

While corroborating the results of similar, earlier studies, it is acknowledged that this research is not without its limitations, not least the size and structure of the sample. Future studies may address this and further research might also aim to determine if and how attitudes change, as a result of the introduction of any policies and interventions.

Notes

¹See, for example, https://www.autm.net/Bayh_Dole_Act1.htm for details of the Bayh-Dole Act.

²The EU is working to develop closer scientific ties between Egypt and the European Research Area, particularly through increased Egyptian participation in Horizon 2020, the ongoing EU Framework Programme for Research and Technological Development. Horizon 2020 is the largest ever EU Research and Innovation Programme, with nearly €80 billion of funding available between 2014 and 2020 intended for collaboration with third world partners such as Egypt. The programme is intended to ensure Europe produces world class science, remove the barriers to innovation and make it easier for the public and private sectors to work together to deliver results.

³The US–Egypt Higher Education Partnerships Program is a US\$57 million five-year programme intended to strengthen the institutional capacity of Egyptian higher education institutions by developing new programmes that address labour market requirements, upgrading curricula, improving teaching methods, stimulating better applied research and the commercialization of research outcomes, and providing for exchanges between partner institutions. The programme recognizes that education and innovation are at the heart of long-term economic growth and will be critical to Egypt's ability to acquire and sustain a competitive advantage in a global knowledge-based economy.

⁴The UK's Newton–Mosharafa Fund is a £20 million fund, available over a five year period, intended to bring together the British and Egyptian scientific research and innovation sectors to find solutions to the challenges facing Egypt in economic development and social welfare. It is part of the UK's £375 million Newton Fund (£75 million per annum over five years, starting in 2014: see <http://www.britishcouncil.org/education/science/newton>) to support science and innovation partnerships between the UK and emerging powers.

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