RESEARCH AND DEVELOPMENT IN THE OCCUPIED PALESTINIAN TERRITORIES: CHALLENGES AND OPPORTUNITIES

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Introduction

In the Occupied Palestinian Territories (OPT), Palestinian higher education and research and development (R&D) have a relatively recent history and face extraordinary challenges not faced by other countries. The study presented in this article examined the existing status of R&D, parameters that led to past successes and failures, and prospects for advancement of R&D in the OPT.

Palestinian universities are young by international standards, the oldest being only thirty years old and the youngest less than ten years old. Research was implemented by faculty at these nascent Palestinian universities and by civil society institutions and independent research centers (NGOs) (MOPIC, 1998). In 1977, the Council for Higher Education (CHE) was established to promote cooperation and coordination among Palestinian higher education institutions. In 1990, the CHE came to oversee policy for the whole sector (general, vocational/technical and higher education). CHE was a vehicle for allocating funds to higher education institutions, and creating a unified system of fees for students and salaries for staff. Except for the CHE, there was no official mechanism available to Palestinian universities and colleges for national planning, stable funding, or impartial and systematic decision-making. During the Israeli occupation and the associated absence of a national legal system, Palestinian universities lacked the legal foundation and framework for regulating their operations and providing them with institutional and professional protection (Gerner, 1989; Baramki, 1996).

Following the Oslo accords and the establishment of the Palestinian National Authority (PNA) in 1994, the Ministry of Higher Education was established and in 2000 was renamed to Ministry of Higher Education and Scientific Research and later reintegrated with the Ministry of Education to form the current Ministry of Education and Higher Education (MOEHE). In a further development, in May 2001, the PNA issued a decree by which the mandate of scientific research was entrusted

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to MOEHE. In doing this, the PNA also signaled its increased commitment to higher education and scientific research as national priorities, both administratively and financially. The MOEHE was invited to join a number of the international fora dealing with issues of higher education, research, and development. Several international research funding institutions encouraged the participation of Palestinian researchers in joint research projects, leading to a number of activities aimed at supporting "regional cooperation." On the regional level, Palestine is represented within and receiving support from, among others: ALECSO (Arab League for Education, Culture and Science Organizations), ISESCO (Islamic Society for Education, Science and Cultural Organizations), ESCWA (Economic and Social Commission for Western Asia of the UN), Union of Arab Universities. Research projects or signed cooperation agreements were implemented between Palestinian institutions and such entities as UNESCO, UNDP, European Union, USA, Belgium, France, Germany, Great Britain, Netherlands, Republic of South Africa, Poland, Norway, Italy, and Switzerland.

The establishment of the PNA was accompanied by slow but important changes in areas of education and R&D. Some existing educational and research organizations took on quasi governmental status, others were created specifically by the Palestinian authority (such as Al-Aqsa University and Palestine Technical College). The new Palestinian ministries, such as Agriculture and Higher Education, became engaged in plans to enhance or promote R&D capabilities (MOPIC, 1998). In 1998, the Palestinian Academy for Science and Technology (PAST) was established. The establishment of the Accreditation and Quality Assurance Commission (AQAC) and of the Quality Improvement Fund (QIF) with the support of the Ford Foundation, the World Bank and the European Union, has helped universities enhance the quality and relevance of their programs and to establish centers of excellence in various fields.

In MOEHE there is a General Directorate of Scientific Research that was created to support and advance R&D in the OPT. A Science Research Council (SRC) was established to assist this Directorate in its mission. Membership of the SRC includes representatives from Palestinian universities and research centers. In 1999, the PNA issued its developmental strategy in preparation for Palestinian statehood. Regrettably, the strategy outlined in the education component of this document did not include any reference to SETI (Science, Engineering, Technology, and Innovations). However, MOEHE presented a strategy for the coming three years on December 23, 2009. The strategy called for more entrepreneurial learning, advancement of R&D as a component of higher education, and ensuring that higher education meets the needs of the Palestinian society (MOEHE, 2009).

An international conference on "Development of Scientific Research at Palestinian Institutions" was held in Paris on November 4-5, 2007 under the auspices of UNESCO and the "Palestinian-European-Academic Cooperation in Education"

(PEACE) program. Participants concluded that much more data on the status of R&D in Palestinian institutions are needed and that better planning and organization would help advance R&D to serve the needs of the Palestinian society. A follow-up PEACE workshop was held on January 16, 2008 at An-Najah N. University, Nablus and expanded on what was discussed in Paris, and this was followed by a meeting in Barcelona in November 2010 (see http://www.peace-programme.org).

The 8th UNESCO-Palestinian Authority meeting convened on March 4-5, 2008 at UNESCO Headquarters in Paris identified areas of cooperation among which is the need for developing a policy framework for science innovation and technology in Palestine. As a result of this and subsequent discussion, a more specific call for a consultancy was issued to map out existing R&D efforts in the Palestinian authority areas and to engage stakeholders in discussion about future directions. In 2009, UNESCO and MOEHE asked the Applied Research Institute of Jerusalem (ARIJ) to study R&D status and potential for development. Here we report on results from parts of these studies that deal with statistics on science and technology, specifically resources devoted to research and development (R&D) at higher education institutions and research centers (be it governmental, non-governmental, public, and private).

Methodology

We adapted the UNESCO questionnaire and Institute for Statistics questionnaire/manuals for data collection on science and technology (http://www.uis.unesco.org/) to develop a questionnaire that covers the basic data points in a user-friendly fashion. The new questionnaire went through a number of edits including input from the Ministry of Higher Education until a new questionnaire was agreed upon. The questionnaire was distributed to stakeholders including universities and institutes of higher education, governmental institutions, private sector institutions employing more than ten people, and civil society institutions. Thus, the questionnaire was sent to over a hundred institutions including all universities, five ministries, and 65 NGOs or private sectors. Field visits were conducted to 37 institutions in the West Bank and sixteen in Gaza. Some institutions were noted not to have R&D efforts and others failed to respond, but we did receive 47 completed questionnaires. The ARIJ team met with the Palestinian Central Bureau of Statistics (PCBS) which had engaged in preliminary data collection (PCBS, 2010). It was noted that:

- PCBS forms were different in some respects but there were common data that could be consolidated.
- In a few cases ARIJ and PCBS targeted the same institution but received different data. The person who filled in the questionnaire made a difference.

We were able to resolve these differences and when we could not, our data was used.
- The PCBS questionnaire didn't target the factors that might promote R&D in Palestine.
- The PCBS questionnaire didn't give detailed information about joint projects with other academic, NGO, local and international institutions.

Consequently, ARIJ and PCBS decided to consolidate the two sets of data to produce the most comprehensive results possible for R&D in the OPT, representing 63 institutions. The data were fed into SPSS software and analyzed.

Results

The combination of ARIJ and PCBS data were received from 63 institutions in the OPT. The survey covers all sixteen educational and higher education institutions engaged in R&D in the OPT, five private sector organizations, three governmental institutions, and 39 civil institutions. In the latter sector, we captured all key organizations. There are twelve universities and nine colleges offering BA degrees (university colleges) in the OPT. Among these universities and university colleges there are eight universities and six university colleges in the West Bank and three universities and three university colleges in the Gaza Strip. The governmental universities include places like Al-Aqsa University and Al-'Arub College. The findings also showed that there are twenty community colleges in the OPT, of which sixteen are in the West Bank and four in the Gaza Strip.

The data showed the total number of personnel captured who are involved in R&D in the OPT is 1,744, of whom 1,435 (82.3 percent) are males. Of all surveyed researchers, 74.4 percent (1,298 of 1,744) are found at higher educational institutions and 22.6 percent (395 of 1,744) at civil society organizations. Thus, universities are the principal sites of scientific research in the OPT. Table 1 outlines the distribution of researchers by education degree in all institutions. There is a dramatic difference in employment of R&D personnel between civil society institutions and universities. The universities have far more PhDs (66.4 percent) than NGOs (18.4 percent). The percentage of MSc holders in civil society institutions is 45.3 percent compared with 27.6 percent at universities. Thus, it is fair to state that R&D at civil society organizations is being done mostly by MSc and BSc level staff. This may be attributed to the fact that PhD holders have preference in university hiring and that NGOs pay significantly better for master's holders.

Table 2 reveals that female representation decreases with the increase in educational degree among Palestinian researchers. In general, the percentage of female researchers holding PhD degrees is 7 percent while this percentage reaches

22.7 percent for MSc holders and 28 percent for BSc holders. Participation of female researchers in civil society organizations is higher than in universities for both MSc holders (30.7 percent versus 20.8 percent) and PhD holders (9.5 percent versus 6.8 percent). The numbers of researchers in the government and private sector are relatively small to make meaningful comparisons.

Table 1 Number of Researchers by Educational Degree and Sector

Sector	Diploma Degree	Bachelor Degree	Master Degree	PhD Degree	Total
Private Institution	0	9	7	8	24
Governmental Institution	0	4	20	3	27
Educational & Higher Education Institution	1	77	358	862	1298
Civil Society Institution	21	122	179	73	395
Total	22	212	564	946	1744
Percent	1.3	12.2	32.3	54.2	100

Table 2 Researchers by Educational Degree and Gender

Sector	Diploma Degree		Bachelor Degree		Master Degree		PhD Degree		Total	
	male	female	male	female	male	female	male	female	male	female
Private Sector	0	0	1	0	1	0	1	0	3	0
Governmental	0	0	3	1	17	3	3	0	23	4
Educational & Higher Education Institution	0	1	52	15	206	54	721	53	979	123
Civil Society Institution	13	5	62	30	61	27	57	6	193	68
Total	13	6	118	46	285	84	782	59	1198	195

The twelve universities in Gaza and the West Bank on average gave numbers that indicate that about 30 percent of staff engages in R&D. Nine of the twelve actually had percentages close to this average. Three institutions regrettably stated numbers that exhibit significant divergence. Al-Quds University and Palestine Polytechnic University both gave rather low numbers of researchers (7.9 percent and 10 percent of staff respectively) while Arab American University-Jenin gave an unreasonably high number (90 percent of staff engaged in R&D). While these three balance each other out when trying to get an estimate of total and composition of R&D personnel in Palestinian institutions, they point out the pitfalls of trying to get accurate counts with surveys that are completed in different ways by different individuals at different institutions. The three institutions simply gave estimates by a Dean of Research or another administrator. Bethlehem and Birzeit Universities by contrast did more accurate surveys asking deans of different faculties to provide the information. Multiplying the average percent (30.8 percent) by the total academic staff (4,607),

we get a somewhat higher number of academic staff engaged in R&D at 1,419 than the actual reported number of 1,096. But we do note that this number is still small, especially compared to a population of Palestinians in the (OPT) areas of over 4 million.

The impact of the Open University is interesting. This university now employs some 30 percent of total teaching staff at all Palestinian universities. However, most of those (85 percent) work part-time. Faculty members complement their income at traditional universities or NGOs by working part-time at the Open University. As noted below, the student enrollment and hence need of teaching staff at the Open University is mushrooming. As more and more faculty try to balance full-time teaching at traditional universities and part-time teaching at the Open University, it is clear that they will have less and less time for research.

Most qualified researchers are at universities. As noted above, about a third of faculty at universities and colleges (where most research is done) engage in R&D in Palestine. While this figure seems high, the number of full-time researchers in all Palestinian institutes of higher education is 78; which is 2 percent of the total academic staff (Table 3). Even assuming we missed 10 percent (maximum) in institutions that did not return the survey, this translated to roughly 1,000 R&D full-time equivalents for the 4 million Palestinians in the West Bank and Gaza, which works out at 250 per million. This contrasts with North America, with over 3,500 researchers per million, and Europe with over 2,500 per million, but is still better than the Arab World with 200-220 per million.

Regarding the distribution of R&D personnel by discipline in general it is clear that humanities dominate followed by social sciences, natural sciences, engineering and technology, health and medical sciences, and finally agricultural sciences (Table 4).

Conducting research in humanities and social sciences does not need expensive equipment and facilities as in engineering and technology. Further, humanities and social sciences papers are usually published in the local and regional journals. Research in engineering is mostly done on an individual basis, and not dependent on clear public or governmental policy and support. Support for research in engineering, science, technology and medical sciences from the private, public and governmental sectors remains weak in Palestine. The agricultural sciences need special attention either in a university program or research.

The lack of opportunities for work in the engineering, science and medical sciences in the OPT leads graduates and researchers to the humanities and social sciences, as more opportunities can be found there in an economy that has been increasingly dependent on humanitarian aid (service economy) with limited means of production.

Table 3 Number of Researchers Involved in Scientific Research

Sector	Part Time	Full Time	0% Involvement	Blank Answer	Total
Private Institution	24	0	0	0	24
Governmental Institution	20	6	0	1	27
Educational & Higher Education Institution	1148	39	68	43	1298
Civil Institution	352	33	0	10	395
Total	1544	78	68	54	1744
Percent	88.5	4.5	3.9	3.1	

Table 4 Researchers Involved in the Different Fields of Science

Sector	Natural Sciences	Engineering & Technology	Medical Sciences	Agricultural Sciences	Social Sciences	Humanities	Total
Private Institution	1	1	1	2	13	6	24
Governmental Institution	0	0	4	0	15	8	27
Educational & Higher Education Institution	237	163	99	29	281	489	1298
Civil Institution	41	38	11	48	171	86	395
Total	279	202	115	79	480	589	1744
Percent	16	11.6	6.6	4.5	27.5	33.8	100

In 2003, education received 14 percent of the total budget for the Palestinian National Authority, of which higher education received only 5.6 percent. These figures have only decreased since then, and are among the lowest in the world. The corresponding funding level for Middle East and North African countries is approximately 30 percent on average. In response to the challenges facing the Palestinian higher education sector, the strategy developed in 2001 acknowledged the fundamental reality that the level of public financial support for Palestinian higher education is not now nor likely in the foreseeable future to be sufficient to ensure fiscal sustainability of the system as it currently exists. Therefore, major reforms are being proposed so that public funds are targeted in ways to improve what will remain a largely public not-for-profit higher education system (Ministry of Higher Education and Scientific Research, 2001).

There is no allocated budget for R&D per se in the OPT. The only exception was $400,000 allocated in 2005. However, our survey shows that there are several funding opportunities available to Palestinian researchers. Table 5 shows that in 2008 a total of $7.65 million was spent on R&D in the OPT. PCBS data for the same period puts the figure at $11.5 million. Much of this funding comes from outside agencies which give Palestinian institutions part of the funding for collaborative projects (data not shown).

Table 5 Total Annual Expenditure on Research and Development (US$) by Sector

Sector	Total Annual Expenditure	Percent
Private Institution	949,187	12.4
Governmental Institution	100,000	1.3
Educational & Higher Education Institution	3,267,408	42.7
Civil Society Institution	3,335,154	43.6
Total	7,651,749	100

Table 6 Outputs of Research and Development in the West Bank and the Gaza Strip by Sector

Sector	Local Awards	International Awards	Patents	Local Publications	International Publications	Consultancies	Total
Private Institution	0	0	0	2	0	32	34
Governmental Institution	0	0	0	11	3	14	28
Educational & Higher Education Institution	21	47	6	776	419	1060	2329
Civil Society Institution	27	4	3	556	151	362	1103
Total	48	51	9	1345	573	1468	3494

The output for research in the OPT was rather small (Table 6). Considering even the small total number of researchers (1,744), it appears that there is less than one International publication per three researchers per year. If we add the local journals, the percentage goes up to 1.1 publications per person per year. This is low when compared to developed countries but on par with Arab countries.

Discussion

The study suggests that much work is needed to advance R&D in the OPT. Our study and those before it collectively point out that we face significant demographic, governance, and fiscal pressures to develop an R&D program that meets the needs of the Palestinian society. This is also complicated by the difficulty of predicting the future of this society (independence, one state in the whole of Palestine, two states Israel/Palestine, and if the latter, the level of freedom afforded to the new Palestinian state in the West Bank and Gaza). Add to this the absence of clear strategy that sets priorities for R&D let alone mechanisms of implementation and the extent of the challenge facing us becomes obvious. Yet it has been noted that: "Few post-colonial societies have been fortunate to have as significant a base of expertise regarding higher education as have the Palestinians. This means that Palestinians have the opportunity to consider carefully the strengths and weaknesses of various approaches to post-secondary education and construct a system that is truly customized to address Palestinian needs and aspirations" (Schrodt, 1999).

Budgets and availability of resources are critical for R&D and pose a challenge even in highly developed and advanced countries. In developing countries (and more so in a Palestinian state that is emerging after decades of occupation and colonization), this becomes a huge challenge. R&D expenditure as a percentage of GDP in 2005 was 3.3 percent for Japan, 2.6 percent for the US, and 1.7 percent for Europe (OECD, 2007). The European Union decided to ramp up its R&D to be equivalent to 3.3 percent of GDP and developed the Framework Program 7 (FP7) to achieve target growth over a seven-year period. By contrast, the expenditure on R&D in Palestine is miniscule and the outputs small (Table 7).

Table 7 Country Comparisons (UNESCO data, Israel CBS, plus our data for Palestine)

Country	Palestine	Jordan	Lebanon	Egypt	Israel
Total population (000)	4017	5924	4099	75498	6928
Researchers per 1,000,000 inhabitants (FTE)	250	1952	NA	617	6784
Expenditure on R&D as % of GDP	0.09	0.34	NA	0.23	4.74
Pupil/teacher ratio (primary)	30	20	14	27	13
Primary to secondary transition rate (%)	97	98	86	86	71
Total book production	114	NA	289	1410	1969
GDP per capita (PPP) US$	1067	4628	9741	4953	24097

Faculty members at Palestinian universities have been able to take advantage of programs to gain more knowledge and experience and sometimes higher degrees. The two largest programs are TEMPUS (Europe) and the Faculty Development Program (PFDP). Palestinian civil society institutions are also conducting R&D activities in various fields and in partnership with a number of international and local institutions. Their governance structure gives them a comparative advantage over local universities.

Qannou et al. (2005) stated that there are a number of obstacles to R&D in the Arab World including focus on teaching (with antiquated methods), lack of a structure, lack of funding, instability, outdated political systems, infrastructure, and lack of coordination (reinventing the wheel in different institutions). We identified those and other challenges including:

The Arab Human Development Report 2009 portrayed a rather poor status regarding many indicators including education and R&D, and proposed that the causes lie in the fragility of the region's political, social, economic and environmental structures, in its lack of people-centered development policies and in its vulnerability to outside intervention. In the OPT, the principal perceived threats to human security include: water shortage (82.3 percent), occupation and foreign influence (96.2 percent), government failure to protect citizens (86.9 percent), poverty (90.6 percent), and corruption (89.4 percent) (Arab Human Development Report, 2009).

Our study reveals that R&D in the OPT is poorly funded and produces very low output compared even to nearby countries (Table 7) and not currently structured to meet the needs of the Palestinian society as evidenced by distribution of R&D efforts in the different fields. There is not even a clear understanding of the centrality of R&D efforts to advance economic social development. For example, as we noted there is very little research in agriculture considering that this is a mainstay of the Palestinian economy. As stated by a World Bank report: "The Palestinian education system is characterized by a proliferation of supply-driven projects lacking a strategic vision and/or impact evaluation" (World Bank, 2006).

Challenges to the advancement of R&D are numerous. There is excessive focus on teaching via rogue memorization without understanding the relevance of knowledge acquisition to society. There is a lack of proper training and incentives for R&D. There is limited infrastructure such as informational database access, laboratories, and centers of excellence. When something is available, it is not shared (not open to other researchers). There is a lack of confidence and recognition of existing skills and knowledge-base. Palestinian experts are frequently bypassed in favor of foreign experts.

Our survey assessed the attitude of stakeholders as to the most significant factors that could enhance R&D in Palestinian areas. The four factors receiving the highest scores in this area were: increased funding, capacity building, providing personal incentives for R&D, and better coordination (data not shown). Lack of coordination and cooperation, for example, is a significant impediment to R&D since scientific achievement today is built on multidisciplinary teamwork (Salazar-Clemena and Meek, 2008). Significant deficiencies in this area exist in the Arab World (see Ben Hafaiedh, 2009) and this is exacerbated in the occupied Palestinian areas due to the fragmentation and restrictions on movement.

Stakeholders identified a proliferation of graduate programs without clear direction. As Shrodt stated:

> The liabilities of the U.S. model have two implications for Palestinian institutions. First, at the present time, the indigenous needs of Palestine can probably only support one, or possibly two, institutions that combine research and graduate education on the U.S. model. If this is true, substantially more basic research will need to be done outside of the universities in specialized institutes or by government agencies. Second, this situation could change if Palestine were to become a major center for graduate education in the region, replacing the role currently filled by European and North American universities. At the present time this is unlikely given the political conflicts in the region but if a true and comprehensive peace was established that included Palestinians as full and equal political partners, it might be possible. (Schrodt, 1999)

In moving forward, the MOEHE hopes to tackle these issues while reducing risk of dependency and domination (Bijker, 2006).

Promoting R&D is an essential ingredient for developing a vibrant Palestinian state. The sectors of production need to be enhanced and this requires different priorities in R&D from what exists now. We recommend a national strategy that gives priority to engineering, science and technology in the higher educational institutes, encourages R&D, improves quality education, and links postgraduate studies to the proposed comprehensive development plans of the future state of Palestine.

A knowledge-driven approach to development also recognizes that no country can achieve significant progress by relying only on its own stock of intellectual capital and technology applications. Science and technology, and in particular knowledge, have become the main driving forces of economic growth, social development and job creation, and the primary sources of competitiveness in the world market. Nowadays, in the era of knowledge-based societies, a genuine development policy requires a clear policy and framework for international scientific and technological cooperation.

Based on the review of literature, the survey (of which we have only presented the highlights and the most significant findings here), and discussion with stakeholders in interviews and workshop settings, these are the recommendations to develop a coherent and effective Palestinian R&D that can serve the future needs of the Palestinian society:

Vision

There is a need to develop a more coherent vision for where Palestinian research should and could realistically be in ten years' time and how it can contribute to the development of Palestine. Palestine should clearly define its R&D policies and set national priorities, clearly delineating the roles of the different R&D stakeholders in achieving these priorities. Palestine should strengthen its SETI policy-making capacity. Regarding fields of R&D, it is recommended that the strategy needs to focus initially on a number of priority fields enabling concentration of the scarce resources available for core areas that serve society's needs. However, the strategy should not exclude other basic research.

Cooperation

Efforts should be exerted to promote interdisciplinary cooperation and inter- and intra-institutional teamwork including between business and academia. A major advantage of international collaboration is to enable Palestinian researchers to access knowledge and technology produced outside Palestine. Mutual priorities for future cooperation are to be fixed to prepare the negotiating platforms of the Palestinian government in bilateral as well as multilateral governmental consultations through

technical committees. There are lots of opportunities to develop bilateral agreements in R&D (e.g. through the European Mediterranean neighborhood policies). Palestinian embassies should include liaisons to develop R&D collaborations. Palestinians should also develop joint R&D with universities abroad through twinning agreements, internships, visiting scholar programs, etc.

Centers of excellence

Centers of excellence need to be established and there have been some preliminary indications that such centers can be very successful. An example is the UNESCO Biotechnology Center at Bethlehem University which later was used to establish a master's program in biotechnology as a collaborative effort between Bethlehem University and the Polytechnic University in Hebron. The establishment of such centers can help in different ways: reducing redundancy of resources at R&D institutions; allowing concentration of resources in a way to increase Palestine's competitiveness at the global scale; allowing a sustainable infrastructure with limited resources; promoting better educational opportunities; and developing research in areas applicable to the needs of the Palestinian society. In interviews with stakeholders, the following centers of excellence were proposed: Water Technology, Renewable Energy, Climatic Change, Geoinformatics, Agriculture, Biotechnology, Medicine and Public Health, Food Security, Urban Planning, Human Rights, and Good Governance.

Human resources

The availability of qualified human resources is critical for promoting R&D. Palestine enjoys the presence of a large number of qualified researchers but they are under-utilized. There are also Palestinian experts in the Diaspora who need to be tapped through "brain gain" incentives. MOEHE should develop a database of Palestinian scientists and encourage cooperation between Palestinian scientists worldwide. Senior Palestinian researchers should be encouraged to lead research activities in their fields of interest and create core research teams. This means that the number of full-time researchers in Palestinian universities should be increased. An incentive scheme should be developed to encourage researchers. The challenge of the Open University drawing part-time teaching staff from traditional universities (and thus decreasing the time available for research at traditional universities) needs to be addressed by introducing regulations that limit this kind of income supplementation and training specifically teaching staff for the Open University.

Ending the occupation

The resolution of the Palestine-Israel conflict in a way consistent with international law and human rights would significantly boost the potential for R&D development

in Palestine. The current geopolitical conditions and restrictions on Palestinian mobility are hindering Palestinian development by and large and R&D in particular.

Governance

The PNA needs to improve the capacities and skills required to ensure the management of SETI strategy including operational management of research and technological development programs, systems and methods for carrying out the selection, monitoring and evaluation as well as techniques for appraising and accrediting of management and activities carried out by research organizations. MOEHE needs to revitalize the work of the Science Research Council and invite the private sector to join until a new structure is devised. There is need to focus on research management and train a number of research managers. The assumption that the best researchers are automatically the best research managers has proven to be false. The PNA needs to enforce the protection of intellectual property rights.

Private-public partnership

As the OPT would eventually become an independent state, it has to develop its economy to absorb Palestinian graduates. In order to create new jobs, the following notes need to be considered: (a) Economic growth should include real primary industry, and (b) R&D should be established in a parallel manner to the industry. Without having these established, the rate of unemployment will worsen in the near future (Hilal, 2008). Yet, it is believed that there is potential for R&D increasing competitiveness of the Palestinian private sector should the occupation be ended (El-Jafari et al., 2008). The Palestinian private sector will need to be encouraged to cooperate with and commercialize the results of research carried out nationally. The PNA needs to support innovation management and strategies in Palestinian enterprises.

Financing

MOEHE recognizes the need to create a more effective, accessible, efficient, and accountable higher education system. Financing reforms that can achieve fiscal sustainability while maintaining the largely non-profit nature of the sector are instruments for reaching these objectives. Our data and other research show the miniscule funding available for R&D in Palestine (less than 0.1 percent of GDP under the best of circumstances). This needs to increase by ten- or twenty-fold to even approach that of less developed countries let alone the developed countries. Developing a financing strategy requires many things: an accurate assessment of the present system; a vision shared by the PNA, the Legislative Council (PLC), MOEHE, the CHE, NGOs and the private sector; the establishment of principles that will govern reform; the definition of roles, responsibilities and mandates; and

agreement on the policies required to achieve the specific goals of the strategy. The idea of the Science Fund was developed earlier by Khatib (2007).

Infrastructure

In general, there is underutilization of existing equipment and other resources in Palestinian institutions. A system needs to be developed to encourage researchers to work together to reduce costs and avoid duplication of efforts and expenses. For example, a single institution could be agreed upon to conduct analysis of pesticide residues while another one could be appointed to conduct heavy metal analysis. For information and communications technologies to be effective in improving management, boosting profitability, competitiveness, and surviving in the national and global economy, organizations have to exert extra efforts in selecting the right ICT applications, enhancing the existing ones, developing others and keeping track with the latest advances in that field. That basically requires the setting up of a specialized unit to perform research and development in relation to ICT for the benefit of all Palestinian institutions. The survey researched this aspect by asking organizations about engagements in R&D activities regarding their use of ICT applications and services. The enterprises' reactions to this issue have showed minor interest in the subject matter where about 10.0 percent of enterprises are involved in activities related to research and development in ICT.

Education

There is a need to reshape curricula and methods of teaching in early school years as well as in higher education to develop critical thinking and a system to connect the knowledge-based information age to daily living. In this regard, Palestine could also benefit from establishing a natural history museum, botanical garden, science museum, and planetarium that would promote science education and consequently R&D.

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