

Innovation and Scientific Research at Jordanian Universities: The University of Petra as a Case Study



Marwan El-Muwalla

Abstract The shift towards knowledge-based economies that depends on innovation, scientific research and a well-trained workforce has led to many changes in the higher education landscape worldwide. In Jordan, the value of research for achieving long-term national, regional and international academic and economic competitiveness has received growing recognition over the past few years. This paper departs from the premise that innovation and research conducted at the institutions of higher education play a crucial role in the development of effective academic systems and in competing in the knowledge economies of the twenty-first century. To this effect, this paper investigates how the University of Petra has promoted scientific research and innovation to secure its academic development and sustainability in a globalized world in which research and innovation have become vital contributors to the advancement of the economy and the society as a whole.

Keywords Innovation · Scientific research · Knowledge-based economy · University of Petra

1 Introduction

Although research has been defined in a number of ways by different organizations and entities working in the field of higher education, there does not seem to be a single, all-encompassing definition adopted by all the parties engaged in the higher education system. Nonetheless, there is a common denominator that is shared by all the definitions, namely knowledge. Indeed, there is unanimous agreement among researchers that research aims at increasing knowledge, and hence enhancing peoples' understanding of a particular topic or issue.

M. El-Muwalla (✉)
University of Petra, Amman, Jordan
e-mail: muwalla@uop.edu.jo

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The Organization for Economic Cooperation and Development (OECD) defines research as “Any creative systematic activity undertaken in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this knowledge to devise new applications” [1]. This definition entails that research plays a significant role in developing a multi-faceted human knowledge upon which economic, social and technological progress depends. According to Tripp et al. [2], in today’s knowledge-based economy “research is the glue that ties society and the economy together, and underpins almost all productive human activity”.

Innovation involves the creation and implementation of a new product or service with the aim of improving the economy. In fact, it is considered one of the key factors underlying the changes that take place in the way of thinking and productivity witnessed by a society. Innovation is not a new activity pursued by individuals and institutions; rather, it has been pursued throughout history as exemplified in the agricultural, industrial and information revolutions that introduced innovations that have changed the quality and value of peoples’ lives [3]. It is therefore not surprising that Rosenberg et al. [4] consider that research and innovation constitute the real wealth of Nations. This explains why research and the ensuing innovation have been an important component of the work carried out by universities since their establishment. It is believed that higher education institutions can only fulfill their goals, if education, research and innovation are considered complementary forces that deserve to be given equal attention.

This paper investigates how the University of Petra (UOP) has promoted scientific research and innovation to secure its academic development and sustainability in a competitive educational milieu that invests extensively in research and innovation as a driving force behind national progress.

2 Innovation and Scientific Research at Arab Universities

Although the institutions of higher education in the Arab region have come a long way during the past 25 years or so, these institutions still face a number of common challenges that need to be addressed to improve the kind of education they offer. One of these challenges is associated with the quality and paucity of innovation and scientific research.

In the past few years, researchers have invested in studying the reasons underlying the weak status of research at Arab institutions of higher education because this problem has hampered these institutions’ advancement as well as their ability to compete with universities in developed countries [5]. The research conducted in this field has revealed that the Arab countries have reacted in very similar ways regarding their approach to research and innovation, and hence the intersection of factors that have acted as stumbling blocks towards the improvement and advancement of scientific research carried out at these institutions.

Research conducted on the different Arab universities dispersed all over the Arab world indicates that research and innovation is lagging behind in these

institutions. Anderson [6] considers that the deterioration of research at Arab universities can be attributed to limited academic freedom, open enrolment policies, and underinvestment in public institutions. Hafiz and Farah [quoted in 5] both attribute the status quo to the lack of strategic planning as well as the disinterest in research by the private sector. According to Almansour [5], Naifah is in agreement with Hafiz and Farah, for he contends that strategic planning is missing at Arab universities and that the research conducted is detached from the market realities. He also notes that the frustrations experienced by the members of staff with regards to the research funding and research incentives that they are granted have played a key role in the decline in the quality and quantity of research; needless to say, these frustrations have forced members of staff to produce research that is adequate merely for promotion purposes. Albargouty and Abosamrah [7] reiterate the impact of low expenditure on the research output noted at Arab universities. They indicate that Arab universities have to allocate more funding towards research and innovative practices if they want to improve their rankings and academic reputation in order to be able to compete with renowned international institutions of higher education in the long-run. The Secretary General of the Association of Arab Universities also discusses a number of challenges that have a negative effect on research in the Arab region; two of the most pressing challenges that he mentions are the low rates of expenditure and the lack of a clear strategic planning [quoted in 5]. These challenges “warn of the poor level of scientific and applied research in the Arab region compared to Western countries”. Interviews administered by Almansour [5] with university rectors and experts in the Arab world have underscored the need to develop a research infrastructure that “values faculty, offers recognition, and supports research through grant funding, training and publication assistance”. The components of this infrastructure are expected to secure the improvement of research carried out at Arab universities and to guarantee a better innovative environment at these institutions.

As far as expenditure on research is concerned, statistics by the UNESCO reveal that research activities at Arab universities is quite humble in comparison with universities in other parts of the world. The 2004 figures indicate that expenditure on research related matters in the Arab region did not exceed USD 1.7 billion which represents 0.3% of the Gross Domestic Product (GDP) of these countries. Also, the 2010 UNESCO figures show that the Arab region is classified among the lowest regions concerning the funding allocated to research and innovation. Abu-Orabi [8] considers that Arab expenditure on scientific research is limited when compared with the scientific research expenditure in industrialized developed countries. While the expenditure amounted to about 0.2–0.6% of the national income GDP in the Arab countries in 2014, this amount was around 2–4% in industrialized countries.

Studies have also considered the quality of research presented by faculty members affiliated to Arab universities. The results reveal that publication in quality journals continues to be an issue that needs to be addressed by these institutions. Statistics provided by Khraif et al. [9] for the year 2015 indicate that publications from Arab universities in Top Quartile-Q1 journals was 34%, while the number of

publications for Seoul National University and the National University of Singapore were 49% and 62%, respectively. The researchers note that the average citations per paper for the aforementioned research remains low, whereas papers grouped under the zero-cited papers index represent a large proportion of those published in the year 2012. These findings show clearly that the caliber of research carried out by Arab universities fails to meet international standards; an issue that needs to be resolved if institutions of higher education in the Arab region want to improve their research reputation.

In addition to the studies conducted on the quality of research provided by Arab universities, studies have been undertaken to investigate the quantity of this research. According to Khraif et al. [9], the total number of papers published by staff working at Arab institutions of higher education in the year 2015 amounted to 35,486, whereas the number of papers published by Korean universities for the same year was 56,204. This is a noted difference if the population of the two regions is taken into consideration. In another study conducted by Al-Khatib [10], the data indicate that by the year 2018 the total number of papers published by researchers affiliated to universities in the Arab world amounted to 410,549. Although an increase is noted in comparison with the 2015 figures, Kent [11] is of the viewpoint that the “combined output of Arab states remains minimal compared to powerhouses in the West.”

Studies conducted on research in the Arab world reveal that Arab universities have to increase their expenditure on research, develop their research infrastructure, give incentives to quality research and collaborate with the private sector to be able to develop and improve the kind of research that is presented by these institutions.

3 Innovation and Scientific Research at Jordanian Universities

In Jordan, the higher-education sector has witnessed significant changes since the establishment of the first institution of higher education, namely the University of Jordan. The transformations experienced since 1962 that included the introduction of new specializations, the adoption of new teaching methodologies, the establishment of private universities, and the advent of internationalization have all played a role in changing these universities’ teaching missions, research interests, economic and social development, and entrepreneurship strategies [12]. One of the challenges that these institutions have encountered is associated with the promotion of scientific research and innovation.

The importance of scientific research and innovation on the socio-economic development of Jordan has tempted the government to give these two scientific fields the attention they deserve. As a result, activities grouped under research and innovation have been “institutionalized under a national umbrella that would set science and technology policy, strategies, plans and programs” [13]. To fulfill this goal, the Higher Council for Science and Technology and the Scientific Research and Support Fund were established to provide guidelines that would contribute to

the development and advancement of the country's science, technology, research and innovation activities. Also, the Law of Higher Education and Scientific Research and the Law of Jordanian Universities were amended in 2018 to secure quality education at Jordanian institutions of higher education [14].

Therefore, the project entitled "Defining the Scientific Research Priorities in Jordan for the Years 2011–2020" was initiated to achieve three aims: (1) to identify the national priorities related to scientific research in the different fields of science, technology, research and innovation; (2) to direct researchers towards the scientific tracks that are expected to contribute to the nations' development; and (3) to provide funding to research projects of a national dimension. In fact, determining the scientific priorities of a number of sectors has given "scientific research the feature of comprehensiveness" and "has realized balance among the different sectors" [15].

The research and innovation status at Jordanian universities for the years 2012–2015 are clearly noted in the research results reached by Khraif et al. [9]. The study shows that the faculty at all the Jordanian universities published 1310 papers in 2015 which is a humble number if compared with the 12,980 papers published at Saudi universities; out of the 13,10 papers, only 57 papers appeared in the top 3 journals. The number of papers in high-impact journals published by faculty at the Jordan University of Science and Technology and the University of Jordan amounted to 5.5% and 2.7%, respectively. The results also reveal that the *h*-index for Jordanian universities for the year 2012 was 26%; a weak percentage in comparison with the *h*-index achieved by other Arab universities. This status quo witnessed an improvement in the academic year 2017–2018 when the papers published at the Jordan University of Science and Technology reached 689 papers with an average of 0.73 papers per staff member [16]. However, much needs to be done regarding the quantity and quality of research produced by members of staff at Jordanian universities if these institutions want to compete with their regional and international counterparts.

However, the combined efforts of the government organizations and those of the institutions of higher education have played a positive role in the remapping of the research activities conducted in the country. It is noted that more funding has been allotted to research and innovation, faculty have been given incentives for publishing research in high-impact journals, and innovative centers were established and rewards were granted to excellence in research. In an interview with the president of the University of Jordan in 2016, the president stated that the university has undertaken a number of measures to advance the university's ranking, including "systemization of scientific research and instituting measures to encourage the faculty to increase publication in high-impact journals" [5]. Such measures, according to the president, have paid off and led to advances in the university's world ranking. Indeed, the faculty affiliated to the university published more than 17,000 research papers by January 2020 and have registered more than 110 patents [5].

Although the abovementioned developments helped in improving the research and innovation environment in the country, there seems to be unanimous agreement amongst specialists and researchers that this activity in Jordan is still very weak [17]. According to Bawab [18], although the Scientific Research and Support

Fund spent a total of USD 58.8 million on scientific research between the years 2008–2018, this figure remains very low. Bawab added that the percentage of the GDP invested in other countries is way higher than in Jordan. Also, Ibanez Prieto [17] quotes Abu Orabi who warned of the poor level of scientific and applied research in Jordan. He attributed the status quo to the lack of funding and the immigration of researchers.

It is my contention that scientific research and innovation have gone a long way in Jordan in the last 20 years. Nevertheless, much needs to be done in this area if universities in this part of the world are to compete with their renowned regional and international counterparts.

4 Innovation and Scientific Research at the University of Petra

Since its establishment in 1991, UOP has given research and innovation due attention. The Deanship of Scientific Research and Graduate Studies is responsible for supporting and promoting these two aspects by setting future plans in accordance with the vision and mission of the university. The Deanship’s organizational structure (Fig. 1) indicates the type of work it performs and the areas of interest emphasized, namely scientific research, business and technology, technology transfer, and graduate study programs.

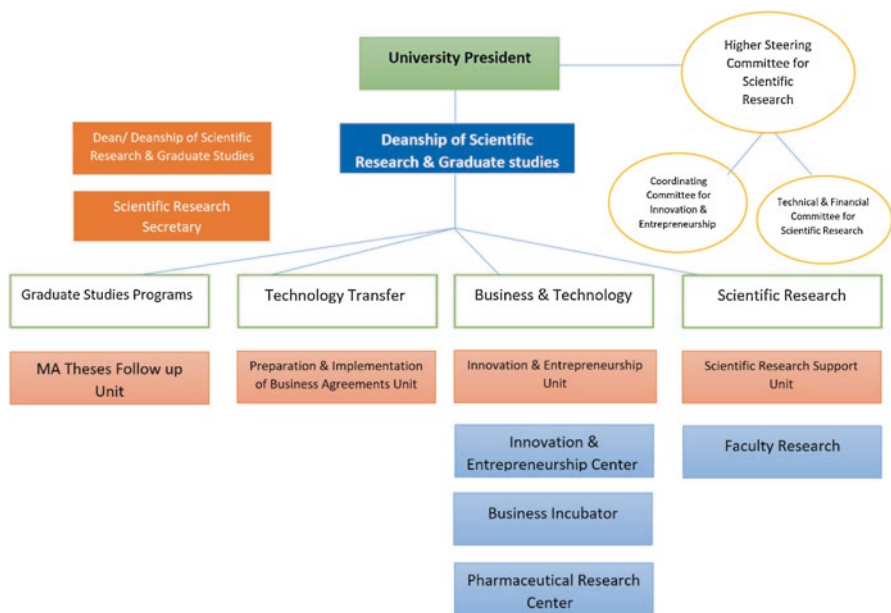


Fig. 1 Organizational structure of the Deanship of Scientific Research and Graduate Studies at UoP

4.1 *Scientific Research*

The value of scientific research has always been acknowledged at UOP. In fact, the belief that research plays a pivotal role in improving knowledge and facilitating learning has made the university adopt a clear systematic strategic plan toward the advancement of research. This plan is continuously amended and improved, and the positive impact accrued has been noted over the years.

During the years 1991–1999, the research activities at the university were modest in terms of quantity and quality. This was the case because the funding and incentives allotted to research projects were limited; publication in high-impact journals was not emphasized; and the university’s main focus, as a newly established institution, was on teaching and building a reputation in that domain.

However, these conditions witnessed a turning point as of the year 2000 when a number of steps were taken to improve the status quo. To this effect, the university introduced a strategic plan for scientific research and innovation that takes into account four major significant aspects: (1) providing adequate funding; (2) encouraging publication in prestigious, high-impact journals; (3) liaising between the research conducted at the university and the national scientific research priorities; and (4) emphasizing applied research.

As far as funding is concerned, the university was committed to spending 3% of its budget on scientific research, with around 55% of this budget allocated to research grouped under the rubric of national interests and priorities. This sum was later increased to 5%, with 3% spent on research related issues and 2% on scholarships for postgraduate studies. The 3% spent on research went to fund: (1) research projects; (2) publishing incentives; (3) participation in conferences; (4) summer research grants; and (5) patents.

This rise in expenditure is clearly noted in the sum of money spent to support publication as well as incentives given to publish in accredited scientific journals. A comparison of the figures for the years 2014, 2016, 2018 and 2020 reveals two points regarding the amount of funding provided towards research. First, there was a quantum leap from the 2014 figures allotted to research and the 2016 figures. In 2014, only USD 5355 was spent on scientific research, while USD 50,120 was spent for the same purpose in 2016. This noted increase may be attributed to the implementation of the regulation on scientific research, patents and participation in conferences of the year 2016, which clearly delineated between the funding allocated for publication and that allotted to incentives to publish in top journals. In 2014, a differentiation was not made between the two types of support; consequently, only USD 5369 was spent to support publication. In 2016, however, the funding assigned by the university was distributed to support publication and incentives for publication, whereby USD 32,760 were spent on the former and USD 17,360 were spent on the latter; this encouraged faculty affiliated to the different faculties to produce research of a diversified nature.

The above figures also reveal a substantial increase in the total amount of funding spent on research between the years 2014 and 2020. In 2014, USD 5355 were

allotted to research publications; this figure jumped to USD 66,255 in 2020. The USD 60,900 increase in 6 years is a clear indication that UOP has realized the correlation between funding and the increase in research output.

This development was the outcome of the amendments made to regulation for scientific research, patent and participation in conferences of the year 2017 which provided more systematic guidelines for research funding. These regulations differentiated between the two categories: funding for support for publication and the incentives for publication categories. The former form of funding provides researchers with the financial sources needed to conduct their research, while the latter form of funding is given to members of staff after publishing their research in quality journals. These incentives set the amount of money spent on research on the basis of the impact factor of the journals and the SCImago Journal Rank (Scopus). Moreover, incentives were allotted to journals published in Arabic and which are not covered in international databases, such as Scopus and ISI; these criteria encouraged faculty and staff to produce research projects that cover a wide spectrum of topics as well as high-quality research papers publishable in prestigious journals (Figs. 2, 3 and 4).

In addition to the funding allotted to the publication fees and the scientific publication incentives, UOP has provided generous financial support to the research projects that cover a wide array of topics, many of which abide by the national scientific research priorities. While, UOP allocated USD 182,615 to funding research

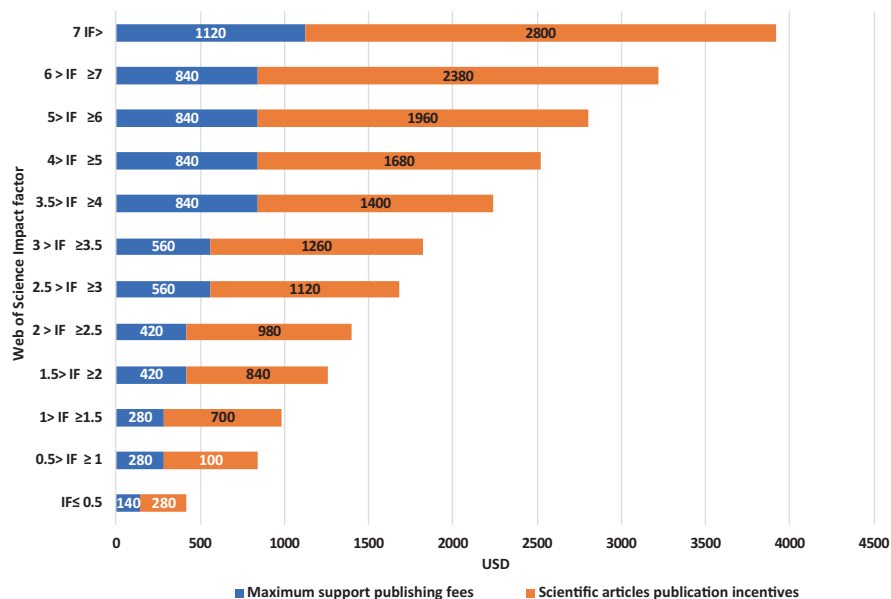


Fig. 2 Funding allotted to support for publication and incentives for publication based on the Impact Factor

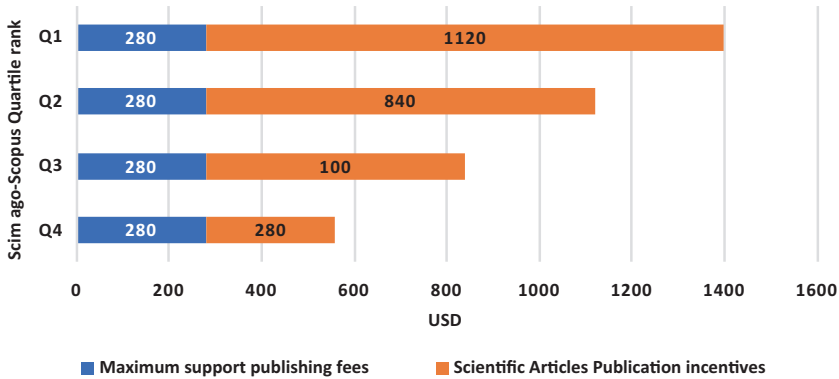


Fig. 3 Publication Support and Publication Incentive Criteria for Research Papers based on the SCImago Journal Rank (Scopus)

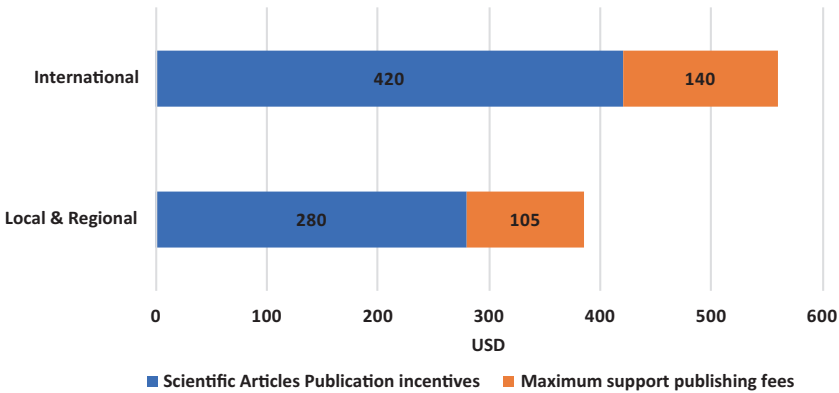


Fig. 4 Support and incentives for journals published in Arabic (No IF in Web of Science-Clarivate Analytics)

projects in 2012, this figure rose to USD 740,628 in 2020 which is a threefold increase in less than 10 years (Table 1).

When research proposals are submitted, the Deanship of Scientific Research and Graduate Studies takes into consideration the national scientific research priorities set for Jordan in the selection process. UOP adopts the vision of the Higher Council of Science and Technology which stipulates that the research sectors grouped under the national priorities can be addressed by researchers “in order to contribute to solving numerous problems suffered by different sectors in the national economy, thus contributing to push forward the wheel of economic, social and cultural development in the Kingdom” [15]. Indeed, out of the 79 research projects submitted for the year 2021, 60 proposals address national priorities (Table 2), which indicates that research related issues at UOP are geared towards the public benefit and are directed towards national needs.

Table 1 Distribution of Funding for the years 2014, 2016, 2018 and 2020

| Year | Support for Publication (USD) | Incentives for Publication (USD) | Total |
|------|-------------------------------|----------------------------------|---------------|
| 2014 | 5,355 | – | 5,355 |
| 2016 | 32,760 | 17,360 | 50,120 |
| 2018 | 52,150 | 15,400 | 67,550 |
| 2020 | 42,875 | 23,380 | 66,255 |

Table 2 Research Proposals & National Scientific Priorities 2021

| National Scientific Priorities | Number of Research Proposals |
|--|------------------------------|
| Innovation & Entrepreneurship | 1 |
| Information & Communication Technology | 9 |
| Basic Sciences | 6 |
| Humanities, Social Sciences & Economics | 12 |
| Agriculture & Veterinary Sciences | 2 |
| Medical & Pharmaceutical Sciences | 24 |
| Engineering, Nano & Bio Technology | 3 |
| Water & Environment Sciences | 3 |
| Not within the remit of the National Scientific Priorities | 19 |
| Total | 79 |

The aforementioned forms of support have impacted research at UOP in terms of quantity, quality and scope. With regards to quantity, the financial support provided has encouraged faculty and staff to indulge more in research, for a steady increase in the number of papers published was noted between the years 2000 and 2020. In 2000, 7 papers were published; in 2010, the number rose to 128; and in 2020 the number stands at 652. This means that from 2000 to 2010, the publication of research increased at a rate of 12 articles per year, whereas from 2010 to 2020 this number reached 52 articles per year which is a noticeable increase in performance (Fig. 5). Although this increase may seem humble, it is considered a marked development if compared with the research activities carried out at other national and regional institutions of higher education [9].

This increase in quantity was coupled with a rise in publication in high-impact journals, which in turn resulted in a significant jump in the number of citations for the papers published. Whereas the citation figures were 287 for the year 2000, these figures amounted to 4458 in 2020. Thus, the citations per published paper ratio rose from 41% in 2000 to 68% in 2020 (Fig. 6).

The number of citations has resulted in an increase in the *h*-index with 33 in 2020, as opposed to 28 in 2019. Figure 7 indicates that out of all the documents considered for the *h*-index, 33 have been cited at least 33 times. This rise in the *h*-index shows that there was a steady increase in the number of papers published in 1 year; a clear indication that the efforts exerted towards research have yielded positive results. However, it is the university's contention that more needs to be done in spite of the improvements noted in the number of citations and the *h*-index in order

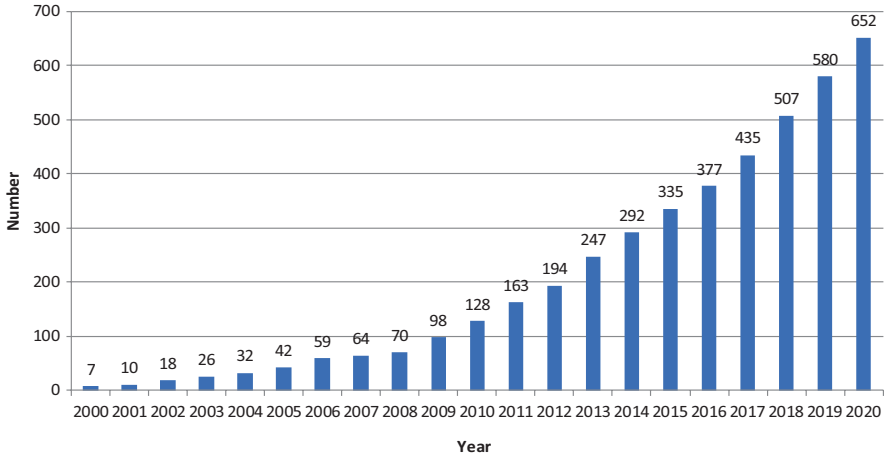


Fig. 5 Accumulative annual research papers published in Journals

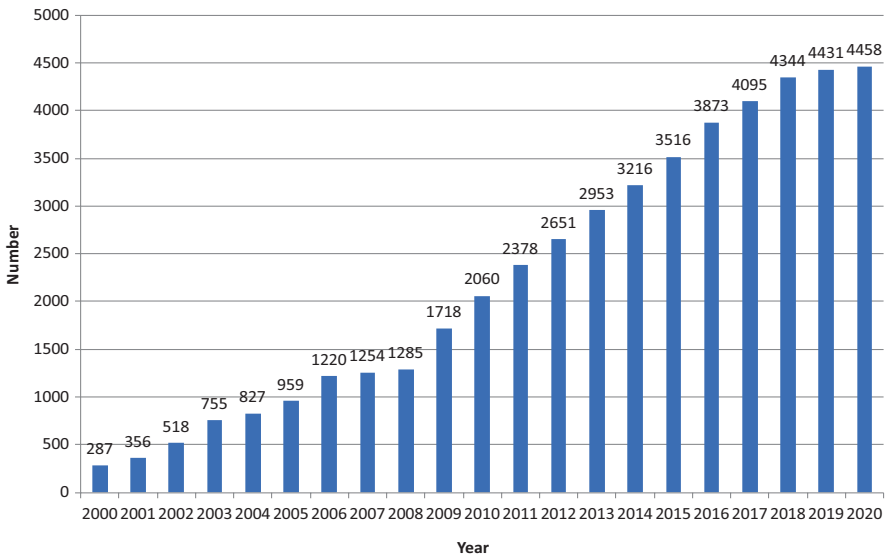


Fig. 6 Accumulative number of citations

to compete with regional and international universities and secure better world rankings. To fulfill this goal, the Deanship of Scientific Research and Graduate Studies is reconsidering the support and incentives allotted to research as well as amending the promotion regulations.

The number of research projects funded also underwent a significant increase during the years 2010–2012. Figure 8 reveals that there has been an exponential

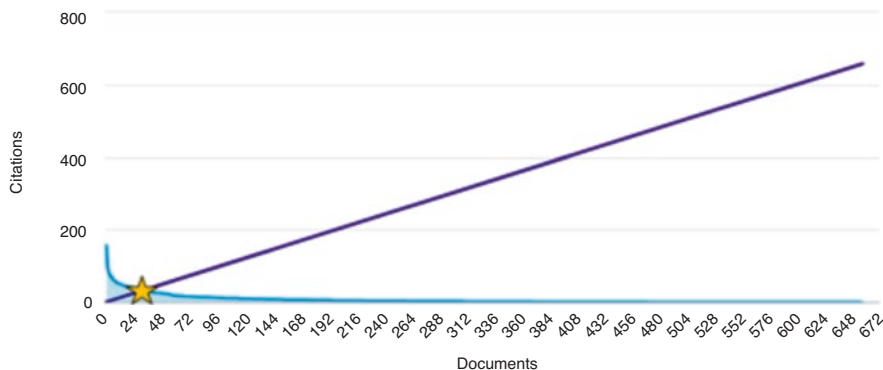


Fig. 7 Number of citations for the 33 documents considered for the *h-index* in 2020

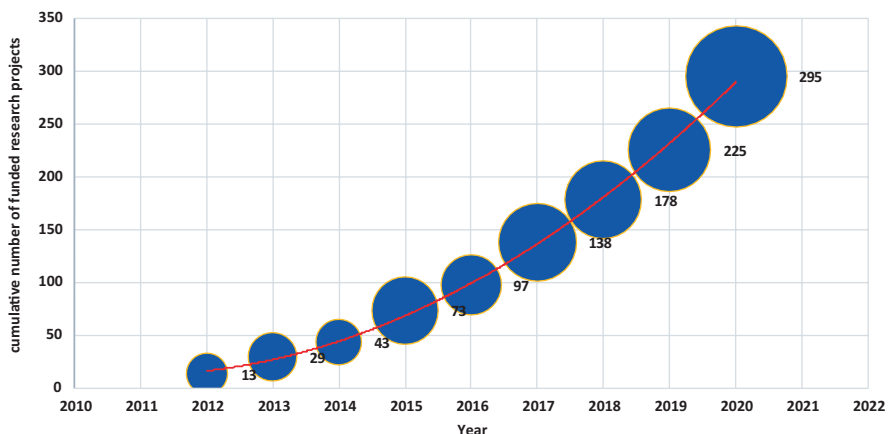


Fig. 8 Cumulative number of funded research projects for the years 2012–2020

increase in the funded research projects at UOP from 2012 to 2020. Whereas the university funded 13 projects in 2012, this cumulative number rose to 295 in 2020. This surge underscores the importance of funding in encouraging faculty and staff to submit projects that might lead to long-term rewarding effects on the national level.

To ensure accountability and effectiveness, the Deanship of Scientific Research and Graduate Studies implements a rigorous assessment process of the submitted project proposals. The proposals are subjected to a two step procedure. First, the project is assessed internally; then, the successful projects are assessed by external reviewers. Once unanimous agreement is reached concerning the project’s academic, economic and social impact, the researcher receives the allocated funding for the project. This evaluation process is considered a key element in setting the university’s research priorities, and hence policy making regarding scientific research.

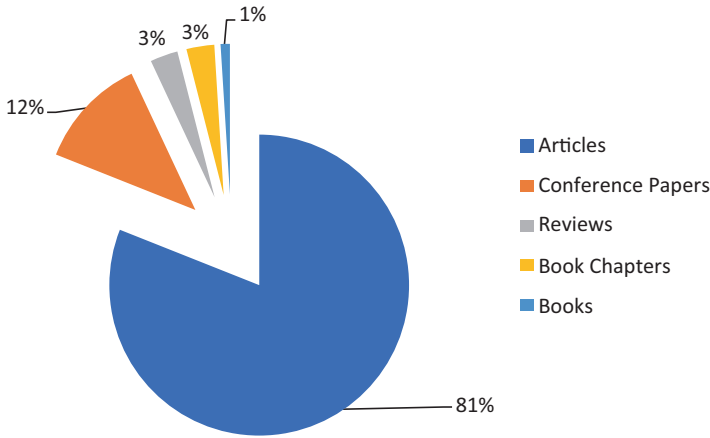


Fig. 9 Forms of Research for 2020

As for the prevalent types of publications, the research published came in different forms: books, articles, conference papers, reviews and book chapters. Figure 9 indicates that articles represent the primary channel for the dissemination of research, followed in order of importance, by conference papers, reviews, book chapters and books; a result that is in accordance with the findings on university research in other parts of the world [19].

The developments noted in the quantity and quality related to the research performance at UOP indicate that the culture of “publish or perish” has steadily gained momentum among the faculty and staff working at the university. The systematic regulations, the generous funding, and the research milieu have all played an instrumental role in improving the research performance at UOP.

A further step taken to encourage research at UOP was the amendment of the Summer Scientific Research Grant in 2016. This grant allows researchers from UOP to spend the summer period at a host institution working on collaborative research. If the host institution does not provide financial support, UOP regulations stipulate that it pays the researcher an economy-round trip ticket and a monthly living expenses allowance for a 3-month period [20]. The cumulative number of researchers who received the grant in 2019 was ten, but due to the COVID-19 pandemic this grant was cancelled for the summer of 2020 (Fig. 10).

To join the fourth age of research, which is characterized by international collaboration between “elite international research groups” to secure the increase in quantity and quality of published research [21], UOP has expanded its scientific collaboration with international institutions of higher education. According to Adams [21], the “citation impact is typically greater when research groups collaborate, and the benefit strengthens when co-authorship is international”. To this effect, faculty members are currently involved in research with the University College of London (UCL), Bradford University, the Royal Academy of Engineering, Universität Tübingen, Abertay University, Imperial College London, University of East Anglia,

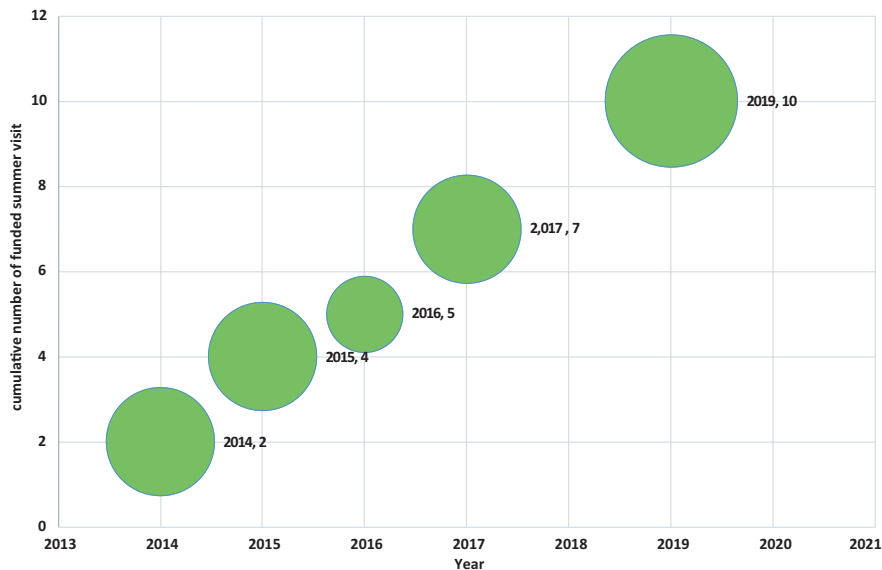


Fig. 10 Cumulative Number of Funded Summer Research Grants

and Norwich Medical School, among others. Researchers at UOP have also received national and international grants and awards to conduct applied research that covers a wide spectrum of topics. For instance, researchers from the faculties of engineering and pharmacy have received a USD 105,000 award from the Newton Khalidi Fund in collaboration with the Royal Academy of Engineering and Bradford University in the UK to work on the project entitled “A New Heavy Metal Treatment Process Using a Bio-adsorbent Based on Modified Olive Leaves Biomass”. These awards and grants indicate that research at UOP has won international acclaim. Table 3 shows the quantity of collaborative research work conducted by faculty at UOP with their national, regional and international academic and industrial counterparts. This is a clear indication that UOP tries to create links between academia, applied research and the market realities.

Needless to say, the scope of research has also been positively affected as a result of the generous funding provided by the university. Faculty at UOP started giving applied research the attention it deserves, and new links with businesses and the industry were established. For example, a joint research project with a local chocolate factory has led to the production of a sugar-free chocolate that is enriched with vitamins and minerals. This end-product, which is considered the first of its kind in the Middle East, has succeeded in fulfilling the following: (1) achieving the requirements of applied scientific research; (2) creating links with the industry; and (3) meeting the needs of the community.

Also, faculty and staff affiliated to the different departments have become more involved in scientific research, producing research that is diversified in nature. The pie chart below reveals the percentage of participation in research conducted in

Table 3 Collaborative Research between UOP and National, regional and International Institutions

| Institution | Documents |
|--|-----------|
| The University of Jordan | 118 |
| Hashemite University | 41 |
| Applied Science Private University | 28 |
| Al-Zaytoonah University of Jordan | 28 |
| Al-Balqa Applied University | 27 |
| Jordan University of Science and Technology | 25 |
| Jordanian Pharmaceutical Manufacturing Co. PLC. | 25 |
| Universität Tübingen | 21 |
| Al-Ahliyya Amman University | 20 |
| Taif University | 17 |
| Al Al-Bayt University | 15 |
| King Saud bin Abdulaziz University for Health Sciences | 14 |
| American University of Madaba | 14 |
| American University of Beirut | 13 |
| Jordan Center for Pharmaceutical Research, Amman | 13 |
| Abertay University | 11 |
| Imperial College London | 10 |
| The World Islamic Sciences and Education University | 10 |
| University of East Anglia, Norwich Medical School | 10 |
| Philadelphia University Jordan | 9 |
| Universität Duisburg-Essen | 8 |
| Yarmouk University | 8 |
| University of Baghdad | 8 |
| Oxford Brookes University | 7 |
| University of Sharjah | 7 |

2020 by the faculty and staff associated with the different specializations at the university (Fig. 11). It is clear that members of staff working in pharmaceuticals, and its related disciplines, have been the most active in research, representing 13.6% of the research conducted at UOP. Indeed, this represents a shift away from the domination of research presented by the social sciences during the years 2004–2010. This discrepancy may be attributed to the fact that the number of faculty employed at the Faculty of Arts and Sciences was much higher in comparison with the number of faculty employed at the Faculty of Pharmaceuticals and Medical Sciences. For example, during the academic year 2004–2005, the faculty affiliated to the Faculty of Arts and Sciences represented 35.5% of all the faculty employed at UOP, while this figure was 15.5% for the Faculty of Pharmaceuticals and Medical Sciences.

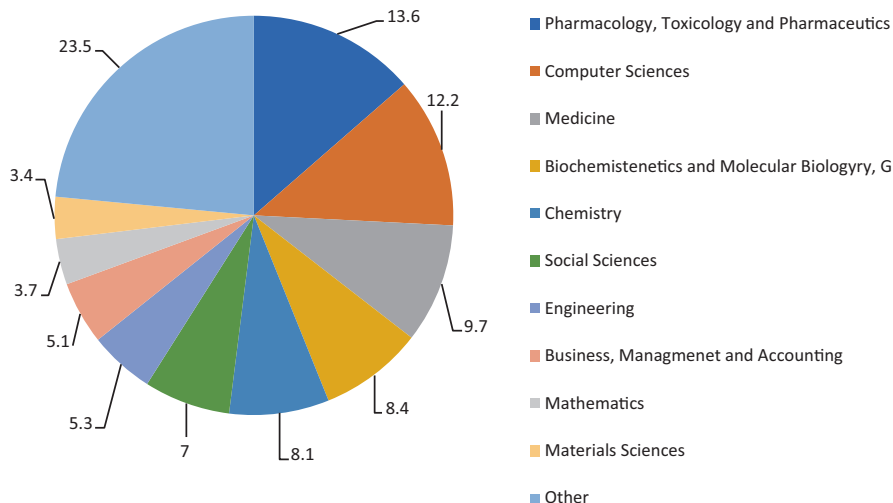


Fig. 11 Research Publication according to field of specialization (percentage)

4.2 Innovation

Innovation at UOP follows the national innovation strategy which aims at creating a Jordanian innovation-based economy and disseminating the culture of innovation, research and development and the development of specialized human resources as the framework for the innovation and technology transfer activities conducted at the university.

Accordingly, a number of steps were taken to implement the framework adopted and to secure its success. The first step was the establishment of centers that aim at encouraging and motivating innovation and technology transfer projects that are in alignment with the national priorities. These include the Petra University Pharmaceutical Center and the Innovation and Entrepreneurship Center that aim at developing the research and innovation capabilities of the faculty and students for long-term sustainable growth.

The second step is related to funding patents and the registration of patent ownership rights. Lately, awareness concerning the need for conducting scholarly activity that translates basic research into commercially viable processes and technology has become of utmost importance to universities seeking sustainable prestige and recognition [22]. This approach has gradually changed the academic culture at universities because it reinstated the need to partner with the industry in order to transfer the new knowledge emerging from university research to the society at large; a gap that still exists between academia and the industry in many parts of the world.

To keep up with these new developments and to encourage innovation and the commercialization of the technological advances achieved by faculty and students, the university's higher administration has allocated USD 35,000 towards these two activities since 2017. This has resulted in 2020 in the registration of six patents by

the university at the Department of Intellectual Property affiliated to the Ministry of Industry and Trade in Jordan, making UOP the first private university in the country to have registered this number of patents. In addition to these patents, two others have been filed with national and international patent registration entities and another patent is in the drafting process (Tables 4 and 5). Indeed, the innovative activities carried out at the university will help in enhancing the university’s reputation, sustaining its scholarship level, maintaining student success and, in the long-run, securing public benefit and national economic development.

The third step concerns the promotion of innovation and technology transfer by holding conferences that tackle such issues. Indeed, UOP held an Innovation and Technology Transfer Conference in 2019 to highlight the importance of innovation and to market its innovative practices by creating links with the industry and businesses. Also, a ceremony was held to honor the researchers who have contributed to

Table 4 Patents Registered in 2020

| Title | Inventor | Status |
|---|--|-----------|
| Portable neck treatment devices | <ul style="list-style-type: none"> • Abdal-Kareem M. Albanna • Majed Naser Albanna • Ghassan F. Issa • Sanad Mohammad Omar Barjawi • Ghiath Mhd Kheir Eriksousi • Tamara Aljubooru | Published |
| Substituted quinolone compounds, their use in the treatment of cancer, and a method for preparation | <ul style="list-style-type: none"> • Ahmad Moh’d Kamel Al-sheikh • Tawfiq Abdul Raheem Mohamed Arafat • Luay Fawzi Moh’d Abuqatouseh • Eyad Mazin Omar Mallah | Published |
| A composition for treating anemia | <ul style="list-style-type: none"> • Nidal Adel Mohammad Al Qinna | Published |
| A composition for accelerating wound healing | <ul style="list-style-type: none"> • Mayyas Mohammad Ahmad Al-Remawi • Faisal Tawfiq Al Akayleh • Nidal Adel Mohammad Al Qinna | Published |
| Orally-dispersible solid pharmaceutical formulation | <ul style="list-style-type: none"> • Mayyas Mohammad Ahmad Al-Remawi • Faisal Tawfiq Al Akayleh | Published |
| Pharmaceutical composition for use as analgesic, anti-inflammatory, or antipyretic agent, and a method of preparation thereof | <ul style="list-style-type: none"> • Mayyas Mohammad Ahmad Al-Remawi • Faisal Tawfiq Al Akayleh | Published |

Table 5 Patents in the Process of Registration

| Title | Inventor | Status |
|--|--|--|
| “Surfactant-free” safe foaming liquid composition for personal care | • Mayyas Mohammad Ahmad Al-Remawi | Filed at the United States Patent and Trademark Office |
| Alginate sodium gelation in a two-step sequential addition of magnesium followed by calcium ions | • Mayyas Mohammad Ahmad Al-Remawi | Filed at the International patent system (PCT) |
| Novel room temperature therapeutic deep eutectic systems of fentanyl and fatty acids | • Mayyas Mohammad Ahmad Al-Remawi • Faisal Tawfiq Al Akayleh • Rana Obaidat (Jordan University of Science and Technology) | Drafting process |

the advancement of innovation, creativity and research and development at the university. These two activities have underscored the importance the university attributes to innovation and technology transfer.

The achievements noted on the innovative front at UOP reveal the systematic planning adopted by the university’s higher administration and the Deanship of Scientific Research and Graduate Studies in this domain. To maintain and improve innovative practices, UOP has to increase the financial support allocated to innovation and to strengthen the links with industry.

5 Conclusion

Much needs to be done with regards to research and innovation at institutions of higher education in the Arab world if they are to compete with their international counterparts. The research published in prestigious, and high-impact journals remains meager if compared with the number of universities in this region and the percentage of faculty employed at these institutions. This has resulted in limited citations and a low *h*-index, which in turn has affected the world ranking of these universities.

Like research, innovation and technology transfer is not faring very well at Arab universities. The educational system at schools does not promote innovation, and interest in innovation and technology transfer is stimulated at an advanced stage in the students’ educational life. Even then, the courses that address innovation, creativity and entrepreneurship are limited and do not expose students to explorative and applied research.

Although research and innovation have gone a long way at UOP since 1991, much needs to be done if the university is to compete with other regional and international institutions of higher education, and hence secure long-term sustainability and better world rankings. To achieve such a goal, more funding has to be allocated to research and innovation and practices that encourage quality research have to be implemented to meet the ever-changing needs of today’s knowledge-based economy.

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