

Architecture for Innovation and Entrepreneur in Terms of Sustainability for Building Regional Competitiveness. “Case study on higher education in Egypt”

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Abstract : This paper study the role of higher education and universities in building regional competitiveness through innovation. The research focuses specifically on the role of innovation centers design and operation considering sustainable development to provide a sustainable operative innovation and entrepreneurship activities. The research shows innovation and knowledge creation as drivers for regional competitiveness; it shows the role universities and its mission as a fourth-generation universities fostering that. The research moves forward to provide some examples and models for international innovation centers at different universities. The research focus on innovation and entrepreneurship pillar in Egyptian higher education strategy and its correlation with sustainability pillar. The research show Ain shams university innovation center as a case study and briefly shows the building design as an EDGE advanced certified sustainable building offering various services for innovation and entrepreneurial activities and fostering innovation ecosystem within the university.

Keywords: regional competitiveness – innovation - Sustainable design - architectural performance- higher education

1. INTRODUCTION

Due to the rapid transformation and change of social and economic behaviour -as result of globalization- Knowledge and social capital have become a key asset of production domination, meaning a driver for economic development for any region. Such transformation intensity the affects the regional competitiveness; in another statement the level of holding onto competition for a certain region across others[1]. On the other side the national economies importance has decreased versus the presence of global competition. [2]. Broadly competitiveness is defined as

“The ability of companies, industries, regions, nations and supra-national regions to generate, while being exposed to international competition, relatively high income and employment levels”[3][4]

Also, the world economic forum in 2012 defined competitiveness as:

“The set of institutions, policies, and factors that determine the level of productivity of a country.”

Through the understanding of such definition competitiveness requires certain dimensions to ensure leadership and domination which are the control over knowledge and the ability of efficient use of it. Leadership

and revolutionary progress are based on innovation and R&D as anchors of change. For that reason, reconsidering the role of knowledge transfer and learning, fostering innovation and empowering technology is critically essential.

Innovation is a fundamental driver that define competitiveness of any regions and through the continual innovation process competitive edge can be achieved. But still innovation exists in a very diverse way that requires a sort of adaptation and reformation through proper strategies that ensure the ability to utilise and create new area of knowledge that help in sustainable and economic development. [2]

Currently Universities are also a key player within the equation of innovation and development. Where it has become important to foster the role of universities to focus on education for innovation as well as empowering the connectivity with the market needs not only as service provider but as partner.(Wissemma, 2009, M *et al.*, 2008)

2. INNOVATION, COMPETITIVENESS, AND UNIVERSITIES

In 2001, a survey of Porter and Stern showed significant results that will impact the connection between competitiveness edge and University role. Where they managed quantitatively the connection between innovation and competitiveness, the important side of this study that it was concerned with universities. The study was carried out through the generation of the innovation capacity index based on four sub-indices. However, the results showed that innovation capacity of a certain region or nation reflects its achieved level of innovation and as a milestone it explains the basic conditions for investments, policy decisions for environment of innovation at that region. The innovation capacity also determines the regional innovation vitality and shows to what extent that region or nation can create a market value through innovation. This capacity depends on three factors [6]:

- The joint innovation infrastructures, this means the elements that affect the innovation on a country scale that may include rates of research, investments practice based on innovation.
- The specific environment and facilities for innovation related to a certain cluster that help in novelty and production of a product.
- The connectivity between the innovation infrastructures and the specific environment for certain innovation cluster. Here the role of universities side by side with agencies and other commercial institutes and associations rises to ensure the connectivity between enterprises and research activities.

Such connection can be obviously seen within different models explaining the concept of competitiveness, among all may be “pyramid model” is one of the clearest models dealing with this concept.

3. THE ROLE OF UNIVERSITIES IN THE PYRAMID MODEL OF COMPETITIVENESS



Fig 1. The structure of pyramid-model of regional competitiveness

The “pyramid model” of Regional Competitiveness Fig 1. The structure of pyramid-model of regional competitiveness is one of the most competitiveness comprehensive models in

territorial dimension. The model was constructed by Lengyel in 2003 and enhanced by Gardner et al in 2004 [7].

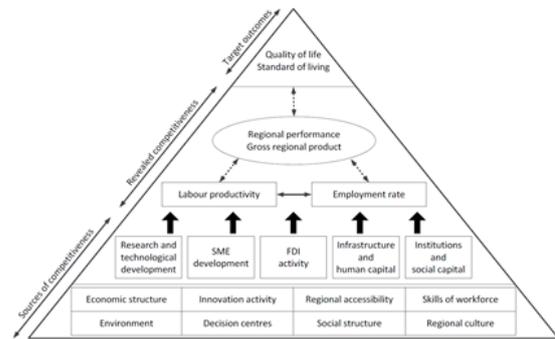


Fig 2. The pyramid model of regional competitiveness. The model Fig 2. The pyramid model of regional competitiveness clearly shows direct and indirect components related to the factors that affect regional competitiveness. The factors affecting competitiveness are divided into two categories according to the connectivity to economic development. The first category - which lies at the base of the pyramid - is the success determinant of regional competitiveness. It is more comprehensive and goes beyond economy to a certain extent and its factors are considered long term ones; even they are barely affected by economic development programs [2]. The second category - which lies at the lower-middle of the pyramid - is a direct economic factor known as development factors. Improving these factors can show a short-term regional effect on economic development as well as improving the competitiveness of operating enterprises in the region. The basic categories of regional development which are included in the standard definition of competitiveness lies at the upper middle of the pyramid and measure competitiveness. All three layers end up with the target of quality of life standard for living. Through this model innovation role can be understood deeply and the role of universities can be seen clearly.

As seen above, the model puts gross regional product at its center between the labor productivity and the employment rate as revealed competitiveness and quality of life as target outcomes. According to Miklos Lukovics Universities can be effective in multiples factors of the pyramid logic and mainly in three parts [8].

1. Research and technological development
2. Innovation activity and entrepreneurship
3. Skill of work force

According to Lengyel there are different classification for regions with competitiveness potential as follow

- **Neo Fordist regions:** which are the regions of low competitive potential and mostly dimensions of second-generation universities is the most active where enterprises at the region rely on innovation coming from other regions.

- **knowledge transfer regions:** which are the regions of moderate competitive potential and mostly dimension of third-generation Universities can be active with its typology. Activities can rely on innovation and can implement innovation centres.
- **knowledge creation regions:** which are the regions of strong competitive potential. In this regions Universities can cooperate with enterprises strongly and easily. The existence of multiple configurations for cooperation can be recognised withing science and technology parks, innovation center, incubators, and accelerators. Universities playing such role represents and new generation of universities known as fourth generation- universities.

The continual and simultaneous development of education, research, innovation, and vocational training is important beside having the knowledge in competitive edge of a region active enterprises is necessary for enhancing competitiveness, this that can be held by universities

through providing strong platforms for innovation and entrepreneurial research facilities that can take place within innovation centres and science and technology parks. These institutes can ensure the quality performance of innovative R&D and the alignment with the region for maintain a competitiveness edge. Otherwise, the results of innovation can therefore come from outside the region or spread out to other regions without benefiting the initiative region and here comes the important of dominating technology transfer. However, building a strong environment for innovation, entrepreneurship and employability is one of the critical roles for universities nowadays. Governments and higher education of a certain region has to put such role as higher priority and to facilitate all needs that ensure the connectivity between academia government and market in a set known as triple helix model (Lawrence and David, 2007, Asgari, Khorsandi Taskoh and Ghiasi Nodooshan, 2021). The **Table 1** below shows the different layout of regions and its ecosystem.

Table 1: Elements of common innovation background of the distinct types of regions.

	Research and technological development	Infrastructure and human capital	Direct investment outside from region	Small and medium sized enterprises	Institutions and social capital
Knowledge creation	<ul style="list-style-type: none"> • Harmonized business and non-business R&D • Integrated R&D • Innovative milieu 	<ul style="list-style-type: none"> • Science parks • Communication networks. • Problem oriented trainings, retraining's 	<ul style="list-style-type: none"> • Attracting decision centers • Hub-and spoke district. • Local Supporting and related industries 	<ul style="list-style-type: none"> • Clusters • Venture Capital • Business incubators for spin-off 	<ul style="list-style-type: none"> • Collaboration among administration and businesses • Cluster-oriented high education • Regional identity
Knowledge transfer	<ul style="list-style-type: none"> • Applied R&D • Coordinated R&D • Technology transfer 	<ul style="list-style-type: none"> • Innovation centers, incubators • Business Infrastructure • Task-oriented vocational trainings 	<ul style="list-style-type: none"> • Supported investments. • Satellite Marshallian industrial district • Local value chain 	<ul style="list-style-type: none"> • Horizontal networks • Business services for start-up • Trainings for managers 	<ul style="list-style-type: none"> • Decentralized administration • High education by local business • Non-profit organizations
Neo Fordist	<ul style="list-style-type: none"> • Non-business and governmental R&D • Separated R&D • Laboratories, equipment's 	<ul style="list-style-type: none"> • Industrial parks • Transportation networks • Vocational training 	<ul style="list-style-type: none"> • Location of companies • Satellite platform district • Local business relations 	<ul style="list-style-type: none"> • Networks of suppliers • Financial promotion • Entrepreneurial skills 	<ul style="list-style-type: none"> • Enterprise friendly administration • Business and Technical higher education • Ability for local cooperation

Source:[11]

As seen from the table above Universities can share in providing a plat form that deals with knowledge status through developing research and providing proper infrastructure that can include Science parks, Innovation centers & incubators, and different sorts of trainings

Also, it shows that the role of universities directly affects Employment rates. This may take place through creation and fostering of employability and career centers as well as boosting human capital through proper capacity building for Human resources.

4. UNIVERSITIES OF FOURTH GENERATION

Historically, University concepts have witnessed three revolutionary transformations that changed the

understanding and definition of its role. These transformations resulted in creating three generations of universities[5]. currently universities are witnessing another shift toward fourth generation universities see **Table 2**.

Table 2: key characteristics of first, second, third and fourth generation universities

	First generation universities	Second generation universities	Third generation universities	Fourth generation universities
Goal	Education	Education and research	Education, research and utilization of knowledge	Education, research utilization of knowledge and proactive economic development
Role	Protection of truth	The cognition of nature	Creation of added value	Enabling value creation through Creation of strategic aims, and the role of the engine in local economy
Method	Scholastic	Mono-disciplinary science	inter-disciplinary science	Multi-actor innovation
Output Human capital development	Professional	Professionals and scientists	Professionals, scientists and entrepreneurs	Professionals, scientists, entrepreneurs and competitive local economy
Orientation	Universal	National	Global	Ecosystem
organization	Colleges	faculties	Institutes and centers	Innovation spaces
Language				
Management	Chancellor	Part-time scientists	Professional management	Disruptors

Source :Construction based in [5][12]and [13]

The first generation - that dated back to the 12century with the establishment of Bologna University in Paris - focus was education “teaching” which means creating professionals. Later, the role of university expanded to include the production of research side by side with teaching role creating both professionals and scientists; this model is called the second generation of universities, also known as the Humboldtian model of education referring to Humboldt University in Berlin. Afterwards, a new revolutionary change took place within the mission and role of universities to encompass economic development and community services another meaning with the spark of the entrepreneurial dimension which means in fact initiating market innovations[10] creating a third mission for universities mostly based on knowledge transfer KT and technology transfer TT. This by default helps start-ups to link with new ideas fulfilling market needs through having ideas brough outside the university, this model of

universities is known for the third-generation universities and was originally initiated by Cambridge University. This model creates not only professionals and scientists but also entrepreneurs. However, not all universities are fulling this model but still applying parts of its philosophy at the time there is a rapid change that calls even for new model of universities that can adapt with the global changes [2] [12]. This model focus in direct collaboration between institutions in science which includes universities on one side with business and society on the other side.

Such rapid changes that include bigdata, IOT “internet of things”, digitalization and new virtual societies and economies and the power of social media, all calls for new model that can understand and interact with such exponential growth and circular process.

Many research studies, articles are dealing with the no how of future universities labelled the fourth-generation universities, mainly fourth generation universities beside

education research and the entrepreneurial dimension may require to:

- Be more dynamic interactive
- Open environment for innovation.
- Flexible in teaching model and staff
- More oriented to interdisciplinarity
- Play a role in the regional economy competitiveness
- Create new values for services

The emerge of the fourth-generation universities was basically a response for the environmental tensions if compared to the third generation that emerged as a reaction towards the economic growth. Miklós Lukovics mentioned that a successful fourth generation university based on empirical research analyzing successful factors for most internationally acknowledged universities. The research was held on two phases the first one was for 6 international higher education ranking criteria, indicators, and methodology. According to Miklós including the third mission in the exploration was impossible in the first phase. In the second phase 22 successful universities were investigated including the third mission. the results helped Miklós to establish a primary model for a successful Fourth Generation” universities. The model had two interfaces that are quite similar with some internal insignificant differences, but both rested on two main pillars the education-research pillar and the third and fourth mission pillar [12].

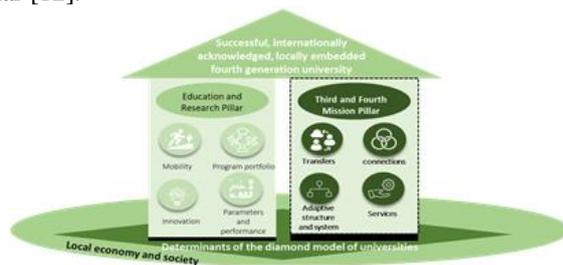


Fig 3 :Virtual model of an internationally successful university
Source: [2] reconstructed by the author

The education-research pillar mainly refers to the roles of the first and second generations of universities and consists of four main components as follow:

- **Mobility:** which focus on supporting opportunities for students and professors’ mobility through international collaboration between universities; as well as the presence internationally through mobility international publication and other forms of international participation[2].
- **program portfolio:** which includes different educational systematic and non-systematic programs for undergrad, post grads studies including vocational trainings.in fourth generation universities program portfolios are extremely dynamic through pull and push approaches. Pull approach focus on responding to different marker and society demands while push approach focus on adopting programs to create of new demands or solutions for marker and society[10].

- **Innovation:** where innovation represent an essential dimension of fostering research towards more entrepreneurial configuration for successful enterprises[2].

- **parameters and performance:** this part may extend to the next pillars where it refers more to indicators that defines qualities of higher education ranking[2].

The third and fourth mission pillar components are mainly four as follow:

- **Transfer which is a third mission pillar:** Previously, innovation was running within closed and protected systems. Research results and investments were developed in a closed loop within a certain institute or company boundaries. Across decades the has been a transformation towards the philosophy of open innovation approach. This new paradigm is a main driver for the fourth generation Universities as well as industry[2], where business and research can rely through expanding its boundaries on benefiting with internal and external ideas for the sake for progress. However, this includes knowledge transfer and technology transfer as mentioned above. Knowledge transfer is mainly about tacit with broader range of skill that works on problem solving through multidiscipline or interdisciplinary collaboration for commercial and noncommercial purposes; while technology transfer which is considered as part of KT is mainly about codified knowledge and methods for flow of information held through basic and applied research for commercialization and economic investment. In the previous decades knowledge based on innovation was usually in a closed loop where results done through a certain investment remains classified and protected within the owner company boundaries [14].

- **Connection:** connection has two levels; external and internal levels. Internal connectivity mostly refers to the connection on the national level and mainly between academia industry and government known as triple helix model[15][16], while external connectivity refers to international collaboration.

- **Adaptive structure:** this approach is important to ensure having a flexible organizational structure which can be easily adapted with best operational configuration. Considering innovation as a core of fourth generation Universities, the dynamics of the innovational workflow requires the presence of a dynamic system as well that is flexible in its response toward changes.

- **Services: has two main dimensions** widening sources for university income through different sorts

of services and counseling as well as contributing to local economy development and enterprises support as in **Fig 3** :Virtual model of an internationally successful university **Fig 3**.

5. INNOVATION PATHWAY WITHIN UNIVERSITY SYSTEM

The current transformation from industrial base economy to knowledge base economy has its influence on all institutions and companies' structure at the operation and infrastructure level. One of these transformational effects is the rise of knowledge-based institutions worldwide. Considering the fourth-generation universities philosophies as well as the pyramid model of regional competitiveness, the transformation towards more effective collaborative research and technological development for stronger innovation and entrepreneurial activities becomes more essential. The role of universities towards fostering research and development and improvement of Enterprises to contribute to shape a strong innovation and entrepreneurship ecosystem in higher education becomes authentic.

The "Entrepreneurship ecosystem" terminology as a concept driven from ecology and a concept coined by MIT explains the method of building a capable ecosystem that can host and incubate innovators and entrepreneurs There are multiple definitions and explanations to "Entrepreneurship ecosystem" and its major components. Some studies deal with it as entrepreneurs and the entrepreneurial environment, studying their interrelations through the systematic thinking of ecology to explore influencing mechanism. Other studies interpretation deals with it as entrepreneurial subjects, entrepreneurial environment, and interactions. Other studies define "Entrepreneurship ecosystem" as an organic system that starts by taking an entrepreneurial initiative as its core. It tracks start-ups development different steps from initial idea, foundation till its expansion. And as an organic system it supports individuals institutes and organization to build a set of shared values [17].

One of the common classifications for elements of "Entrepreneurship ecosystem" divides it into two groups as follow:

- **Fundamental elements:** these elements are the essential foundation to build the ecosystem itself and includes the national system, culture, and market.
- **Structural elements:** these elements are engine for development of the ecosystem and includes R&D, financial and labour capitals.

Qianyu Zhu has applied EPM model as an approach to explain "Entrepreneurship education ecosystem" and divided it into three major dimensions as follow:

- **The environment (macro-dimension):** this dimension assures the presence of a proper environment that can ensure smooth and easy ecosystem operation on different levels.
- **The platform (meso-dimension):** this dimension includes different institutes of the innovation and entrepreneurship ecosystem like enterprises, universities, incubators, training organisations and so on.
- **The driving force (micro-dimension):** this dimension includes different actors within the ecosystem such as entrepreneurs, teachers. Professors, programs and curricula for innovation and entrepreneurship

Accordingly, innovation centers can play a great role in fostering innovation through education. A proper design for innovation centers architecture with a good understanding of the dimensions of the eco system can help in providing an attractive environment for innovators and entrepreneurs. This gives the chance to universities to do its role within the pyramid model of regional competitiveness. In terms of sustainable development having the environment being eco-friendly and sustainable would serve in aligning innovation policy with SDGs

6. FOSTERING INNOVATION WITHIN UNIVERSITY THROUGH ARCHITECTURE

University campus can play an important role side by side with other university strategies for education and research development to foster innovation system. Generally, innovation systems can be fostered through powerful entrepreneurial activities and career development services within universities.

Innovation systems focus in finding Ideas at early stages and helping them to develop to a level serving enterprises. Mainly there are three major stages that can help ideas from students' researchers or business / investors to be elaborated to its final phase as commercial competitive product as follow:

- **Pre-incubation stages:** at this stage universities provide facilities that helps finding novel ideas that can be incubated its next stage.
- **Incubation:** at this stage universities provide facilities that helps ideas getting more elaborated toward true values and products.
- **Post incubation:** can be provided by universities through larger scale of facilities within science and technology parks.

The first and second stages can be hosted within innovation and entrepreneurship centres and mostly classified as [18].

- **Innovation centres that promote multidisciplinary learning:** such centres focus on driving cross-pollination and fuse creative academic fields to provide more potential for novel ideas and innovation. Texas Christian University (TCU) is one of the successful examples
- **Innovation centres that foster industry partnership:** such centres work on enhancing industrial partnership, providing facilities that helps business to collaborate with academia within the center. Penn State Behrend is one of the successful examples where it created an advanced manufacturing and innovation center having partnership with Greater Erie Industrial Development Corporation.
- **Innovation centres promoting Entrepreneurship:** such centres work on providing the chance for students to create start-ups. Universities develop pre and incubation programs for university students, researchers, and graduates. Institutions like Iowa State and the University of Utah are examples of this type of innovation centres where such centres are mostly flexible and opened for students 24/7.

7. SUSTAINABILITY

Sustainable development and SDGs goals are core elements within any means of regional competitiveness or development. Higher education institutes and Universities as part of the contemporary movement and development works on encompassing sustainable approaches in different means, some of these approaches are more related to sustainable performance and switching toward sustainable campus. currently green movement is mostly the dominant movement in sustainable development [19] [20]. Green campus as an international approach is concerned with environmental issues , innovation, and research daily application to campus management. This helps in providing awareness about what has to be done as part of the education and operation process. Green campus has a positive impact on regional development socially and economically. Innovation is part of this ecosystem. Having green and sustainable structures especially at the level of innovation center helps in fostering both innovation and entrepreneurial activities as well as sustainable development. [21]

8. EGYPT HIGHER EDUCATION VISION FOR INNOVATION AND ENTERNEURSHIP

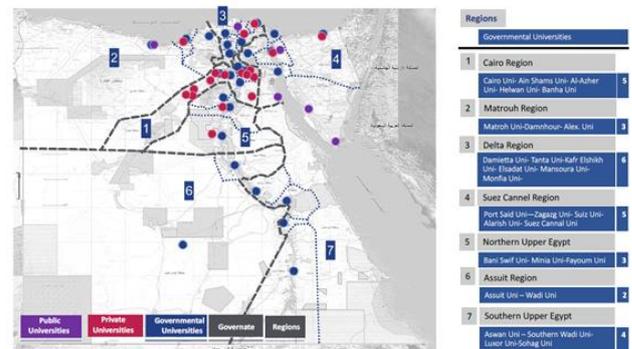


Fig 4: Distribution of universities across Egyptian territories

As published in Egyptian Higher Education Report 2022 UNESCO National Commission in alliance with the Ministry of Higher Education and Scientific Research, Egypt Ministry of higher education and research in Egypt is focusing on reformation of the body of higher education as whole to fulfil Egypt new vision 2030 Currently ministry of higher education and research (MoHESR) is developing its future strategic plan that is still under refinement based and with regard to three major axes as follow:

8.1 The first Axes “Egypt’s vision 2030”: (MoHESR) currently is developing its future development plan to be aligned Egyptian 2030 comprehensive vision that encompasses the united nation SDG’s. Education and research have been a focal point of Egypt new plan, where all efforts held towards creating a stimulating climate for creation of knowledge and regional competitiveness. The vision is focusing on activating and developing an integrated national innovation system that serves regional priorities as well as international needs besides, improving higher education qualities to meet international standards to encourage internationals to study in Egypt as well as fostering entrepreneurship and increasing employability.

8.2 The second Axes “Pillars for fourth generation Universities”: (MoHESR) is currently working on reforming its current assets in higher education to match with the philosophies and pillars of fourth generation universities with regard Virtual model of an internationally successful university and relying on:

- Mobility of students and researchers
- Connection between universities, industry, and government “triple helix model”
- Innovation that impacts research and economy development
- Digital transformation that empowers transfer of knowledge and technology
- Investments and enterprises.
- Adoptive structure and system
- Parameters and performance (indicators of rankings)

8.3 Regional economic development plans: (MoHESR) is working on linking the academia and research to Egyptian market sectors that serves economic growth. Higher education side and scientific research sector - by side with relevant other ministerial sectors -has great potential to transform the Egyptian economy into knowledge base economy. For that reason (MoHESR) has studied the regional economic activities as an essential dimension upon which is new vision will be established **Fig 4**.

Geographically, Egypt is divided into seven regions, which are Greater Cairo, Alexandria, Delta Region, Suez Canal, North Upper, Assiut Region and lastly South Upper Regions.

Based on the three main axes (MoHESR) has derived seven pillars to approach its development goals as follow

8.4 First principal “Integration”: where integration means creating and integral outfit for all higher education institutes that enables them working together though regional consortiums that serve the geographical regions; in addition to enabling such consortiums as well to integrate with each other and with local and international market activities.

8.5 Second principle “Interdisciplinary”: through interdisciplinary, academia will focus on empowering program portfolios with an integral education approach that helps graduates solve society complex problems and labour market needs. Universities having well-established multidisciplinary programs and institutes will accelerate the creation of dynamic interdisciplinary programs inspired from regional and market needs and bridging the gap between academia and business.

8.6 Third Principal “Connectivity”: where connectivity is concerned with two levels, fostering the communication between higher education systems and bodies internally though:

- Geographical connectivity between institutes of higher education within the same region.
- virtual connectivity through establishing networks and infrastructures for digital transformation.
- Market connectivity national connections among universities-industry and government though career and employability centers.

While externally, connectivity means internationalization and international collaboration with other entities outside the country.

8.7 Fourth principle “Effective participation”: this will take place through providing universities the power to establish companies and enterprises based on innovation & research to help in knowledge and technology transfer. Moreover, to enable graduates and students to create their own start-ups through a strong innovation system that supports an outstanding pre-incubation, incubation, and post incubation programs.

8.8 Fifth principal “Sustainability”: it focuses on three pillars for sustainable development projected on higher education ecosystem. the first pillars a ensures an economic sustainable model to support higher education services with less relay on governmental financial support through:

- Establishing national universities owned by governmental universities with new financial model to support financial independence.
- Establishing start-ups, enterprises, and providing services and consultations with competitive edge and market value.

The second pillar focus on establishing a well-performed campuses with environmental qualities that support innovation and knowledge creation and includes research center, innovation and career centers, and science and technology parks beside classical education spaces and outdoor facilities.

The third pillar works on enhancing social qualities for students, professors, research and employee within higher education through empowered social programs and capacity building offered by “training and development centers” TDC’s.

8.9 Sixth principle “International referencing”: the philosophy of international referencing is to provide all higher education services with an international quality and competitive edge to attract outsider universities, educators, and students to study in Egypt as an international hub for higher education.

Egypt is developing a new approach for building program portfolio that is design of main three components as follow:

- Classical academic programs
- Innovation and entrepreneurship
- And employability



Fig 5: higher education vision for program portfolio

As seen in **Fig 5** the new program portfolio shows that innovation represents a major part of the new ecosystem of higher education in Egypt. The way where the new eco system will work is based on the establishment of ISF innovation support fund centrally within the ministry of higher education to support higher education institutes and individuals in all innovation journey from preincubation stage till the formation of full Enterprise. At the level of universities and institutes there has been a work towards the establishment of innovation centers for supporting students’ researchers and individuals towards building their entrepreneurial future.

9. ARCHITECTURE AND INNOVATION CENTERS LAYOUTS

Innovation centers in the Egyptian model works on providing different level of special configuration to serve innovation and entrepreneurial pathway as follow:

- **Training spaces:** training spaces are designed to be with flexible layout and furniture to provide multiple training configurations. These spaces offer different magnitudes of training and capacity building activities for innovators and entrepreneurs' discovery and enhancement.
- **Preincubation and incubation spaces:** these spaces are design to be with flexible layout as work or coworking space for entrepreneurial activities. Spaces are usually designed to encompass desks and outlets that help in providing easy changeable configuration for these workspaces as needed.
- **Tenant offices:** these spaces are designed to offer satellite offices for enterprises from industry willing to serve the innovative ecosystem within the universities.
- **Shared and open spaces:** these spaces are design to provide shared facilities and informal spaces to beneficiaries to have their activities.

9.1 Introducing sustainability as part of Egypt higher education vision in the establishment of innovation centers.

Referring to the fifth principle of Egypt higher education vision which is sustainability, The different higher education institutions works on introducing sustainability as a dimension in their built environment development. A lot of initiatives are taking place to foster the transformation toward more sustainable campuses and practices. (*The Supreme Council of Egyptian Universities Welcomes all Egyptian Universities to Present and Share their Environmental Research Projects and Successful Experiences in Order to Maximum Advantage in Achieving Long-Term Development Goals in the Field of En | Assiut University*.)

Innovation centers are part of these built environment ecosystems. For that reason, there are a lot of efforts made to foster sustainability in higher education institutes.

In terms of architecture design, there are different levels of sustainability movements and levels starting from green design based on minimizing the negative impact on the environment up to regenerative design.

Design toward sustainability seeks a careful study for site potential as well as having a design that optimize energy consumption and material usage, protect water, focus on vital lifecycle and foster the enhancement of indoor environmental qualities [23] [24],[25].

9.2A case study on Ain Shams University innovation center

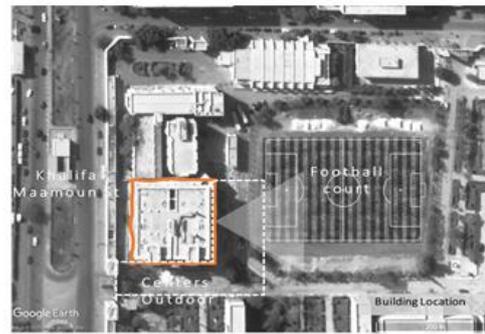


Fig 6 : ihub location, Ref: (IHUB, 2022)

ASU as one of the oldest and largest Universities in Egypt and the middle east with over than 200000 Student has taken inconsideration its Role in driving our national economy forward through creating an Edge linking the Academia with the market sector focusing on Innovation and entrepreneurship as the driving forces for change and leadership in **Fig 6**.

In 2012 to 2014, the innovation center known as “i Hub” was established locally at the faculty of engineering and started to expand offering various innovation support and activities. In 2022 Ain Shams university extended the role of the innovation center known as “i Hub”. ASU Innovation Hub is the first governmental University center for innovation entrepreneurship and employability. The vision of the center is “To become a leading regional Innovation, entrepreneurship and creativity hub and international collaboration model that facilitates interdisciplinary ideation, innovations support, and implementation activities to enforce entrepreneurship and Innovation.” The center mission is “To provide the best possible environment for innovation that empowers and motivates innovative participants and entities to develop their ideas, concepts, and business models. In addition to providing the best possible required services and consultations that help participants enrich their knowledge, improve their skills, and reach their goals in an innovative way. (IHUB, 2022)

Fig 7.

The new center established in 2022 took place through the renovation of an existing structure located at Khalifa el Maamoun Street, Heliopolis, Cairo, Egypt. The building consists of six floors each of 1150 m² with total area of 8200 m².

The building consists of different innovation support units aligned with Egypt higher education vision for fostering innovation and entrepreneurship which includes Training facilities, Pre-Incubators spaces with standard qualities, Incubators-startups and partners with outdoor areas, Main admin spaces and common shared spaces see **Table 3**.

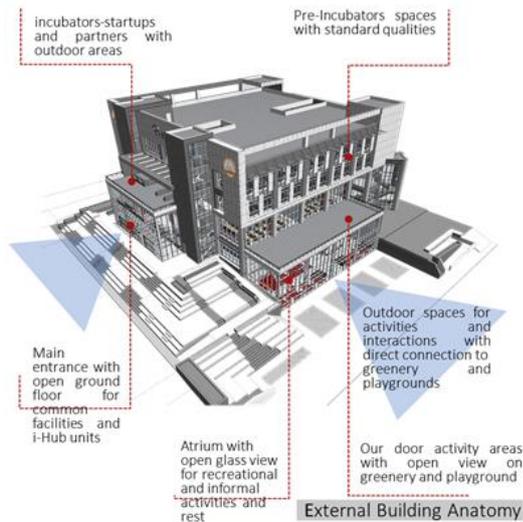


Fig 7: iHub building components, Ref: (IHUB, 2022)

Table 3: iHub Building space program.

Components
Shared and informal spaces
Innovation and event lounges
Fun zone area for refreshment
Workshops and small prototyping facilities
Events spaces
MPU Hall theater seats configurations
MPU Hall for different events
Operational space
I Hub beneficiary Units:
<ul style="list-style-type: none"> • Technology transfer • Business development • Operations
Training and capacity building
Multiple size shared training - coworking halls with fixable furniture configuration 6 Training halls
Incubation and post incubation spaces
Multiple size sized with fixable furniture configuration to be used as
<ul style="list-style-type: none"> • Entrepreneurial areas • Startup areas • Strategic partners or sponsorship spaces
Serving spaces
Administrative spaces for ASU and facility management area
services circulation &lobbies
Stairs and elevators cores
Catering Service point Stairs and elevators cores
Spaces were design with flexible configuration to facilitate different operations . In terms of sustainability the projects

are a part of the university plan to raise awareness for SDGs. The building was design to meet sustainable design goals through minimizing of energy consumption, water reduction, and material optimization in addition to enhancement of indoor environmental quality. The building obtained EDGE advance certificate(iHub Innovation and Entrepreneurship Center - Ain Shams University - EDGE Buildings) where EDGE “Excellence in Design for Greater Efficiencies” is a free software, a green building standard, and an international green building certification system.it is an IFC , a member of the world bank group innovation. It was created to provide a measurable and credible solutions to prove the business case for building green and to unlock financial investment.[28]

The design used different active and passive design techniques to be green that includes roof and external walls insulation as well as low-E-coated glass. In terms of air condition systems, the design worked on using highly efficient air conditioning system for providing both energy good indoor environmental quality as well as proper cooling loads performance; side by side with the electrical systems the building offered up to 42% energy savings. In terms of water efficiency and saving the building used smart systems that caused water saving up to 44%.The building partially reused some of the existing elements helping in the deduction of embodied construction material with savings up to 62% in Fig 8.

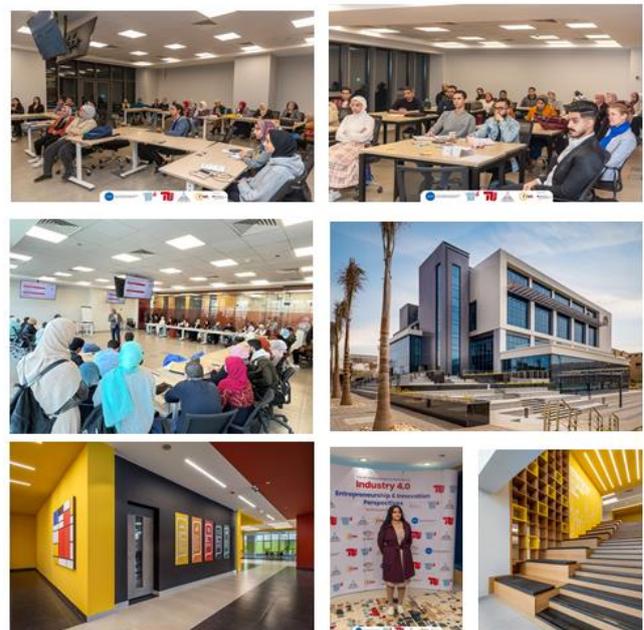


Fig 8: pictures from Ain Shams innovation center showing the different activities held fostering innovation and the flexible use of spaces.Source : (IHUB, 2022)

10 CONCLUSION

Innovation and entrepreneurship are one of the cores of regional competitiveness. Higher education plays an important role in driving regional competitiveness through innovation and research. Innovation centers are pivot institutes for the transformation from Neo Fordist region to

knowledge creation region. Egypt higher education 2030 takes innovation as one of its main pillars and principles specifically the seventh principle of its vision. The vision is based on regional approach for sustainable development of Egyptian economy through higher education and scientific research relying on fourth generation universities transformation fostering innovation. The innovation ecosystem is supported on the ministerial level by ISF “innovation support fund and locally by innovation Center and equivalent bodies. There has been a lot of progress toward creating and establishing these centers with a sustainable background that includes environmental, economic, and social aspects.

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