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Winning research through ideal research laboratory

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Abstract

Research is evolving due to the availability of plethora of enablers such as technology, information, data, communication, research outcomes and publications. This study is a review on ideal research laboratory in 21st century. The aim is to highlight the features of an ideal research laboratory in the conceptualization of ideal breakthrough research in 21st century. The report examines what research looks like in the 21st century and the things expected in an ideal research laboratory in 21st century. The concept of research was explained, the skills needed in the 21st century were stated, the research development trend was highlighted and the guidelines for the ideal research laboratory which is expected to produce ideal breakthrough results were also be presented.

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1. Introduction

According to Kothari (2004), research is an art of scientific investigation and the vital source of technological progress (Fayomi *et al.* 2018). It is referred to as an academic activity. It is a valid and authentic contribution to the

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existing knowledge and the pursuance of facts through study, observation, comparison and experiment. Also, Webster (2017) defined research as a systematic search for the truth or facts about something. It is usually used for establishing or confirming facts, reiterate the outcomes from work done previously, giving solution to existing or new problems, support propositions and theorems, or develop innovative and new theories. Research involves productive activity engaged on a regular basis in order to improve awareness of people on art, culture, and consciousness to devise ideals (OECD, 2002). Thus, research can be considered to be an effort of moving from a state which is known to the unknown state; it basically involves evolving the frontiers of understanding and knowledge. Knowledge gained from research are used in several ways such as categorization, description explanation, evaluation, comparism, correlation, prediction and control (Walliman, 2011).

1.1. Research in 21st Century

Research in the 21st Century has changed rapidly from research in earlier centuries and this is predominantly due to advent of Information Communication Technology and the skills now being acquired by researchers. In the 21st century, the essential skills required are critical thinking, creativity, collaboration, metacognition, and motivation (Lai, 2012). In the 21st century, research has been found to differ in the ways highlighted below (Hartley & Hesketh, 2017):

- Research laboratory is now a classroom extension
- Teaching laboratory is now a research laboratory extension
- Increasing Student Access to Scientific Literacy
- Journal Clubs/Special Classes (online and offline)
- Laboratory Meetings
- Student determines level of involvement
- Student involvement determines amount of responsibilities
- Student involved in problem identification, hypothesis formulation, etc.
- Increasing student access to research

Boer *et al.,* (2002) did a study on how research is being impacted on in the 21st century, from the team's findings; the key areas of research development are explained in 5 trends as:

- The advancement of learning and information technologies has huge impact on research with a considerable high speed of change. Findings from the study shows an increase in collaborative cross-border systems among researchers, an improvement in the openness of databases, advancement in the rate of computation, and the increase in the utilisation of automated journals. With the help of information technology, research in 21st century is faster, globalised, easily accessible and advantageous due to effective management of resources, database and infrastructure. Despite these benefits, some issues with ICT which might affect research in this century are the reliability of electronic sources, the availability of knowledge, investment in ICT infrastructure and unbundling the university.
- The marketization and changed role of policies: academies are presently faced with high output steering, lump-sum funding and attempt to establish the relationship among higher learning universities and their surroundings. The management of research institution in the 21st century is more complicated. Also, the increased number of individual research institution amidst the fact that schools get substantial fraction of their funds from contract research for third parties indicates an enhanced competition.
- Globalisation, internationalisation and regionalisation: Global demands toward higher learning have become essential, and are anticipated to moreover gain importance. Globalisation can also be regarded as a driving force for global co-operation, as colleges build huge consortia that present teaching and research on a global scheme
- The advance of the leaning society: Because of the natural link between advancement of the learning community and the academy, it is challenging to disengage the importance of the expectation of the university. The learning community is not an outside drift that influences the academy. A critical argument for the evolution of immeasurable systems is that the current education product slightly studies

from regular science regarding the value of "controlled circumstances", but admits the heterogeneity of information and the value of innovative stakeholders.

- Demographical trends: human resources management has grown in value as a management field in colleges and different research institutions.

It is highly important for planners of laboratory in the 21st century to be aware that the facilities needed for research need not to be invented solely and lastingly for any single type or model of research activity. The main emphasis of research is persistently changing and it should be anticipated that the research program may change between design and utilisation (Hidalgo, 2018). Therefore, an ideal research laboratory needs to be flexible enough to accommodate prospect programs in the future and also upholding efficiency in the cost at the design time. In addition to flexibility and cost, safety and quality of the environment are other key factors to be considered in the design of an ideal 21st century research laboratory. Inclinations to micro- and nano- level research are evidenced in the evolution of modern research technologies such as mass spectroscopy and magnetic resonance imaging devices (Pelling *et al.,* 2017). Design trends include environmentally regulated environments in the labs. A machine is more automated with microcomputer guided systems coupled with the necessity to regularly substitute and modernise the facilities. Some of the modern technology requires severe demands on building utilities and environmental controls. It is necessary that labs be planned with transportable carts and shelving to provide for modern facilities and a rearrangement of the workflow. To guarantee a flourishing design, planners must envisage future trends of a research study that will take place in the laboratory through contact with laboratory users.

2. Ideal Research Laboratory

Research Laboratories are workplaces where scientific researches are being carried out. The comfortability, security, and sustainability should be the major considerations for the design of Research Laboratories. With the emergence of ICT, virtual research laboratory is now becoming more popular in the 21st century. Many research equipment are becoming more portable and now comes with their software, it is now a practice for people to have their research laboratory as their work station. In this case, the requirements are computers, software and other hardware like the optical microscope. Since the hardware required is becoming more portable, it is now possible to have a laboratory, promote the laboratory online and pass communication regarding the research online (Popoola *et al.,* 2018). It has been identified that research laboratory owners (or clients) in the 21st century push project design teams to create research laboratories that are responsive to current and future needs, that foster interaction and collaboration among scientists from various disciplines, that has helped in the recruitment and retaining of qualified scientists, and that enables development and partnerships (***Watch,D.,Tolat, D.*, 2017** ; Odukoya *et al.,* 2018.)

Essential design problems to consider in deciding a structural design involve:

- Building depth and impact on floor-to-floor altitude;
- Capacity to organise building with laboratory modules;
- Provision for perpendicular or parallel extension;
- Vibration standards; and
- Expenses.

2.1 Architectural Consideration

Over the past 30 years, builders, engineers, facility handlers, and researchers have improved the design of standard wet and dry laboratories to a much high level. The following recognises the genuine answers in designing a standard lab.

2.2.1 Laboratory planning module

The research facility module is one essential factor in any lab office. If planned precisely, a research facility module will totally control all the auxiliary and development frameworks. A very much structured secluded plan will accommodate numerous advantages such as:

- Adaptability – The research laboratory module should "advance diversity" inside the building. Research is advancing constantly and structures need to take into account possible change. Various private research organizations make physical changes to a level of 25% of their laboratories every year. Majority of educational institutions occasionally alter the structure laboratory by of 5 to 10% . **(***Watch,D.,Tolat, D.*, 2017**)**

- Enlargement – The use of research laboratory planning modules empowers the structure to suit easily to any normal developments or withdrawals without losing facility usefulness.

According to *Watch,D.,Tolat, D.* (2017**)** a standard research laboratory facility module has a broadness of approximately 10 ft. 6 in. In spite of the fact that the profundity ranges from 20– 30 ft. The profundity depends on the measurement required for the laboratory and the cost-viability of the design framework. The 10 ft. 6 in. measurement depends on two series of casework and gear (each line 2 ft. 6 in. deep) on each divider, a 5 ft. path, and 6 in. for the divider thickness that segments one lab from another. The 5 ft. way width ought to be viewed as a base in view of the specification of the Americans with Disabilities Act (ADA). Laboratory Research center module can be two or three dimensional.

- Two-Directional Laboratory Module – a Different level of flexibility and adaptability can be practiced by planning a research laboratory center module that works in the two ways. This allows the casework to be set up in the two directions. This idea is more versatile than the fundamental laboratory module theory yet may demand additional expanse. The utilization of a two-directional lattice is helpful to give varying lengths of the run casework. The casework may be moved to produce a particular sort or size of workstation.

- Three-Dimensional Laboratory Module – This connects the fundamental research laboratory facility module with a few laboratory passage plans for each floor of the structure. It can have a solitary hall arrangement on one story, a two-hallway format on another, etc.3. Flexibility: In this present day laboratory, the ability to create, reconfigure, and permit prepared use has turned into a main concern.

3.1 ***Flexible laboratory interiors:*** **These includes**

- Equipment zones – These ought to be built in the first structure to house equipment, mobile, or fixed casework in future.

- Mobile casework – This incorporates mobile work areas and versatile base cupboards. It empowers analysts to design and arrange the laboratory facility depending on their craving.

- Flexible dividers – These can be cut down and set back up in an alternate zone, giving the laboratory areas to be arranged in an variety of dimensions

- Overhead benefit carriers – These are dangled from the roof. They can have utilities like channeling, electric, information, light apparatuses, and snorkel debilitates. They give high adaptability as services are raised off the floor, giving open floor space to be arranged as required.

Research Laboratories centers ought to have straightforward append/separates at dividers and roofs to accommodate brisk and reasonable affix up of gadgets. Facilities ought to be structured so seethe spreads can be joined or disconnected. Reservation ought to be permitted in the utility halls.

3.2 Flexible engineering systems

Research Laboratories are planned with overhead connects and disconnects taking into consideration adaptability and quick connect of equipment. The Engineering frameworks ought to be structured to such an extent that smoulder hoods can be included or evacuated. While space ought to be permitted in the utility passageways, roofs, and vertical chases for future HVAC, pipes, and electric needs, these sorts of research laboratory centres ought to have simple interfaces or separate at dividers and roofs to give room for quick and moderate connection of equipment.

3.3 Laboratory and Personnel Safety

Protecting human health and life is supreme, and protection must perpetually be the primary interest in laboratory construction design. Security-protecting the building and facilities from illegal access are also of significant interest. Nowadays, study tools authors must operate within the compact regulatory conditions so as to build reliable and prolific laboratory spaces.

3.4 Sustainability Considerations

The standard laboratory uses considerably large power and water per square meter than the standard office structure due to intense air-conditioning demands and different health and security concerns. Consequently, designers should attempt to build sustainable, long performance and low power or energy consuming laboratories that will reduce overall environmental impacts, preserve inhabitant security and optimize the whole building facility on a life-cycle basis.

3.5 Three Laboratory Sectors

According to Srinath (2010) There are three research laboratory divisions. They are Educational laboratories, government laboratories, and private sector laboratories.

- Educational laboratories are essentially training facilities but also incorporate amazing research materials that are of interest to the general public
- Government laboratories are those managed by federal auspices and those run by the state government for the public interest.
- Private sector laboratories are controlled by organisations, regularly motivated by the demand to improve the research operation for profit making

3. Conclusion

Research in the 21st century is fast paced and ICT has been identified to be the key enabler. Thus, to achieve an ideal breakthrough research result, the use of internet, software and computers are inevitable in an ideal research laboratory. Moreover, the researchers must have the required skills which are basically critical thinking, creativity, collaboration, metacognition, and motivation.

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