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"Public/Private Approach to Space and a New Approach for Space Exploration"

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Abstract

The public/private approach to space is about how space is being reached by private companies and government in either past or present time and how they will access space in future using different innovative scientific technological means. "The deeper the exploration in to the space, the further the possibilities in outer space will be" So that, human space exploration is an extremely essential and interesting phenomenon because it is ongoing discovery and exploration of celestial structures in outer space by means of continuously evolving and growing space technology. The study of space science is carried out mainly by astronomers with telescopes, the physical exploration of space is conducted both by unmanned robotic probes and human spaceflight.

With the growth of 21st century, space activities are evolving with phenomenal success compare to success rate over the last 50 years. Majorly, public sectors are working in SSO orbit (associated with security) and private sectors are increasingly working for LEO orbit missions. The possibility of successful space experiments depends upon past heritages of space manned or unmanned missions and current mission activities like ISS and NASA's curiosity rover. Space race beginners must improve from past manned missions mostly flown by Soviet Union and USA and also analyse how to make manned missions more effective and cheaper. The main motive for new space approach is to make space business more commercialized and cost effective. Economic benefit comes through miniaturization of space launching vehicles using COTS components. Such purposeful and efficient space experiments can be made by adapting new designing approaches such as small satellites (Cubesat, Microsat and Nanosat). The lesser complexity brought into by COTS electronics, the lesser space will be occupied in the launch vehicle by payloads, lesser energy will be needed and lesser the overall budget will be. New commercial approaches for space evaluation could be useful to explore our neighbouring bodies like the Mars, the Moon, the Venus and asteroids/comets those have most likely hood of past life evidences.

The main purpose of this paper is to analyse and investigate present and past human activities for space explorations. It will also talk about the roles of government and industry to improve public/private sector's partnership towards space. Moreover, it will also discuss opportunities and barriers, those humans are experiencing while working on space missions under national and international space policies and strategies. At last, the paper will discuss about benefits and barriers that private organisations have while working on space projects.

Keywords: Human space exploration, Mars, Asteroid, Moon, CubeSat, comet, Private space activities

Acronyms/Abbreviations

Sun Synchronous Orbit (SSO)
Low Earth Orbit (LEO)
International Space Station (ISS)
Commercial of the Shelf (COTS)
Public/Private Partnership (PPP)
National Aeronautics and Space Administration (NASA)
International Space Station (ISS)
Public/private partnership (PPP)
Space Act Agreements (SAAs)
Commercial Crew Development (CCDev)
Sierra Nevada Corporation (SNC)
Space Launch System (SLS)
National Oceanic and Atmospheric Administration (NOAA)
Federal Aviation Administration (FAA)
Federal Communications Commission (FCC)
Department of Defence (DOD)
National Geospatial-Intelligence Agency (NGIA)
Missile Dense Agency (MDA)
National Reconnaissance Office (NRO)
Defence Space Council (DSC)
European Space Agency (ESA)
Indian Research Space Organisation (ISRO)
China National Space Administration (CNSA)
Japan Aerospace Exploration Agency (JAXA)
Russian Federal Space Agency (RFSA)
Polar Satellite Launch Vehicle (PSLV)
Qualifying model (QM)
Flight Model (FM)
Dynamic Random Access Memory (DRAM)
Ground Sampling Distance (GSD)

1. Introduction

1.1 Background

Space race had started in 1957 by USSR and then competition of space exploration among the nations has increased dramatically. Initially, two nations, US and Soviet Union were taking part in this race because they had technical support from military and funding capability of government. Then after, other countries started developing orbital payloads like Italy, France and Great Britain with the help of their healthy reference with race beginners. Subsequently, countries, like Indonesia, India, China and Japan had started developing their payloads and satellites with external help. Later on, by knowing the need of often sequential launching, orbital handling and data retrieving, various competitors had started developing indigenous launching vehicles and ground stations. In late 2000, national agencies were taking help from private master companies (located overseas) to buy launching tickets from agencies which were capable to provide launch services to transform payloads from earth's surface to LEO orbit.

1.2 Aim

The main aim of public/private space access is to research latest efficient and innovative technologies for satellites designing, rocket launching, developing orbital small scientific payloads and their operating system. That innovative change will give birth to a new space age and cost effective public human access to space. The new research approach would be based on the same principle as old public days but comparatively cheaper and help to make space one profitable business and major innovation. For example, NASA is giving contracts to private companies to test the delivery of cargo to ISS using commercial off the shelf technology and vehicles itself [7]. The main objective behind commercial activities is to reduce the cost of space flights and increase efficiency of private prototypes to manage space investigation. Moreover, space is publicly available and same for all humankind to explore, so space agencies could unveil ideas of small satellites (1U, 2U, 3U CubeSats) and other engineering payload activities to involve public sector, like group of interesting people, university graduates and experts those who are very keen to work for space science and technology. Together with the help of public's views and their more generic needs, private companies (and government agencies) would be able to transform a baby step to giant leap into the dark space in less time. Alternatively said, Earth is already carrying 7.2 billion people, due to overcapacity (due to increasing number day by day) of Earth and lack of natural resources, the big dream is space colonization through which relocation of human and changing animals' habitats could be possible.

1.3 Scope

This paper is comprised of recent human orbital activities to space, what should be the role of government and industries to improve people's understanding, to increase their curiosity and their involvement day by day. Further discussion will include opportunities and barriers that public and private organisations have and finally space programs under taken by private organisations in past. The further sections will include a discussion on new sophisticated technological approaches for space research and the need of space foundation in each nation to make space flights cheap and easily accessible to public.

2. Recent Human Orbital Space Activities

Access to space for either public/private sectors has been too expensive (nearly hundred/s of million). Due to funding constraints, several missions have been delayed or cancelled by NASA. Public and private sectors are making partnership named public/private partnership (PPP) and with the help of that NASA has supplied reusable cargo to make space journey to and from ISS [12]. NASA made space shuttles were not in use after 2011, so US space program depended upon Russian soyuz vehicles to make a journey to ISS. In recent year, NASA overcome traditional costlier cost-plus system and used PPP as a cost effective strategy to develop commercial spacecraft and deliver space cargo for manned missions. US space explorations are based on cost-sharing contractual agreements and Space Act Agreements (SAAs). With the help of PPP and SAAs, government is able to facilitate with commercial development capabilities and moreover agreements were also proven cost sharing and innovative. In 2009, NASA started developing Commercial Crew Development (CCDev) PPP program for human access to space. Four private companies were given contract to participate in space flight vehicle development, like Space X, Boeing, Sierra Nevada Corporation (SNC) and Blue Origin. Recent space activities facilitate modern, cost-effective, power saving approach for NASA to reach to ISS using commercial crew which will be easier for partner space race participants to access earth's orbit. Recently, prime minister of India congratulates ISRO for a successful launch of PSLV-C34. The mission launched Cartosat-2 series satellite and other countries 19 co-passenger satellites. The co-passenger satellites were from USA, Canada, Germany and Indonesia as well as two satellites (SATHYABAMASAT and SWAYAM) from Indian Universities.

2.1 Recent/Ongoing Space Missions

1. *Soyuz:*

Soyuz TMA-20M is a Soyuz which is a 2016 spaceflight to the ISS. It transported three members of the Expedition 47 crew to the ISS. TMA-20M is the 129th flight of a Soyuz spacecraft. The crew consists of a Russian commander and flight engineer, as well as an American flight engineer. It is the final planned Soyuz TMA-M, which will be replaced by the upgraded Soyuz-MS.

2. *ISS:*

Three Expedition 48 crew members are orbiting Earth awaiting the addition of a new trio preparing to join them next month on the International Space Station. At present, the International Space Station (ISS) project aims at improving science and technology to enhance life and industries on the ground. Fifteen countries are participating in the ISS project including the United States, Russia, European Countries, Canada, and Japan. Moreover, Japan has completed its manned space facility "the Japanese Experiment Module Kibo," and trains astronauts who will operate the ISS and Kibo at JAXA.

3. *NASA's planned future missions:*

NASA is planning to launch 13 cubesats through the Space Launch System (SLS), which will carry 13 CubeSats to test innovative ideas along with an un-crewed Orion spacecraft in 2018. The purpose of SLS is to carry science and technology investigations to help pave the way for future human exploration in deep space, including the journey to Mars. Most importantly, SLS's first flight provides the rarest opportunity for these small experiments to reach deep space destinations, as most launch opportunities for CubeSats are limited to LEO. The space organisations like Science Mission Directorate of NASA also finds new scientific ways for atmospheric improvisations like CuSP payload (to measure particles and magnetic fields in space, testing practicality for a network of stations to monitor space weather) and LunaH-Map (to map hydrogen within craters and other permanently shadowed regions throughout the moon's south pole) [1].

In 2016, several new rockets and spaceport are planned to be designed and operate by private companies. The more nations explore the space, the more missions they could plan and schedule so supplier companies has started developing commercial reusable launch vehicles as a long stated goal. Space-X concludes that recovered structures and engines did not suffer significant damage [2] so reusing resources of previous missions also planned in mid-2016[3]. In the same year (14th March), collaborated European and Russian space agencies had launched an ExoMars mission which will take 7 months to make a voyage until Mars. Manned missions include the return of Scott Kelly and Mikhail Kornienko in March, after a 340-day mission on the ISS, the longest-ever continuous stay by astronauts at the station. In addition, four ISS Expeditions (from 47 to 50) will be launched in 2016 by NASA.

3. Roles of government and industry to boost private/public partnership towards space

3.1 Importance of space activities

It is very important to increase awareness among organisations, institutions and society towards space explorations because its birth (BIG BANG) is a mysterious and World has taken baby step to explore

the space and it is very expensive to travel into the immense deep space and find another living body with limited resources. Such exploration needs many skilled young engineers, scientists, physicist, astronomers and astronauts to research various effective and efficient technologies to make space travel less expensive for private missions and for public. Awareness can be brought into human life by industry and government by adopting new political, economic, and legal frameworks and also providing financial support. The positive morale of government support is to make nation capable in order to compete global space groups and to prove challenging multinational space efforts worldwide.

Globally Government should make collaborative law for founded and present bodies (floating in vacuum) belong to all human being on earth. Otherwise, disputes could happen among the founder nations in future for those property which never belonged to them. Government must investigate what technologies that other nations have, how to use/reuse that and make space missions as cost effective as possible. Government must work in collaboration with other nations and must come up with a shared view which works for a common goal for global improvement (For example, Indian government went to Japan and discussed about the available technologies with scientists which could help Indian farmers in their farming and making their crops more productive). Public sector has been investing much in technological progress which couldn't possible by private sector because of high cost to company, long payback times and risk. Government should take sustainable steps for transporting human to space.

Commercial crew development provides effective means to reach the goal. Government must provide sufficient resources, define policies to increase space capabilities and cost efficient space program. Government should run agencies and public organisation for space exploration, aeronautical and scientific discovery. The agencies should carry research and implementation in aeronautics, exploration systems, new science and space operations. US government run many agencies, like National Oceanic and Atmospheric Administration (NOAA), Federal Aviation Administration (FAA), Federal Communications Commission (FCC), Department of Defence (DOD), National Geospatial-Intelligence Agency (NGIA), Missile Dense Agency (MDA), National Reconnaissance Office (NRO), U.S. Strategic Command (USSTRATCOM), Army Space and Missile Defence Command (ASMDC), Air Force Space Command (AFSC) and Defence Space Council (DSC) to run space exploration programs.

Agency	Budget	Stimulus
Department of Defense (DoD)	$26.53 B	-
National Reconnaissance Office (NRO)	$15.00 B	-
National Geospatial-Intelligence Agency (NGA)	$2.00 B	-
National Aeronautics and Space Administration (NASA)	$17.78 B	$1.00 B
National Oceanic and Atmospheric Administration (NOAA)	$1.18 B	$0.07 B
Department of Energy (DOE)	$0.04 B	-
Federal Aviation Administration (FAA)	$0.01 B	-
National Science Foundation (NSF)	$0.65 B	$0.15 B
Total	$63.19 B	$1.23 B
Combined Total	$64.42 B	

Figure 1 U.S. Government Agency Space Budgets 2009

3.2 Evaluation after investing and involving academic institutions:

After providing sufficient facilities to public/private sectors, government must take care whether the public/private space agencies, organisations, institutions and other interested group of people are justifying the allocated budget of space missions. Management must study whether space missions are feasible to do, importance of the mission and its outcome. Government must do detailed analysis why it is worth to spend hugh amount of money behind space department. Government must capable to answer opposition communities by giving fundamental knowledge and increasing awareness. Government and private companies must work together to mitigate the knowledge gap of academic institutions like, engineering universities, faculty of computer science and other research faculties. The purpose behind involving academic universities is to have innovative ideas from fresher engineers, to utilize and develop their skills, increasing their curiosity and enthusiasm and utilizing demographic strength of the nation. Government must make sure that space business must be transparent globally.

3.3 Government's owned nation's full launching facilities

The Indian Research Space Organisation (ISRO)
The European Space Agency (ESA)
The China National Space Administration (CNSA)
the Japan Aerospace Exploration Agency (JAXA)
NASA
the Russian Federal Space Agency (RFSA or Roscosmos)

Table 1 Full Satellite Launching Facilities (public)

Among them (mentioned in table 1), NASA, RFSA and CNSA have human spaceflight capabilities. The US government has encouraged private sectors to develop commercial vehicles for space explorations so,

from US side space race has picked up even more speed. Private companies are developing Suborbital Reusable Vehicles (SRVs), they are private and reusable to carry human and cargo out of earth's atmosphere [4].

3.4 Private and public sector's collaboration

1.	Orbital Sciences Corp.
2.	Space Exploration Technologies Corp. (SpaceX)
3.	Sierra Nevada Space Systems
4.	Lockheed Martin, Boeing and United Launch Alliance
5.	Blue Origin
6.	Virgin Galactic
7.	The Ultrawealthy
8.	Bigelow Aerospace
9.	Spaceship One

Table 2 Major Players in Space Travel (private sector)

Around 500 people have travelled to space, among them merely were professional astronauts and cosmonauts on government mission [5]. Which shows it could have been hard for private companies to make it to the space. So public and private sectors must work collaboratively to make space missions economically less expensive and easily affordable. Government must have deal with other nations to get help for space explorations and other experimental satellite launching. For example, it will be too costly to launch a whole rocket for couple of orbital payloads. Instead of that, it's better to borrow some space when other nations are launching their vehicles and making space activities streamlined worldwide. For example, recently, India has launched 19 overseas satellites through vehicle Polar Satellite Launch Vehicle (PSLV)-C34 [6].

3.5 Science Education

Government should reflect on the educational value of high-profile human space activities. As noted by the late Carl Sagan (1994), exploratory spaceflight puts scientific ideas, scientific thinking, and scientific vocabulary in the public eye. It elevates the general level of intellectual inquiry [10]. The whole scientific enterprise has the greatest possible interest in encouraging this process. Government must offer high quality science programs which uses the context of space exploration to engage teachers and students in the teaching and learning of science and must provide a stimulating environment for hands-on learning. All areas within the centre are supported by an integrated technology system which supports a rich learning environment.

4. Current opportunities and barriers of human access to space under National/International space policies & acquisition strategies

4.1 How space exploration facilitate human

- It helps to solve fundamental question about our place in universe and helps to learn mystery of life and its existence beyond earth
- Help to solve history of our solar system
- Expanding the techniques as per the challenges related to human space
- Create new industries as per requirements and needs of the research
- Peaceful connection with other nations
- New searched planets are sources of inspirations for explorers and scientists
- Human space exploration gives opportunity to demonstrate that humans can live for extended, even permanent, stays beyond low Earth orbit
- Such techniques and space systems required to transport and sustain explorers to drive innovation and encourage creative ways to address challenges
- Mars travellers (nations) will learn how to work together to achieve common shared goal
- ISS is giving opportunity to collaborate and highlight common interest and provide global sense of community
- Such space explorations have long lasting benefits and applications [7]

4.2 Barriers

According to Jemison, to reach to the space, public must be involved in designing capable technology and must not left out of the space. Moreover, he added that, "The reason we are not on the moon has nothing to do with technology and everything to do with public will and commitment" [8]. Lack of exploration and curiosity demotivate human fundamentally towards space science so that human should be involved in space exploration.

4.2.1 Landing on planets

For instance, landing a human on mars would be altogether trickier than landing a manmade robot. Robots (NASA's Curiosity) accelerate at 15g (15 times acceleration gravity) to land on Mars. Such speed could be disastrous and also cause death to a human. This research also suggests that such a high speed could detach the retina from the human eye while landing [8].

4.2.2 Cost

It is true that human spaceflight is expensive. However, even this should be seen in context: NASA's annual $14 billion budget is only 5% of the US military budget ($283 billion in 1999) [10]. Cost of space travel (per person) is depends upon distance of travel and duration of stay in space. XCOR (a private company) is offering space flight travel in $95,000 per person same way, Virgin Galactic's first commercial space tourism flight offered human space flight in $2 million per person. These numbers seem not affordable for a common people of society. Although, the travelling cost would become cheap within couple of generations due to COTS components.

5. Space programs undertaken by private organisations in past and recent time

Asteroid mining, orbital 3-D printing, and manned spaceflights are all part of the modern-day space race. The following companies are involved in recent and past space equipment manufacturing and transporting human into the space:

Private Company	Spaceship/Product Name (space qualified)
SpaceX	Dragon spacecraft and Falcon 9 rocket
Orbital Sciences	Cygnus and Taurus 2 rocket
Blue Origin	New Shepard
Bigelow Aerospace	Sundancer and BA-330
SpaceDev/Sierra Nevada Corp.	Dream Chaser
Virgin Galactic	Spaceship Two
Boing	CST-100 Starliner (Crew Space Transportation)
XCOR Aerospace	Lynx
Made in space	3D printer, Material recycler, manufacturing devices for struts and beams and provides additive manufacturing methods in vacuum
Ad Astra Rocket Company	Variable Specific Impulse Magneto plasma Rocket (power source: Solar panels)

Table 3 Companies and their cargo/spaceship

6. Opportunities and barriers behind private organisation's space exploration activities

Now, many private organisations are capable to work in the field of space technology and those private organisations could be universities/institutions, company (small group), interested communities and individuals. The main concern of private organisations is to make profit, growth and maximize awareness of space science and research in society. Space organisations (like ISRO) are becoming commercial as scientific, they need products of premier institutes. Private space organisations look for strength in fundamentals, wherever the person is from. It is essential to have people from different institutions to work on same ideas with diverse point of view and strong team work skills.

6.1 Opportunities for private organisations

1. Joint research and advancement in research in programs of space organisation
2. Institute/Organisation can have opportunity to organize (or to be part of) educational programs, seminars, workshops and conferences.
3. To do research in many areas and give project's practical training/internships to graduates
4. To meet National and International space scientists and to learn from them
5. To follow proper direction in research with help of national experts, arrange peer review the team work, get suggestions, improve work and implement accordingly
6. By collaborating with space organisations, private and public universities can offer not only bachelor programs, like Avionics, Aerospace Engineering and Physical Sciences but also post-graduate and doctoral programmes in niche areas of space science, technology and applications.
7. Science missions can however be performed using a different approach in which the students of academic institutions/universities and experts/scientists of research departments can get funds from a public organization, perhaps a space agency, and then buy the space equipment and the launch services from a private space transportation company. It is likely that in this way the overall cost of space science will decrease and more scientific missions can be run with a given public investment [11].

6.2 Barriers

6.2.1 Cost:

The main barrier behind space exploration of private organisations is cost/fund, in many situations organisations starts working on space research activities and then somewhere organisers faces situations in which they don't have sufficient funding for purchase of resources, like costly hardware/software, equipment,

testing facilities, clean room environment for mature testing for QM and FM. In such cases, the project got delayed and terminated.

6.2.2 Project Scope:

The decision taken by the deciding committee (program director) is primacy and all system developers/engineers must obey the deadline and work according to that. Sometimes a small change in mission objective could have made major changes on project scope and the team has to re-work on the final working model of the project and it is time consuming and expensive process.

7. New Approaches to Space expedition

Moore's law is really proved true here for space missions, missions includes on-board electronics and the base of electronics is transistors which are made up of dual polarity diodes.

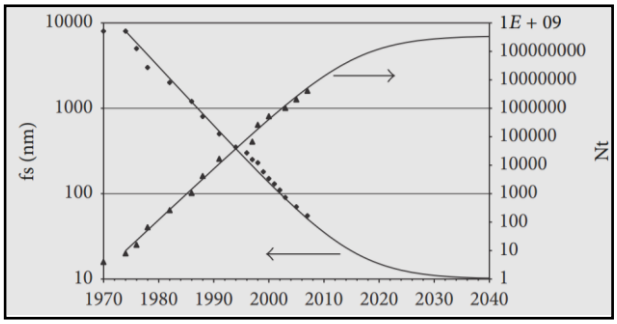

Figure 2 Moore's law graphical representation

The above figure represents minimum feature size fs (triangles) and Moore's law in terms of the number of transistors per chip Nt (squares) for DRAM's as a function of time. The solid lines represent a fit with the evolutionary model [9].

According to proven transistor's law, bigger satellites/payloads are emerging with a smaller version (CubeSat/NanoSat/ MicroSat) and are significantly faster than bigger satellites using commercial components. Today, Nanosats (1 to 10 Kg) are progressing so quickly that they could cover resolution (GSD) equivalent to regular heavy weight satellites (> 2500 kg). So, COTS technology is replacing the old version of space hardware. Evidence shows that, using COTS, small satellites is increasing four times faster than large satellites per annum. Moreover, smaller satellites need less resources, funds, manpower, energy, time, expertise, care and risks as well.

8. Results

8.1 Space race achievements

Space race has been started by USSR in 1957 on October 4. Although, Chinese people have been called front runners of space age named "first space age", then Soviet Union has begun a new space age called "second space age" and then after United Status has joined the space in mid-20th century. Beginning in the late 1950s, space would become another dramatic arena for this competition, as each side sought to prove the superiority of its technology. From the second space age to till date super powers had launched several satellites in space as mentioned in the table below.

	Russia/ USSR	**United Status**	**China**	**Total**
1961-1970	16	25	-	41
1971-1980	30	8	-	38
1981-1990	25	38	-	63
1991-2000	20	63	-	83
2001-2010	24	34	3	61
2011-2020	21	3	2	26
Total	*136	*171	5	*312
*Includes the two unsuccessful launches of STS-51-L and Soyuz T-10-1				

Table 4 Space age front runners

Space exploration has been a competition among nations, like Russia, Soviet Union and United Status. With the help of other nations and technology space explorer expert nations spent days as mentioned in table below:

Russia	437.7 days
Soviet Union	365 days
United Status	340.4 days

Table 5 Nations longest stay in space

Country Organization	Spacecraft Deployed	LEO SpaceCraft	MEO SpaceCraft	GEO SpaceCraft	Other SpaceCraft
World	7142	5232	383	880	647
Russia/USSR	3488	3057	187	154	90
UNITED STATES	2137	1345	142	187	463
CHINA	244	176	7	55	6
JAPAN	197	109	4	53	31
Globalstar	84	82	2	0	0
INTERNATIONAL TELECOMMUNICATIONS SATELLITE ORGANIZATION (INTELSA	81	1	2	72	6
EUROPEAN SPACE AGENCY	71	31	18	8	14
INDIA	71	36	2	31	2
FRANCE	69	46	1	11	11

Figure 3 Top 10 entries for Satellite/spacecraft launching activities

8.2 Space activities done by private organisations/Universities

Satellite	Launch Date	Launch Vehicle	Remarks
Jugnu	12 October 2011	PSLV-C18	Nano-satellite weighing 3 kg developed by IIT Kanpur
SRMSAT	26 April 2012	PSLV-C18	Nano-satellite weighing 10.9 kg developed by SRM University
ANUSAT	20 April 2009	PSLV-C12	Research micro-satellite designed at Anna University. Carries an amateur radio and technology demonstration experiments.
Youthsat	20 April 2011	PSLV-C16	Indo-Russian stellar and atmospheric satellite with the participation of university students. It weighed 92 kg.
**Also includes payloads from academic institutions recently launched through PSLV-C34.*			

Table 6 Payloads designed by academic institutions (For example) [13]

8.3 Recent cheapest space activity

The Mars has been budgeted at 4.5bn rupees ($74m), which, by Western standards, is staggeringly cheap. The American Maven orbiter that arrived at the Red Planet on Monday is costing almost 10 times as much. Indian Prime Minister has appreciated Indian Mars mission for its cost efficiency in Madison square of US and also stated that India's real-life Martian adventure was costing less than the make-believe Hollywood film Gravity.

9. Discussion

Public/Private approach to access space is not well-known to all human being because they don't know mysterious behind solar system birth, the space is composed of billions of solar systems and billions of stars in them. Human is not so curious because space is being kept limited to private or public companies/organizations, instead of that all people must be involved into the space explorations and must give their opinion to government and private companies to make space discipline more curious and exciting.

Research problem is well-known to the world that space in universe is endless and it has endless unknown things to look at. There are limited resources a human has on earth to explore the universe and resources could not be enough to explore the whole universe. Earth's extinction will be going to happen without warning someday so, by manned/unmanned space travel human could find ways to land on other planets, live there, retrieve non-renewable earth's resources from other planets/comets and possibly a better way to live for humankind. Most importantly, human should learn from past space missions how to improve space research by commercialization and reutilization.

Although, space missions are expensive and for some functionalities high cost is inevitable, but global space runners must look at recent (comparatively cheaper) launched space missions like Indian Mars orbital mission which had spent 7 rupees (0.1 USD) per km (to make voyage till Martian orbit) and upgrade their technologies for economic benefit. Space centres must emphasise on latest COTS technologies for small scientific experiments those have less life time (few weeks or a year). For effective and successful space missions, relations of stakeholders between inter-industries must be strengthened. Moreover, a creative and innovative team must be formed using local interested skilled people, organisation's stakeholders, industry experts and young graduate engineers. While doing live space experiments many men/women astronauts have sacrificed their lives so we cannot leave their dreams incomplete and we can't escape from reality and need of space discovery. The world has to think in these directions.

10. Conclusions

This paper has analysed new and collaborative approach for space discovery which influences active participation of Government departments, companies, academic institutions/universities. Moreover, this paper highlights old and new approaches of space human explorations, demonstrates drawbacks and opportunities of space research using small satellites, reducing launch costs, commercialization, harness and mass reduction. Most importantly, the major strength of space program is University graduates, every year a lot engineers graduates and they are seeking opportunities to work so,

it is better to use in-house manpower and enhance their skills to higher level. According to Moore's law, technology in electronics and digital computing is constantly emerging on improving side and which is extremely beneficiary for the development of energy efficient and cheaper missions. Due to miniaturization, micro and nano satellites' market has taken a speed, every capable and interested group of academic institutions has started developing small satellites under guidance of respective nation's space agencies. Even developing a small satellite is not a small task, it is composed of every field of engineering (Electronics, Computer, Network, Tele-communication, Mechanical/Mechatronics, and Information Technology) so, it incorporates all fields' graduates. To have such capable human manpower, it is very important to promote fundamental science knowledge from childhood. Space exploration will continue to inspire and educate us forever.

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