

# Establishing space activities in non-space faring nations: An example of university-based strategic planning

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## ARTICLE INFO

### Keywords:

Capacity building  
Developing countries  
Small satellite  
STEM

## ABSTRACT

In 2015, Kyushu Institute of Technology initiated the Joint Global Multi-Nation Birds Satellite (BIRDS) program. As of September 2017, young professionals from Bangladesh, Ghana, Nigeria, Thailand, Mongolia, Philippines, Malaysia, and Bhutan are being involved in BIRDS program. To help the young professionals acquiring the right tools and preparing them to successfully establish indigenous space activities, the space strategic planning project was established in February 2017. During the project, young professionals from Bangladesh, Ghana, Mongolia, and Bhutan were invited to think about the strategy their home country should be following in the next ten years to achieve their country's goals in terms of space sciences, engineering, and utilization, while respecting the country needs and constraints. In this paper, the efforts undertaken by the different young professionals are reported and the guidelines for each country space strategic planning are described. From this work, the authors aim at promoting space activities development in non-space faring nations and encouraging non-space faring nations to find their right strategy to achieve sustainable indigenous space activities despite the nation's constraints.

## 1. Introduction

In 2006, LaSEINE at Kyutech started to develop its own small satellite programs, which were mainly carried out by Japanese undergraduate and graduate students. Then, from 2013, small satellite programs involving non-Japanese students started. Since then, most of the satellite projects involve more than fifty percent of foreign students, which majority comes from non-space faring nations. As of September 2017, twelve projects were initiated. The projects involve eighteen satellites, going from CubeSats to 50 kg-class satellites, constellation and even one interplanetary spacecraft. Among these twelve projects, nine satellites were successfully launched and six are planned to be launched in 2018.

Kyutech is one of the rare universities in Japan enabling such diversity in its satellite programs. The main reason is that Kyutech is the only Japanese university offering an English space engineering program to graduate students, the SEIC, that started in 2013. This course was designed along with the establishment of PNST, a United Nations/Japan Long-term Fellowship Programme. This fellowship program, in collaboration with the UNOOSA and the Japanese Ministry of Education, Culture, Sports, Science and Technology provides scholarships to six students from non-space faring nations to enrol in graduate studies (two scholarships for the Master course and four scholarships

for the Doctor course). Details on PNST fellowship and SEIC can be read from [1–3].

Over its five years of existence, seventy-one students from twenty-six countries enrolled in SEIC. Among the seventy-six students, twenty-nine students from non-space faring nations were supported by PNST program. More than fifty students took part to SEIC at any given time. The country distribution of the students taking part to SEIC is shown in Fig. 1. The results of the PNST fellowship program are reported in [4,5].

One of the major outcomes of SEIC is the initiation of the BIRDS program in 2015. In this program, young professionals participate to the design, development, testing, and operation of a 1U CubeSat, whose development costs are secured by the young professionals' home institution. Upon completion of the project, the young professionals shall go back to their home country and help establishing indigenous space activities.

As of September 2017, young professionals from Bangladesh, Ghana, Nigeria, Thailand, Mongolia, Philippines, Malaysia, and Bhutan are being involved in BIRDS program. Nigeria, Thailand, Philippines, and Malaysia already have space activities being carried out. However, Bangladesh, Ghana, Mongolia, and Bhutan have non-existent space activities being carried out and when the young professionals from these countries will go back to their respective home country, government officials or university presidents are expecting them to help the

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**Acronyms/Abbreviations**

ANU	All Nations University
BIRDS	Joint Global Multi-Nation Birds Satellite
Kyutech	Kyushu Institute of Technology
LaSEINE	Laboratory of Spacecraft Environment Interaction

Engineering	
NUM	National University of Mongolia
PNST	Post-graduate Study on Nano-satellite Technologies
SEIC	Space Engineering International Course
UMaT	University of Mines and Technology
UNOOSA	United Nations Office for Outer Space Affairs

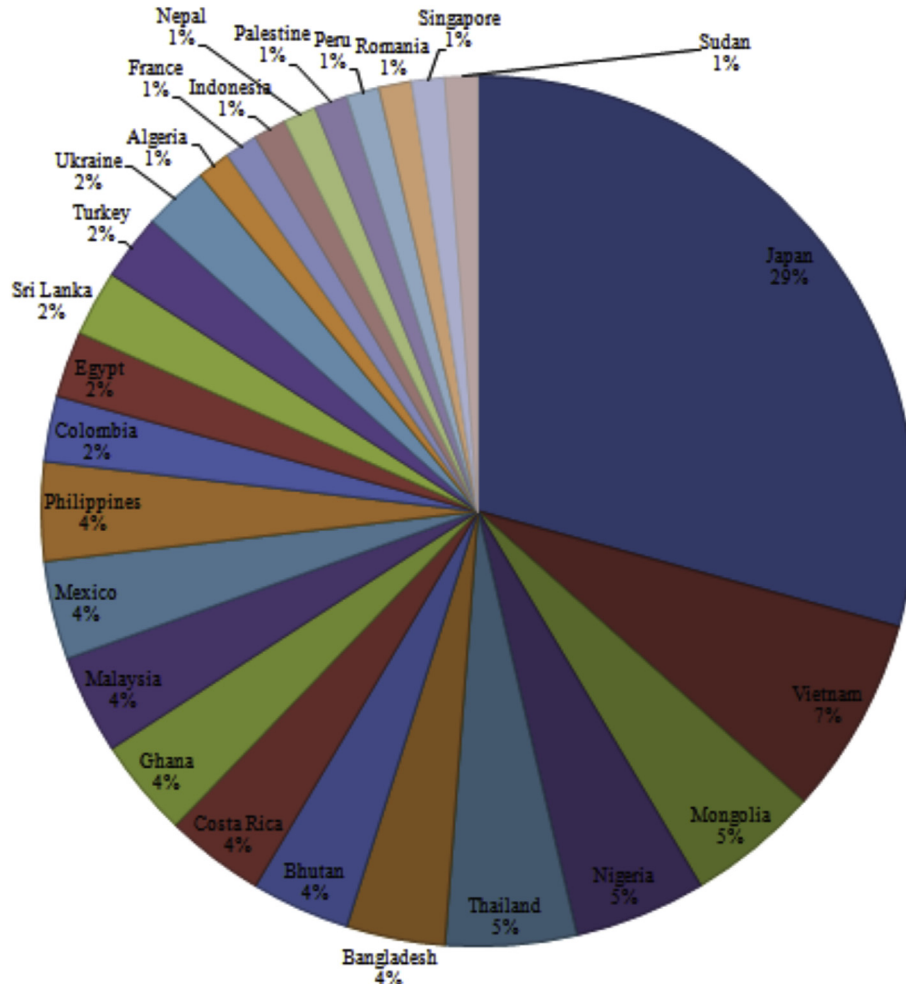


Fig. 1. Students' country distribution of SEIC program (PNST and non-PNST students included) as of September 2017.

country move forward toward sustainable indigenous space activities. To help the young professionals acquiring the right tools and preparing them to successfully achieve the tasks that are expected from them in their home country, Kyutech initiated in February 2017 a space strategic planning project. During the project, young professionals from Bangladesh, Ghana, Mongolia, and Bhutan were invited to think about the strategy their home country should be following in the next ten years in order to achieve their country's goals in terms of space sciences, engineering, and utilization, while respecting the country needs and constraints.

In section 2 of this paper, the way the space strategic planning project was carried out is described. Then, in section 3, the preliminary outcomes from the project are detailed. Finally, the conclusion and future prospects are presented in section 4.

## 2. Space strategic planning project description

### 2.1. Birth of the project

The first generation of BIRDS program, BIRDS-1, started in October 2015 and in July 2017, the five CubeSats developed by Bangladesh, Ghana, Mongolia, Nigeria, and Japan were successfully released from the International Space Station through the Japan Aerospace Exploration Agency's Kibo module. The second generation of BIRDS program, BIRDS-2, started in October 2016 and overlapped with BIRDS-1 for one year to ensure proper knowledge transfer between the young professionals taking part in the project. In BIRDS-2, young professionals from Bhutan, Malaysia, and the Philippines are developing a CubeSat for each respective country. The young professionals involved in the development of BIRDS-1 and BIRDS-2 are presented in Fig. 2. This paper does not aim at describing BIRDS program in details, but the interested readers are welcomed to read about BIRDS through the newsletter distributed every month from the project website [6].

BIRDS programs' mission statement is to “make the first step toward



**Fig. 2.** BIRDS-1 and BIRDS-2 teams from left to right: front row - G. Maeda, H. Masui, M. Cho (PI), R. S. I. Antara, S. Kim, S. B. B. Mohammad Zaki; central row - E. Matey, A. Dagvasumberel, J. Quansah, T. Tejumola, Y. Tokunaga, M. I. Monowar, A. H. Kafi, J. Castorico Javier, C. Dorji, A. Cabuenas Salces; back row - B. Bonsu, E. Dashdondog, I. O. Adebolu, R. J. Umunna, T. Yamauchi, T. Tumenjargal, Y. Choden, M. H. B. Azami, K. K. Pradhan, D. Yamaguchi.

creating an indigenous space program by designing, building, testing, launching, and operating the first satellite for participating nations" [7]. In particular for the young professionals from Bangladesh, Ghana, Mongolia, and Bhutan, the BIRDS CubeSat is the first ever satellite developed, launched, and operated by these respective countries. The young professionals are thus pioneers and the entity they belong upon return to their home country is hence expecting them to lead space related activities.

Moreover, all young professionals participating to BIRDS have an engineering background and only a limited if not non-existent professional experience. As "pure engineers", it can thus be difficult to understand the political, social, and economical constraints of one's country. Yet, the understanding of those constraints is essential to not only initiate indigenous space activities, but to sustain such activities.

As a first step toward widening horizon on space-related aspects other than engineering, SEIC program had the privilege to host special lectures from Dr. Werner Balogh of the UNOOSA and Dr. Yuri Takaya from Kobe University on "the international dimension of space activities: space law and policy for engineers" from January to March 2017. The lectures goals were to:

- provide comprehensive understanding of the latest developments in national and international space law and policy;
- teach about international space cooperation and space governance;
- equip participants with the knowledge, tools, and vocabulary necessary to become active, responsible, and well-informed stakeholders in the formulation of national space law and policy;
- enable participants to competently interact with law-, policy- and decision makers; and
- improve participants skills in promoting international space co-operation in support of exploration and the peaceful use of outer space.

As a complement to support and sustain these special lectures, it became clear that a practical hands-on project for countries without current space activities being undertaken shall be established. As a result, the space strategic planning project was born in February 2017, whose main objective was to help the different engineers from Bangladesh, Ghana, Mongolia, and Bhutan to actively and concretely think and plan for sustainable indigenous space activities to achieve each respective country's objectives within the next ten years. The participating young professionals' names, countries, and affiliations are given in Table 1.

## 2.2. Methodology of the project

The space strategic planning project started in February 2017 and ended at the end of August 2017. As aforementioned, each country's young engineers had to think and plan for sustainable indigenous space activities that will help support and achieve a critical ten-year goal with respect to each country's needs and constraints.

During the first session of the space strategic planning project, guidelines were established to help the different countries start and identify what aspects should be carefully considered. The main guidelines were as described below.

- Identify your wish - what would you like to achieve within ten years through space utilization?
- Think about your country space program state ten years from now – What should your country's space program achieve? What are the needs in your country?
- Identify limitations and barriers – What can actually be done? What cannot actually be done? What are the resources? What are the lacks?
- Adjust the initial wish and establish a detailed plan to achieve a feasible goal that would benefit your country.

After the first session, it was decided that the space strategic planning project's sessions will be held once a month. During the sessions, each country presented about their progress and improvements based on the previous session comments. During the sessions, each country presented in front of the other participating countries and supporting LaSEINE's faculty and research team members.

## 3. Preliminary results and discussion

Over the space strategic planning project six-month existence, the different countries established a plan that was refined little by little throughout the different sessions. As can be seen from Table 1, the stakeholders in the different countries are different and though some of these countries are geographically close, they have different needs and constraints. This led to different types of strategic planning.

Bhutan, Bangladesh, and Mongolia are somewhat close geographically and have similar issues at the country level such as disaster management, urban planning, and natural resources management. Yet, the outcomes of their ten-year plan were quite different due to the difference between the stakeholders nature.

For Bhutan and Mongolia, the participants have secured employment position in the government of Bhutan and at NUM, respectively. This implies that their plan shall be established with respect of these entities' vision and goals.

For Bangladesh, though the stakeholder for BIRDS was BRAC University, the participants have not secured position as faculty

**Table 1**  
Space strategic planning participants and their affiliation.

Country	Name	Affiliation <sup>a</sup>
Bangladesh	R.S.I. Antara	BRAC University
	A.H. Kafi	
	M.I. Monowar	
Bhutan	Y. Choden	Government of Bhutan
	C. Dorji	
	K.K. Pradhan	
Ghana	B. Bonsu	ANU
	E. Matey	
	J. Quansah	
Mongolia	A. Dagvasumberel	NUM
	E. Dashdondog	
	T. Tumenjargal	

<sup>a</sup> Stakeholder in BIRDS program for each country.

member upon their return. They hence have more flexibility for their ten year vision. Yet, funding needs to be secured and hence the benefit to the possible stakeholders shall be carefully taken into account.

For Ghana, though geographically different than the other countries, some issues such as natural resources management and urban planning are similar. Moreover, as for Bhutan and Mongolia, the participants have a secured position as faculty member at ANU upon their return. Hence, their strategic plan shall be established with respect to ANU's vision and goals.

The following sub-sections describe the outcomes for each country involved in the first generation of the space strategic planning project.

### 3.1. Bhutan

In the case of Bhutan, the main stakeholder is the government, which announces in 2016 as its long-term goal “[...] to operate our own geostationary satellite and possibly lease similar transponder to other countries” [8]. To achieve this, different approaches can be considered. One approach consists in partnering with a foreign entity that will build the geostationary satellite for Bhutan. Then the Bhutanese engineers will learn how to operate the satellite. In this approach, Bhutanese will develop capabilities in the long term through the training of engineers in satellite operations. Another advantage of such approach is that the data obtained could be useful to neighbouring countries and a commercial value could be created from data exploitation providing a return on investment to the government of Bhutan. However, building a geostationary satellite takes time and this might be a problem in case a rapid action to an urgent issue, such as disaster management, needs to be taken.

The full development of a geostationary satellite in Bhutan by Bhutanese engineers within ten years would be quite challenging and represent a too big leap to take after the development of a CubeSat. Thus another approach that can be considered is the building of local capacity and knowledge within ten years through the indigenous development and operations of CubeSat class satellites. In the long term, this approach can offer Bhutan independence with regard to space development, motivate younger generations to pursue higher education, foster industry development in various sectors, and be a catalyst for partnering in international projects.

The Bhutanese participants will graduate in March 2019 and hence, have still plenty of time to refine their strategic plan in collaboration with the concerned parts in the government of Bhutan. Thus, they have not decided on a preferred approach and are still considering different options with their pros and cons.

### 3.2. Bangladesh

In the case of Bangladesh, as aforementioned, the main stakeholders are unclear. This gave full potential to the participants to express their own wish for Bangladesh space program in ten years and explore the methods and necessary actions to be undertaken to achieve this goal.

Bangladesh participants have chosen an approach to build capacity and technology locally to achieve deep space exploration capabilities within ten years. They divided their plan in three phases. The first phase focuses on training engineers, fostering younger generation toward space field education, and implementing research and development laboratory while promoting, through friendly national competitions, the development of “made in Bangladesh CubeSats” that will address imminent issues for the benefit of Bangladeshis. As Bangladesh strength in space assets development is demonstrated in the first phase, international collaborations in research and more complex systems development are expected to take place in the second phase. Moreover, as the demand for engineering products grows, industrial sector is expected to diversify and grow. In the final phase, with the skilful workforce increase in parallel of the industry capacity and knowledge, it is expected that Bangladesh would have sufficient resources to

initiate a deep space exploration program.

Though, the stakeholders are still unclear, the first phase of the preliminary strategic plan is aligned with the Perspective Plan of Bangladesh 2010–2021 in which it is stated that space technology shall be used for disaster management and prevention [9]. The efforts made by the Bangladesh engineers during the BIRDS-1 project draw attention from the whole country including government officials through the large media coverage. This allows them to be in a particular position to seek funding and influence their country's future space policy and development.

### 3.3. Mongolia

In the case of Mongolia, the main stakeholder is NUM. As for Bangladesh, Mongolia's approach is to build capacity and technology locally. However, the ten year goal is not to achieve deep space exploration, but to provide low cost telecommunication to the country to prevent and manage natural disaster as well as monitoring various activities, such as mining.

To achieve their ten-year goal, the engineers established a multi-directional action plan tackling various aspects. First aspect considered is organizational through the establishment of an organization or agency dedicated to space affairs along with the elaboration with space policy. Second aspect is education with the creation of a space course at NUM that will serve at nurturing skilful workforce. Third aspect considered is research with the establishment of a laboratory dedicated to research and development as well as testing of up to 50 kg-class satellites. As a complement, the fourth aspect considered is manufacturing with the creation of a workshop facility that will enable NUM to be independent in the manufacturing of satellite elements. The final aspect considered is space and ground segment development with the initiation of satellite projects evolving to be more and more capable along with a ground station with advanced capabilities to support the satellites operations.

In Mongolia case too, the funding to carry out the described activities is not yet secured. Nevertheless, actions are being undertaken to convince private and government officials of the worth of such plan for the improvement of Mongolian citizens' life as well as economic benefit.

### 3.4. Ghana

In Ghana case, as for Mongolia, the main stakeholder is a university, ANU, and as for Bangladesh and Mongolia, the chosen approach by Ghana participants is to build, locally, capacity and technology. In Ghana case, the ten-year goal is to collect and provide critical data to positively contribute to the resolution of the water pollution problem.

It is estimated that 60% of Ghana's water resource is polluted [10] and the major driver for such pollution is illegal mining activities, called *galamsey*. Without any actions to improve the water quality, Ghana may have to import its water from neighbouring countries in a near future [11]. *Galamsey* is usually taking place in remote areas, very difficult of access. Moreover, regular field work to collect data and verify the different mining procedures are implemented safely and according to the law is a lengthy and tedious work. There is hence a clear and urgent need for space applications to collect data on water conditions. Such data could then be distributed to the government to help drawing adequate measures to prevent and better manage artisanal and small scale mining. The collected data could also be used to raise awareness among the artisanal and small scale mining communities about the damage the employed techniques generate. The collected data could also help generating solutions that will sustainably provide safer mining techniques to artisanal and small scale miners.

To achieve such ambitious goals, the engineers from Ghana recognized the necessity of multi-directional plan with different activities to be carried out in parallel. One activity consists in developing, in Ghana, by Ghanaian engineers, a technology demonstration oriented



CubeSat monitoring water pollution of Ghana. As a follow-up on the first activity, the second activity to be undertaken is the sustainable and constant development of improved water monitoring satellites throughout the years. A third activity is to develop a robust ground system for satellite operation and data collection. A fourth activity to be executed is the format in which data will be processed and distributed depending on the targeted end users. A fifth activity is human resource development through dedicated outreach programs and university curriculum for examples.

On November 20–23, 2017, the Second International BIRDS Workshop was held at ANU in Ghana. During this workshop, BIRDS partners gathered to discuss their latest progress and Ghana used this opportunity to invite experts on *galamsey* from UMaT, Tarkwa, Ghana. The workshop helped increase and maintain the interest of the Ghanaian government into space utilization and its benefit for the Ghanaian society. As a result, ANU is now leading efforts on proposals to the government not only for the development of Ghana's second satellite, but also for the establishment of a policy-based framework for the organization of Ghanaian sustainable space activities.

### 3.5. Overall results

The countries involved in the space strategic planning and overall the countries involved in the BIRDS program are non-space faring nations. These nations not only lack of human resources in space engineering, but also in all other space-related domains, such as law and policy, diplomacy, management, business, economics, and more. Yet, the constraints in non-space faring nations limit the space workforce. There is hence a need to develop not only an engineering-based workforce, but a multi-disciplinary space workforce able to play multiple roles to serve their country at best from engineering to policy making.

Through the space strategic planning project and practical work on the development of a CubeSat, the young professionals are challenged to work from different perspectives and widen their knowledge and skills related to space activities. Though it is performed at a university, the understanding of stakeholders' requirements, establishment of an implementation plan, and the securing of funding while complying with a nation's constraints and regulations, or lack thereof, is not just a classroom exercise. It is a preparation to a multi-disciplinary demanding career.

The combination of space strategic planning projects with practical space-related activities can hence be a powerful and efficient tool to prepare young professionals to their future careers, while maintaining their passion for space.

## 4. Conclusion and future prospects

From the preliminary results presented on university-based strategic planning, it appears that there is not a single winning recipe to establish sustainable space activities in non-space faring nations.

As previously reported [12] two main trends seem to emerge: 1) owning from foreign entities parts of or a whole satellite with high reliability to ensure desired mission success; and, 2) locally building capacity and technology to develop in-house satellites. Both approaches have their pros and cons and none can be judged better than the other. The choice of one method over the other mostly depends on the stakeholders' requirements on the short and long term. From Kyutech case studies, it appeared that university-based stakeholders tend to favour the second approach. This makes sense since universities main goal is to provide education to nurture to next generation of engineers, scientists,

and other skilful workforce.

Though there is no winning recipe to establish sustainable space activities in a non-space faring nation, you might consider the following guidelines in case you wish to initiate such activities in your country:

- 1) identify your passion with regard to space activities you would like to see take place in your country;
- 2) identify the possible stakeholders;
- 3) identify your home country needs in the short and long term;
- 4) identify the constraints, limitations, and barriers; and
- 5) adjust your initial passion formulation based on 2)–4) and establish a detailed plan to achieve a feasible long-term goal that would benefit your country.

The first generation of BIRDS' young professionals graduated in September 2017 and went back to their home country following their graduation. Thus, it is premature to draw final conclusion from the preliminary results presented in this paper. The different country strategic plan actions shall be followed to study how Kyutech's space strategic planning project was beneficial and how it could be improved in the future.

## Acknowledgments

The authors would like to express their sincerest gratitude to R.S.I. Antara, A.H. Kafi, M.I. Monowar, Y. Choden, C. Dorji, K.K. Pradhan, B. Bonsu, E. Matey, J. Quansah, A. Dagvasumberel, E. Dashdondog, and T. Tumenjargal for their dedication and hard work throughout the space strategic planning project. The authors also express their deepest gratitude to Dr. W. Balogh and Dr. Y. Takaya for the useful exchange of opinions and fascinating lectures on space law and policy. This work was supported by JSPS Core-to-Core Program, B. Asia-Africa Science Platforms.

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