

FEBRUARY 2019

Executive summary, impact, market analysis, execution plan, management scheme, and financial plan



ICARUS: INSIDE CAMPUS MULTIPURPOSE SEGWAY

Created as a part of Zero Carbon Initiative

Proposed by: Team Skullers

ABOUT US

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EXECUTIVE SUMMARY

Statistics from National Action Plan for Reducing Greenhouse Gas Emissions (RAN-GRK) in 2014 shows that transportation is the second largest economical sector which contributes more than 25% of all carbon emissions in Indonesia. Inside ITB Ganesha campus alone, the number of personal vehicles operating reaches up to 5650 vehicles daily, which translates into 191,31 tons of carbon emissions each year.

Carbon emission is a major contributor to climate change.

In order to curb carbon emission, the initiative to utilize emission-free vehicles inside ITB campus is put into action a few years ago. Namely, the provision of public bicycles. In 2014, of 63 public bicycles available at ITB, only 15 bicycles were in operable condition. The remaining 48 were mostly in various states of disrepair. On a larger scale, usage of emission-free vehicles such as electric cars, electric bicycles and other emission-free



technologies have become very promising trends for the future, marked by developed countries competing to increase the ownership ratio of their electric vehicles.

Indonesia also supports the development of electric vehicles by establishing regulatory framework and production facilities. In 2025, the ratio of electric vehicles is projected to comprise one-fifth of total vehicles in Indonesia as a result of Indonesia's low-carbon emissions vehicle program (LCEV). ITB has also recently built an SDGs Center as a means to support sustainable innovations to make ITB Zero Campus a reality.

ITB as a leading campus in innovation and technology must continue to innovate and become a pioneer in environmentally friendly technology that is the future of our world. That's how ICARUS was born.

ICARUS (Inside Campus Multipurpose Segway) is a concept of modern carbon-free mode of transportation consisting of segways and docking stations placed all around ITB campus. Based on line-follower principle, ICARUS makes it easier for its users to reach certain locations in ITB independently and safely with a high degree of flexibility. ICARUS has a built-in self-distribution feature to distribute the segways to each station evenly where the electricity is supplied



through the installed Photovoltaic (PV Grid) to ensure no carbon emission.

ICARUS targets four main user groups in campus. They are academic staff based on seniority. Others who might benefit from ICARUS includes administrative staff, students, and external visitors. ICARUS is an initiative from Skullers team, consisting of five Engineering Physics students with backgrounds in the fields of Instrumentation and Control, Energy Management, Sensors and Actuators, and Building Physics who all share a desire to contribute to Zero Carbon initiative by applying green technology starting from ITB.



IMPACT

How can we help this campus? What happens when we implement ICARUS in campus?



Facilitating intracampus mobilization, especially for senior teaching staffs.

Not all means of transportation inside campus can be easily accessed, especially for some people with certain difficulties. Usage of transportation modes that require a certain level of physical fitness can be troublesome for some, particularly when it comes to places inside campus with an uphill contour. ICARUS provides a solution by creating a safe and accessible mode of transportation for everyone. ICARUS comes with storage boxes for stowing your personal items while you're riding.

With ICARUS, mobility problems for those with certain difficulties will be solved.

Contributing to Sustainable Development Goals (SDGs)

ICARUS fulfills Sustainable Development Goals, especially on point number 9 on industry, innovation, and infrastructure as well as point number 13 on handling climate change. It is done by creating a transportation mode for intracampus transportation. ICARUS also creates an impact in reducing carbon dioxide emission as an alternative to car usage by academic staffs inside campus.

Popularizing the Usage of Solar Panels without Inverter

Every ICARUS station is equipped with a power supply unit consisting of a 30V LiPo battery to store power generated from solar panels and act as a temporary storage for grid electricity if the power from solar panels is not enough. There are six 1642 mm x 92 mm x 40 mm monocrystalline solar panels placed on the roof of every station.

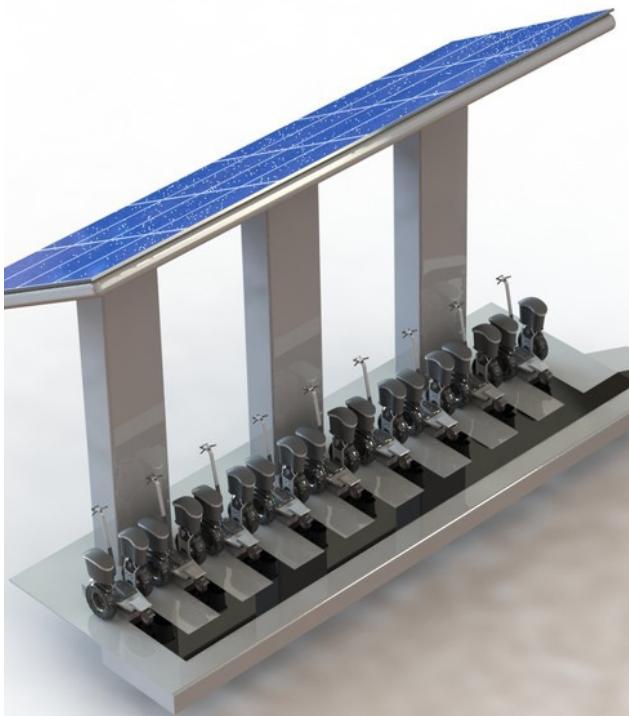
Monocrystalline solar panels are more efficient than polycrystalline solar panels. The solar panels will be positioned by taking geographical location of ITB into account to determine the optimal position for solar panel placements.



The station generates its own electricity to power the system and charge docked segways.



According to NASA Langley Research Center Atmospheric Science Data Center (2002), Bandung City has insolation of 5.03 kWh/m² per day with peak sun hour as long as 5 hours per day. With 5 stations inside of ITB and 18% efficiency, it will exert 37,485 kW a day and 13,682 MW. It will reduce electricity cost as big as Rp 20.075.361,00 per year. Not to mention, the energy is whole-fully clean energy and will also be used by the segway to charge it's battery.



The stations installment don't need DC-AC inverters. These inverters create losses in energy conversion and are expensive. The DC-AC inversion process is not needed because the segway uses batteries that accept DC as input. The station will be cheaper and more efficient than a normal solar panel installment which gives the power back to the grid. The stations give the power directly into batteries as storage to be used to charge the segways.

Reducing Fossil Fuel Usage Inside Campus and Encouraging Public Transportation Usage

According to data from Indonesian National Standard (SNI) 2002/51/E, vehicles permitted to operate in Indonesia are required to have a maximum average carbon emission of 122.62 g/km. Consisting of 120 g/km carbon dioxide and 2.62 g/km carbon monoxide. Under the assumption that everyone uses ICARUS, it will reduce 191,31 tons of carbon emission each year, which is equal to 16,378 trees carbon dioxide absorption. ICARUS also encourages reduction in the need to use private transportation to go to campus as side-effect on the lifestyle because of the inside campus transportation alternative.



OUR VISION

We aim to be a pioneer in technology-based internal transportation solution in order to achieve Sustainable Development Goals.

OUR MISSION

- Increase awareness on the importance of climate resilience, especially to ITB civitas academica.
- Encourage people to reduce carbon emission by using less personal transportation inside ITB Ganesha campus.
- Develop a technology-based internal transportation solution to achieve Sustainable Development Goals.

SUSTAINABLE DEVELOPMENT GOALS



source: un.org

OPERATION PLAN

ICARUS consists of three major components: Segway, Station, and Mobile Application

ICARUS STATION AND MOBILE APPLICATION

- Recharging station for ICARUS segways
- Eco-friendly: Generates its own electricity from Photovoltaic Grids and stores charges in 30V Li-Po batteries. No carbon emission!
- Serves as a docking station for idling segways
- Can be upgraded if more segways are needed
- Interconnected: Dispatch system means anyone with access to ICARUS mobile app can use it anytime



ICARUS SEGWAY

- Line-follower: no risk of stray segways
- Global Positioning System (GPS)
- Self-balancing: safe for everyone!
- Comes with storage boxes for storing items while commuting,
- Self-distributing: distributes themselves to stations with higher demands.

HOW IT WORKS

- Each ICARUS segway operates on line-following principle and utilizes global positioning system (GPS) in order to accurately position itself.
- Users order a segway with ICARUS mobile application and select their preferred pick-up location. Orders are then sent to the station nearest to the user and a segway will be dispatched to the user's pick-up location.
- Once aboard, ICARUS segway will take the rider following a line route automatically to their pre-determined destination.
- After alighting, ICARUS segway will automatically return to the nearest station.

DEVELOPMENT PLAN

No.	Development Target	Timeline (Month)											
1	System Research and Development	System Research and Development											
	a. Research of Segway Duplication												
	b. Implementation of Automation												
	c. Website Development												
	d. System Integration												
2	Construction and Testing Phase	Construction and Testing Phase											
	a. Construction of Line and Single Station												
	b. Testing Phase												
	c. Feedback and Evaluation												
3	System Improvement	System Improvement											
	a. Evaluation Result Implementation												
	b. Expansion												
	c. Construction of additional lines and shelter												

ICARUS will be developed in four stages:

- **System Research and Development**

In this phase, 25 Segways bought from the market will be developed and fitted with a line following and automated control system. The mobile application will also be developed and integrated in this stage. The process of research will be focused on duplication of the segways, implementation of automated control, and website integration. Estimated time needed for this stage would be 6 months of continuous development. While the system is being built, research to duplicate the system will be conducted to prepare for second year expansion to segment 2 market.

- **Construction and Testing**

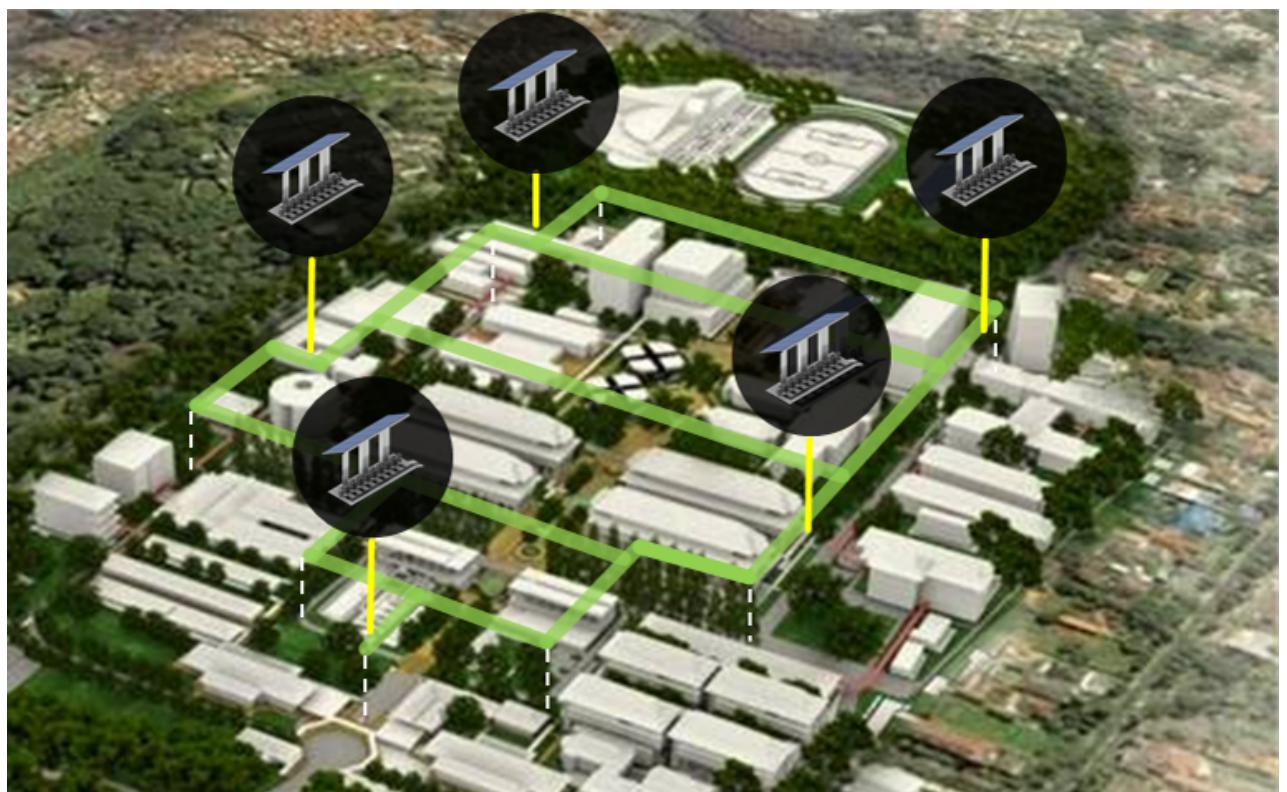
After the system has been deployed, construction, operation of inner loop line, single shelter, feedback and evaluation will be made. Then, the additional infrastructure to scale the system will be developed in small incremental stages to gain customer feedback and evaluation. The construction of single shelter will be made on the inner loop line (in East GKU) and the inner loop line will be painted on the road such that all features of ICARUS can be operated at a small scale inside the inner loop of Labtek V, VI, VII, and VIII. Customers can give feedback by pressing button on the application to speak or type their feedback.

- **System Improvement**

After considering customer feedback and evaluation, implementation, expansion, construction of additional lines and shelter will be made to the test system. Improvements will continuously be added to the system based on feedback received. Addition of four remaining shelters and 20 segways will be done to implement the full service on all ITB areas, including self-distribution and estimated waiting time.

- **System Expansion**

The developed system will be expanded according to market response. After first year implementation on the first segment of the market, expansion to second segment of the market will be done in the second year implementation. Segway and server amount will be increased by twice the amount to manage a projected market expansion, which is estimated at 2000 users that consists of first and second segment users on the second year implementation. The expansion will also increase revenue and publication. Therefore, a projected 20% user amount increase on third and fourth year will be expected. The amount of segways added will be based on future needs.



ICARUS Final Station Location Plan
Original image source: itb.ac.id

BUSINESS PLAN

SEGMENTATION

ICARUS' consumer will be segmented into three segment, each divided by the needs of every segment:

Segment 1: Professors and Head Lecturers

- Main transportation mode to move between classes and buildings while carrying relatively heavy items.
- Proof of ITB's innovative initiatives

Segment 2: Students, administrative staff, and lecturers

- A way to relax and enjoy campus environment
- Extra or secondary transportation mode

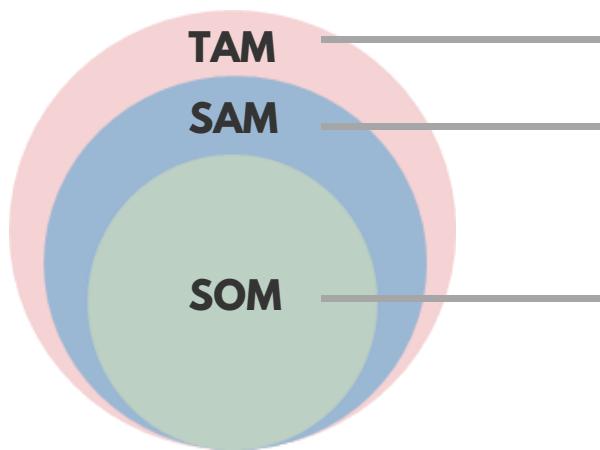
Segment 3: Outside Campus Civilian

- Recreation mode and technology innovation inspiration

After dividing potential customer to three segments, analysis to decide target market is done by analyzing resources, type of service to be offered, diversities within the market, and competitors' market coverage strategies

- The resources that ICARUS have is low and can't possibly cover all market segments, therefore concentrated market is a feasible solution.
- The type of service to be offered is transportation mode that will only be accessible inside campus with purpose to create a more effective and zero carbon emission to reduce campus carbon emission from usage of carbon emitting transportation mode inside campus.
- Professors and head lecturers are the most non-diverse market with similar needs to be fulfilled.
- The only competitor for inside campus transportation mode are bicycles which requires user effort in such campus terrain to be used.

TARGET MARKET ANALYSIS



Institutions in Indonesia

Students and other members of ITB academic community

Lecturers, staffs, and people with special needs

ICARUS' target market is defined by using TAM (Total Available Market), SAM (Serviceable Available Market), and SOM (Serviceable Obtainable Market) model.

Tenaga Akademik dan Non Akademik

	Tahun													
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Total Tenaga Akademik		1.097	1.038	1.041	1.030	1.019	1.022	1.022	1.182	1.155	1.175	1.207	1.307	
Pendidikan*	Sarjana	91	72	53	48	40	34	53	34	25	20	19	12	
	Magister	422	379	354	325	277	246	354	357	330	332	300	363	
	Doktor	571	587	634	657	702	721	743	791	800	823	888	932	
Jabatan Fungsional**	Guru Besar	63	66	75	74	79	95	119	132	137	145	161	167	
	Lektor Kepala	329	321	316	319	324	298	288	294	295	308	308	299	
	Lektor	336	360	368	362	361	399	394	415	415	431	438	443	
	Asisten Ahli	309	258	225	204	183	164	151	146	124	145	131	133	
Ratio Tenaga Akademik : Mahasiswa		1:13	1:16	1:16	1:15	1:17	1:18	1:18	1:16	1:18	1:18	1:16	1:17	

* Dosen dengan jenjang pendidikan profesi pada tahun 2014 sebanyak 3 orang
** Dosen yang belum memiliki jabatan fungsional pada tahun 2014 sebanyak 169 orang dan tahun 2015 sebanyak 265 orang.

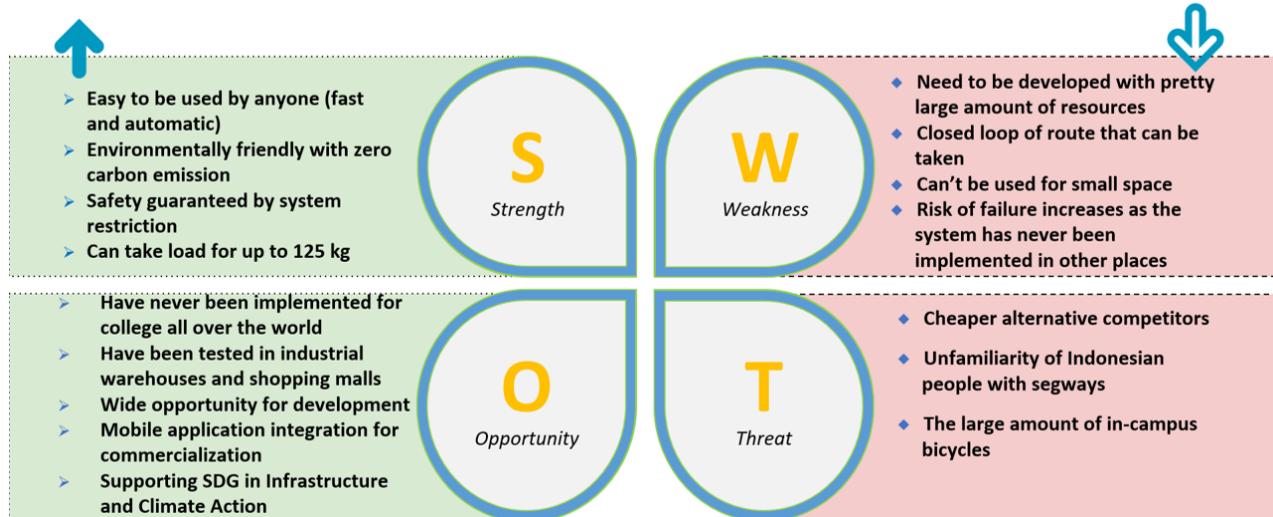
source: itb.ac.id

Possible TAM for ICARUS is all possible institutions which ICARUS may be implemented in for intra institutional transportation mode. Possible SAM for ICARUS are all students and academic community members in Institut Teknologi Bandung, consisting of total of 23,034 people.

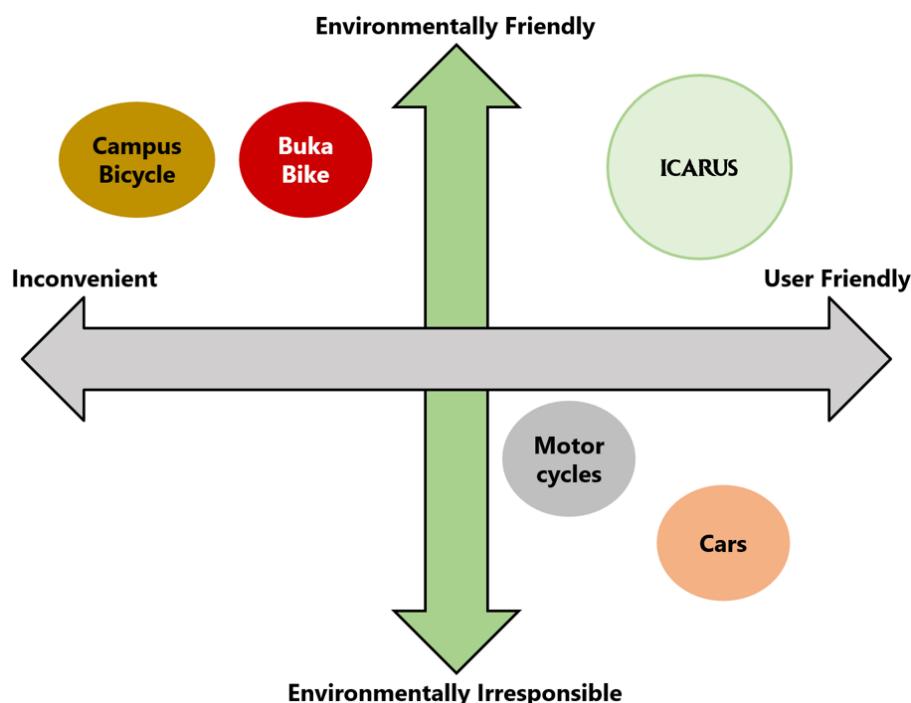
The SOM for ICARUS is all professors and head lecturers in Institut Teknologi Bandung who have problems in accessing mobility infrastructure inside ITB, approximately 466 according to ITB Infographic data on 2015. ICARUS' expectation is the whole SOM market which is 466 professors and head lecturers.

POSITIONING AND COMPETITOR ANALYSIS

SWOT ANALYSIS



COMPETITOR ANALYSIS



ICARUS' Position in in-campus transportation mode is described by the diagram above. The factors are user friendliness and environmental friendliness. User friendliness accounts feasibility to be used by vast amount of campus civitas academica, environmental friendliness accounts carbon emission and sustainability. ICARUS is a user and environmentally friendly in-campus transportation mode.

STAKEHOLDERS AND INITIAL INVESTMENT PLAN

STAKEHOLDERS

ICARUS' Stakeholders are:

1. PT SMI (Main Investor)
2. ITB (Institution to be implemented, maintenance workforce)
3. Other Investors
4. Professors and Lecturers (Main target market)
5. College Students (Secondary target market)
6. Communities in Bandung (Publication)

INITIAL INVESTMENT PLAN

ICARUS' Initial investment plan is to gather SDG concerned investors that want to create impacts in new environmentally friendly advanced technological transportation implementation for infrastructure and climate action purpose. The potential investors are:

1. PT SMI as a catalyst for SDG (88% of initial investment)
2. Large industrial company with potential to use the system (12% of initial investment)



ZERO CARBON



MARKETING PLAN

Our implementation plan stems from the behavioral study of our SOM target (professors and lecturers), which results in the following observations:

- Developed financial condition (owns a car or a motorcycle)
- Generally busy schedule and relatively low energy compared to younger adults
- Knowledgeable, able to operate technology
- Appreciates time, innovative ideas, and breakthroughs

Based on our observation above, the following steps will be taken in order to introduce ICARUS:

- Introduce the service and engage with the professors and head lecturers.
- Announce the service on public places and campaign regarding environment awareness (especially carbon emission) and the importance of time and mobility.
- Promoting the idea that ICARUS is a proof of ITB's innovation by including ICARUS in ITB official medias.

The small amount of first segment implies that there are possibilities to open another market segment for ICARUS, that is segment 2 (Students, administrative staff, and lecturers). The behavioral study of this segment gives:

- Seeks relevancy
- Places value on experiences
- Trust peer-generated endorsements
- Want their purchases to make them feel good
- Tech-savvy
- Responds to edgy campaign
- Wants to co-create culture

Therefore, the expansion should bring the idea of shaping environmentally friendly culture in technologically advanced transport mode through:

- Peer-to-peer students marketing
- Brochures for administrative staffs
- Posters, banners, and brochures for lecturers

FINANCIAL ANALYSIS

ASSUMPTIONS

By the technical and resources capability, development plan, market capability, and competitor analysis, few assumptions are made:

- Early revenue sourced from segment 1 market (professors and head lecturers) will be paying Rp 20.000,00 per month for the services with total of approximated 1000 users.
- Secondary revenue sourced from segment 2 market (students, administrative staff, and lecturers) after expansion will be paying Rp 20.000,00 per month with total of approximated 2000 users.
- Annual user growth of 10%.
- Annual rate of 5% for NPV and IRR calculation.
- Annual minor and 5 years major maintenance for segways and stations.

COST

After stating some assumptions, cost analysis was conducted and the results are:

- Fixed cost

Workforce for first year development and maintenance

- First year development (Total Rp 36.000.000,00) each year
- Maintenance Rp 36.000.000,00 each year after

Segway (Total Rp 380.000.000,00)

- 25 Segway at average price Rp 15.000.000,00
- 25 Container at average price Rp 100.000,00
- 25 RF Transceiver at average price Rp 100.000,00

Station (Total Rp 169.000.000,00)

- 30 pcs 16% efficiency solar panel at average price Rp 2.300.000,00
- 5 Mechanical structure + workforce Rp 15.000.000,00
- 5 Wiring+Powerwall+Inverter Rectifier+RF Transceiver Rp 5.000.000,00

Application (Total 24.000.000,00) each year

- First year development Rp 24.000.000,00

Marketing Campaign (Total 30.000.000,00) each year

- Digital marketing Rp 15.000.000 each year
- Offline peer-to-peer marketing Rp 15.000.000 each year

Maintenance

- Segways Rp 7.500.000,00 each year, Rp 125.000.000,00 each 5 years
- Stations Rp 2.500.000,00 each year, Rp 50.000.000,00 each 5 years

• Variable cost

Application (increases with users amount)

- 1.1 Annual multiplier
- Initial amount of Rp 24.000.000,00 on second year

Segway expansion (increases with users amount)

- Buying all the segway needs due to rising users amount, approximated each year 5 segways until 50 segways

REVENUE

The revenue collection sourced from users in segment 1 for second year to third year. Third year to fourth year are sourced also from segment 2. The revenue amount is Rp 20.000,00 per user per month. By projection, we get IRR 10.83% with NPV Rp 151.285.506,00 with payback period of 6 years and ROI 65%.

Financial Analysis						
Time (year)	1	2	3	4	5	6
Internal Rate of Return			0.11			
NPV			151,285,506			
Cost						
Segway	380,000,000	75,000,000	75,000,000	75,000,000	75,000,000	75,000,000
Station	169,000,000	-	-	-	-	-
Application	24,000,000	24,000,000	26,400,000	29,040,000	31,944,000	35,138,400
Workforce	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000
Marketing Campaign	30,000,000	30,000,000	30,000,000	30,000,000	30,000,000	30,000,000
Maintenance	10,000,000	10,000,000	10,000,000	10,000,000	175,000,000	10,000,000
Total Cost (year)	649,000,000	175,000,000	177,400,000	180,040,000	347,944,000	186,138,400
Revenue						
Users Amount	0	500	1100	2100	2310	2541
Total Revenue	0	120,000,000	264,000,000	504,000,000	554,400,000	609,840,000
Cash Flow (year)	-649,000,000	-55,000,000	86,600,000	323,960,000	206,456,000	423,701,600
Revenue Source	Sales Amount	Conclusion		Annual Rate	5%	
Business Model : Monthly Subscription Rp 20.000,00/month growing each year by 10% each year and segment 2 expansion in third to fourth year	Rp 20.000,00 per users per month	Payback Period	~ 6 Years	NPV	151,285,506.08	
		IRR	10.83%	MIRR	0.09	
		ROI	65%			

FINANCIAL PROJECTION



The cash flow projection over time was calculated by assuming the system goes through difficulties and have accounted scaling factor due to users amount and maintenance needs. The projection is realistically based. It takes all the assumptions into account and added additional optimistic factor of workforce cost which ICARUS only need to firstly develop and then maintain annually.

From the cash flow, IRR, ROI, NPV, and Payback Period, we can conclude that the project wouldn't be a profit-centered project but can sustain itself to be the service it needs to be. However, the system generates a huge amount of benefits and impacts that we have mentioned before, especially in the environmental and infrastructure sector to reach SDG goals number 9 and 13. The project can be classified as an impact investment that is sustainable financially and technically.

CONCLUSION

ICARUS is one of the many ideas to achieve the dream of green living. It is a bold and brave step to make impacts and changes to our daily life. We wish to support life and to live it to the fullest. And that we can achieve by make good use of the technologies humanity had developed and all the free and renewable resources the mother nature provided us.

ICARUS helps you to do your work at best and get more productive. The segway gives ease of access for people with physical limitations. It provides great luggage capacity helping people to transport from one point to another. This vehicle is easy and safe to operate following the provided track.

ICARUS is battery powered which encourages people to reduce the usage of fossil fuel and carbon footprint. It is powered by electrical power generated by PV which harvest green free energy from the sun. This mode of transportation supports Sustainable Development Goals and wish to achieve it.

ICARUS is the green technology of the future. It utilizes the green power for accessibility and productivity. ICARUS is the investment in humanity to achieve the sustainable living.

We wish you to be our partner in building green life with ICARUS. Help us to promote sustainable living while making great use of technology. The benefit of ICARUS is not only for you and me but for the future of the earth. Save the world, live better.

