

Kingdom of Cambodia
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REPORT OF

**Training Workshop on “Sustainable Industrial Development
by Integrating TEST Methodologies into
Syllabuses/Curriculum”**

Output 1.1.4: Awareness raising and lesson learned dissemination with
focusing on resource efficiency in Cambodia

Under

The UNIDO project

“Low Carbon Development for productivity and climate change
mitigation through the Transfer of Environmentally Sound Technology
(TEST) methodology”



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1. Introduction

Cambodia’s economic growth has been one of Asia’s fastest over the last decade. The rapid growth has led to an increase in agricultural and industrial activities, which has significantly contributed to environmental degradation, including water pollution, solid waste, and GHG emissions leading to climate change. Cambodia remains among the countries most affected by extreme weather, ranking as the 12th most vulnerable in 1998–2018. In 2015 alone, estimated losses associated with adverse climate impacts amounted to approximately USD 1.5 billion, equivalent to 10% of the country’s annual GDP. Following the strategic objective 4 of the Cambodia Climate Change Strategic Plan (CCCSP: 2014–2023), which demonstrated that climate change mitigation through promoting the low carbon development in the industrial sector, plays an essential role in Cambodia especially and aims to strengthen awareness-raising efforts to promote replication and upscale adoption of Resource Efficient and Cleaner Production (RECP) in Cambodian industry. The promotion and adoption of RECP relevant approaches are under the framework of the project **“Low-carbon development for productivity and climate change mitigation through the Transfer of Environmentally Sound Technology (TEST) methodology”**.

The project is a GEF-funded initiative implemented by the UNIDO in close collaboration with the Ministry of Industry, Science, Technology and Innovation (MISTI)—former the Ministry of Industry and Handicraft (MIH) of Cambodia.

The Global Environmental Facility (GEF) through the GEF 6 cycle presently funds the UNIDO to implement the TEST integrated approach in Cambodian industry aiming to improve the resource efficiency, productivity of each factory as well as improving the working conditions, while reducing their environmental footprint. The project’s approach combines policy and advocacy elements with technology transfers in the areas where most manufacturing industries are located and present major negative effects to the environment and biodiversity, as well as socio-economy—public health.

The project’s objective is to reduce the long-term risk of climate change through the transfer of environmentally sound technologies in Cambodian industries. The primary outcome of the proposed project is “knowledge and technical capacity are enhanced in Cambodia to reduce industrial discharges and greenhouse gas (GHG) emissions.” An outcome for effective monitoring and evaluation has been included as well. The following outputs were defined to get the primary outcome:

- **Output 1.1.1.** Necessary policy measures and technical guidelines strengthened to ensure industrial polluted discharges and greenhouse gas (GHG) emissions;
- **Output 1.1.2.** Incentives established to encourage industries improve the economic, social and environmental dimensions of their activities;
- **Output 1.1.3.** TEST integrated approach implemented at the national level through trainings and demonstration in selected companies; and
- **Output 1.1.4.** Awareness increased with a focus on resource efficiency and dissemination of the lesson learned during the project.

This project will provide a good opportunity to all relevant stakeholders on the awareness raising and advocacy event to integrate this into the existing syllabus/curriculum, policy implementation and policy makers. Under the project’s **Output 1.1.4, Activity 1.1.4.4.** Develop training material on integrated and sustainable industrial development to be used in universities and technical

schools is one of the crucial activities needed to achieve the said output. In the light of the above, the DCC in coloration with its partners provided a training workshop on “Sustainable Industrial Development by Integrating TEST Methodologies into Syllabuses/Curriculum”, especially focused on the integration of the TEST methodology into the curriculum of the Institute of Technology of Cambodia (ITC), which is the leading technical institution in Cambodia, providing services in the industrial development in the country.

2. Objectives

The overall goal of the training workshop on “Sustainable Industrial Development by Integrating TEST Methodologies into Syllabuses/Curriculum” is to provide knowledge on the UNIDO TEST methodology and on aspects of its practical implementation to university lecturers such as the ITC and also other relevant technical universities for updating their syllabus/curriculum with the TEST Content in order to assure the inclusive and sustainable industrial development in Cambodia. Specifically, the training workshop aims to:

- (1) introduce the concepts of the TEST methodology and its implementation towards sustainable industrial development through presentations of contents, case studies, best practices and existing curriculum development of TEST/ RECP;
- (2) increase capacity of ITC lecturers and staff, involved ministry officers as well as the other relevant university staff on the aspects of TEST methodology and implementation;
- (3) develop training materials on the TEST integrated approach and sustainable industrial development to be used in universities and other institutions; and
- (4) translate the gained knowledge of TEST methodology into practices of academia and students through various learning and teaching platforms.

3. Expected outputs

- **Deliverable 1:** the concepts of the TEST methodology and implementation towards sustainable industrial development will be introduced to all participants.
- **Deliverable 2:** the ITC’s lecturers and relevant university staff will be trained on TEST/ RECP and expected to convert the gained knowledge by integrating it into existing subjects or syllabuses/curriculum.
- **Deliverable 3:** training materials on the TEST methodology and its approaches will be produced and shared with participants to be used within the ITC and others.
- **Deliverable 4:** Academicians and students will be aware of the TEST methodology through the integrated TEST subjects and able to actively to apply the knowledge in the universities and future business benefits.

4. Methodology

The five-day training workshop was virtually conducted from 28th June – 02nd July 2021 through the delivery of crucial presentations and best practices sharing from well-experienced and high competent experts/professors from UNIDO and respective universities that have various research and work experiences in the field of TEST/ RECP across the region and world (**ANNEX 1: Agenda of the training workshop**). The training workshop was participated by the head of the

Department of Industrial and Mechanical Engineering, and Department of Food and Chemical Engineering of the ITC, key researchers, lectures, and staff who are strongly involved in teaching, research, and particularly upgrading the teaching and learning curriculum in the ITC. It was also participated by government officials from the National Productivity Center of Cambodia (NPCC) and Department of Industrial Technics and Safety (DITS), the DCC, the General Directorate of Environmental Protection, and key relevant institutions (**ANNEX 2: List of participants**).

1.1. Slide presentation

Slide presentations were provided in English included contents of each day presentation, definition of terms, illustrated figures, charts, and eye-catching pictures of the TEST methodology and its relevant approaches designed by the experts/trainers, which make the participants easily to catch up.

1.2. Best practices sharing

In addition to slide presentations, the experts/trainers shared plenty of best practices and case studies of each designated lecture based on their research work and practical experiences with all the participants, which catalyzed and provided very interactive participation during each session. Additionally, link to publications, spreadsheets, and tools also well-distributed to the participants.

1.3. Interactive Q&A and wrapping up sessions

At the end of each presentation, there were interactive questions and answers raised by the participants and respective trainees. During each day's presentations, participants were provided opportunities to explore and ask questions regarding the TEST methodology and relevant implementation and subjects concerned, particularly the share of how they could translate knowledge in the actual teaching and student learning context.

5. Results of the training workshop

5.1. Day One

5.1.1. Opening Session

On behalf of **Dr. Tin Ponlok**, 2nd vice-chair of the National Council for Sustainable Development and Secretary of State of the Ministry of Environment, **Dr. Hak Mao**, Director of the DCC, welcomed and thanked participants participating in the training workshop. He then emphasized that the academic sector plays an essential role in raising public awareness and distributing the information wisely, particularly with emerging issues like climate change. He noted that the DCC has successfully integrated climate change into school curriculums from primary to high school levels and university programs. With the successful experience, he firmly believes that the TEST will be integrated into the university curriculum while two or three universities will be piloted and extended further in the future.



Dr. Hak Mao continued that Cambodia is highly vulnerable to the effects of climate change, and the country’s vulnerability is characterized by frequent floods and irregular rainfall, along with an agrarian-based economy, limited human and financial resources, insufficient physical infrastructure and technologies. Meanwhile, the combined effects of climate change and COVID-19 have severely affected people living with a different group of people. He stressed that over the past 10 years, the Royal Government of Cambodia has significantly increased the national budget allocation to address climate change, in fact, it has doubled over the last five years, reaching USD 550 million in 2019, equivalent 2% of our GDP. Climate change may reduce the country’s annual average GDP growth by 6.6% and absolute GDP by 2.5% in 2030, and up to 9.8% in 2050 and this may delay reaching upper-middle-income status by one year, meaning we will reach the status by 2031.

Dr. Hak Mao noted that to address climate change, the government has actively participated with the international communities. For instance, we ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1996, the Kyoto protocol in 2002, and the Paris Climate Agreement in 2017. He stressed that the country has already made remarkable progress in climate change policy, particularly in mainstreaming climate change into national and sub-national planning. The country has developed and continued to implement the CCCSP 2014 – 2023, and we are also building a new climate change strategic plan and extend the scope of the strategy more comprehensively. We developed and submitted the Updated NDC in December 2020 and we are preparing a Long-Term Strategy for Carbon Neutrality by adhering to the principle of “common but differentiated responsibilities and respective capabilities, in the light of different national circumstances” and is expected to submit in November 2021.

Dr. Hak Mao continued that based on the Updated NDC, overall GHG emissions in 2030 without FOLU are expected to rise by up to 79 million tCO₂e/year, while overall GHG emissions with FOLU are expected to increase to 155 million tCO₂e/year. The energy sector contributed around 22%; however, with mitigation action, we are expected to reduce emissions by around 42%, equivalent to 64 or 65 million tCO₂e. By implementing the TEST, he expected to partially contribute to achieving the updated NDC since the energy sector will rise in the long run.

Dr. Hak Mao expected that the participants, especially lecturers and professors from the universities, will absorb and learn more about the TEST methodology and its conceptual framework and subsequently integrate it into the curriculum. However, this process will take more time, human resources, and approval from the Ministry of Education, Youth and Sports. In the meantime, the respective participants could conceptualize perceived from the TEST training and share it with colleagues and students and integrate it into curriculum accordingly.

Finally, **Dr. Hak Mao** expressed his sincere thanks to the UNIDO for providing financial support, particularly to all stakeholders and private sectors who actively participate and contribute efforts in project-relevant activities such as the MISTI, MME, and of course, the MoE.

Dr. Nguon Kollika, the Dean of the Faculty of Industry Mechanical Engineering, expressed his appreciation for inviting the ITC to participate in the training. He then gave a brief background of the ITC. Established in 1964, the ITC has been working in a long history to provide technical skills and produce human resources to support the country's industrial demand. From 2021 to 2030, the ITC has tried to develop itself to be the leading university in Cambodia with specific two visions (1) to respond to the market demand in terms of the research and development and (2) to develop

the academic program to match the international standard. Thus, the ITC has modernized its experimental and research equipment with over 80 Ph.D. holders who actively work on campus and promote research collaboration with public and private entities. Regarding the TEST program, **Dr. Nguon Kollika** emphasized that we will try to upgrade the syllabus/curriculum with TEST content, considering some modifications of the existing curriculum. We will try to find particular one or two courses to be proposed in the engineering program. On the other hand, the process would take about a year because some integration or modification of the course or any part of the program at the ITC needed to pass a committee called the "trustee committee" who could accept or deny all proposed courses.



Dr. Nguon Kollika was content to join this training workshop with academic staff, key experts in teaching and research from the Mechanical and Industrial Engineering Department, and the Chemical and Food Engineering Department. He suggested the ITC staff paying attention during this training program and wished a successful program to sharpen to outcomes of the training for integrating into our curriculum.

Mr. Sok Narin, UNIDO Country Representative, shared his perspective on the Introduction of PCP Program and Inclusive and Sustainable Industrial Development (ISID) for Cambodia. He greeted Excellencies, participants, and project partners. On behalf of the UNIDO team, he thanked all institutions for collaborations in conducting the first-ever training on curriculum integration into university level to transfer the knowledge of Low Carbon Development for Productivity and Climate Change Mitigation through the TEST project, which jointly implanted by the MISTI and MoE with the support of the GEF.



Mr. Sok Narin stressed that this project is one of the first projects which is designed and implemented under the program for country policy, which is jointly designed with the Royal Government of Cambodia to support the implementation of industrial development policy. First is on growth value chain development linking into the tourism sector, and second is notable economic zone development, technology innovations which address several cross-cutting issues, including circular economy, skill development, and industrial policy. He continued that the objective of this TEST project is mainly to contribute to reducing long term risks of climate change through the TEST knowledge, particularly in food and beverage factories whereas resource efficiency in the productions will be implemented and resulted in reducing the GHG emission and protecting the environment and resources at the same time. He noted that the implementation of the integrated tools on the RECP will reduce GHG emissions by about 500,000 tons, which is a significant contribution to achieving the Updated NDC targets.

Mr. Sok Narin noticed that developing skill and technical expertise among mid-levels at the industrial level is essential, and the gaps between industrial linkage with the university is still required for improvement. Therefore, the collaboration with our partners such as the DCC, MISTI, and especially the ITC in joining hands for organizing such a training will merge the cross-cutting issues and the practice of the industry sector. The training also provides an opportunity for lecturers and students to learn not only the theoretical approaches but also practices at the same time. As a result, the university can also innovate its teaching and learning courses to match the markets' demand, achieve national policies, increase economic growth, and create more jobs for people.

Last but not least, he expressed his sincere appreciation to the GEF for financial support and all our trainees to share knowledge with the ITC on how to integrate the TEST methodology into the curriculum, corresponding to the demand of the markets while sustaining the environment at the same time.

Dr. Rana P. Singh, Project Manager, highlighted the Introduction of the TEST Project. He briefly acknowledged the important talks from the previous remarks, for instance, the vital role of the project to the environment. He noted that we are expecting to integrate the TEST into the academic curriculum. He also mentioned the points raised by Mr. Narin about the objective of this project in terms of the national lead and country partners the program and how the TEST fitting into the Updated NDC in the national and global level and later on His Excellency Dr. Tung Ciny might likely cover how this TEST project is fitting into the national context.



Dr. Rana P. Signh strongly emphasized the vitality of the TEST in contributing to achieving the Sustainable Development Goals (SDGs) within the industry in Cambodian performance. He noted that it is neither excellent nor worst; it is somewhere in between, and we see it is on track. So overall, what we want to see for the national and economic health industry plays a significant role in the country. There are still some limitations and need for more improvement in terms of education and research investment, scientific journals, and the publication.

Dr. Rana P. Signh highlighted that the TEST project significantly translates Cambodia's economy on the fast track. Even we have a lot of financial supports from the outside. The externalities are unstable, so we have to manage our things in our interests, with our own human resources, so that the role of universities is critical. We have to ensure how to integrate this knowledge into our route and replicate it massively, and we cannot always depend on outside resources. He stressed that any program has to start from a step, and that is why we are beginning, and we are delighted that all stakeholders are cooperating. Importantly, we had supported from international experts/ trainers who are very much knowledgeable from different countries while the number of participants was a lot. It shows excellent efforts and opportunity that the TEST methodology will be in the proper education route and cut the country dependency from the outside experts. It will retain Cambodia's money within her pocket with good economic achievement, good institution, good sustainability, and the path will be successful.

During the opening remarks, **H.E. Dr. Tung Ciny**, Secretary of State and Project Director, the MISTI, expressed his sincere thanks to the UNIDO and GEF for their strong and continuous commitment to supporting industrial development in Cambodia. He noted that the MISTI is firmly committed to inclusive and sustainable development with the support from all partners. We have implemented several initiatives to promote green industry



and climate change mitigation by integrating the TEST methodology. The project has provided technical assistance to selected manufactories to implement the TEST with a holistic approach to the global resource of energy efficiency to reduce the emission, resulting in a significant reduction in companies' costs and improving the well-being of workers. The capacity of the ministry's officer and company's staff was also built through training and experience sharing experience.

H.E. Dr. Tung Ciny added that the TEST methodology considers the environmental approaches by adopting a running environment beneficial for companies in both the short- and long-term. The MISTI strongly supports green industrial development in Cambodia, while the TEST will increase the sustainability and competitiveness of Cambodia Universities with the corrective approach, including tools like resolving safety and production, environmental management system, and corporate social responsibility. He finally announced the opening TEST training workshop and wished the participants good luck and fruitful discussion.

5.1.2. Introduction of Participants

Participants were asked to introduce their names, organizations, fields of expertise and the expected outputs from the training. Due to the high number of the participants and time constraints, only representatives from respective universities, namely the ITC, the Royal University of Phnom Penh (RUPP) and National University of Battambang (NUBB) along with governmental officers from the MISTI, the MoE and MME presented the impression of their respective institutions, key experiences and outcomes from the training (**ANNEX 4: Screenshot photos of the participants**).

5.1.3. Presentation on Introduction to the online TEST Toolkit

Dr. Branko Dunjic, Director of Cleaner Production Centre of Serbia, Faculty of Technology and Metallurgy, University of Belgrade, Serbia, presented the online TEST Toolkit, which comprises two main topics (1) TEST approaches and (2) TEST Toolkit.

He then introduced his background, a chemical engineer and specialist in polymeric materials, and has experienced working with companies and universities. From his experiences, he noted that there are still gaps between the university and the industrial sectors, so the university should play an essential role in bridging the gap. There are some elements/subjects that the respective universities could consider the special courses offering for the students, such as resource efficiency, life cycle assessment, sustainable industrial development, and holistic approaches like TEST in your university.

He stressed that the TEST Toolkit is available online (<https://www.test-toolkit.eu/test-tools/>), and probably the rest of his talks and colleagues can be found in the Toolkit’s site. He noted that the TEST approach embeds traditional "one-stop improvement" or "audit-like" approaches to RECP in the system approach, driving continuous learning and improvement. The particular TEST steps follow the learning cycle (Plan, Do, Check, Act in ISO standards). TEST builds on the following tools: (1) the Resource Efficient and Cleaner Production Assessment (RECPA) methodology, which includes exploring new eco-efficient technologies, (2) an effective and supportive information system for material and energy flows based on Material Flow Cost Accounting (MFCA) principles; (3) the core elements of an Environmental Management System (EMS) and an Energy Management System (EnMS) to integrate RECP into enterprise operation and to sustain performance and its continuous improvement.

For the rational of the TEST approach, he emphasized that it is basically based on the experience, people in companies especially manager of companies, they really do not know the total cost, or risk

resource use in efficiencies for financial and environmental benefits, which is the key to convincing industry to pursue sustainable production beyond a project cycle by:

- Revealing the “total costs” of resource use inefficiencies within production and associated pollution through the quantification of non-product output costs (NPO costs). Elements of MFCA can be used to track physical and financial flows, as traditional accounting provides insufficient and often misleading information regarding material flow efficiencies. When considering NPO costs, the real environmental costs increase on average by one order of magnitude, which is usually very surprising to industry.
- Assessing performance related to the use of raw materials, water, auxiliary materials and energy inputs as well as to the generation of major pollution outputs, and comparing them to industry sector benchmarks and international best practices, which often provides a good indication of achievable improvements.
- Identifying and investigating in detail the leverage points (priority areas, sources and causes of losses and pollution) to gain an in-depth understanding of key resource/energy consumers in a process and focus on the core problems and opportunities.

He noted that the TEST architecture is based, and follows the same logic, you will first assess the actual performance, and what I said about benchmarking that is the most important part in testing is to see how a company is actually performed. The second is to together with company and identify focus flows and focus area. The next slides are the concrete steps, and we are going to go through all of those steps. There are 10 steps in the planning phase. Then, in check, to monitor and evaluate and in Act, we have to make it sustainable. So, it is not done only once in company then forgotten. We have to integrate it in some kinds of management system, in environmental management system, energy management system or in the management philosophy of the company.

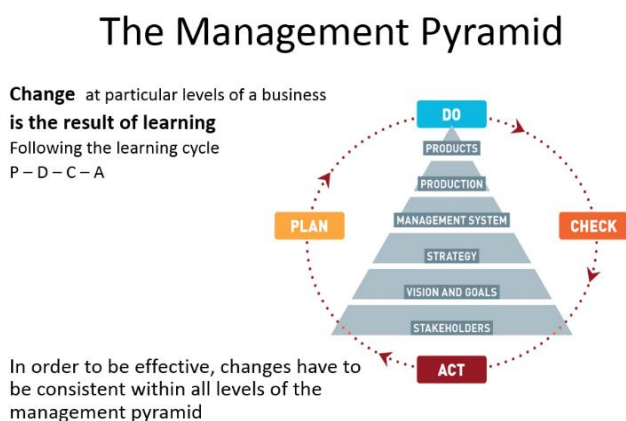


Figure 1: The management pyramid of the TEST approach

Table 1: The TEST learning cycle (Plan, Do, Check, and Act)

	Step	Purpose
PLAN	1.1. Initial assessment	Initial screening: go/no-go decision to start TEST.
	1.2 Policy statement	Formalize top management commitment to sustainable production and resource efficiency.
	1.3 TEST team	Plan, organize and train internal company team.
	1.4 Identifying total cost of pollution and priority flows	Starting the diagnosis: Identify the total cost of pollution (non-product output costs) and the priority flows at company system boundary.
	1.5 Setting up focus areas	Continuing the diagnosis: identify priority areas at the level of company units (cost centres) with the highest potential for improvement.
	1.6 Revealing sources and causes of inefficient material and energy use	Concluding the diagnosis: identify sources and reveal root causes of inefficiency and pollution in priority areas.
	1.7 Option generation	Opening the scope of possible improvement solutions.
	1.8 Feasibility analysis	Identifying a set of optimized measures.
	1.9 Action plan	Plan for implementing selected measures.
	1.10 Information system	Plan for monitoring system to measure performance including efficiency of material and energy flows.
DO	2. Implementation of the action plan	Implement improvement measures and increase performance in resource use.
CHECK	Monitoring and evaluation	Measuring performance of important material and energy flows.
ACT	Act and sustain	Reflection on experience gained and integration of TEST into business strategies and operations.
FOLLOW-UP AND CONTINUOUS IMPROVEMENT		

Sources of references:

For the supporting materials, which is needed, he noted that we can download it in PDF version you can print it, you can explore it. It has more than 60 pages with many boxes, and case studies, presentations, including in the below links:

EU BREFs : <http://eippcb.jrc.ec.europa.eu/reference/>,

IFC Industry Sector Guidelines

http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/ehsguidelines

GREEN FOODS on line WIKI: http://wiki.zeroemissions.at/index.php?title=Greenfoods_Wiki

For textile sector: <https://eippcb.jrc.ec.europa.eu/reference/textiles-industry>

He shared the template of the TEST Toolkit that consists of the TEST guideline for planning and operation, initial screening template, policy checklist, and so on. He mentioned that what I have navigated on the TEST site (<https://www.test-toolkit.eu/test-tools/>), the training Toolkit can be used as a resource material to design and deliver TEST trainings in Cambodia by customizing the approach to your needs and collect ideas for further developing the TEST methodology and of the training Kit to be introduced TEST in the curricula in the ITC and with other technical universities.

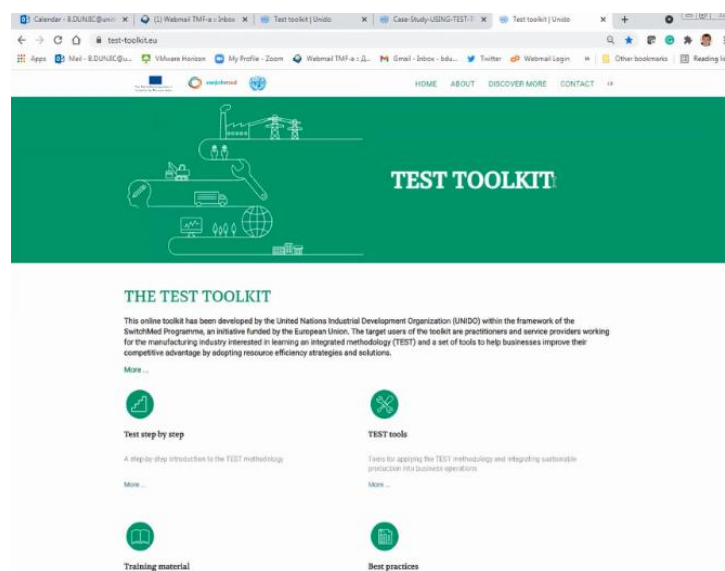


Figure 2: Demonstration of the TEST Toolkit on the website

Overall, the test methodology consists of four main steps: (1) Planning, (2) Support and operation, (3) Performance evaluation, and (4) Improvement. He then explained each step of the TEST methodology and actors involved in the process and the session followed by the questions and answers. He provided clear explanation of each step with practical examples and figured how we could utilize/integrate the step to apply in the industry and some work in the university.

5.1.4. Questions and answers, wrapping up

Question: Dr. Nguon Kollika

Based on your explanation, how do you assess the performance of the industry?. We asked the question because the ITC tries to have more collaborative research with industry, and it is a problem with us working with the industry.

Answer: Dr. Branko Dunjic

Okay, if I understand well, it was more comment than of a question. There are some challenges in working with industry, and most of the companies do not cooperate. They do not see what systematic approach like the TEST can immediately benefit to them. It takes not only technical knowledge, but it also takes some; how would you use your negotiation skills to speak with the company, with the managers in the TEST methodology. When you talk to companies, you never talk about the environment, and they will stop listening – they do not really mind the environment, and their need is to pay salaries to the employees. Therefore, the only solution is to provide the systematic approaches and supports of how the company will gain if they could apply the TEST methodology and vice versa in terms of energy use, waste generation, etc.

Comment: Dr. Nguon Kollika

As we know and following your presentation, the textile industry plays an essential role in Cambodia's economic growth. To me, I do believe that this TEST approach and methodology will help to find the right skills to bridge the gap for the textile and its relevant industry in the country.

Reply: Dr. Branko Dunjic

Thank you, professor, for your comment. As a matter of fact, the textile industry was really a hot topic, and we have many resources regarding the TEST in the textile industry, and we had very good training on the issues in textile industry, starting from the production of fibers then making fabric, etc. The main issue in textile industries is due to distributing chemicals management and water, water use. I will share another Toolkit developed by the UNIDO, called IAMC Toolkit, so that you will have a technical guideline about the textile industry written by the best expert in this field. Based on the toolkit, it is good for Cambodia to encourage the companies to adopt more water-efficient, chemical-efficient procedures and use chemicals that are not hazardous and do not pollute water. Regarding the textile and green industry, as a matter of fact, we are preparing a similar training now for Vietnam, Indonesia, and Sri Lanka, but I will talk to the project manager probably we can invite people from your university to participate so that you will be able to see what are the best techniques in the textile industry.

Link to the IAMC: https://iamc-toolkit.org/wp_Finishing_FINAL%20DRAFT_16_08_2016-MM.pdf

Question: Dr. Sor Sambo, from the ITC

From what I understood, in order to have the involvement from the management of industry/company, as the university, we should not directly talk about the environmental aspects of applying the tool to the company. Nevertheless, the economic benefits and supports in terms of the tool should be negotiated with the company owners. The Test methodology is entirely new for us as lecturers, so do you have any case studies that we could go through them in the next session?

Answer: Dr. Branko Dunjic

Thank you for your comments and questions. We have the case studies from Ukraine and other companies to share with you, and we can also adapt our lectures and give more case studies. The case studies are also available in the TEST Toolkit. For the steps in the TEST methodology, you are not obliged to go through every step and document every step. It's up to you and what you need to do is to follow the logic. The logic is the first step to assess the company's performance right to compare it with the average companies from that sector or the best companies and present it to the management, together with the TES, what is the potential for improvement with the management

TEST compliant. For the question and the comment about the environment, based on my experience working with companies, if we mentioned a lot about the environment, legislation, water, etc., the company would not be so committed. Therefore, if you merge the economic and environmental benefits, they will be more motivated to work.

Question: Mr. Tieng Kimseng, from the MISTI

Could you please explain the TEST (Transfer of Environmentally Sound Technology) from the ordinary people's perspective? Could you define its scope of application in the industry?

Answer: Dr. Branko Dunjic:

Every company thinks that they are doing pretty well, and surviving and having enough finance to sell the products and get profits. You just directly imply that through the TEST how much they save; for instance, you can say two to three percent of the profits without making a lot of investment and getting any new clients. So, this will be increasing the profitability of the company.

Question: Dr. San Vibol, the RUPP

First of all, I would like to thank you for providing an excellent presentation, and I think the TEST methodology is beneficial for the industrial sector in Cambodia. I am now researching industrial pollution loads since in 2008, I published a paper about the industrial pollution load in Cambodia and the industrial protection system developed by the World Bank. The main challenge of the least developed countries is the lack of data availabilities, and we could not find the industrial pollution intensity for Cambodians produced by the researcher in Cambodia. There are many emerging technologies available in Cambodia, but it is pretty tricky for me to find the right technology for Cambodia, meaning the switching from conventional technology to the technology that could reduce emissions. Therefore, what technology should apply in the research on how to emerge technology for the industry, garment sector, and company?

Answer: Dr. Branko Dunjic:

In the chat box, we provided the links to download textile finishing technical guidance. Furthermore, the IAMC Toolkit is an innovative approach for the sound management of chemicals and chemical waste. Based on the report, you can see some examples that we work with Peru, El Salvador, Egypt, and Morocco, so it is crucial. Those countries are facing similarities like Cambodia, and also you can find some examples in supporting policies, optimization of the use of natural resources, etc.

At the end of the first day's session, Dr. Branko Dunjic recalled the TEST Toolkit briefly, that it is online while we just invest our efforts and time to compile all the documents; it is just a starting point, so we need to play around with it. The basic TEST philosophy and methodology should be used as a checklist, and we could maybe skip some of those steps formally. Frankly speaking, the introduction into the curriculum, it, of course, depends on the legislation and procedures and how we make the curriculum. Including a life cycle approach for students in the curriculum and the right technology for the least developed countries are also recommended.

5.2. Day Two

5.2.1. Agenda 1: Brief recapitulation of the Day one

During the first start of the second day's session, the facilitator, Dr. Rey Sopheak requested Dr. Rana P. Singh to have the insights of the training session, as he expressed his thanks to the DCC and ITC for active participants and particularly the UNIDO headquarter for good coordination of

the training workshop. Dr. Branko Dunjic recapped what he distributed yesterday, such as the TEST toolkit and its practical steps. He also highlighted some questions and answers raised by the participants, especially the remarks on applying the TEST into the curriculum and industrial sectors.

5.2.2. Agenda 2: Presentation on the TEST methodology and RECP assessments

Mr. Cesar Barahona, a senior technical advisor for Eco-Industrial Parks, and Industrial Resource Efficiency, UNIDO, explained that the concept of Resource Efficient and Cleaner Production called RECP is to make the resources more efficient with the limitation of disturbing the natural resource towards the needs of society and sustainable development while maintaining the resources for the future generations at the same time. He noted that the RECP was formed due changes caused by over population, over extraction of natural resources, environmental pollution such as waste generation and so on. This has impact on our lives and now we have the concept of circular economy to apply all of the resources in efficient and sustainable way.

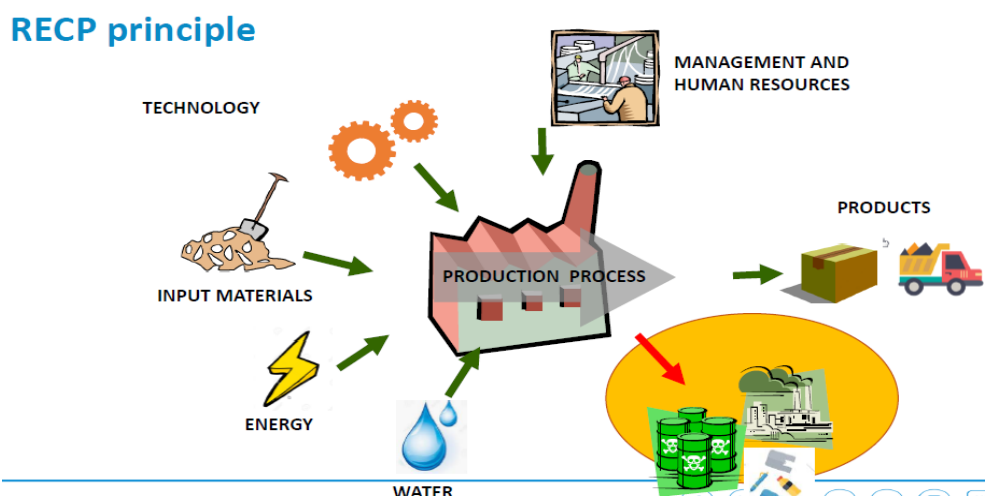


Figure 3: The RECP principle

He stressed that business concern shall consider are three main points (1) Cost to business including prices of raw materials, energy and water, cost of waste and pollution, low resource productivity: materials, energy and water; (2) risk to business including lost productivity due to interrupted supply of materials or lacking access to waste management, suspension of operating licenses due to illegal waste disposal, business risks of chemical accidents. Risks for employees and community, market reduction, impact on environment; and (3) generation of emissions. With the resource efficiency it means we could produce more with number of resources and this is the role of the university to provide the approaches and solution to the industrial sector. Resource efficiency is imperative that has to be improving resource efficiency has become an economic imperative for any business to survive, and every industry has the possibility to improve its resource efficiency through a systematic intervention. He then defined the definition of the RECP, which is the integrated and continued application of preventive environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and environment.

Why is RECP important? It is important because it provides economic savings, business security, new business opportunities and social responsibility. He gave more example of best practice of RECP in some companies in Palestine and Tunisia. The challenges of RECP implementation was also described such as (1) limited awareness due to lacking awareness on resource efficiency

including costs of inefficiency including hidden environmental costs for businesses, impacts of behavior and process conditions on materials, energy, water use and waste generation, unexploited potential of increasing resource productivity; (2) lack of knowledge on resource saving, waste and emissions minimizations techniques and practices, knowledge on environmental legislation, lacking benchmarking, lack of infrastructure; and (3) insufficient technology and capital for infrastructure for water treatment, waste recycling, etc.

The RECP principle started with the production side, meaning the company produces products to supply the demands, while the input materials, energy and water are used along with technology, human resources and management. As consequences, the waste water and chemical substances are discharged into the environment. To convert to costs to the benefits, there are two approaches. One is the RECP, how to increase the number of materials which is going to the final products (2) the TEST approach, how much it costs for the company to produce the waste. Therefore, when we could calculate the number, we are aware of the opportunity to invest and address the problem whether the company has balance between the materials used and products made.

Moreover, the RECP practices and strategies were presented in three levels. Level 1 contained reduction at the source; level 2 was the internal recycling, while the level 3 consisted of external recycling and symbiosis and biogenetic cycles. Then, he presented the Input and Output Balance separating product from non-product output, material balance definition of qualitative and quantitative approach, the ratio of costs between non product output costs and costs for treating pollution. He highlighted that the integration of the RECP into existing management system and core business values for continuous improvement through (1) assessing actual performance; (2) Identify and focus on Leverage Points; and (3) Information and Management System for RECP.

Part 2 on the scope of work for the RECP assessment under the project, he noted that the RECP assessment method of which the process contained (1) planning and organization; (2) initial assessment; (3) detailed assessment; (4) feasibility analysis; and (5) implementation and continuation. He then explained the scope of work with practical examples of the RECP assessment. Particularly, for the feasibility analysis, some examples for factories were provided including calculating capital cost of investment and annual cash flow.

In the final step of the RECP implementation during the implementation and continuity, he noted those three sub-steps should be taken into account (1) prepare implementation to define responsibilities, priorities, what options need more study, timeline and resources; (2) cross cutting tasks include collection of additional information on process inputs and outputs such as installation of water and energy counters, establishing measurement and reporting routine, installation of environmental benchmarking system, developing an environmental statement of the manager; and (3) Monitoring establishment of parameters and indicators to be monitored to evaluate results of the options.

5.2.3. Agenda 3: Presentation on the rational process of Conducting an Initial Assessment (IA)

For the rationale part for conducting an Initial Assessment, it mostly distributed by Mr. Cesar Barahona, and Branko shared some documents with the participants, and hopefully, participants can review them. He would recommend using a template for initial assessment, where you have an obvious checklist about the company, questions to ask before going to a company, and whether the company is appropriate for the TEST.

5.2.4. Agenda 4: Questions and answers, wrapping up

Question: (Unknown)

Regarding the any courses such as supply chain, energy efficiency and so on, does the UNIDO provide any support to university to create any departments on the subject matter?

Answer: Dr. Rey Sopheak

The question is mostly about what the UNIDO works in Cambodia. The UNIDO is closely working with factories to reduce the cost of productions in order to stay competitive, but at the same we are also working with the university to integrate the TEST subjects into curriculum or existing subjects, but not trying creating a department.

He added that I would like to mention the feasibility study; meanwhile, typically, when we talk about the low-cost option, it is easy to implement, but a high-cost one will need further study. Therefore, in your presentation at the feasibility study points, there are technical aspects: the environment and economy. Within the two points, I think it may be a chance for the university to collaborate or support a factory or industry to assure the process.

Question: Dr. Sor Sambo

Could you briefly explain the differences between the RECP and TEST methodology?

Answer: Mr. Cesar Barahona

The RECP methodology focuses on the process and the product, reducing the number of materials and energy of the productions while increasing the production yield. You could estimate how much money you will gain by implementing this methodology and how much the environmental benefit you will bring by implementing this methodology, so this is called RECP. The TEST includes a slightly different approach that includes the non-product cost, which is not ending the product, and it will calculate how much money to produce what we want and vice versa.

Comment: Dr. Rana P. Singh

Dr. Rana mentioned that many learning outcomes were shared with all participants, and he hoped that those would benefit to all. Universities are in a perfect position to gain such a knowledge, which should be transferred to match the market demand in Cambodia. On the other hand, expertise is not frequently made, but when it happened, it is based on the outside, where experts come from outside sources. Therefore, in particular circumstances, gaining this knowledge and incorporating it into the university curriculum somewhere in the university has a huge impact and chance to provide knowledge to meet market demand. This will be a sustainable way for learning outcomes in university by incorporating the TEST into the curriculum.

5.3. Day Three

5.3.1. Agenda 1: Brief recapitulation of the Day Two

To start with the third-day discussion, the moderator, Dr. Rey Sopheak, requested Dr. Rana P. Singh to have short remarks. He greeted all participants and thanked them for active participation, particularly from the DCC, ITC, and ministry staff. He hoped we all keep attention till the rest days of the training workshop. Then, Dr. Anton Kleshchov, the National Project Coordinator of the Global Eco-Industrial Parks Program based in Ukraine, recapped some critical points of yesterday lecture. He noted the vitality of the RECP about sustainable industrial development. Moreover, the differentiation between the RECP and TEST methodology also raised; he noted that the RECP is related to the process of estimating products and costs of services to increase

efficiency and reduce risks to humans and the environment (how much the product would cost and when it would provide the benefits). In contrast, the TEST is the integrative approach, including the RECP, which provides tools for companies towards sustainable production.

5.3.2. Agenda 2: Presentations

There were three sections of Dr. Anton Kleshchov's presentation; the first section highlights the setting up priority areas; the second section includes identifying priority areas for energy flows and revealing sources and causes of inefficiency; and the third section covers the generation of energy efficiency solutions. Section 1, energy priority flows can be recommended through collecting past consumption and driver (production) monthly data by energy source (electrical and thermal energy) and calculating the KPI based on monthly records and regression analysis. He noted that populating the energy mapping tool for a sample company can be achieved by the energy source identified, visualize trends of energy consumption and cost, and breakdown of energy among sources (physical and financial breakdown).

He continued that we also understand that using regression analysis; it is not 100% correct, so that we have to verify it with the other results sometimes. Using the regression analysis could describe the relationships among variable (consumption and drivers) as follows 1). plotting the consumption versus the potential driver, the criteria for reliable equation is the correction exceeding 0.75 ($R^2 > 0.75$); 2). the equation constant (intercept) represents the baseload; and 3). the slope of the line reflects the sensitivity of consumption to the variation in driver.

For section 2, he stressed how to identify priority areas for energy flows and reveal sources and cause of inefficiency. This session was mostly derived from his experiences. He noted that significant energy users based on significant component of the organization consumption, equipment, process, facilities, systems, and considerable opportunity for improvement. How we quantify each energy user? It is based on:

- Energy consumption estimates based on nominal plate value of the machines;
- Data collected during spot measurement campaigns; and
- Real time energy consumptions from metering systems in place.

He then explained that there were several tips for analysis energy user:

- It is always better to install submeters from the early stages of TEST. However, you have to be cautious not to install submeter on non-significant consumers.
- Production volume is not always the driver for consumption. (A cold store is driven by the ambient temperature; HVAC is driven by ambient conditions and occupancy...).
- Although on demand measurements can help in analysis, beware of the measurement doesn't tell anything on its own. You have to understand the process, and to analyse the readings.
- Companies often have answers to all questions, the important part is how you ask the question to get the right answer.
- Mapping users based on nominal plate value of machines.
- Not the optimum way of mapping, but is a good start, especially when submeter data is missing.
- Energy Mapping tool is useful for this mapping.
- Results from this mapping highlight the locations to install submeters, if not installed.

Moreover, approaches to identify source and cause of inefficiency were included as followings:

- Technology Benchmark

- Balance over full system
- Energy balance over focus area
- Matching supply and demand
- Optimization of Operating parameters
- Using checklists

The third section was about the generation of energy efficiency solutions, and he provided some practical examples of the simplest solution for types of company that the expert could deal with the lightning system. He also shared the case studies of the voltage asymmetry influence on resource consumption at power generating plants in Ukraine and other related materials.

5.3.3. Agenda 3: Questions and Answers

Question: Dr. Nguon Kollika

What are the best approaches/ ways to introduce energy efficiency audits to the university program because I am not very clear about that since there are many systems such as pumping systems, energy utilities, and so on? What is the nominal plate value of the machines?

Answer: Dr. Anton Kleshchov

We have several projects that could involve students in such kind of activities, and students also have chances to work in the company; meanwhile, university and company have like the consortium, which could be a platform to learn together. During the student’s research to complete their diploma, this is a good chance for them to work with the company based on their expertise. Nominal plate value is the value of how much that specific energy costs in producing that specific product.

Question: Dr. Sarin Chan

Could you share how to find an excellent sectoral expert?

Answer: Dr. Anton Kleshchov

From my perspective, the source of sectoral experts is from the university, and then we go to the specific departments. Practically, in Cambodia, the linkage between the university and industry is not close yet, so we need to understand the gap between what the university will provide and what the industry will need from the university.

5.4. Day Four

5.4.1. Agenda 1: Brief recapitulation of the Day Three

To begin with the fourth-day session, Dr. Anton Kleshchov recalled the important discussions on the energy flows, priority areas for energy flows and revealing sources and causes of inefficiency, and solutions towards energy efficiency. The shared topics are crucial parts of the lectures to share with the students and future consideration for future integration into the university’s curriculum.

5.4.2. Agenda 2: Presentations

Dr. Andrii Vorfolomeiev, the associate Professor, Institute of Energy Saving and Energy Management, National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” in Ukraine presented the three main parts. The first part was basics of the RECP methodology; the second part was on the introduction to work with the SMEs; and the last one focused on selected case studies of the RECP projects in Ukraine.

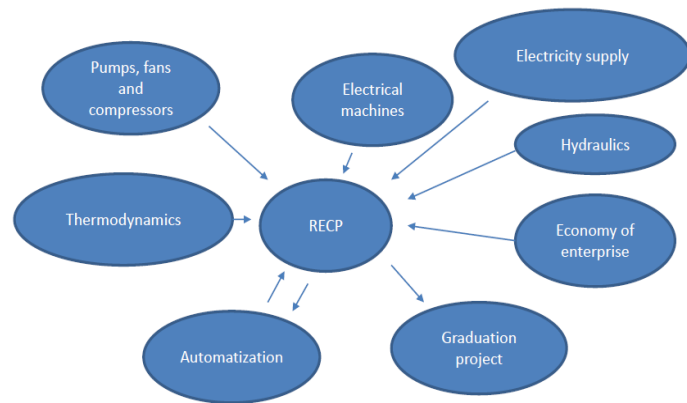


Figure 4: Relevant principle of the RECP

For the basics of the RECP methodology, he mentioned that it is as a discipline in Igor Sikorsky Kyiv Polytechnic Institute; he teaches first year students about the RECP discipline, meanwhile the discipline can be linked with Thermodynamics, Pumps, Fans and Compressors, Electricity supply, Electrical machines, Hydraulics, Economy of enterprise, Graduation project, and Automatization. The subjects will improve student’s practical knowledge and how they could work with the company after graduation. On the other hand, he emphasized that the integration of the RECP in the curriculum will be based on country experiences, needs, and regulation. He then introduced the evolution of approaches to environmental management, in which the RECP was introduced in the 1980s by the UNIDO to prevent environmental pollutions and reduce the scarcity of the natural resources linkage with the industrial sectors.

He defined the RECP Concept as a complex consecutive preventive environmental strategy used in the industrial processes for increasing economic efficiency of the enterprise, decreasing of production risks for the personnel, and decreasing of environmental exposure. The RECP aims at optimizing the productive use of natural resources (materials, water, and energy), minimizing the adverse impact of production systems on environment and nature through reduction of wastes and emissions, and minimizing risks to people and communities and enable their development. Moreover, the business benefits of the RECP through improving business security, business performance and the involvement of stakeholders was raised.

He provided the key success factors working with industry on sustainable production through (1) identification of the full potential for financial and environmental benefits; (2) people who influence resource efficiency at all business levels (operational, managerial, strategic); and (3) SP tools are customized in a way that matches the needs of an enterprise within its operating framework conditions and enhances organizational learning. The RECP cycle also included in the presentation. The steps in the RECP assessment were presented, and the measure resource efficiency differed based on the companies, locations; for example, resource productivity (ratio of gross domestic product (GDP) to total resource use), €/kg; materiel consumption per capita, t/capita; and productivity (million inhabitants/km²); water productivity, EUR/m³; eco-efficiency (ratio of GDP expressed in euros to some general indicator of environmental impact).

He stressed that internal benchmarking processes included checking the consistency, looking for patterns and similarities, and finding the dependencies. The RECP practices contained good housekeeping, input material change, better process control, equipment modification, technology change, onsite reuse and recycling, production of useful by products and product modification.

Some examples of the SMEs model were also presented, for example, using concrete additive; the enterprise has reduced gas consumption for heat treatment and saved more than USD 37,000 per year by using concrete admixtures. A recycling system has allowed the company to recycle 2,100 tons of waste and 690m³ of water, generating savings of nearly USD 7,500 per year.

Last but not least, he stated that the RECP Centre started in 2013 within the framework of the UNIDO project “Promoting the Adaptation and Adoption of Resource Efficient and Cleaner Production (RECP) through the Establishment and Operation of a Cleaner Production Centre (CPC) in Ukraine” (2012-2020). We have been working with more than 40 companies with more than 100 RECP assessment results. For more about the RECP: www.recpc.org and for Implementation of resource efficient production in Ukraine <https://youtu.be/MdSAV2BG3PA>.

5.4.3. Agenda 3: Questions and answers

Question: Dr. Sar Sambo

As your experiences of working many companies, so who will pay for the assessment?

Answer: Dr. Andrii Vorfolomeiev

It depends, sometimes the company pays on its own; usually, many assessments are subsidized by the national government, but there is also some charge service from the company. Dr. Rey Sopheak added that two main projects are currently supporting those who could support the energy assessment in Cambodia. One is a UNIDO-funded project with the pilot of 50 factories, and the EU supports other funds through GGGI to pilot with other 50 factories. Moreover, there is some demand from big brands that require the factories to be compliant with the heat index so that the factories will conduct the assessment throughout the technical supports from the international experts. Many opportunities and investments are coming, so the university should have its own experts and students to catch up with the opportunities. Dr. Sar Sambo suggested UNIDO should involve and start engaging ITC and students in any learning event in this regard.

Question: Dr. Nguon Kollika

There are still gaps for students to come cross the problems in the industry since the knowledge that they perceive from the university maybe not enough to fulfil the needs of industry, particularly the process of energy efficiency, waste product included in the TEST and RECP approaches. Could you share any experiences with this matter? And about the monitoring is that internal monitoring or any urgency to carry out such work?

Answer: Dr. Andrii Vorfolomeiev

We conducted a lot of monitoring and most of them are the external experts. It is also important to understand real outcomes of the work, and to provide the data for donors who pay money for such kind of the assessment.

Question: Dr. Sar Sambo

In the beginning, there are many systems in the factory, such as the electrical and chemical systems. Whereas in the university, there are plenty of subjects being taught to the students; how could you bring the knowledge from the university, particularly the RECP, to apply in the industrial company?

Answer: Dr. Andrii Vorfolomeiev

At the end of the course, students could have the basics of the RECP and the relevant disciplines to apply in the company they are working on; some are working as chief engineers and service providers. Moreover, the team of experts should be integrated with in the RECP methodology.

Answer: Dr. Banko, I think that our contribution, as lecturers from university and also trained experts, we need to be systematic when we go to the company, and our task is to provide analytical and methodological approaches to solve the gap of the company and productions. Through the TEST methodology, a systematic and holistic approach, we need to inform and repeat the students that the TEST is like in your scientific work, methodological procedure, steps, etc. When they go to companies, they will forget some points because they are under pressure of some external factors. They should then follow the learned methodology and integrate it with what they experienced to have clear pictures of the process and product.

5.5. Day Five

5.5.1. Agenda 1: Brief recapitulation of the Day Four

On the last day of the training workshop, Dr. Andrii Vorfolomeiev discussed some important notes from the previous sessions, such as the basic RECP methodology and some practical examples from the companies across Ukraine. He also highlighted some interesting RECP approaches/disciplines that are crucial for teaching, research, and industrial business benefits.

5.5.2. Agenda 2: Presentations

Dr. Branko Dunjic shared a presentation on Monitoring and Targeting and Introduction to Material Flow Costs Accounting. He noticed that following his experience, getting the data from the companies is difficult, so this presentation was to show how to get the data from the companies. Based on his research, he shared a reference on Material Flow Cost Accounting for reference. He expressed that the ratio of the costs on generating pollution (process losses) is essential for the companies to consider; meanwhile, it is, sometimes, 10 times higher than the cost for treating pollution, which the company directly paid. He mentioned why do we focus on money from the very beginning? Because pollution is money (mainly lost input). As we know, money is the language of top management; that is why understanding Non-Product Output (NPO) costs could help you set the baseline for what you can save and define the priorities. He also shared the template of material flow cost accounting and its operational steps. He also presented the identification of priority flows based on total NPO costs, environmental risks (toxicity), and the total amount of bulky materials. He finally shared a study on the application of MFCA in waste reduction, a case study on a small textile factory in Thailand.

Mr. Salil Dutt, Chief Technical Adviser of UNIDO based in Jakarta introduced the optimization of Wastewater Treatment and Management (WTM) operation. He started with the distribution of earth's water (fresh water accounts for 3% and saline water is about 97%) and he also demonstrated the water projection in the world. He then stressed that wastewater treatment plant is a facility in which a combination of various processes (e.g. physical, chemical, and biological) are used to treat industrial wastewater and remove pollutants. He added that wastewater is treated to meet the effluent discharge standards suitable to be discharged into the natural environment.

He asked why should we optimize wastewater treatment plants? Wastewater treatment inefficiencies can lead to negative impact in receiving water bodies and population in the downstream; Wastewater treatment requires resources like chemicals, energy and other resources have potential to save cost; wastewater recycling can lead to availability of water resource for the business sustainability; Efficient WWTP management and recycling can protect the underground water (quality and quantity); efficiency WWTP operations can bring economic, environmental and social benefits.

He noted that measuring water pollution level based on the following points:

- Water pollution can be seen from changes in color, odor, and the death of water biota, either partially or completely.
- Level of pollution can be measured by the testing the influent (inlet to WWTP) and effluent (outlet from WWTP) parameters.
- The parameters can be physical, chemical, and biological
- Most common parameters are: pH, temperature, color, turbidity, BOD, COD, DO, TSS, TDS, TOC, Mixed Liquor Suspended Solid (MLSS), Mixed Liquor Volatile Suspended Solid (MLVSS), organic and inorganic compounds, cations, anions, microorganisms, heavy metals, etc.

Regarding water treatment options, he stressed that they could be done in four ways (1) raw water clarification/ pretreatment plants; (2) water softening and filtration; (3) membranes separation systems; and (4) demineralization plants and condensate polishing system. There are three ways of wastewater treatment options (1) industrial effluent treatment; (2) sewage treatment; and (3) recycle systems/ZLD. For instance, the majority of wastewater treatment in textile industry will follow the diagram: from Influent to equalization and aeration

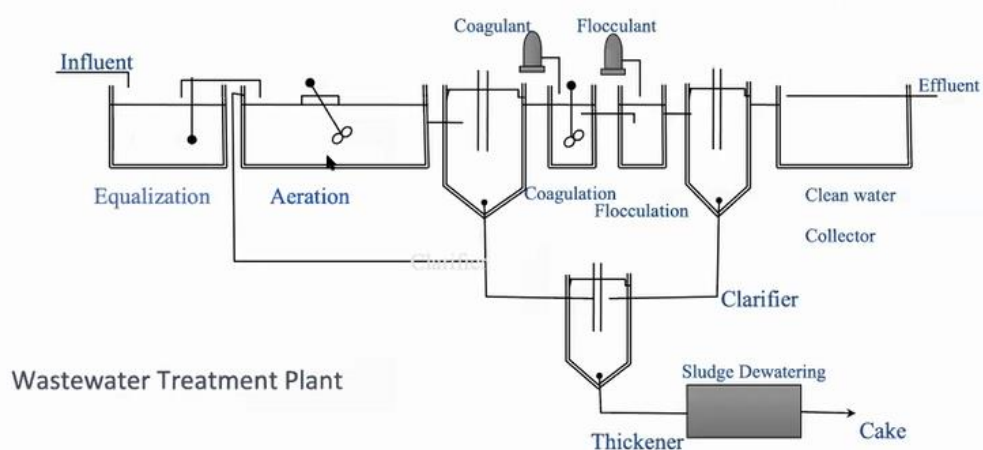


Figure 5: Flow diagram of wastewater treatment in textile industry

He then added that there are few optimization strategies for a wastewater treatment plant:

- There is no “one-size-fits-all” concept for optimizing a wastewater treatment plant;
- A solution always needs to be project oriented and developed on-site;
- Check the relevant quality parameters at the inlet and outlet of different stages regularly;
- Evaluate the design Vs operating parameters – quantity, flowrate, quality of influent parameters;
- Temperature Adjustment for Optimized Wastewater Treatment;
- Optimize the efficiency for the motor, pumps, compressors, filter press, centrifuge;
- Saving of Energy Costs through Optimal Aeration;
- Optimize the chemical dosing;
- Maintain and optimize uniform aeration in the aeration tank;
- Maintain microorganisms in the biological treatment (maintain MLSS);
- Avoid shock loading of pollutants.

Dr. Rey Sopheak, National Project Coordinator, UNIDO, introduced the TEST Contents integration into existing subjects or as a new subject. He noted that the expectation from the five-day training covering the TEST approaches, best practices in the industrial sectors, sharing of data and case studies, and TEST-related subjects in the universities in Ukraine; thus, the lecturers could

use the materials and integrate the gained knowledge/material into the university’s curriculum in two ways. The first way is to integrate them into the existing subjects, and the second option is to add them as new subjects in the curriculum to promote sustainable industrial development in Cambodia. He also shared some ITC’s program which could include in the TEST such as Enterprise Management, Operational Management, Greener Boiler Technology, Water Chemistry, Wastewater Pollution Control, and so on. In order to achieve the outcomes of syllabus/curriculum integration, the lecturers who are willing to add the TEST methodology in the existing subjects should submit the revised syllabus with some highlighting of TEST Content integration. Additionally, if a new subject is proposed, please endorse TEST integration with a new draft syllabus.

5.5.3. Agenda 3: Questions and answers

Question: Dr. Nguon Kollika

We have seen many exciting parts of the lectures from the first day until the end of the training. Additionally, Dr. Sopeak just mentioned some interesting parts/subjects to be included in the curriculum, I hope that our colleagues from the two departments could have inputs and questions on the points and mainly keep in touch with the experts to make this curriculum happen. For now, we have to gather further information and all files and then combine those as inputs for internal discussions before making the decisions. I encouraged the ITC staff to raise any questions and suggestions to the experts.

I have a question for Dr. Salil on the WTP. Based on your experiences, are there any laws or regulations which all kinds of factories need to follow? Furthermore, what kinds of industries should follow the regulations?

Answer: Mr. Salil Dutt

Different countries have different treatment systems, law and regulations, but they are basically based on where water is discharged into which receiving body: ocean, river, or lake. Moreover, various sectors have national standards which are sector specific. For example, if a factory does not come under any specific sector requirements, they have to follow the general standards. However, for textile, chemical pesticides, the paper also has their specific discharge standards because they pollute and have various pollutants in their wastewater.

Question: Mr. Tieng Kimseng, NISTI

1. Can UNIDO provide specialist/prof to test the courses that integrated in the curriculum?; 2. How many courses should be integrated to cover all the content of TEST methodology?; and 3. Can UNIDO provide short course, e.g., two-week or one-month course to provide project-based training by applying TEST methodology.

Answer: Dr. Rey Sopheak

Regarding the content integration, we do not limit any subjects, and they could be related to any subjects – creating new subjects or adding to the existing ones that are useful for industrial sectors. The training materials and contents are also available online, and for the training videos and related materials, we will share them with you.

Comment: Mr. Samnang SOU, the MISTI

Thank you so much to organizers and professors in delivering this remarkable training course. Though I am from different area but I am totally interested in the RECP and TEST methodology so that I would be able to recommend to SMEs within my own associates. I would like to also request to the program to recommend the basic technology to be applicable or feasible for SMEs. Thank you and till then we meet again, virtually.

6. Summary and Conclusions

At the end of the training workshop, on behalf of the trainers, **Dr. Branko Dunjic** recapitulated the learning outcomes from the first day to the end, covering TEST Toolkit, TEST Methodology, relationship between TEST and RECP that is very useful for academia and industrial work. He also highlighted the energy and environmental system, energy audits, and practical examples of energy assessment in Ukraine, material flow costs accounting, and wastewater treatment technology, which is applicable and useful to apply in Cambodia. The trainers were very impressed and thankful to all participants and organizers for conducting such a remarkable training. They hope that the practical knowledge sharing, tools, case studies, and presentations will bridge the connections between the university and industrial sectors, especially the university curriculum's improvement to match the market demand towards suitable industrial development. They also noted that the team is available and warmly welcome to support the university in integrating the TEST and RECP in the syllabus/curriculum and relevant subject matters to the TEST methodology and its implementation.

The five-day training workshop had completed successfully with active participation and discussion from trainers and participants along with fruitful results. The trainers gave apparent explanations and shared best practices and practical experiences of the TEST and RECP following designated courses' expectations. All the materials such as slide presentations, tools, relevant case studies, and training videos were well distributed to the participants. The participants were delighted with the learning outcomes, and they expressed their sincere appreciation to the experts and organizers for organizing the vital training workshop. The knowledge gained from the training provided enormous impacts for the teaching and research within the technical universities; meanwhile, the academicians and students will be aware of the TEST/ RECP through the integration of its relevant subjects, and students will be able to actively apply the knowledge in the university and sustainable industrial sector in Cambodia.

7. Reflections

Lastly, three main speakers had delivered final remarks and provided significant reflections about the training workshop as follows:

On behalf of the ITC, **Dr. Nguon Kollika** expressed his sincere thanks to all experts for providing valuable materials, information, and knowledge on the TEST/ RECP. He strongly believed that his colleagues would gain more practical knowledge and understanding of the TEST and its relevant approaches to be integrated into the curriculum and use them as the crucial learning and teaching platform in the university to meet the market demands in Cambodia. Remarkably, he will report the vitality of the TEST methodology and the outcomes from the training to the ITC management and organize an external meeting to integrate the TEST and its approaches into the university curriculum.

Dr. Hak Mao, on behalf of the DCC, the GSSD/MoE, thanked all speakers for providing concrete lectures during the five days, and he was very impressed by the participants and trainers. He noted that the conceptual framework of the TEST plays a critical role in contributing to achieving the Long-Term Strategy on Carbon Neutrality partially. Moreover, the TEST project provides significant impacts in terms of capacity building and formal education, which plays very significant roles in increasing the economy and addressing environmental concerns at the same time. He appreciated the UNIDO team's efforts in coordinating to identify inclusive trainers, who are very dynamic and competent, in providing excellent training outcomes for all the participants,

especially from the university. Then, he encouraged all the participants, mainly from the university, to integrate the TEST approaches into the curriculum/syllabus as he was very content to hear the commitment from the university in this consideration. He stressed that we cannot integrate this concept into university curriculum with very short period of time and we need to find a resource person for the expected new subject matter as well as budget allocation; however, we can mainstream it through raising it to the students during your respective lecture time. We experienced with the integration of climate change into curriculum and take many years. Building from this successful experience, we do expect that the TEST methodology will be mainstreamed into the university curriculum and we can pilot from one or two universities first; for example, the ITC. Moreover, he highlighted that the TEST concept already supported by the Senior Minister, Minister of Industry, Science, Technology, and Innovation, and next step, we should seek support from the Ministry of Education, Youth and Sport to make the curriculum happen in the near future. Finally, he thanked the UNIDO and looked for future supports and collaboration on low carbon initiatives in the country.

Dr. Rana P. Singh, project manager, greeted and thanked partners for conducting the momentous event, namely the DCC, to invite very qualified participants who committed and attended the entire training period for five days, full of attention and interests. He congratulated all participants to acquire such a high level of knowledge from the valuable training workshop provided by very experienced trainers across the globe. Two main things he requested from the participants. First, regarding knowledge sharing and knowledge receiving from the training course, the participants should share those on the social media platform to reach other levels of people. Second, he encouraged the partners, especially the ITC, to immediately incorporate the knowledge gained into the academic syllabus as a valuable subject for the Cambodian context.

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APPENDIX 1: Agenda of the TEST training workshop

Date: 28 June-2 July, 2021

No	Module	Time	Content	Lecturer
Day 1				
	First connection to the virtual platform	2:30 – 2:45	Participants should connect before the training starts in order to solve technical issues in advance	
	Opening	2:45-2:50	Introduction of Project Output. 4 and Capacity Building for University	Dr. Hak Mao, Director, Department of Climate Change, General Secretariat of the National Council for Sustainable Development (GSSD)
		2:50-2:55	Introduction of ITC Program Upgrade	Dr. Soy Ty, Deputy Director General of Institute of Technology of Cambodia (ITC)
		2:55-3:00	Introduction of PCP Program and Inclusive and Sustainable Industrial Development (ISID) for Cambodia	Mr. Sok Narin, UNIDO Country Representative
		3:00-3:05	Introduction of TEST Project	Dr. Rana P. Singh, Project Manager
		3:05-3:10	TEST Project Implementation from MISTI as Main Counterpart	H.E. Dr. Tung Ciny, Secretary of State and Project Director, the MISTI
1	Introduction of Participants	3:10 – 3:20	Introduction of participants (experience, role and expectations)	Participants
2	Introduction to the TEST Toolkit	3:15 – 4:15	Introduction to the online TEST Toolkit. The participants should familiarize themselves with the toolkit available at: https://www.test-toolkit.eu/ .	Branko Dunjic
	Q & A Session, wrap-up	4:15 - 4:45	Participative example Planning a TEST assessment in a company. Discussion with participants	All
Day 2				
1	Brief recapitulation of the Day 1	3:00-3:15	Discussion with participants	Branko Dunjic
2	TEST Overview	3:20-4:00	TEST overview, tools for sustainable production and their synergies Discussion on working with industry.	Cesar Barahona

3	Initial Assessment	4:15-5:00	The Rationale; The process of conducting an IA; The business case; Barriers; Conclusion	Branko Dunjic
Day 3				
1	Brief recapitulation of the Day 2	3:00-3:15	Discussion with participants	Anton Kleshchov
2	Detailed analysis of Energy flows and EE solutions	3:15-4:15	Setting up priority areas within energy flows Identifying priority areas for energy flows and revealing sources and causes of inefficiency Generation of energy efficiency solutions	Anton Kleshchov
3	Q & A	4:15 - 4:45	Discussion with participants	All
Day 4				
1	Brief recapitulation of the Day 3	3:00-3:15	Discussion with participants	Anton Kleshchov
2	Introduction to the RECP methodology	3:15-4:15	Basics of the RECP methodology; Introduction to work with the SMEs; Selected results of the RECP projects in Ukraine	Andrii Vorfolomeiev
3	Q & A	4:15 - 4:45		
Day 5				
1	Brief recapitulation of the Day 3	3:00-3:15	Discussion with participants	Andrii Vorfolomeiev
2	Performance evaluation and basics of MFCA	3:15 – 3:45	Monitoring and targeting; Introduction to Material Flow Costs Accounting	Branko Dunjic
3	Waste Water Treatment plant	3:45 – 4:15	Introduction to the optimization of WTP operation.	Salil Dutt
4	How to introduce TEST into University curricula	4:15-4:30	Introduction of TEST Contents integration into existing subjects or as a new subject	Sopheak Rey
5	Final Discussion	4:30-4:50	Final Discussion and Summary of the 5 Day Workshop	Dr. Branko Dunjic
6	Wrap-up	4:50 – 5:00	Knowledge Transfer, and Inclusive and Sustainability of Industrial Development (ISID)	Dr. Rana P. Singh

APPENDIX 2: List of participants

Virtual

Training workshop on “Sustainable Industrial Development by Integrating TEST Methodologies into Syllabuses/Curriculum” of the Institute of Technology of Cambodia (ITC)”

Phnom Penh, 28th June – 02nd July 2021

No.	Name in Latin	Gender	Position	Organization	Tel. Number	E-mail	Signature				
							D1	D2	D3	D4	45
1.	H.E. Dr. Tung Ciny	M	Secretary of State / Chairman of PSC	MISTI	012 429 406	tungciny1@yahoo.com	✓				
2.	Dr. Hak Mao	M	Director of Department and Project Manager	DCC/GSSD	078 996 479	maohakccd.se@gmail.com	✓	✓	✓	✓	✓
3.	Mr. Sok Narin	M	Country Director	UNIDO		N.SOK@unido.org	✓				
4.	Dr. Rana Singh	M	Project Manager	UNIDO		R.P.Singh@unido.org	✓	✓	✓	✓	✓
5.	Dr. Rey Sopheak	M	National Project Coordinator	UNIDO	017 668 964	S.REY@unido.org	✓	✓	✓	✓	✓
6.	Dr. Nguon Kollika	M	Head of Department GIM	ITC	077 523 228	nguongkollika@gmail.com	✓	✓	✓	✓	✓
7.	Mr. Sar Sambo	M	Production and Operation Management; Ethics, Health and Work Safety	ITC	012 987 662	sar@itc.edu.kh	✓	✓	✓	✓	✓

8.	Dr. Chan Sarin	M	Head of research unit in Energy Technology and Management	ITC	017 387 607	sarin.chn@gmail.com	✓	✓	✓	✓	✓
9.	Dr. Kinnaeth Vongchanh	F	Head of Thermal Energy Lab; Energy Efficiency; Heat Exchangers; New and Renewable Energy	ITC	099 351 199	kinnaethv@yahoo.co.uk	✓	✓	✓	✓	✓
10.	Dr. Kruey Sothea	M	Advanced Industrial Processes; Materials selection	ITC	077 717 198	kruysothea@gmail.com	✓	✓	✓	✓	✓
11.	Mr. Meng Chamnan	M	Green Boiler Technology	ITC	017 232 747	mengchamnan2008itc@gmail.com	✓	✓	✓	✓	✓
12.	Mr. Seng Piseth	M	System of Fabrication Lean; Industrial Ergonomics	ITC	012 432 408	sengpisethgim@yahoo.com	✓	✓	✓	✓	✓
13.	Mr. Khloeun Reaksa	M	Organisation et Gestion d'Entreprise (OGE) or Enterprise Management and Organization	ITC	096 534 9932	reaksakhloeunitc@gmail.com	✓	✓	✓	✓	✓
14.	Mr. San Sophak	M	New and Renewable Energy	ITC	017 830 805	san.sophak@yahoo.com	✓	✓	✓	✓	✓
15.	Dr. YOEUN Sereyvath	M	Project management Chemical and instrument analyses	ITC	010348588	svath@itc.edu.kh	✓	✓	✓	✓	✓
16.	Dr. KHOEURN Kimleang	F	Water Chemistry	ITC	086455931	khoeurn@itc.edu.kh	✓	✓	✓	✓	✓
17.	Ms. SIENG Sreyvich	F	Lecturer-Researcher, Chemical Plant Safety	ITC	099 949415	sreyvich@itc.edu.kh	✓	✓	✓	✓	✓

18.	Mr. KONG Sela	M	Industrial Chemical Process	ITC	077 200 594/ 096 8030 387	selakong@itc.edu.kh	✓	✓	✓	✓	✓
19.	Mr. Chong Bou	M	Department of Techniques and Industrial Safety	MISTI	012 835 260		✓	✓	✓	✓	✓
20.	Mr. Hoeung Kimsay	M	Department of Handicraft Affairs	MISTI	011 663 289		✓	✓	✓	✓	✓
21.	Mr. Pek Samnang	M	General Department of General Department of STI	MISTI	017 72 82 20		✓	✓	✓	✓	✓
22.	Mr. Khiev Ty	M	General Department of General Department of STI	MISTI	085 819 822		✓	✓	✓	✓	✓
23.	Ms. Chheng Socheat	F	General Department of General Department of STI	MISTI	012 935 751	chhengsocheat82@gmail.com	✓	✓	✓	✓	✓
24.	Mr. Sok Leng	M	Institute of Standard of Cambodia	MISTI	012 859 169		✓	✓	✓	✓	✓
25.	Mr. Ly Luch	M	Institute of Standard of Cambodia	MISTI	077 685 618		✓	✓	✓	✓	✓
26.	Mr. Chheng Phirun	M	Department of Techniques and Industrial Safety	MISTI	012 704 231		✓	✓	✓	✓	✓
27.	Mr. Sok Bunsry	M	Chief office	MISTI	011 214 485	bunsry@yahoo.com	✓	✓	✓	✓	✓
28.	Mr. Sin Rithy	M	National Productivity Center of Cambodia	MISTI	098 246 141		✓	✓	✓	✓	✓
29.	Mr. Lim Vichhey	M	Department of SME, MISTI	MISTI	077 680 689		✓	✓	✓	✓	✓
30.	Mr. Sou Samnang	M	Department of SME, MISTI	MISTI	011 62 63 33		✓				

31.	Mr. Hout Samnang	M	Department of Handicraft Affairs, MISTI	MISTI			✓	✓	✓	✓	✓
32.	Ms. Tit Sreyleap	F	Vice chief officer	MISTI	077 790 600	Tithsreyleap@gmail.com	✓	✓	✓	✓	✓
33.	Ms. Ly Chanthol	F	National Productivity Center of Cambodia	MISTI			✓				
34.	Mr. Tem Rithy	M	National Productivity Center of Cambodia	MISTI			✓				
35.	Mr. Soung Samnang	M	Department of Industrial Affairs	MISTI	070 492 503	suongsamnang2015@gmail.com	✓				
36.	Mr. Tieng Kimseng	M	National Institute of STI, MISTI	MISTI			✓				
37.	Ms. Lo Naysim	F	Deputy Director	MISTI	011 212 382	lo.naysim@misti.gov.kh	✓	✓	✓	✓	✓
38.	Mr. Both Sopheak	M	National Institute of STI	MISTI	016 654 555	both.sopheak@gmail.com	✓	✓	✓	✓	✓
39.	Mr. Kin Sothea	M	Deputy Director	MME	012 940 030	ksothea.edd@gmail.com	✓	✓	✓	✓	✓
40.	Mr. Chiphong Saraty	M	Deputy Director	MME	017 285 022	Sarasy.mime@gmail.com	✓	✓	✓	✓	✓
41.	Mr. Kim Tepsopheanith	M	Officer	MME	086 655 576	pheanithtep@gmail.com	✓	✓	✓	✓	✓
42.	Mr. Sary Seyhariddh	M	Officer	MME	012 513 011	saryseyhariddh@gmail.com	✓	✓	✓	✓	✓
43.	Ms. Chhat Lyda	F	ISOC project of National University of Battambang	UBB	031 774 4841	Chhat13@gmail.com	✓	✓	✓	✓	✓
44.	Mr. RIEN Ratha	M	ISOC project of National University of Battambang	UBB	012 612 203	ratharien007@gmail.com	✓	✓	✓	✓	✓
45.	Mr. PEUO Vibol	M	Lecturer of Agriculture of National University of Battambang	UBB	012 500 451	etharack168@gmail.com	✓	✓	✓	✓	✓

46.	Mr. KHIN Sophary	M	Lecturer of National University of Battambang	UBB	010 275 655	sopharykhin@gmail.com	✓	✓	✓	✓	✓
47.	Mr. Chea Nara	M	Director, Department of Air Quality and Noise Management	MoE	012 758 687		✓	✓	✓	✓	✓
48.	Mr. Aing Haypheng	M	Vice-chief, Laboratory	MoE	089 339 373	hayphengaing@gmail.com	✓	✓	✓	✓	✓
49.	Ms. Yin Voleak	F	Official, Laboratory	MoE	077 369 677	voleakyin@yahoo.com	✓				
50.	Ms. Luch Sokleang	F	Vice-chief, Laboratory	MoE	093 876 518	sokleangloch@gmail.com	✓	✓	✓	✓	✓
51.	Mr. Chin Chamroeun	M	Chief Office	EPA	078 585 377	Chchamroeun15@gmail.com	✓	✓	✓	✓	✓
52.	Ms. HUOT Syradeth	M	Officer	EPA			✓	✓	✓	✓	✓
53.	Ms. Tin Sophors	F	Chief of Office, Department of Climate Change	DCC/GSSD	012 244 662	camclimatesophors@yahoo.com	✓	✓	✓	✓	✓
54.	Mr. Doeun Dara	M	Chief of Office, Department of Climate Change	DCC/GSSD	078 23 23 16	doeun_dara@yahoo.com	✓	✓	✓	✓	✓
55.	Ms. Heang Phallin	F	Communication officer	DCC/GSSD	012 433 316	heangphallin123@gmail.com	✓	✓	✓	✓	✓
56.	Ms. Seth Sopunnaleap	F	Vice chief of office	DCC/GSSD	088 626 1623	sethsopunnaleap@gmail.com	✓	✓	✓	✓	✓
57.	Mr. Pich Sokhim	M	Vice Chief of Office, Department of Climate Change	DCC/GSSD	089 919 196	sokhim_rua@yahoo.com	✓	✓	✓	✓	✓

58.	Ms. Tep Sokpanha	F	Officer, Department of Climate Change	DCC/GSSD	012 557 449	tepsokpanha@gmail.com	✓	✓	✓	✓	✓
59.	Dr. Seak Sophat	M	Vice dean of the Faculty of Development Studies and MCC program coordinator	RUPP			✓				
60.	Mr. Phat Chandara	M	Lecturer - Department of Natural Resource Management and Development	RUPP			✓	✓		✓	✓
61.	Dr. Chou Phanith	M	Lecturer - Department of Natural Resource Management and Development	RUPP	012 792 378	chou.phanith@rupp.edu.kh	✓	✓	✓	✓	✓
62.	Dr. San Vibol	M	Lecturer - Department of Natural Resource Management and Development	RUPP		sanvibol@gmail.com	✓	✓	✓	✓	✓
63.	Mr. Khan Lyna	M	Lecturer - Department of Natural Resource Management and Development	RUPP			✓	✓	✓	✓	✓
64.	Dr. Anton Kleshchov	M	UNIDO National Project Coordinator, Global Eco-Industrial Parks Programme	Ukraine: Country-Level Intervention			✓		✓		✓

65.	Dr. Branko Dunjic	M	Director, Cleaner Production Centre of Serbia,	Faculty of Technology and Metallurgy, University of Belgrade, Serbia			✓	✓	✓	✓	✓
66.	Mr. Salil Dutt	M	Chief Technical Advisor	UNIDO Indonesia			✓		✓	✓	✓
67.	Mr. Cesar Barahona	M	Lead Expert and Project Coordinator Industrial Resource Efficient Division	United Nations Industrial Development Organization			✓	✓	✓	✓	✓
68.	Dr. Andrii Vorfolomeiev	M	Associate Professor, Institute of Energy Saving and Energy Management,	National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Ukraine			✓		✓	✓	✓
69.	Mr. Sem Savuth	M	Workshop Facilitator		010 723 250	sem_savuth@yahoo.com	✓	✓	✓	✓	✓
70.	Mr. Lun Lido	M	Vice Chief of Office, Department of Climate Change	DCC/GSSD	092 248 348	lunlido.07@gmail.com	✓	✓	✓	✓	✓
71.	Ms. Phan Sreyrith	F	Staff	UNIDO		sreyroth.phan@ncdd.gov.kh	✓	✓	✓	✓	✓
72.	Mr. Ol Phearith	M					✓	✓	✓	✓	✓

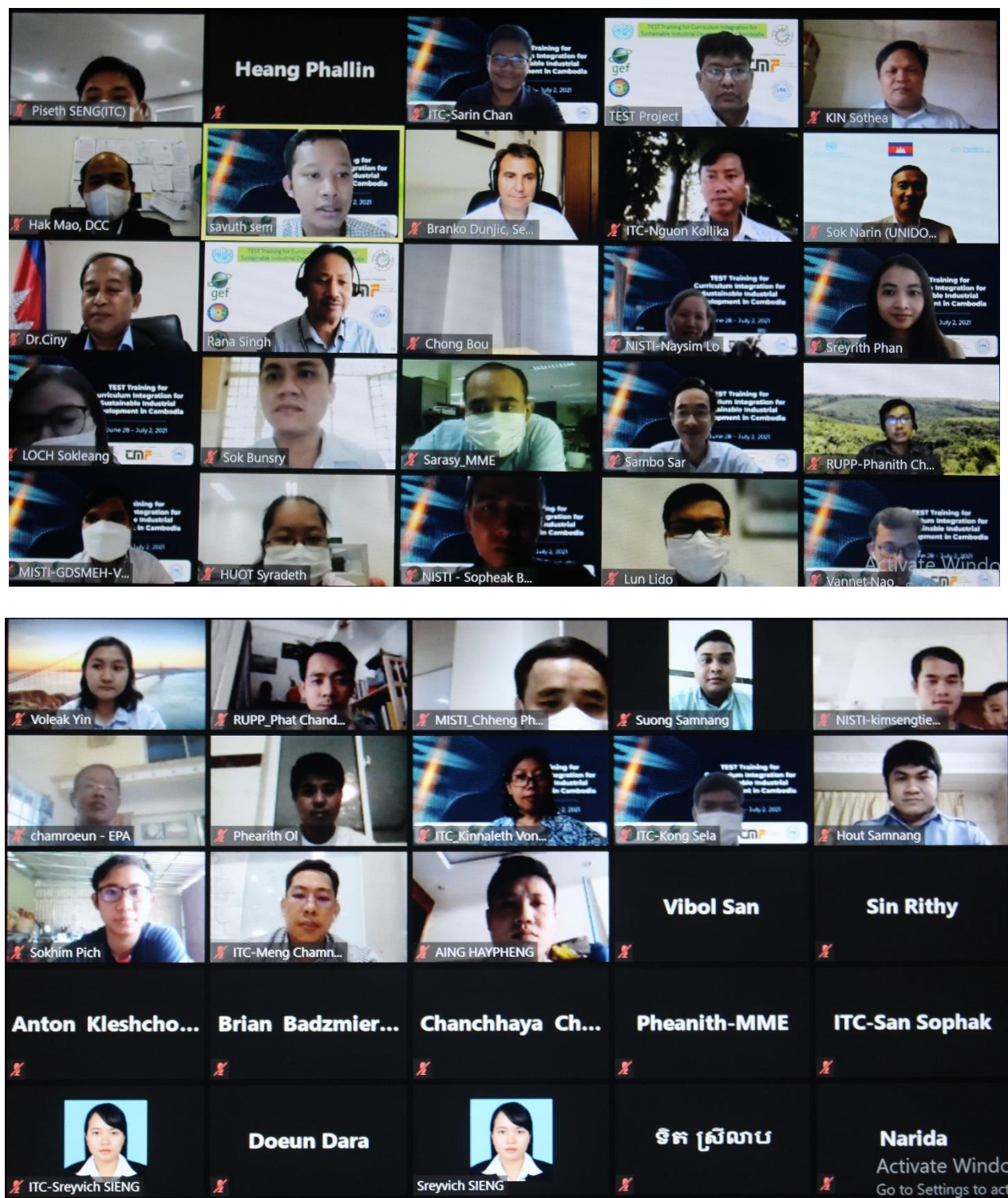
73.	Mr. Chanchhaya Chhom	M	Staff	Green Move Consulting Company	077 831 699	Chhaya22.cc@gmail.com	✓	✓	✓	✓	✓
74.	Mr. Nao Vanneth	M	Staff	Green Move Consulting Company			✓	✓	✓	✓	✓

អ្នកចូលរួមសរុបរួម៖75..... នាក់ (ស្រី៖....15.....នាក់)

Total number of participants: 75 (Female 15)

Training Workshop “Sustainable Industrial Development by Integrating TEST Methodologies into Syllabuses/Curriculum”

APPENDIX 3: Screenshot photos of the participants



APPENDIX 4: Training questionnaires

Name:

PROGRAM

TEST on-line training via zoom

from 26 June to 2 July, 2021

Pre-training questionnaire

1. What is/was your major(s)?

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2. Please state the highest degree that you obtained

.....

3. Please state your current occupation and organization

.....

4. Please describe your main duties/responsibilities

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5. Please describe the goal of your organization

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6. Please describe past or current activities of your organization which you think they are relevant to the training

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7. Why are you interested in this training?

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8. What are your expectations from the training?

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9. How are planning to utilize the knowledge and skills you obtained from this training?

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