



Integrating the Circular Economy in Forming the Future Naval Engineers

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Abstract. The circular economy has established itself as the economic model that can make a major contribution to achieving the sustainable development goals set by the United Nations through the 2030 Agenda. The European Union has adapted the model to its demands so as to transform the European economy in order to achieve the goal of climate neutrality. A great responsibility lies with the education system. The Department of Engineering and Management of the Technological Systems (EMTS) from Drobeta-Turnu Severin, permanently concerned with the adaptation of graduates to the requirements of the socio-economic environment, will include in syllabus contents related to the circular economy. One of the department's study programs is Navigation and Maritime and Inland Transport (NMIT). The article presents the result of research on the possibilities of immediate integration of the circular economy model in forming the future naval engineers. Two scenarios are analyzed.

Keywords: Circular economy · Curricula · Syllabus

1 Introduction

The 2030 Agenda for Sustainable Development, a document issued by the UN for “transforming our world”, has brought before the world's governments 17 Sustainable Development Goals (SDGs) and 169 targets to ensure the balance between the pillars of sustainable development: economic growth, environmental protection and social development [14]. The European Union, in full agreement with the 2030 Agenda, considers that one of the tools by which Member States can meet the SDGs is the Circular Economy Action Plan. Circular economy is defined: an economic model based inter alia on sharing, leasing, reuse, repair, refurbishment and recycling, in an (almost) closed loop, which aims to retain the highest utility and value of products, components and materials at all times [7, 18].

The International Maritime Organization (IMO) is the United Nations specialized agency whose role is to set standards for the safety, security and environmental performance of international maritime transport. Shipping ensures the connection of international markets covering 80% of global trade. Therefore, the IMO is directly involved in the implementation of the SDGs associated with the 2030 Agenda. At this level, it is mentioned that there is a need for government involvement in the development of

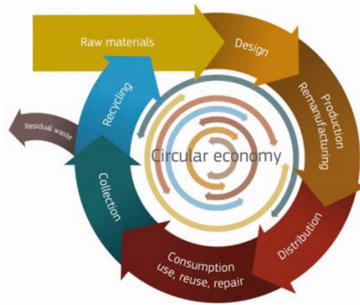


Fig. 1. The main phases of a circular economy model [12]

national policies and strategies, with the IMO acting at regional and global level by formulating innovative maritime policies [19].

The study program Navigation and Maritime and Inland Transport (NMIT) operating within the University of Craiova, Faculty of Mechanics, Department of Engineering and Management of Technological Systems, has as mission the training of human resources with superior training, complex, in the field of Marine Engineering and Navigation, in measure to continue the Romanian tradition in the naval field and its related activities, the formation of general, specific and attitudinal skills, so that graduates can develop their own successful professional careers. The program ensures the formation of a level of scientific, engineering, managerial and complementary knowledge but also practical skills appropriate to current and future needs for the shipping and navigation industry, respectively the shipbuilding and offshore industry. It also ensures the need for specialists capable of designing, organizing and conducting managerial activities in most of the departments of the shipping and shipping sector [16].

In this context, it is necessary to study the circular economy model so that future naval engineers can successfully integrate into the new operating models of the sustainable global economy. Our graduates will be contemporaneous with a period of essential transformations in the way ports and shipping are organized in order to meet the objectives of the 2030 Agenda.

2 The Circular Economy in the Context of Sustainable Development

The world economy functioned, for a century without restrictions, in a linear system which raw materials were transformed into consumer products. The main preoccupation of those involved in the extraction of raw materials, in their processing with the help of means of production and labor was the quality of products, as the only criterion for competitiveness on the world market. The impact on the environment, consisting of pollution, depletion of resources, biodiversity degradation, climate change has become visible in the last decades of the twentieth century (1972 - Stockholm Conference, 1992 - Rio Conference). This economic system has proved unsustainable.

The circular economy, characteristic of the 21st century, is a model of sustainable economy. The essential change from the old model is the application of the life cycle

product by implementing the steps related to reuse, refurbishment or recycling, so as to minimize the disposal of waste in the environment (Fig. 1). The stages of the circular economy were set by the European Union in the program “Towards a circular economy: A zero waste program for Europe” [1, 12].

The circular economy is an integrative model through the connections made between the fields of activity they involve. At the same time, it is a large-scale project because it aims at structural and innovative transformations in all sectors of the economy, adapting and reorienting social work and education systems, allocating considerable financial resources to support producers, investors, distributors, consumers and recyclers. It turns out that the implementation of the circular economy requirements will take a long time and the European Union considers 2050 as a time horizon.

The success of this model depends on the conscious involvement of every citizen of the European Union. The future will be digital, decarbonized and circular. The training of specialists with skills in understanding the functioning of the circular economy mechanism in any field of activity becomes a necessity.

3 Integrating the Circular Economy in Forming the Future Naval Engineers

The focus of the NMIT program is to promote high-profile, flexible, interactive and continuous higher technical education in line with the requirements of European and global education, with the aim of creating engineers capable of working in the field of international shipping crewing companies, and not least for the offshore industry or other related fields. The human resource of the department is anchored in research in the field of marine engineering and navigation [4, 9–11], environmental engineering [2, 5–8], management and engineering and is involved in making multidisciplinary connections between the fields of research and the circular economy.

3.1 The Curriculum of the NTMF Program - Expression of Adaptation to the Requirements of the Socio-economic Environment

The curriculum of the NMIT program aims to develop professional skills to ensure the insertion of naval engineers in the labor market [15, 16]. In order to identify new educational requirements regarding the competencies and abilities of graduates, the EMTS Department periodically analyzes the socio-economic environment which, lately, stands out through a special dynamic. Meetings are held with employers, local and regional authorities to find out their expectations from graduates of the department. Six working groups are organized at the departmental level (for each undergraduate and master’s degree programs). The conclusions of the meetings are discussed with the management of the department.

Students do internships at various employers and have the opportunity to see directly to what extent the curriculum is useful for the field studied. The Career Counseling and Guidance Center of the University of Craiova conducts regular studies and analyzes on the integration of graduates on the labor market, one of the objectives being the correlation between curricula and socio-economic requirements.

Table 1. SWOT analysis of the opportunity to study the circular economy

<p>Strength</p> <ul style="list-style-type: none"> • Global interest in the new model of the circular economy: it is taken over by many international bodies - UNCTAD, UNIDO, UNECE, including the IMO, etc. • Involvement of the European Union in the implementation of this model - it is not seen as a recommendation but is considered an instrument through which the goals of the 2030 Agenda can be met. • The model is well structured, all stages are outlined in EU documents • Web of Science database in the topic Circular economy are registered over 13000 articles • In the EMTS Department there are teachers who already have research in the field • Application of modern methods in the educational process • The NMIT curriculum is internationally open • Drobeta Turnu - Severin is a port on the Danube • In Drobeta Turnu - Severin there is a shipbuilding unit with a tradition of over 100 years in shipbuilding • Effective collaboration and communication with employers and local and regional authorities 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Romania hardly implements this model - The national strategy on the circular economy will be approved by the end of 2022 • Insufficient allocation of funds for the implementation of the circular economy • The benefits of this model are unknown • Not found in companies' strategies • Examples of good practice are not promoted • The SV Oltenia region contributes the least to Romania's GDP, compared to the other regions of Romania
<p>Opportunities</p> <ul style="list-style-type: none"> • New jobs • Development of new shipping modes • New business models (from waste generator to circular) • Limiting non-circular solutions • Development of small ports and those on inland waters • A port involved in the circular economy develops the region in which it operates • Increasing the interest of young people in the NMIT study program 	<p>Threat</p> <ul style="list-style-type: none"> • School dropout • Labor migration • Demographic decline

A SWOT analysis was performed to determine the opportunity for students to study the circular economy (Table 1).

Table 2. Părțile interesate relevante în transportul naval

Component	Stakeholders	
Ship	Ship Owner	
	Ship Operator	
	Ship Management	
	Classification Society, Class	
	Shipyards	
	Ship Recyclers (Demolition Yards)	
Freight	Charterer	chartering on the trip
		chartering on time
		chartering on contract of affreightment
Auxiliary services	Chartering Broker	
	Sale & Purchase (S&P) Broker	
	Banks and private investors	

One of the professional competencies that the NMIT program develops through the curriculum is the use of specialized technical knowledge to explain and inter-pret issues related to maintaining the ship's good airworthiness, maritime and river safety and environmental protection. This last component will be strengthened by teaching knowledge about the circular economy.

Two scenarios regarding the circular economy are outlined. A first scenario is that of introducing a new discipline, but in the group of optional disciplines or, a second scenario that materializes by completing the syllabuses of some disciplines already in the curriculum. As an optional discipline, the knowledge of circular economics will not reach all students because it is a new concept on which they cannot make assessments in terms of usefulness. Much more effective is the second scenario in which all students will study the defining elements of the circular economy.

3.2 Analysis of Structures and Stakeholders in the Naval Field

The major components of the shipping industry are:

- ship
- freight
- auxiliary services

Table 2 presents the relevant stakeholders in shipping.

At the same time, shipping is a major link in direct freight logistics worldwide, based on ports and ships. The circular economy involves shipping in reverse logistics, a component of global waste management. between the fields of research and the circular economy.

3.3 Integration of the Circular Economy Model Forming of Future Naval Engineers

By analyzing curricula and syllabuses, the circular economy model can be integrated into the following disciplines:

- a) Environmental protection, in the first year, semester 1. Contents: Agenda 2030 with the SDGs and the circular economy as a tool for the application of the SDGs (principles of the circular economy) [17, 21];
- b) Ports and waterways, second year, semester 3. Contents: Ports as nodal points in the economy circular [3];
- c) Prevention of environmental pollution, third year, semester 6. Contents: Life cycle of ships in the circular economy [13, 17, 20];
- d) Naval logistics, fourth year, semester 7. Contents: Naval transport and logistics in the circular economy (reverse logistics) [21].

4 Conclusions

1. The circular economy is a concept that will be applied throughout the world economy. Large-scale use of secondary raw materials, reuse of components, keeping products and materials in use for as long as possible, designing products free of waste and pollution, recycling, will lead to the regeneration of the Earth's natural systems.
2. The circular economy will change the structure of shipping. Future specialists need to know the principles and structure of the new business model in order to adapt to new realities and perform.
3. Through the NMIT program, the EMTS Department prepares naval engineers through a dynamic curriculum, adapted to economic, social and environmental requirements. Understanding that the future of IMST graduates will be marked by the circular economy model, its principles and requirements can be integrated into the syllabi of the NMIT curriculum. The research is carried out in parallel for the other programs of the department.

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