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CIRCULAR RUDIMENTS OF CONSTRUCTION PROJECTS IN SPACE

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Abstract

Extraterrestrial colonization has been a dream for humanity for years. It can now be said that there are some players around the world who invest more and more funds and have announced their goals to start settlements there. For instance, NASA has stated publicly that it intends to approach this purpose in the next 15 years. It is worth to explain that no space colonies have been built so far. In order to prevent commodification of the cosmos from enhancing the interests of the already powerful contemporary institutions, and to minimize the risk of exacerbating the detrimental processes such as economic inequality, and environmental degradation, a general discussion about the adoption of the principles of sustainable development, including Circular Economy as only applicable to any attempts of human colonization in space, should be started. The article is a collection of basic principles related to the implementation of the idea of Circular Economy in construction projects. It is also a guide for future generations and an attempt to answer the question: *how to prepare for revolutionary changes like space settlements*. In addition, it presents some existing difficulties in implementing the idea of sustainable development on Earth. So if we cannot save our planet today, maybe thanks to Circular Economy, we will be, at least, able to protect the cosmos and that what has remained there tomorrow?

Introduction

Not only national agencies are going to colonize the cosmos. A founder of SpaceX, established this institution, to make a human settlement on Mars real. So it turns out that not only governments but also private initiatives are trying to settle the cosmos. It does not bother the fact that sometimes there are failures. Mars One was a Dutch organization which aimed to establish a permanent colony on Mars by the year 2027. The concept had been criticized by experts as lacking critical concepts about hardware, or logistics concerns. The first martial cargo mission was proposed to launch by 2022, followed by a crewed mission in 2024, but due to financial and organizational problems, followed by a court decision to liquidate the organization, it will not happen [1].

Regardless, there is a probability that will occur a circumstance that will enable landing on other planets and beginning settlement processes. In this case, we should prepare ourselves (sectors, science, policies, procedures) for this situation today.

An interest in the subject of this article results from numerous observations of the possibilities of implementing the Circular Economy idea in construction projects. Planning change is much more difficult than planning new ventures from the very start. Therefore, changing the approach to resource management and switching it into a circular model as part of construction projects carried out in different parts of our planet is so difficult. It requires a holistic view of the problem supplemented with a number of support tools and methods. In addition, it is more expensive than the traditional approach, hence it does not motivate to act. However, one should imagine that if the process of change towards Circular Economy on Earth is proceeding on the path of evolution, then planning colonization of space requires building rudiments and rules of conduct from the very beginning. So that later changes would not have to take place, and the expensive returns of actions would not be necessary. A goal of the article is to give some thoughts about a state of advancement, speed and possible limitations of Circular Economy implementation in the construction industry on Earth. Moreover, it intends to present a road map for future construction project management executed in space during extraterrestrial settlements.

Resistance to change

When innovation is implemented, the whole economy or just a company's organization (or at least parts of it) need to undergo some

changes to adapt to the new reality. This process is likely to cost a lot, and obviously, the introduction of an innovation faces some internal resistance [2].

Paraphrasing Niccolò Machiavelli's quote, there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new approach to resource management or even a new model of construction project management required by Circular Economy.

Changes like this often run into some form of human resistance. Obviously many people who are affected by change experience a kind of emotional confusion. Even positive or rational changes may be prone to risk.

However, there are different reactions to change; from aggressive elimination, passive resistance, to concealed support, or real euphoria. All of that can be observed as a type of response to change. Managers sometimes underestimate this phenomenon.

Therefore, when planning new projects for the space colonization and settlements in cosmos, all stakeholders should take into consideration the best methods of activity with a high degree of innovation in order to avoid a need for changes in the future. In other words, every activity of humans in space should start by planning the most sustainable strategies.

Changes in small steps

Besides the theoretical considerations or developed models, everyday life provides many examples of implementing the Circular Economy concept in the construction sector. However, it is still a drop in the ocean but on the other hand a good starting point towards a more sustainable future.

In a box that was standing in one warehouse of building materials located in Bydgoszcz, everyone could place materials left over after a house renovation, which are usually either thrown away or stored in the basement forever. Used paints, adhesives and mortars would be useful, as well as painting tapes, wallpaper knives, drywall screws, insulation materials etc. As a result of this campaign, all these things were given to one particular technical school in Bydgoszcz whose students participate in different voluntary projects involving repairs of flats that suffered fire damage [3].

During the reconstruction of building envelopes in the UTP University of Science and Technology campus in Bydgoszcz in 2019, in order to achieve energy efficiency of the buildings, an old decorative concrete

layer was replaced by a new mineral wool insulation layer. The concrete elements were deconstructed very carefully (figure 1) and later stored on wooden pallets for future use (figure 2).



Fig. 1. Deconstruction of the decorative layer

Source: Author



Fig. 2. Storage of concrete elements on wooden pallets

Source: Author

Unfortunately, these materials have a little chance to be used again due to limited publicity. However, some websites dedicated to exchanging the information about old and ready-to-reuse materials or equipment may appear on the market. As an example of such a portal can be given CEBS project located on the website: www.zamknietyobieg.pl (literally “closed loop”) - the original idea of the author of this article (figure 3).

A heart of the site is a form embedded on the site. It enables for registering a product offered for other users. A first step is simple and consists in setting a type of the product from the enclosed list (construction waste, demolition waste, equipment, raw materials, ready-to-use materials). Next, a potential user can indicate a precise product features (a specific type of nutrient, description, quality, quantity) as well as give contact details along with expected pickup conditions (deadline, address etc.). It is worth to underline that in signing in helps a quite simple and intuitive set of hints (graphics, explanation text etc.). As a result of the registration, a new pin appears on a map – also published on the website. Thanks to special algorithm a form converts a location (e.g. "121 St James's Square, London, UK") into coordinates which help in setting the pin in a proper place on the map.

The most significant advantage of the described solution is that synchronization between a database and the map is automatic.

CEBS project is still in its beta version, aimed at non-commercial purposes, and all data is transferred on own risk of the user. However, after a test period and managing all legal aspects, the idea can be switched into a commercial model.

It is believed that thanks to the information technologies, Circular Economy can be implemented on a larger scale.

The presented solution can be successfully applied in every country all over the world after considering local legal and market specificity.

There were described chosen activities connected with Circular Economy implementation in the construction sector. Being aware that this is only a small collection of examples of good practice, it should be noted that the transformation of the world towards Circular Economy may take a very long time. Therefore, when planning to settle in space, all the sustainability factors should be considered at the very beginning.

Space construction projects

The existing belief of cosmic settlements is based mainly on the assumption that humanity represented by a narrow group of experts, scientists, cosmonauts explores unexplored areas of space in the search for new resources or new places for landfill waste disposal. There are many opinions that if we want to avoid terrestrial pollution, without giving up our modern lifestyle, we may think, in the near future, to relocate the most economic activities to other planets, while ‘reorganizing’ Earth into a more ecologically sustainable mode. However, treating the cosmos as another mine, or garbage dump, on which waste is left in a process of cleaning our own planet, is both absurd and irrational.

According to [4], the off-shoring of manufacturing in space could provide better or more convenient circumstances for the production of goods. Campa et al. underline that these potential ‘factory’ planets may be philosophically acceptable if the planet is already devoid of life and, can enable to accelerate reducing Earth's carbon footprint. On the other hand, how to make sure if we have exclusive rights to other planets? Moreover, there are many examples of bad practice recorded in the common experience which does not allow us to believe that creating a coherent sustainable system on Earth is possible. Maybe it is time to realize the fact that such a picture of the world is an unsurpassed pattern, and the only thing we can do is to strive to minimize damage inside our world and not to destroy outside.

Therefore, it is suggested to reverse the current mainstream reasoning and quit from protecting Earth as a priority. This does not mean that we should not work on reducing the pollution of the planet where we live. On the contrary, it is necessary to strengthen the recognition of new, less polluting and less harmful technologies. However, writing a blank page with non-intrusive ink could be seen as a metaphor for strategies of

settlements on other planets. Procedures of coexistence in space should take into account the common good of people and extraterrestrials. Exploration technologies and settlement methods should be environmentally friendly and be in line with Circular Economy principles.

According to some anticipations found in literature, colonizing space will have the opposite effect that globalization has had on our planet. Whereas the latter has homogenized the whole world in a way and, additionally, will probably result in a single race of brown-skinned human beings, space colonization will generate unprecedented phylogenetic and ideological diversity [5]. It is also possible that the global village will fracture into a great number of distinct cosmic settlements.

Going further with anticipations the need to extend the energy supply chain in remote and inaccessible locations would strengthen in the future [6]. Also, the planned space colonization may require 'space-resilient' structures, where both the construction materials and energy are supplied 'in-situ'. If so, Circular Economy may be a valuable mode of executing the construction project in space.

Circular Economy model for space projects

According to [7], evolutionary approaches to a variety of human goals have been successfully attempted in the fields of biomimicry (engineering based on naturally-evolved designs and processes) and Darwinian programming that evolves designs by evolutionary processes. Moreover, such an approach is proposed also to human space settlement. To confront this idea, it has to be said that, in the 1980s, planned construction of a permanently manned space station in low earth orbit reopened the discussion about the establishment of a manned lunar base within next 25 years for exploration of the Moon and space [8]. According to these authors, the evolution of a lunar base towards a lunar colony and manufacturing facility could have only be initiated by a powerful transportation system allowing for cost-effective space construction projects and manned spaceflight to other planets. Over 30 years after the publication of these words, it clearly sounds that predictions about the future are always very risky. Today we can add that these requirements are not enough. Experts must invent a model of space investment and construction project and describe how it should look like.

Construction management must take into account not only the basic variables of the construction projects present in typical undertakings on Earth (scope, time, cost and quality), also known as a project management triangle, but also this professional service should accept a whole life cycle

as a standard perspective. It should take Circular Economy as the only possible attitude, and acquire the Design-Build-Operate-Maintain-Deconstruct as a leading business model for space construction projects.

Only this approach can guarantee the full responsibility of space colonizers for the effects of implemented activities.

Summary

This article was focused on giving some reports about a state of advancement, speed and possible limitations of the implementation of the Circular Economy idea in construction projects on Earth. Moreover, it contains a road map with some recommendations for future generations who will manage extraterrestrial settlements. Such construction project management executed in space should include thoughtful, reasonable solutions. Among them, there are: applying the whole life perspective of the project, Circular Economy as a rudiment for planning construction projects in space, and full involvement of project stakeholders in each phase of the project, as a basic business model.

The future is not easy to predict. As shown at the beginning of this article, sometimes extraordinary, great dreams end in a brutal way. This does not mean that we should sit with folded hands and passively expect the future. Among the further research objectives, it is necessary to perform the deepening of the model of construction projects implemented in accordance with the Circular Economy principles. Particular attention should be paid to the various risks that can be revealed when managing projects on other planets.

This will require not only the qualitative recognition of individual risk factors but may also address the challenge of quantifying these risks. Such a goal is extremely difficult to achieve, but it is possible if, in addition to knowledge and experience, we also take into account skill of creative imagination and an ability to determine cause-and-effect relationships in the field of construction projects.

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