CHEMICAL ENGINEERING TRANSACTIONS
VOL. 107, 2023
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.cetjournal.it
Guest Editors: Petar S. Varbanov, Bohong Wang, Petro Kapustenko

ISBN 979-12-81206-07-6; **ISSN** 2283-9216
DOI: 10.3303/CET23107019

Role of Science Centres in the Field of Sustainability

Szabolcs Rákosi*, Attila Pongrácz

Department of Humanities and Human Resources Development, Apáczai Csere János Faculty of Education, Humanities, and Social Sciences, Széchenyi István University, 42 Liszt Ferenc Street, H-9022 Győr, Hungary
rakosi.szabolcs@sze.hu

Sustainable Development is hard to imagine without a responsible, smart society. Accordingly, Education and Awareness-raising are essential prerequisites for social knowledge and acceptance of Sustainability. This research examines the role of today's innovative educational and awareness-raising institutions and science centres in presenting Sustainable Development issues playfully and experientially, and thus in shaping the attitudes of upgrowing generations and adults. The research aims to investigate how and to what extent science centres in Hungary reflect in their content and operations the Sustainable Development Goals (SDGs) declared by the UN and Sustainability in a broader sense. A questionnaire survey was carried out by contacting 14 science centres, supplemented by an analysis of the external communication of the institutions and a telephone inquiry. The results indicate that instead of representing the diversity of SDGs, on average, only 30 % of them are presented, and science centres are highly specialised, which threatens equal access and fairness. This study is outstanding in several respects: it contributes to the development of institutions by presenting promising practices, and its academic relevance is given by the fact that research on the operation of science centres is still lacking in Hungary.

1. The world of science centres

The science centre is a new type of institution that spread widely by the 20th century. Its main aim is to stimulate public interest in towards science, especially STEM (Science, Technology, Engineering, Mathematics) fields, which are growing rapidly worldwide (Joyce, 2014). Numerous out-of-school learning initiatives operate with similar goals (Caprile et al., 2015), but science centres stand out among them. Their unique interactive playgrounds provide the opportunity to teach visitors of the centre with scientific precision, but through the experience of playing, without being noticed. Often used tools of these institutions are science shows, as well as interactive sessions involving visitors, such as scientific experimenting, robot programming or creative design sessions.

1.1 Impact of science centres

Studies measuring the impact of science centres have produced convincing results. According to Falk and Needham (2011), students have a better understanding of scientific phenomena after visiting a science centre, and 79 % of them have an increased interest in Science. Falk et al. (2016) proved that science centre visits are positively correlated with an understanding of Science and Technology and openness to STEM careers. The potential and significant reach of science centres is demonstrated by the fact that 199 institutions surveyed by Groves (2005) recorded nearly 77 million visits in a single year. The study of Bamberger and Tal (2008) proved that the positive effects caused by science centre visits can also be detected in the long term, and the visits induce further widespread effects, e.g. development of social relationships and lifelong learning skills. Persson (2015) positioned science centres as indispensable players in Education, Science and Technology. These institutions can play a key role in educating and shaping the attitudes of the entire population since schools are not the primary arena for science education and awareness-raising (Falk and Dierking, 2010). Decades of international research have focused mainly on the individual and economic impacts of these institutions, with the study of Sustainability only being a peripheral issue at best. In the Hungarian professional discourse, however, the study of science centres has not been included at all.

Paper Received: 22 June 2023; Revised: 27 July 2023; Accepted: 27 October 2023
Please cite this article as: Rákosi S., Pongrácz A., 2023, Role of Science Centres in the Field of Sustainability, Chemical Engineering Transactions, 107, 109-114 DOI:10.3303/CET23107019

1.2 Science centres in Hungary

The world of science centres has many similarities with museums. In addition to the familiar museum experiences of the past decades, non-formal learning sites offering new activities, up-to-date equipment, and innovative methodological solutions to meet the needs of the times are often difficult to distinguish from classical science centres (Rákosi, 2022). Based on the contents and the pedagogical methods used – interpreting the concept of a science centre in a broad sense – 14 institutions in Hungary were classified as science centres by this research. These include classical science centres, Agoras, smaller STEM education sites like Student Labs, robotics-focused centres, and institutions (such as an observatory) that can be seen as modern editions of classic learning spaces with innovative experience-based methods and interactive content.

1.3 Role of science centres in presenting Sustainability

An important function of science centres is supporting Public Education and awareness-raising of adults through experiential learning by presenting the latest professional content and using innovative teaching methods (Rákosi and Pongrácz, 2022). Compared to Public Education, these institutions enjoy a high degree of freedom in the way of their operation in defining the required pedagogical methods and professional contents. In addition, they possess high-quality infrastructure and modern equipment, and on top of that, their maintainers (e.g. universities and municipalities) are generally committed to Sustainability. Although there is no official data available on the number of visitors to science centres in Hungary, some institutions report up to 100,000 visitors per year. Their visibility is shown by the fact that the 14 examined institutions together have more than 187,000 followers on Facebook, according to the authors' data collection. Based on the above, it can be stated that these institutions have a significant outreach and can be an ideal platform for showcasing the social, scientific, and economic objectives of Sustainable Development.

2. Method of research

This research used mixed methods to investigate how and to what extent SDGs and, in a broader sense, Sustainability is reflected in the operation of science centres and the contents offered to their visitors.

The documentary analysis part of the research was carried out in the first half of July 2023, and the summary includes the content available on the websites and Facebook profiles of the institutions at that time. Analysing news feeds, contents published from the beginning of 2023 were taken into account. Where a science centre operates as part of a larger, e.g. Agora-type institution, the document analysis did not examine only the possible sub-page of the science centre but also the website and Facebook profile of the whole host institution.

This research focused on contents and messages directly related to one of the SDGs. The achievement of the goal of Quality Education was not examined, as the support of Public Education is a fundamental mission of today's science centres, and this goal is present in the operation of all the institutions studied. The analysis also excludes those contents that can be linked only indirectly to SDGs, such as the online ticket purchase option available on the website, which can be connected to the protection of the ecosystem or the general promotion of science experimentation to the pursuit of innovation. Nor are contents included which are only tangentially related to one of the goals. Based on this, e.g. a public program specifically focusing on the protection of the land life ecosystem was considered relevant, but at the same time, programs that only present a phenomenon of the land life in a general manner were excluded.

During the examination, the decision was made to record the mere fact of the appearance of each SDG, regardless of the number of occurrences, since a high frequency does not necessarily mean a richness of content or a higher quality. One reason for this is that some institutions publish much repetitive content. A good example of this is a scientific lecture planned for October 2023, the promotion of which has been continuously present on the Facebook profile of the organiser since March 2023. Quantity does not necessarily equate to higher quality either, as the way social media works means that a single consciously-structured, well-timed, pinned post with attractive visual elements or promotion can reach many more followers than a whole collection of less consciously structured posts.

The second method of this research was an online questionnaire using Google Forms, which was available to the 14 institutions between June 19 and July 5, 2023. A mix of close-ended questions with rating scales and open-ended questions examined how, according to the science centre's self-assessment, Sustainability appears in content offered to visitors and in the operation of the institution. The questionnaire was anonymous, and no information was required that would provide an opportunity to identify the responding institution.

The research was completed by a phone call inquiry. In June 2023, the 14 institutions participating in this study were contacted via phone numbers available on their website or Facebook profile, and the front office was asked whether the science centre offers any kind of content (e.g. exhibit, lecture, other activity) to the general public on the topic of Sustainability.

3. Results

Summarised below, which SDGs appear in the external communication of science centres, how the institutions self-assess their contents of Sustainability, and how these topics are represented by the front office departments to a potential visitor.

3.1 Appearance of SDGs in the external communication of science centres

In Table 1, science centres have been anonymously marked with the numbers 01-14, and the appearance of each SDG in the external communication of the science centre has been highlighted in green.

Table 1: Appearance of UN Sustainable Development Goals on the websites or Facebook pages of Hungarian science centres

	#01	#02	#03	#04	#05	#06	#07	#08	#09	#10	#11	#12	#13	#14
No poverty														
Zero hunger														
Good health and well-being														
Gender equality														
Clean water and sanitation														
Affordable and clean energy														
Decent work and economic growth														
Industry, innovation and infrastructure														
Reduced inequalities														
Sustainable cities and communities														
Responsible consumption and production														
Climate action														
Life below water														
Life on land														
Peace, justice and strong institutions														
Partnerships for the goals														

Analysis of the websites and Facebook profiles shows that Partnerships for the goals SDG is present in all the institutions surveyed, which is particularly welcome. The most common partners of science centres are educational actors and tourism or other service providers. A typical manifestation of partnership is when science centres run a joint campaign with event management companies to promote a major event. Another typical phenomenon arises from the mode of operation of the Agoras. In this case, the science centre is often a host institution that provides a venue, or it organizes a joint program (e.g. concert, exhibition) with another partner. In the case of Agora-type centres, which also function as urban event venues, this is part of the daily operation. It is also gratifying that the SDG Industry, innovation, and infrastructure appear in 10 science centres and Sustainable cities and communities in 7 institutions. Life on land topic is also present in 10 centres, which can be explained by the thematic focus of some of the institutions. However, it is regrettable that two SDGs (No poverty; Peace, justice and strong institutions) are not included in the contents of any of the institutions, and two more goals (Decent work and economic growth; Reduced inequalities) are present in only one single institution. Overall, of the 16 SDGs examined, 13 are present in no more than 50 % of the institutions, and each science centre represents, on average, 4.86 different SDGs, which is only 30.37 % of the total number of SDGs examined. This suggests that the science centre ecosystem in Hungary – despite the availability of modern infrastructure and significant experience in innovative teaching methodologies – does not consider itself a competent actor in the presentation of most of the SDGs.

3.2 Online survey of science centres

Overall, 50 % of the institutions surveyed (7 science centres) responded to the researchers' questions.
The first question examined to what extent science centres agree with the statement “Sustainability is primarily about taking environmental issues into account”. The responses show that the science centre community has extremely mixed views on this issue. Two institutions strongly agreed, and two others strongly disagreed, and the further respondents were split between the "tend to agree" and "tend to disagree" options. In this way,

respondents refuted the preliminary assumption that science centres interpret the topic of Sustainability broadly, taking into account social, economic, and further aspects in addition to environmental issues.
It is interesting to note that science centres commented much more positively about the contents offered to visitors on Sustainability than about the presentation of this topic in their communication, as seen in Figure 1. According to the self-assessment of the respondents, the extent to which Sustainability is available at public events is much greater (Mean = 4.14 on a six-point Likert scale) than the extent to which the topic is presented on their websites (Mean = 3.50) or social media (Mean = 3.00).

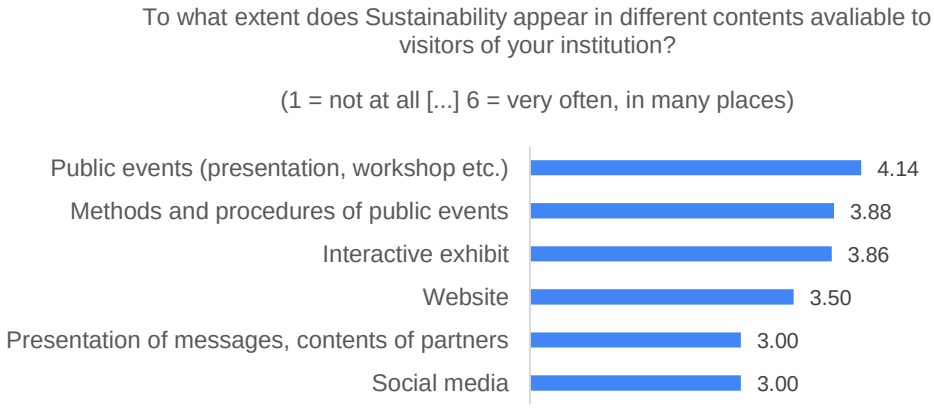

Figure 1: The emergence of Sustainability during various activities and platforms of the science centres

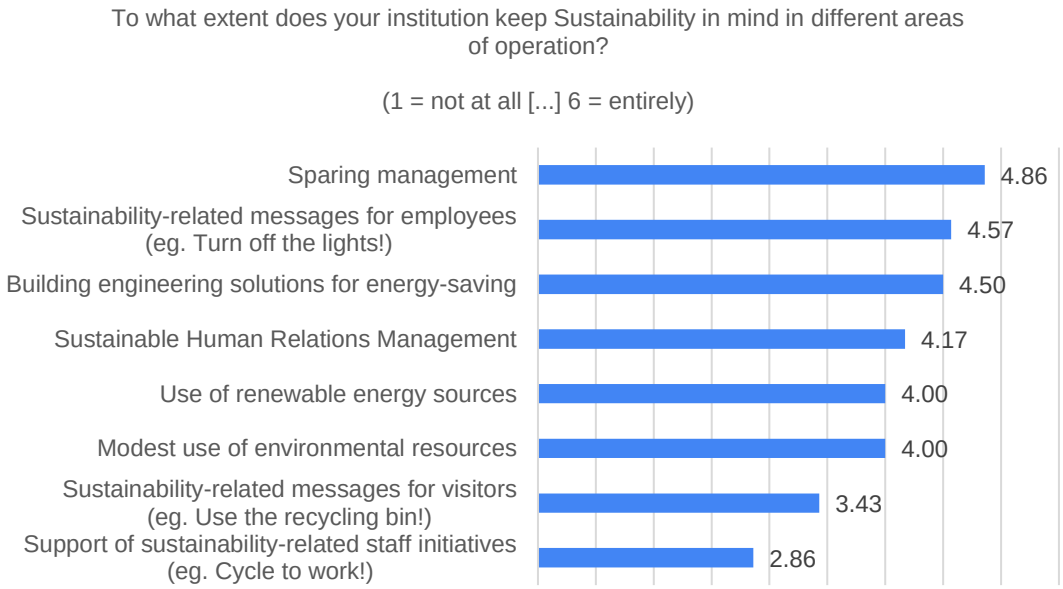

Figure 2: The emergence of Sustainability during the operation of the science centres

Another question investigated the extent to which Sustainability appears in certain areas of operation. As shown in Figure 2, when evaluating the options formulated by the researchers, issues related to Economic Sustainability were rated much higher than Environmental Aspects. However, in response to an open-ended question asked at an earlier point in the questionnaire ("What does sustainability mean to your institution?"), the responses were much more evenly distributed between environmental and economic issues (Environmental protection: 3, Economic sustainability: 3, Waste reduction: 2, Viable services: 2, Renewable energy: 2, Environmental sustainability: 2, Environmental awareness: 2 votes).

3.3 Sustainability-related content offered to the general public according to the front office of science centres

The third element of this research was a phone call to the front office of the 14 institutions. Calls were made in June 2023, during working hours, on one occasion. The question asked as a potential visitor was whether the science centre offers any content that specifically addresses the topic of Sustainability. 4 institutions (28.57 %) gave a rather positive response, but only one of them (7.14 %) indicated that a paying visitor would definitely find Sustainability-related content in the exhibition of the science centre.

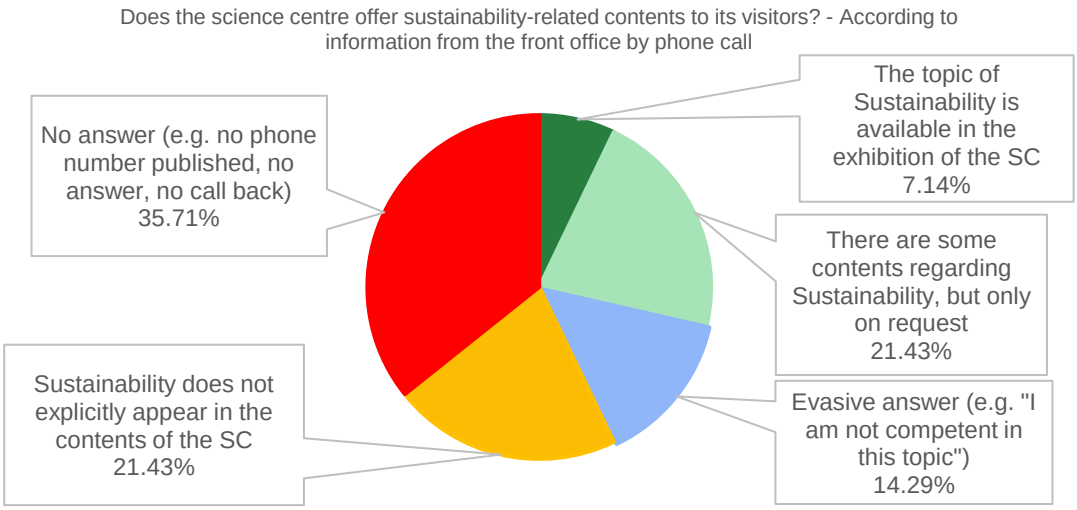

Figure 3: Sustainability-related contents for the general public according to the front office of science centres

4. Discussion

During the few years that have passed since the declaration of the UN's SDGs, the majority of science centres in Hungary have included the topic of Sustainability in their contents, but every institution has the potential for further development. Based on the research it can be concluded that the presentation of SDGs in the science centres is extremely diverse and in some cases, the information published on the website or Facebook and the content represented by the front office are not in harmony. It could be even considered natural that, related to the thematic focus, Innovation, and industry are emphasized in some science centres, while Life on land is highlighted in others, but rather than accepting this division, it might be more useful to strive for complexity. Given the inequalities in the territorial cover of science centres in Hungary (Rákosi, 2022), social justice, which is also included in SDGs, would be served if institutions with different profiles were able to reflect distinct goals, striving for balance and complexity.

A promising practice is Mobilis Győr, which offers study circles and special sessions for schools with several SDGs appearing at the same time: from Industry, innovation and infrastructure, through Responsible consumption and production, to Life on land. This puts the institution at the forefront of raising the awareness of Sustainability among the upgrowing generation. Agora Science Centre in Debrecen presents 9 SDGs in its external communication, making it the most complex of the examined institutions. This centre is where the issue of Gender equality is most prominent, which, in addition to social justice, should be highlighted also from an employment perspective, as a higher proportion of women in the labor market could be a sustainable solution for the labor shortage facing Hungary. A particularly exciting initiative is the AI picture gallery of Szent-Györgyi Albert Agora in Szeged. The exhibition of images created using Artificial Intelligence combines Art and Science and presents Technology in an easy-to-understand way even for non-STEM-interested visitors of the Agora. EDU&FUN is an institution presenting Robotics and Coding. Each of its five thematic summer camps and study circles is closely linked to an SDG, e.g. Industry, innovation and infrastructure; Sustainable cities and communities, or Climate action. KOLLABOR in Békéscsaba is an outstanding example of how even a small, low-budget institution can become a valuable member of the science centre ecosystem. Its Cricket Farm project serves several SDGs at once, from Industry, innovation and infrastructure, Responsible consumption and production; to Good health and well-being and Life on land.

The key to further development could be the spread of a complex approach such as these above. Just as in a partly art-focused Agora, Innovation can be presented to visitors through artworks created by AI, the reverse

can also be true: Peace, justice and strong institutions could be embedded in the framework of the robotics project of an automotive science centre that is primarily focused on Innovation – even if such social issues may seem to be more distant from the ambitions of a technology centre.
The limits of this research need to be fixed. The number of items is low, especially in the analysis of the online questionnaire. Although the entire sample was approached, to ensure representativeness, due to the small number of items, even a few missing answers may distort the results. For this reason, the results of the research are not considered to be general, but at the same time, they are suitable for providing an overview of the attitude and opinion of the science centre ecosystem regarding Sustainability.

5. Conclusions

The institutions examined in this research receive hundreds of thousands of visitors every year, and their equipment and methodological skills make them ideal scenes for presenting SDGs. However, the results of this research indicate that the way and extent of presenting the SDGs are extremely diverse in these institutions. Even the most complex science centre presents only 56.25 % of the examined SDGs, and 81.25 % of the examined goals appear in at most half of the institutions. Based on their self-evaluation, the topic of Sustainability appears most often at public events, but its degree and frequency are not outstanding either (4.14 on the six-point Likert scale). During the telephone research, the front office department of only one institution clearly stated that it offers Sustainability-related content to visitors. It can be concluded that science centres do not effectively represent Sustainability, and the presentation of the SDGs in a complex manner during their current operation is hardly typical. To ensure fair and equal access in these typically publicly-funded institutions, there is a need to present a wider range of SDGs instead of further specialisation. Promising practices described in the previous chapter can provide an excellent starting point for this.
Impact assessment of science centres is completely absent from the professional discourse in Hungary. The importance of this study, in addition to its recommendations for practice, is that it can be seen as a first step towards reducing this gap. One possibility for further research on this topic is to repeat the investigation in a year, which could provide an opportunity to assess whether progress has been made in the representation of the SDGs. At the same time, it would also be beneficial to examine whether the possible networking and closer cooperation between different institutions could lead to a more effective presentation of Sustainability.

References

Bamberger Y., Tal T., 2008, An Experience for the Lifelong Journey: The Long Term Effect of a Class Visit to a Science Center. Visitor Studies, 11, 2, 198–212.

Caprile M., Palmén R., Sanz P., Dente G., 2015, Encouraging STEM Studies for the Labour Market. Study for the EMPL Committee. European Parliament, Brussels, Belgium.

Falk J.H., Dierking L.D, 2010, The 95 percent solution: School is not where most Americans learn most of their science. American Scientist, 98, 6, 486–493.

Falk J.H., Needham M.D., 2011, Measuring the Impact of a Science Center on Its Community. Journal of Research in Science Teaching, 48, 1, 1–12.

Falk J.H., Dierking L.D., Prendergast Swanger L., Staus N., Back M., Barriaul C., Catalao C., Chambers C., Chew L-L., Dahl S.A., Falla S., Gorecki B., Lau T-C., Lloyd A., Martin J., Santer J., Singer S., Solli A., Trepanier G., Tyystjärvi K., Verheyden P., 2016, Correlating Science Center Use With Adult Science Literacy: An International, Cross-Institutional Study. Science Education, 100, 5, 849–876.

Groves I., 2005, Assessing the Economic Impact of Science Centers on Their Local Communities. Phase 2 of an international study of the impact of science centers, funded by the Association of Science-Technology Centers (ASTC) and thirteen individual science centers,. Questacon – The National Science and Technology Centre, Kingston, Australia.

Persson P-E., 2015, The Impact of Science Centres. The 2015 ECSITE Conference, 11-13 June, Trento, Italy.

Rákosi S., Pongrácz A., 2022, Territorial scope and regional development functions of science centres. In: Makkos A, Kecskés P., Boldizsár B. (Eds.), The future fed by the past – tradition and development, Proceedings of 25th Apáczai Conference, Széchenyi István University, Győr, Hungary, 4 November 2021, 19-29. (in Hungarian).

Rákosi S., 2022, Impact system of science centres and their potential in regional development. In: Fekete D. (Ed.), Current challenges of creative economy and tourism. Annual of Count Bethlen István Research Center, Universitas-Győr Nonprofit Ltd., Győr, Hungary, 99-114. (in Hungarian).