Diyala Journal of Engineering Sciences

Journal homepage: https://djes.info/index.php/djes

ISSN: 1999-8716 (Print); 2616-6909 (Online)

A Survey on Using BIM to Enhance Economic Sustainability in Artistic and Cultural Projects

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ARTICLE INFO

Article history:
Received June 21, 2022
Accepted September 26, 2022

Keywords:
BIM
Economic Sustainability
Artistic and Cultural Projects

ABSTRACT

Artistic and cultural buildings play a vital role in protecting national and cultural identity. Therefore, the necessity of adopting modern technologies when constructing and maintaining such buildings has become a necessity, especially with the continued growth of the construction industry and a move towards sustainable construction. Building Information Modelling (BIM) is a technology used to simplify and improve business performance in the construction industry while saving time and money. This paper aims to find the justifications for conducting research on the importance of using BIM to promote a sustainable economy in Iraqi artistic and cultural projects. This paper was conducted through literature reviews and field surveys of experts in such buildings. The results showed that there is a weak government effort to implement BIM and the owner does not request the use of BIM in the design and implementation of projects. In addition, BIM can also contribute to the efficient use of natural and industrial resources while reducing attrition and waste and improving energy efficiency by reducing energy consumption and using renewable energy. Accordingly, the researcher recommended the importance of conducting research on the importance of using BIM when creating artistic and cultural projects, in addition to the necessity of educating future generations about the concepts of sustainability and sustainable economy on a larger scale and the necessity of using biotechnology that preserves the environment and natural resources, as well as the necessity of educating the concerned authorities on how to do that.

1. Introduction

Building Information Modeling (BIM) has gotten a lot of interest from academics and industry [1]. BIM not only adds technical value to the development process, but it also provides an innovative and integrated working platform that improves efficiency and sustainability across the project life cycle [2]. Three fundamental factors, namely social, economic, and environmental, are frequently used as metrics to assess the amount of sustainability across all areas [3].

Economic sustainability is more difficult to evaluate since there is limited data identifying where the green economy is emerging [4]. However, it has been demonstrated that BIM enhances a constructed facility's life-cycle cost savings. According to Lu et al. [5] a cost benefit analysis on a sample BIM project resulted in a cost savings of 6.92 percent (490.86 HKD/m^2). Guo, et al. [6] used BIM in conjunction with an energy-simulation system to conduct an energy consumption study, which gave more complete data for optimum design choices. BIM technology can find the best alternatives to energy problems during the early design stage,

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DOI: 10.24237/djes.2023.16109

which saves time and cost compared to traditional methods that rely on two-dimensional diagrams, as traditional methods are an ineffective way to evaluate energy performance [7].

The artistic and cultural buildings are characterized as buildings with large areas and high elevations, so the necessity of adopting modern technologies when constructing such buildings has become a necessity with the trend of the times towards green construction. It is also possible to achieve a sustainable economy when constructing green buildings by adopting modern technologies in modeling and visualizing the buildings of the future.

Achieving a cost-effective construction project requires an evaluation and comparison of all costs and benefits that will occur during its expected economic life. Economically, a building design is considered cost-effective if its life-cycle cost is lower, which covers construction and operating costs. Building life cycle cost components include the initial cost of design and construction, costs of ongoing operations and maintenance, parts replacement, and disposal costs or salvage value [8].

Many current economic evaluation methodologies can be used to compare the economic performance of buildings or building systems in an effort to find the most cost-effective option. Life-cycle cost (LCC) analysis, cost-benefit ratio or saving-investment ratio, internal rate of return, net benefits, and payback period are among the most widely used methodologies [9].

When the integration of LCA and LCC with BIM has been explored in recent literature, it has been argued that the use of BIM tools can significantly relieve some of the limitations of LCA and LCC analyzes (e.g. time taken to collect input data)[10,11] .Currently, different approaches are observed in the BIM-LCA/LCC integration literature [11].Scientists use a wide range of tools to model the project and run various simulations [12,13] or use BIM tools to automatically extract bill of quantities and link them to LCA/LCC databases[14,15].

Dawood [16] proposes a model for achieving optimal or near-optimal design for residential buildings. The best design is the lowest power consumption and LCC. Kehily et al. [17] Examines the idea of leveraging BIM data to perform full LCC calculations using cost estimating tools. The goal is to associate all relevant data, such as interest rates, with BIM data in order to do a complete LCC analysis in real time. Marzouk et al. [18] proposed a decision-making framework that includes BIM, Monte Carlo simulation, and genetic algorithms as an ideal approach to select the optimal materials for a given building, both economically and environmentally.

This paper aims to find the justifications for conducting research on the importance of using BIM to promote a sustainable economy in Iraqi artistic and cultural projects. And some of objectives:

1. To know the possibility and necessity of applying the concept of sustainable building to cultural and artistic projects.
2. To know about the most important benefits of BIM that achieve a sustainable economy in the establishment of artistic and cultural projects.

The paper was organized as follows: First, a literature review was presented on the use of BIM to evaluate economics in projects. Second, the research methodology used was discussed, and thirdly, the results of the questionnaire were presented, discussed, analyzed, and revealed the truth about the use of BIM in the creation of artistic and cultural projects in Iraq and its importance to promoting economic sustainability. Finally, conclusions are drawn.

2. Methodology

To achieve the objective, the following research was followed:

- Theoretical aspects: Reviewing the literature about the research topic by summarizing the international studies, including books, papers, and theses.
- Practical aspects: The researcher used the questionnaire as a tool to find out the opinion of experts in the field of establishing artistic and cultural projects about the importance of using BIM in

promoting the sustainable economy of these projects, as it helps in collecting comprehensive and adequate data to achieve the objectives and results of the research.

2.1. Design of questionnaire

When conducting a review of previous studies, all information that helps in achieving the objectives of the study was collected, organized, studied, and analyzed to be suitable for conducting the study. After several stages of meetings, discussions, and modifications, the questionnaire was developed.

The questionnaire consists of three parts, each of which is clarified:

Part One: The General Information

This part contains an analysis of general information related to the characteristics of the study sample (name, specialization, name of the ministry/department, years of experience).

Part Two: The current use of BIM models in building practices and sustainable economics in the creation of cultural and artistic projects:

This section aims to investigate the extent to which information modeling technology is used in construction practices and a sustainable economy by identifying the major barriers to its adoption when creating cultural and artistic projects, as well as determining whether it can be adopted or whether its application is required to achieve a sustainable economy. The five-likert [19] scale was used to design the sections. The measurement scale is (strongly disagree-disagree-neutral-agree-strongly agree).

Part Three: The most important paragraphs that using BIM can contribute to improving it to achieve a sustainable economy in Iraqi cultural and artistic projects:

In this part, the researcher focused on the viewpoint of the samples regarding the importance of the items included in the questionnaire, which the use of information modeling can contribute to improving to achieve a sustainable economy in Iraqi projects. The five-likert scale was used to design the sections [19].

2.2 Questionnaire data analysis

The five-point Likert scale was used for the first and second parts. The measurement scale is (strongly disagree-disagree-neutral-agree-strongly agree). Electronic questionnaire forms were used using Google Forms, and they were sent to 30 respondents who specialize in creating artistic and cultural projects, and the response rate was 100%. Then they were collected and analyzed statistically using the statistical package social science (SPSS) program version (26), and finally the results were extracted from the survey.As stated in the Table (1) below, Likert scale points were employed, ranging from (1) to (5).

Table 1: Likert scale [19]

Likert-Scale	Interval	Difference	Description
1	1.00-1.79	0.79	Strongly disagree
2	1.80-2.59	0.79	disagree
3	2.60-3.39	0.79	neutral
4	3.40-4.19	0.79	agree
5	4.20-5.00	0.80	Strongly agree

3. Results and discussion

The questionnaire was quantitatively and statistically analyzed using SPSS. The data was analyzed in order to analyze the reasons for not adopting BIM and the most critical paragraphs that lead to its improvement in order to improve economic sustainability in artistic and cultural projects.

Part one: The General Information:

This part contains an analysis of general information related to the characteristics of the study sample, and the answers were analyzed as follows:

The questionnaire's questions were designed to be answered by 30 people work in the Iraqi Ministry of Culture. The first branch of this part represents the name of the sample (optional), while the second branch represents the name of the department for the respondent, as shown in the following Table (2).

Table 2: The respondent's department's name

Department Name	No.
Engineering Department	13
The Department of Fine Arts	3
Iraqi Fashion House	3
Department Of Film and Theatre	3
National Library	3
Tourism And Antiquities	5
Total	30

Figure (2) Shows the respondents' academic background where the percentage of Bachelor (57%), Master (40%), Diploma (3%).

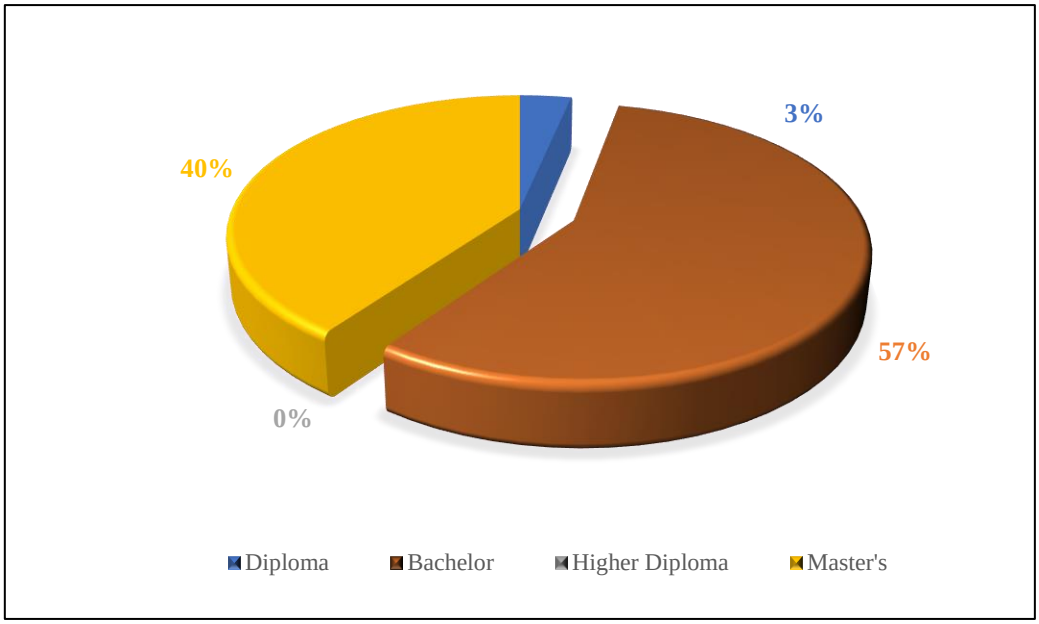

Figure 1. Educational level of respondents

Figure (3) Shows the responders' specialization where the percentage of Civil Engineer (50%), Architect (23%), Mechanical Engineer (10%), Electrical Engineer (17%), and other (0%).

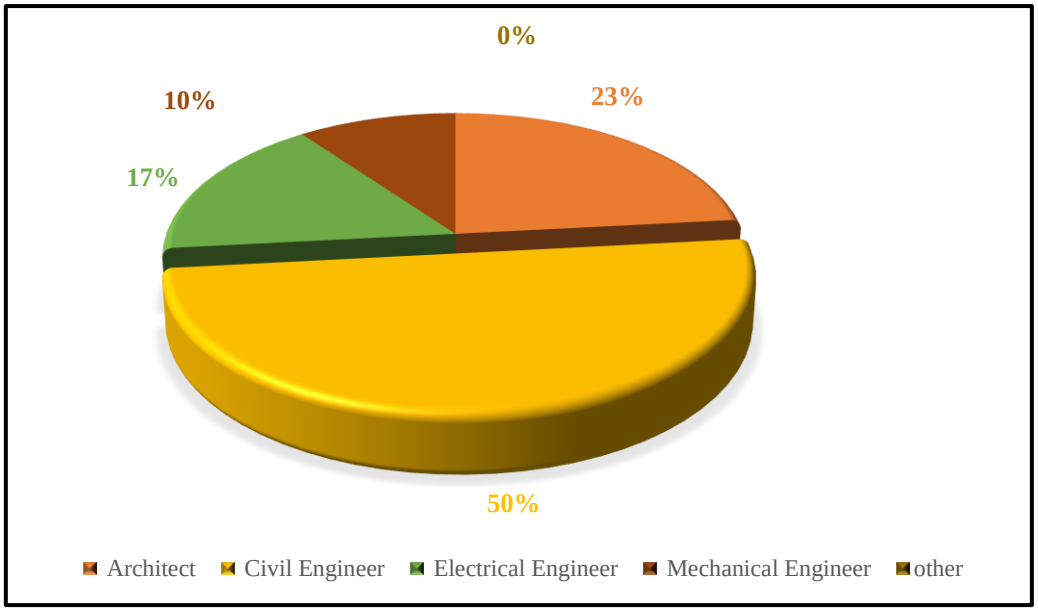

Figure 2. Specialization of respondents

The last section represents the number of years of experience of the respondent, which was represented in five categories (less than 5 years, 5-10 years, 10-15 years, 15-20 years, more than 20 years). The results are shown in the Figure.

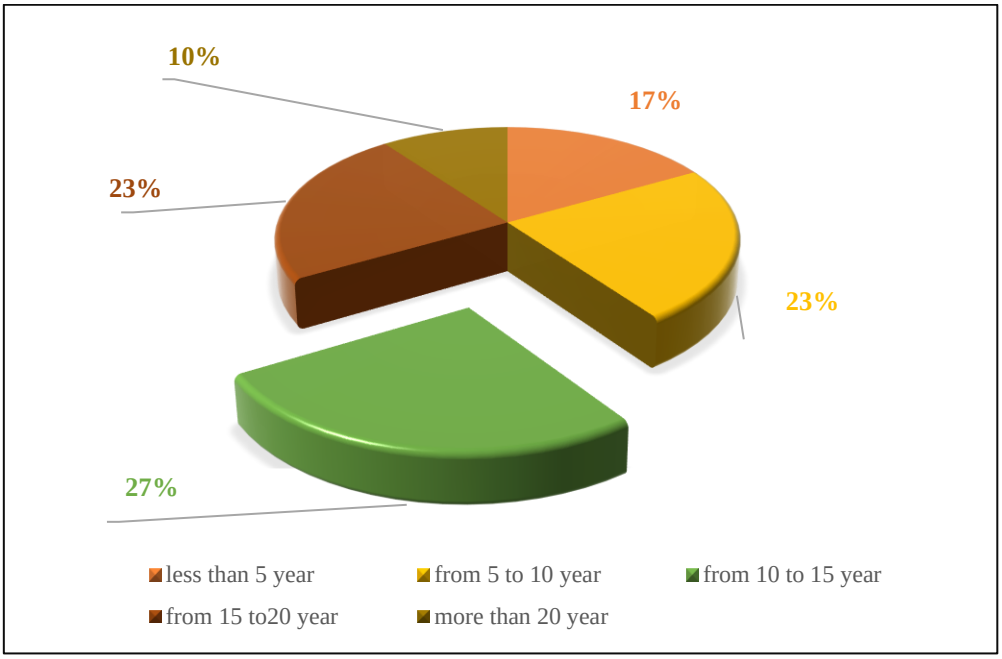

Figure 3. The practical experience of the responders

Part Two: The current use of BIM models in building practices and sustainable economics in the creation of cultural and artistic projects:

The First Portion: According to your knowledge of the current status of the projects implemented by your institution, how do you evaluate the following reasons that face the application of BIM technology?

1. The high cost of BIM software and the cost of updating these programs.
2. A shortage of experts in the field of BIM.
3. Weak government efforts to implement BIM.
4. Weak knowledge of the benefits provided by BIM.
5. Skill weakness among engineers and difficulty in learning BIM programs.
6. Fear of using modern technologies and relying on traditional methods only.
7. Unavailability of cadres and specialized experts to train BIM programs.
8. The owner does not require the use of BIM in the design and implementation of the project, and therefore there is no reason to think about adopting it at work.

The results are shown clearly in Table (3).

Table 3: Statistical analysis of items for the Part Two- First Portion

Item	Strongly disagree	disagree	neutral	agree	Strongly agree	Mean	Std. Deviation
Q1	0	1	8	17	4	3.8	0.714
Q2	1	0	2	15	12	4.23	0.858
Q3	0	0	2	10	18	4.53	0.629
Q4	0	3	3	15	9	4.00	0.910
Q5	2	3	10	10	5	3.43	1.104
Q6	0	2	9	12	7	3.80	0.887
Q7	0	1	4	14	11	4.17	0.791
Q8	0	1	2	8	19	4.50	0.777
Total						4.0583	0.52186

The results showed that the highest average was given for question No. (3) (weak government efforts to implement BIM) with a standard deviation of (0.629 (and an arithmetic mean of (4.53), which corresponds to a score of "strongly agree" in the five-point Likert scale previously described in Table No. (1), followed by question No.(8)(the owner does not require the use of BIM in the design and implementation of the project , and therefore there is no reason to think about adopting it in the work), with a standard deviation of(0.777) and an arithmetic mean (4.50), which corresponds to a degree (strongly agree), while in the last place came Question No. (5) (Skill weakness among engineers and difficulty in learning BIM programs) with a standard deviation of (1.104) and an arithmetic mean (3.43)which corresponds to a degree (agree).This result is in agreement with the finding of other researchers [20].

The Second Portion: Through your experience, please put a tick (√) in front of what represents your view of the most important paragraphs that you think can or should be applied when creating projects for the department to which it belongs: as the results shown in the chart below:

1. The possibility of applying the concept of sustainable building to cultural and artistic projects by its department.

2. The possibility of applying a sustainable economy in order to reduce the life cost of projects.
3. The necessity of economic evaluation of the life cost of the project from the early stages of design.
4. The necessity of using new technologies that preserve the environment and natural resources.
5. The necessity of educating future generations on the concepts of sustainability and sustainable economy more broadly.
6. Preparing courses and workshops to introduce the concept of sustainable development and sustainable economy in your institution.
7. The need to educate the concerned parties about how to efficiently use the environment's resources and reduce energy consumption.
8. It is necessary for the state and the ministry to support the use of information modeling technology in the creation of cultural and artistic projects through financial support and incentives in an attempt to implement the green BIM approach (green or sustainable economy).

The results shown clearly in the Table (4).

Table 4: Statistical analysis of items for the Part Two - Second Portion

Item	Strongly disagree	disagree	neutral	agree	Strongly agree	Mean	Std. Deviation
Q1	0	0	3	17	10	4.23	0.626
Q2	0	0	3	19	8	4.17	0.592
Q3	0	0	0	11	19	4.63	0.490
Q4	0	0	0	6	24	4.80	0.407
Q5	0	0	0	3	27	4.90	0.305
Q6	0	0	1	8	21	4.67	0.547
Q7	0	0	0	8	22	4.73	0.450
Q8	0	0	1	7	22	4.70	0.535
Total						4.6042	0.26278

The table (4) shows (Through your experience, please put a tick (√) in front of what represents your view of the most important paragraphs that you think can or should be applied when creating projects for the department to which it belongs) from which found that the highest average was given for the question No. (5) (The necessity of educating future generations on the concepts of sustainability and sustainable economy more broadly.) with a standard deviation (0.305) and an arithmetic mean (4.9) which corresponds to a score (strongly agree) in the five-point Likert scale previously described in Table No. (1), followed by question No. (4)(The necessity of using new technologies that preserve the environment and natural resources.) with a standard deviation (0.407) and an arithmetic mean (4.8) which corresponds to a degree (strongly agree), while in the last place came Question No. (2) (The possibility of applying a sustainable economy in order to reduce the life cost of projects.) with a standard deviation (0.592) and an arithmetic mean (4.17) which corresponds to a degree (strongly agree).

Part Three: The most important paragraphs that the use of information modeling technology can contribute to improving it to achieve a sustainable economy in Iraqi projects:

In this part, the researcher focused on the viewpoint of the samples regarding the importance of the items included in the questionnaire, which the use of information modeling can contribute to improving to achieve a sustainable economy in Iraqi cultural and artistic projects in a way (Strongly disagree, Disagree, Neutral, Agree, Strongly Agree) and as shown below:

1. Improve design efficiency by being able to simulate a design model.
2. Helping to make more flexible decisions to serve the sustainable economy of enterprises.
3. Less time on design.
4. Provides a phased methodology for preparing designs.
5. Improve the design team's skills and make communication and information sharing between project owners and contractors easier.
6. Focus on the environmental requirements of the design
7. Focus on the economic requirements of the design.
8. Through simulation, we can improve designs to meet the needs of modern architecture.
9. Reducing design risks that could affect the sustainable economy of projects.
10. Completion of the work quickly and within the budget.
11. Effective utilization of natural and industrial resources while minimizing depletion and waste.
12. To develop a sustainable economy, increase productivity and work quality.
13. Choosing the location and construction orientation in order to reduce the cost of developing projects in terms of natural lighting and ventilation, as well as ease of access to the site.
14. Promote the use of natural resources, recycled or ready-made materials in construction to achieve a sustainable economy in projects.
15. Direct integration with building energy analysis software applications and selection of the best alternatives to achieve the building's sustainable economy.
16. A better choice for thermal insulation, ensuring less wear and longer life.
17. It improves building energy efficiency by reducing energy consumption and using renewable energy.
18. Reducing and managing construction waste.
19. Better management of the building and its extensions for the period of the building.
20. Obtain estimates of the quantity of materials needed to ensure that they are not damaged or wasted.
21. Obtaining the appropriate products for processing.
22. efficient water use.
23. sustainable development of the site.

The results shown clearly in the table (5).

Table 5: Statistical analysis of items for the Part Three

Item	Strongly disagree	disagree	neutral	agree	Strongly agree	Mean	Std. Deviation
Q1	0	0	3	13	14	4.37	0.669
Q2	0	1	4	14	11	4.17	0.791
Q3	0	5	6	7	12	3.87	1.137
Q4	0	0	6	10	14	4.27	0.785
Q5	0	0	6	15	9	4.10	0.712
Q6	0	0	3	14	13	4.33	0.661
Q7	0	0	1	17	12	4.37	0.556

Q8	0	0	5	8	17	4.40	0.770
Q9	0	0	5	13	12	4.23	0.728
Q10	0	3	8	8	11	3.90	1.029
Q11	0	0	1	14	15	4.47	0.571
Q12	0	0	1	17	12	4.37	0.556
Q13	1	3	4	14	8	3.83	1.053
Q14	0	0	3	18	9	4.20	0.610
Q15	0	0	3	13	14	4.37	0.669
Q16	0	1	1	14	14	4.37	0.718
Q17	0	1	3	7	19	4.47	0.819
Q18	0	1	3	10	16	4.37	0.809
Q19	0	0	2	16	12	4.33	0.606
Q20	0	0	4	10	16	4.40	0.724
Q21	0	0	3	14	13	4.33	0.661
Q22	0	0	1	17	12	4.37	0.556
Q23	0	0	5	13	12	4.28	0.702
Total						4.2670	0.49024

Table No. (5) shows (Through your experience, please put a tick (√) in front of what represents your view of the most important paragraphs that you think can or should be applied when creating projects for the department to which it belongs) from which found that the highest average was given for the question No.11 and 17 ((11). Effective utilization of natural and industrial resources while minimizing depletion and waste, (17).It improves building energy efficiency by reducing energy consumption and using renewable energy.) with a standard deviation 0.571 , 0.819 and an arithmetic mean 4.47 which corresponds to a score (strongly agree) in the five-point Likert scale previously described in Table No. (1), while in the last place came Question No. (13) (Choosing the location and construction orientation in order to reduce the cost of developing projects in terms of natural lighting and ventilation, as well as ease of access to the site.) with a standard deviation 1.053 and an arithmetic mean (3.83) which corresponds to a degree (agree). This outcome is consistent with what other studies have discovered [5-7].

4. Conclusions and recommendations

The conclusions reached in light of the research findings can be summarized as follows:

1. When investigating the current practices of using BIM in the creation of artistic and cultural projects, the researcher reached the conclusion that there is a weakness in the government's use of information modeling technology, in addition to the fact that the owner does not require the use of BIM in the design and implementation of the project and a lack of knowledge of it.
2. There is a necessity for educating future generations on the concepts of sustainability and a sustainable economy more broadly. In addition to using modern technologies that preserve the environment and natural resources.
3. BIM can contribute to the efficient use of natural and industrial resources while reducing attrition and waste and improving building energy efficiency by

reducing energy consumption and using renewable energy sources.

Accordingly, the researcher believes that there is a necessity and justification for conducting research on the use of BIM to promote a sustainable economy in the establishment of artistic and cultural projects in order to show the benefits that BIM achieves in establishing these projects, including the economic benefits, which the next research will focus on.

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