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# LEGO and Low-fidelity Materials as prototyping Tools in Co-Creation Activities involving Multidisciplinary Participants

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**Abstract**
This study examines co-creation prototyping with LEGO and low-fidelity materials. 122 people from the fields of design, the pure sciences, forestry, and tourism are involved in this 6-hour co-creation program. The advantages of early design prototyping with LEGO and low-fidelity materials are examined in this study. LEGO and low-fidelity materials enable multidisciplinary participants to explore, analyse, and modify ideas in three dimensions, validating design solutions, idea formulation, and idea evaluation. It can be concluded that LEGO and low-fidelity materials are good co-design prototyping tools for team and strategy building because they motivate members to participate more during group discussions, manage design modifications, and demonstrate new design directions.

Keywords: Co-creation; prototyping tools; prototypes; LEGO


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## 1.0 Introduction

In our day and age of technological advancement, co-creation between stakeholders and designers is becoming more and more important. Prototyping is a key part of making co-creation activities work well, but for many product teams, it is still one of the most confusing parts of the co-creation process (Dow, et al.2010, Isa, and Liem, 2014; Ali, & Liem, 2015). It's not clear because a prototype can be almost anything, from a set of paper sketches showing the different screens or states of an app to a fully functional, pixel-perfect app (Jensen, & Steinert, 2017; Sanders, & Stappers, 2014). LEGO is without a doubt one of the tools extensively used construction kits that are used to produce tangible ideas and are required as a base for tools in activities that include co-creation (Ranscombe, et al. 2019; Isa & Liem, 2021 Robertson, & Breen, 2013). However, when LEGO is used for physical prototyping, it has significant limitations, including its rigid adherence to orthogonal structure and a restricted number of element (brick) kinds. These limits prevent LEGO from being utilised to create complex models (Wolf, 2014; Isa, Liem, Ali, & Isa, 2020). That is why this study also analysed the combined use of LEGO and low-fidelity materials as prototype tools in co-creation activities. The goal of this analysis was to find ways to compensate for LEGO's shortcomings. This paper will try to answer these research questions:

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RQ 1: Could the use of LEGOs and Low-fidelity materials benefit the multidisciplinary background of people in the co-creation workshop with the idea-generation phase? And
RQ 2: What are the advantages of using LEGO and Low-fidelity materials as prototyping tools in co-creation activities involving multidisciplinary participants?

## 2.0 Methodology

The researchers decided to use LEGO Serious Play (LSP) as a technique in order to facilitate the experience of stakeholders in broadcasting their needs, which will subsequently be transferred to designers as knowledge and important information (Harn, & Hsiao, 2018; Creswell, 2012). The LSP method was chosen because it takes into account all of the virtual elements, including thinking, problem-solving strategy, and communication that is user-friendly for both individuals and groups (Kristiansen, & Rasmussen, 2014). LSP was initially utilised and presented to the public by Robert Rasmussen in the year 1999. At that time, it was practised as a strategy and tool, but since that time, it has been further developed into an innovative approach to ensure that it is compatible with the environment of today.

LSP allows for direct involvement with stakeholders, giving them the freedom to experiment with their creativity and investigate multiple avenues leading to the desired design of a product (Kristiansen, & Rasmussen, 2014; Roos, & Victor, 2018) This is possible since there are no predetermined answers to the questions raised by the stakeholders. The data collecting and analysis strategy used in this study was adapted from Goldschmidt and Rodgers (2013) and Dow et al., (2013). Throughout the design process, facilitators took notes and photos. However, the researcher focused primarily on a specific segment of the data as well as pertinent expert reviews. The data was analysed by evaluating audio and video recordings, field notes, and images from the design practice. This study documented the use of diverse data collection methods from various viewpoints.

### *2.1 Workshop Arrangement*

The workshop was broken up into 5 different sections (see figure 1). Creative development was the focus of three of these sessions (phase 3), and each session dealt with comparable goals, tools, and approaches for all of the groups. The remaining sessions (phases 1 and 2) consisted of an introduction, session 4 (phase 4) consisted of a group presentation, and the final session (phase 5) consisted of a group face-to-face interview.

At the beginning of the first workshop session, there was a concise overview of the study, followed by a briefing session on the methods and procedures that would be used. Following that, participants were requested to fill out a form that would record their background information and sign a consent form in order to indicate that they were willing to take part in this research. After that, the researcher provided a concise explanation of the project's purpose, guidelines, and regulations according to a clearly and explicitly formulated design brief. The project brief was:

> *"Issues: Langkawi Island is a popular tourist destination in Malaysia, which lost many forested areas during rapid tourism development; in recent years, deforestation for tourism development in Langkawi has become the greatest threat to the local natural environment, notably in limestone forest areas. While the majority of the limestone forests on the island are privately owned, they are frequently mined for marble. Since the majority of the island's population relies significantly on tourism as their primary source of income, the ecotourism idea provides a viable means of conserving and protecting the island's environment and natural resources while preserving the island's primary source of revenue.*
>
> *Your Task: You need to develop a Theme Park that promotes and creates awareness to protect and save limestone forests on Langkawi Island. Create an environment that is welcoming and attracts people from all backgrounds and cultures. A successful theme park must be anchored with memorable attractions that people want to ride or see over and over again. Participants need to propose 10 campaigns/awareness related to the conservation and protection of Langkawi's limestone forest that should be included at the Theme Park for the people to experience. (Ex: special booths/ game/ space promoting Malaysian F&B, fashion, beauty, anime and education)."*

The design brief was also used to limit the design scope, because of time constraints and design activities were also prescribed as part of the brief. This particular theme park project was selected for the workshop because it involves a multidisciplinary group of participants who have prior knowledge and experience in a variety of specialised fields. For example, students from QUT were experts in the preservation of limestone forests, students from UiTM were experts in the design and development of concepts, and students from UPM were experts in eco-tourism and recreation parks.

Following the briefing session, the participants began to generate concepts by utilising low-fidelity materials and LEGO bricks. Then, once they had finished the task, they were required to present it to the experts, and finally, each member of the group was interviewed in relation to their feelings and thoughts I before the session, (ii) during the session, and (iii) after the session, regarding the ideas they had created as well as the processes they had gone through. In addition to this, a form was provided for them to fill out, on which they were to indicate which tools they prefer to use while producing ideas and how these tools assist with their idea development. The interview script was transcribed, and then it was reviewed using a method of data analysis that was suggested by Miles and Huberman (1994) and Bishop, K., and Said, I., respectively (2017).

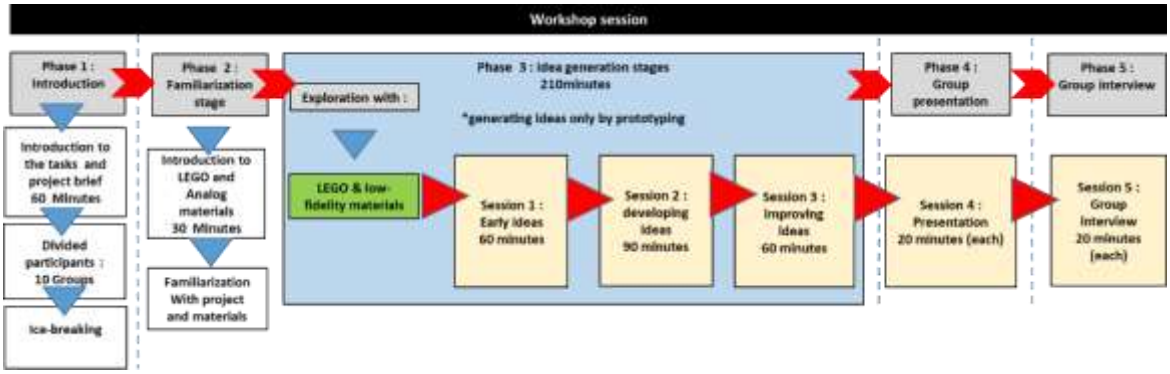


Figure 1: The workshop session

*2.2 Participants selection*

The workshop involved a total of 122 participants, 17 of whom are Industrial Designers, 21 pure sciences students from QUT, Australia and UPM, 21 from UPM stakeholders, 20 local tourists and 22 secondary students (visitors, students, lecturers, and general employees). The participants were selected at random and invited without the knowledge that they would be tasked with the task of co-creation prototyping using LEGO and low-fidelity materials. This was carried out in this manner to validate that none of the participants are more talented than the others. All of the participants, who ranged in age from 22 to 35 and were comprised of 54 males and 68 females, gave their time to take part in the session. 70 students from Universiti Putra Malaysia (UPM), Queensland University of Technology (QUT) and Universiti Teknologi MARA (UiTM) also took part in the case study to gather data on the applicability of using ecotourism as a tool for conservation activities in Penarak and UNESCO Geopark Kilim, Langkawi.

Table 1. Distribution of participants in a group

| | Group 1 | | Group 2 | | Group 3 | | Group 4 | | Group 5 | | Group 6 | | Group 7 | | Group 8 | | Group 9 | | Group 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Background | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F |
| Industrial Design (UiTM students) | 1_(D1) | 0 | 1_(D2) | 1(D3) | 1_(D4) | 1_(D5) | 1_(D6) | 1_(D7) | 1_(D8) | 0 | 1_(D9) | 1_(D10) | 1_(D11) | 1_(D12) | 0 | 1_(D13) | 1_(D14) | 1_(D15) | 1_(D16) | 1_(D17) |
| Pure sciences (QUT & UPM Students) | 1_(S18) | 1_(S19) | 1_(S20) | 1_(S21) | 1_(S22) | 1_(S23) | 1_(S24) | 1_(S25) | 2_(S26) | 1_(S27) | 1_(S28) | 1_(S29) | 1_(S30) | 1_(S31) | 1_(S32) | 1_(S33) | 1_(S34) | 1_(S35) | 1_(S36) | 2_(S37, S38) |
| Forestry (UPM Students) | 1_(F39) | 1_(F40) | 1_(F41) | 1_(F42) | 1_(F43) | 1_(F44) | 1_(F45) | 1_(F46) | 1_(F47) | 2_(F48, F49) | 1_(F51) | 1_(F52) | 1_(F53) | 2_(F54, F55) | 1_(F56) | 1_(F57) | 2_(F58) | 0 | 1_(F59) | 0 |
| Eco-tourism (UPM Students) | 1_(E60) | 1_(E61) | 1_(E62) | 1_(E63) | 1_(E64) | 1_(E65) | 2_(E66, E67) | 1_(E68) | 1_(E69) | 1_(E70) | 1_(E71) | 1_(E72) | 1_(E73) | 1_(E74) | 1_(E75) | 1_(E76) | 1_(E77) | 1_(E78) | 1_(E79) | 1_(E80) |
| Local Tourist | 1_(L81) | 1_(L82) | 1_(L83) | 1_(L84) | 1_(L85) | 1_(L86) | 1_(L87) | 1_(L88) | 1_(L89) | 1_(L90) | 1_(L91) | 1_(L92) | 1_(L93) | 1_(L94) | 1_(L95) | 1_(L96) | 1_(L97) | 1_(L98) | 1_(L99) | 1_(L100) |
| Secondary Students | 1_(SS101) | 2_(SS102, SS103) | 1_(SS104) | 1_(SS105) | 2_(SS106, SS107) | 1_(SS108) | 1_(SS109) | 1_(SS110) | 1_(SS111) | 1_(SS112) | 1_(SS113) | 1_(SS114) | 0 | 1_(SS115) | 0 | 2_(SS116, SS117) | 1_(SS118) | 1_(SS119) | 1_(SS120) | 1_(SS121, SS122) |
| Total Male & Female | 6 | 6 | 6 | 6 | 7 | 6 | 7 | 6 | 7 | 6 | 6 | 6 | 5 | 7 | 4 | 7 | 7 | 5 | 6 | 6 |
| Total participants | 12 | | 12 | | 13 | | 13 | | 13 | | 12 | | 12 | | 11 | | 12 | | 12 | |

* M : Male F: Female QUT : Queensland University UPM : Universiti Putra Malaysia UiTM : Universiti Teknologi MARA Malaysia (D1 - SS122) participants' coding

*2.3 Workspace, facilities and materials*

The co-creation session took place at the students' hall at Mahsuri Secondary School on Langkawi Island, Malaysia. The school took the initiative to invite participants from seven secondary schools in a few districts in Kedah, as well as to provide the space and amenities that this workshop required. Participants were divided into groups and placed in round table discussion settings to make them more relaxed, comfortable, and easy to create and make ideas together (see figure 2).

Figure 2. Round table discussion set up for making and creating

Participants were given the materials and equipment specified in Table 2 so that they could experiment with them while the co-creation process was being conducted. Referring to the table the other materials were those with low-fidelity characteristics that could be

employed with the required creating tools for prototyping. Table 2 shows the diverse range of low-fidelity materials and types of LEGOs given to the participants to play around with in facilitating the co-creation process.

| | Tools | LEGO | Other Material |
|---|---|---|---|
| **Building Task** | Pencil, pen and marker, Cutter, Scissors, Masking tape, Glue | LEGO bricks, LEGO parts , LEGO mini figures, LEGO baseplates | Boxboard, mounting board, rope, modelling clay, sticks, decorative sticks, stickers, ice-cream sticks, wire, foam, straw, sponge |

Table 2. List of tools and materials provided for the workshop sessions

## 3.0 Results and discussions

*3.1 Participant's selection of prototyping tools*

Figure 3, summarises the preferences of tools they selected for prototyping activities. The majority of participants showed a preference for LEGO for prototypes compared to other low-fidelity materials. Particularly, participants valued the contribution of LEGO as a prototyping tool, because it facilitates divergent and convergent exploration of ideas, as well as a more accurate evaluation of the design through interactions with the prototype/model.

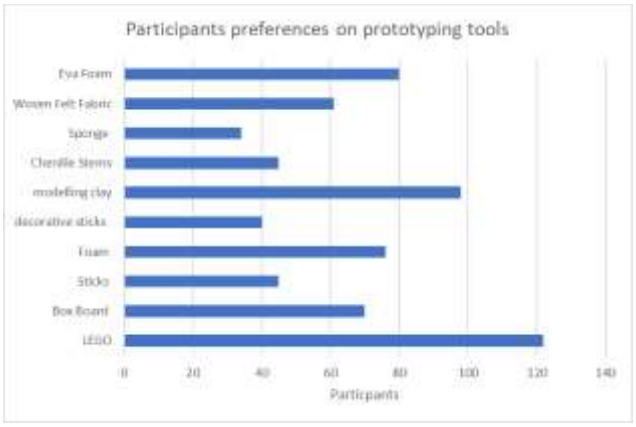


Figure 3: Participant preferences of tools in the workshop

*3.2 LEGOs and Low-fidelity materials benefits multidisciplinary background of people in developing ideas*

As shown in Figure 4, the majority of respondents who came from multidisciplinary backgrounds participants strongly agree and agree that LEGO and other low-fidelity materials benefitted them in areas of communication. It can be assumed that the element of "playfulness" by using LEGO and low-fidelity materials encouraged participation and improved communication between them. This is followed by group decision-making and planning. Lastly, they also agree and strongly agree, that it influences and improves their interpersonal engagement. This indicates that participants were comfortable when using LEGO and Low-fidelity Materials as tools in the idea-generation activities. Thus, it can be concluded that LEGO and low-fidelity materials may enhance creativity and encourage users to develop their ideas together (Peters & Ahmadpour, 2020; Isa & Liem, 2020; Van Waart, et al., 2015).

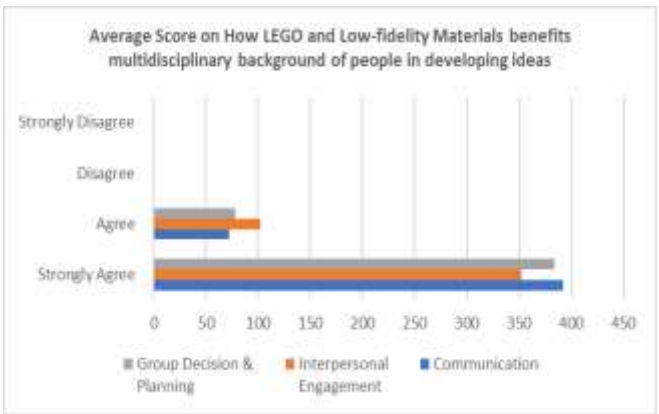


Figure 4: Score on how LEGO and Low-fidelity Materials benefit participants

Another evidence of how LEGOs and Low-fidelity materials benefit the multidisciplinary backgrounds of people in the co-creation

process can be seen in Figure 5 below. Here, we can see that majority of respondents strongly agree and agree that prototypes using LEGO and other low-fidelity materials can be used as a tool to facilitate communication and engagement among team members and stakeholders. Here we can see that the possibility of combining LEGO with other materials, which are easily mouldable and transformable, may reveal design problems more quickly, and accurately so that reflective, iterative, and interpretative solution finding (Isa and Liem, 2020; Ranscombe et al, 2020), as well as facilitate teamwork.

The combined use of LEGO and Low-fidelity objects resulted in effective prototyping when transforming ideas into convincing design directions in the early product planning stages. It motivated the participants to refine their ideas to iteratively create and evaluate better solutions while introducing new meanings and functionalities. Combining LEGO and Analog Objects in low-fidelity prototyping provided designers-stakeholders with quick and proficient feedback on their designs, which enabled them to work more flexibly and adapt to comply with realistic project requirements and deadlines. This further will nurture communication and engagement among them.

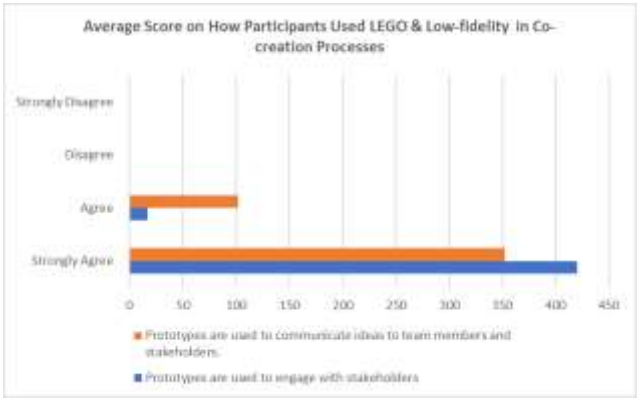


Figure 5: Score on how participants used LEGO and Low-fidelity in developing ideas

*3.3 Advantages of using LEGO and Low-fidelity materials as prototyping tools in co-creation activities*

*3.3.1 Low skill requirement to use:*

LEGO offers a low-skill requirement for both designing and building models. Model creation is made simpler by LEGO's interlocking stud mechanism, which only permits connecting pieces in a relatively limited number of ways. Additionally, LEGO is a user-friendly construction kit that not only adults but also young children may use because connecting pieces only requires a little amount of effort and skill. From the comprehensive overview, we can draw the conclusion that combining LEGO and low-fidelity materials as prototyping tools may give people from different fields more room to be creative in co-creation activities.


Figure 6: Low skills needed while prototyping with LEGO and low-fidelity materials

*3.3.2 Engaging people:*

Initially, LEGO was mainly intended to entertain people as it was introduced as a toy, however, due to its playfulness, LEGO is used to encourage participation in a wide range of activities, this playfulness facilitates greater stakeholder engagement and participation in the design procedure. The advantages of LEGO and low-fidelity materials as physical prototype tools may be observed in their capacity to engage users in the design process, as well as their interchangeability and reconfigurability.

Figure 6: Prototyping with LEGO and low-fidelity materials engaging team members

*3.3.3 Assembly speed and multiple modifications:*

When comparing the skill levels of multidisciplinary participants prototyping with LEGO and low-fidelity materials is created quicker compared to other physical prototyping methods. The palpable, imperfect, and incomplete character of the low-fidelity material used in this study causes the participants to feel unsatisfied with their ideas, which motivates them to constantly improve them and test them out repeatedly in order to understand how they work.

Figure 7: speed in prototyping and uncomplicated modifications

## 4.0 Conclusion

The primary purpose of this investigation is to generate a co-creation tool that is adaptable in terms of both time and location, so that it may be utilised during any stage of the design process involving multidisciplinary backgrounds of people. When compared to high-fidelity materials, which are suitable for prototyping more complex product designs but require more time and a greater number of components and templates, using LEGO bricks and other low-fidelity materials to prototype ideas takes significantly less time and does not require nearly as much of either type of component. They will help multiple backgrounds of people who are not designers to prototype ideas easily to anticipate future needs, future experiences, and future ways of living. Papert's theory of constructionism (Papert, 1980) underlines the fact that actively making things with one's hands increases one's thinking and learning. From this theory, it can be concluded that making things with LEGO and low fidelity can facilitate thinking and learning in more effective ways.

This conclusion presents an interesting opportunity for additional investigation into the components that contributed to the outcome of this research. Each of the materials provided, when viewed in light of the prevalent design behaviours, attitudes, and mindsets among the participants, possesses both strengths and weaknesses with regard to how they are being applied and how they contribute to each of the stages in the design process. This is because each of the participants approaches to design in their own unique way. Notably, all of the participants placed a high value on the contribution of LEGO and other materials as prototyping tools for the design development process. This is due to the fact that using these materials allows for easier divergent and convergent exploration of ideas, in addition to a more accurate evaluation of the design through interactions with the prototype or model.

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