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Empowering the Community to Design a Household Waste Management System Through Design Thinking

Ronald Julion Suryadi[1], Johanna Renny Octavia[2]
Department of Industrial Engineering, Parahyangan Catholic University, Indonesia

Abstract

The waste issue caused by a linear economy concept has a serious impact on the environment, society, and economy. The damage of this issue is threatening the community's resilience and well-being today and in the future. For instance, Bandung City had suffered a waste disaster in 2005 which is known as Bandung Lautan Sampah. In line with this, the local government of Bandung City has implemented the Reduce, Separate, and Benefit (KangPisMan) program which targets each region to reduce waste by 30% by 2025. Overall, the waste generation data indicated that Bandung City will not achieve the reduction target. To mitigate the worst scenario, it is necessary to accelerate the adoption of a suitable waste management system in the city, especially in the household area where the majority of waste comes from. Thus, the objective of this research was to design a pilot project that empowers a community to reduce household waste. The community involved in this pilot project for the design of a household waste management system was the residents of RW 005, Cisaranten Kulon Village, Bandung City. Design thinking was applied as the research methodological approach, given that waste is a complex, wicked problem. Through design thinking, we expect to design a waste management system, that is human-centered and sustainable, as a solution to this problem. In this research, together with the community, we have successfully developed a system prototype, which consists of a waste material flow system, an organization structure, a circular business model canvas (CBMC), a Standard Operating Procedure (SOP) for waste transportation, and a door-to-door education program. Furthermore, the prototypes will be implemented and evaluated for prototype improvement.

Keywords: *Design thinking, community empowerment, household waste, pilot project, waste management*

INTRODUCTION

How is it possible that community empowerment actions in household waste management issues can create a sustainable place to live? As most of us are aware, municipal solid waste (MSW) is a dilemma for some communities since it causes several troubles. Even though communities still be apathetic toward the disruptive influence of MSW, the disastrous impact of MSW keeps haunting how people live today and in the future. If these people's living pattern imperfection is not transformed, the threats of resilience and well-being in the living environment will not be achieved in the future. Consequently, it is essential to accelerate the adoption of a suitable waste management system in the city, especially in the household area where the majority of waste comes from (Indonesian Ministry of Environment and Forestry, 2020).

With the fact that Indonesia is an enormous country with a large population, Indonesia is projected to generate 36.9 million tons/year in 2020 (Indonesian Ministry of Environment and Forestry, 2020). This amount was larger than the waste generation in 2019 in which it escalated to 5.5 million tons/year over the previous year (Indonesian Ministry of Environment and Forestry, 2020). Besides, 47.01% of Indonesia's waste generation in 2020 is not managed by the waste management

Corresponding author
ronald.j.suryadi@gmail.com
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system. This number means there are 17.3 million tons/year of waste that is illegally dumped or even burnt. It seems that Indonesia does not learn from the previous disaster in Bandung, which was called Bandung Lautan Sampah in 2005.

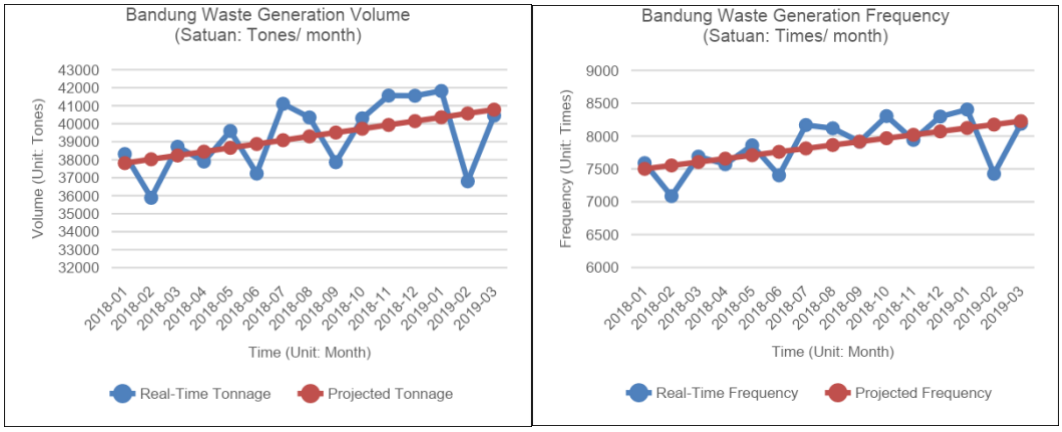


Figure 1. Bandung waste generation over the years: (a) Volume; (b) Frequency.

Reminiscent of national condition, Bandung city waste generation has identical issues. Based on simple linear regression calculation, either tonnage or frequency of Bandung waste generation over years is projected to step up (Bandung City Environment and Hygiene Service, 2019), see Figure 1. For this reason, Bandung city suffers the issue of limited land to hoard the MSW. Legoknangka, currently Bandung landfill, only provides a quota of 1,200 tones/day for Bandung City, although Bandung City produces 1,500 tones/day (Bandung City Environment and Hygiene Service, 2019). Therefore, the sustainable living environment of the communities in Bandung is jeopardized by the waste issue since not only a spatial problem but also other indirect effects due to dumping waste, i.e., global warming threats. If this issue is not fixed immediately, the risk of some communities being trapped by the danger of health can be increased. Correspondingly, a new strategy of waste generation reduction is critical to creating to mitigate the risk and make the city more resilient and well-being as stated in Sustainable Development Goal (SDG) 11.

LITERATURE REVIEW

As well stated above, Bandung city is threatened by the upcoming issue of the waste generation that exceeds its current capacity for waste management. People nowadays adopt a linear economy in their consumption pattern which is products are destined for landfills or will be burnt after people finished consume them. However, a linear economy does not only harmful to the environment and society, but this type of economy misses the opportunities to gain benefit from the waste treatment economically. An economy concept called a circular economy is a 'panacea approach' to solve the waste issue in the linear economy world and offers innovative and sustainable pathways of production and consumption (Merli et al., 2018). The circular economy has principles (MacArthur, 2013) such as rethinking waste as the source material in the product cycle, developing a resilience system through diversity, and transforming the material uses into renewable sources. In addition, ReSOLVE (Regenerate, Share, Optimise, Loop, Virtualise, and Exchange) approach (Jabbour et al.,

2019) is one of the approaches that could be used to transform the society's economic model from a linear economy into a circular economy.

On the flip side, a household waste management issue is a social problem in the society that has multiple stakeholders, many conflicts within the system, unable to be formulated, and unclear causal relationships in which this social issue is called a 'wicked problem' (Buchanan, 1992). Regarding this 'wicked problem', a systemic, as well as human-centric, is needed to solve this 'wicked problem' which this problem could be solved by a design thinking approach. Design thinking is an innovative social approach that is focused on human needs that integrate social needs, technology conditions, and the succession of a business need (Lewrick et al., 2018). This approach is well known as the double diamond approach which the first diamond is used for exploration and mapping, and the other is used for innovation implementation. Further, the bottom-up social innovation is a common framework for supporting a sustainable economy, social equity, and a healthy environment and achieving SDGs as the main goal (Millard, 2018). Overall, innovating solution for the household waste issue is related to SDG 11 and SDG 12 to enable a resilient and well-being city through redesigning the product cycle into the circular economy model.

METHODOLOGY

This research uses an adaptation of the design thinking method as its methodological framework. This research methodological framework can be seen in Figure 2(a). Firstly, this research began with topic determination. The chosen topic was social innovation on the waste issue. Second, it came to a preliminary study that complements this research with empirical data from previous research and several interviews with some stakeholders. This stage found the urgency of this research to design a pilot project of waste generation reduction strategy in the household area, as said above.

The third step is design thinking iteration. Design thinking is a strategic innovation framework that can be used for social innovation which is human-centered and can be integrated with society's needs, technology readiness, and business objectives (Lewrick, Link & Leifer, 2020). Generally speaking, there are 2 clusters of design thinking. These clusters are also known as the double diamond approach. The steps are not a linear process however, they can be iterated from the beginning or in the middle as the performance is going on in the research. These steps were done by several dialogue techniques, such as focus group discussion and interviews. As well, the obtained data from every meeting are mapped by the design thinking toolbox.

The first three steps are categorized as problem space. Three of these steps are used to define what the problem is going on in society. The timeline of the problem space activities can be seen in Figure 2(b). Firstly, this cluster begins with the understanding step. At this step, the problem identification was done to recognize what issues society has in certain areas. Second, it is continued by the observation step. At this step, all stakeholders' needs were identified. Third, define the point of view step. At this step, the problems were formulated to define a point of view.

The second diamond is categorized as solution space. Two of these steps were used to define how the solution is designed in society. The timeline of the solution space activities can be seen in Figure 2(b). Firstly, this cluster begins with ideate space. This step generated numerous ideas and selected those ideas. Then, it is continued by the prototype step. At this step, prototypes of the selected solution were created. After the design thinking iteration, the solution from this research was analyzed and produced conclusions. Additionally, circular business model canvas (CBMC) was used

(Lewandowski, 2016) to define the past and the transformation design of the new waste management system.

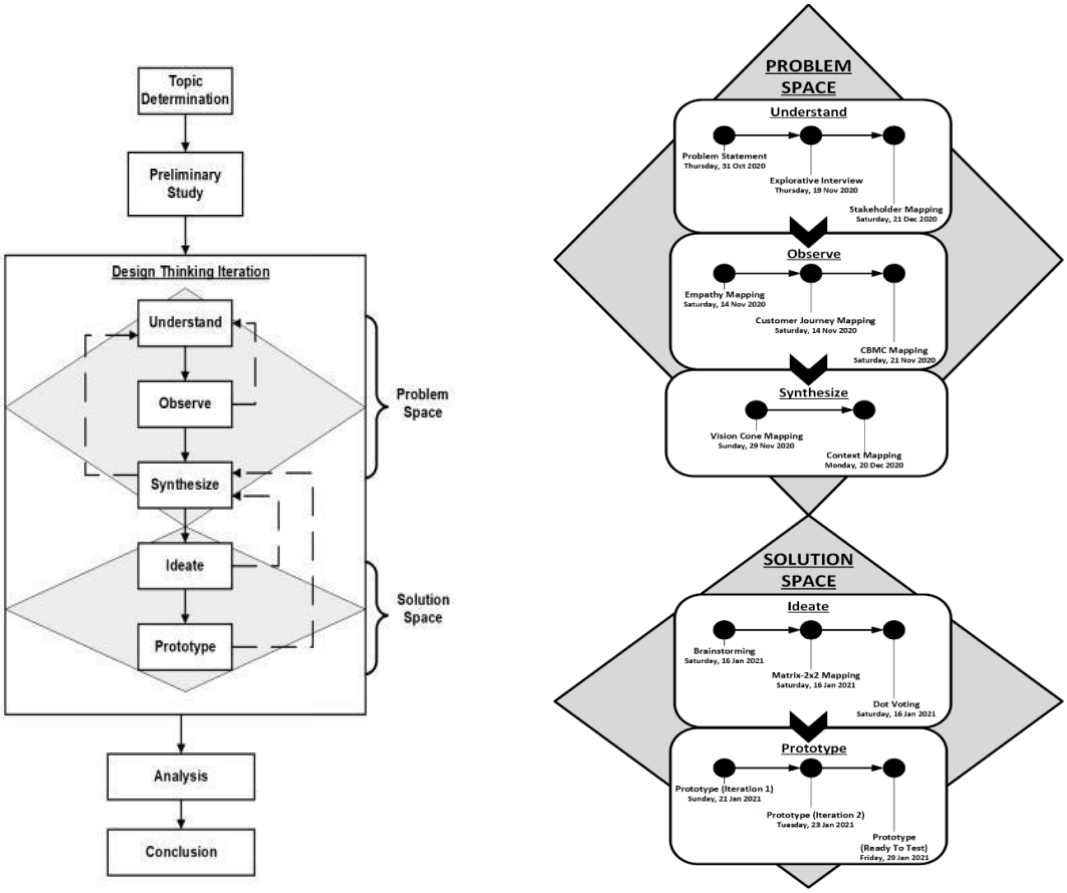


Figure 2: (a) Methodological framework; (b) Design thinking timeline.

FINDINGS AND DISCUSSION

In harmony with the design thinking approach, this research has two major discoveries. Initially, this research found the initial waste management system condition in the research object. Following this, local citizens and several stakeholders started to take steps to transform the waste management system to build a well livable environment in their neighborhood.

Empathize process of baseline condition of the system

Before all else, RW 005 Cisaranten Kulon Village is located in east Bandung in which this location is obliged to implement the KangPisMan program into their waste management system. In this research, the system was observed to recognize how further this location has already implemented the KangPisMan into the system. Therefore, varied focus group discussions (FGDs), several interviews, and many explorations with the villagers and local stakeholders are conducted in this research to empathize what issues of a waste management system are carried out by the local citizens.

Every focus group discussion (FGD) with the villagers was carried out using formal meetings (a.k.a. musyawarah) in creative techniques, such as using paper notes to deliver ideas and maintaining brainstorming sessions. Local citizens who consisted of the head of Rukun Warga, Rukun Tetangga (RT) chiefs, Pemberdayaan Kesejahteraan Keluarga (PKK) participants, and several citizens are invited to the meeting and persuaded to voiced their opinions about their neighborhood, especially about the waste issue, see Figure 3(a).

Figure 3: (a) 31 Oct 2020 FGD; (b) 19 Nov 2020 Interview (c) 19 Nov 2020 waste bank exploration; (b) 20 Dec 2020 TPS visit

By this, the result of numerous meetings successfully identified that this RW was willing to enhance its waste management system. In addition, the interview was held with the urban village head of Cisaranten Kulon. As a result of this interview, the urban village head stated that Cisaranten Kulon village has already had a mission to implement the KangPisMan program into all RWs in this area, see Figure 3(b). Further, exploration is executed to recognize how well the waste management system is going nowadays, see Figure 3(c,d).

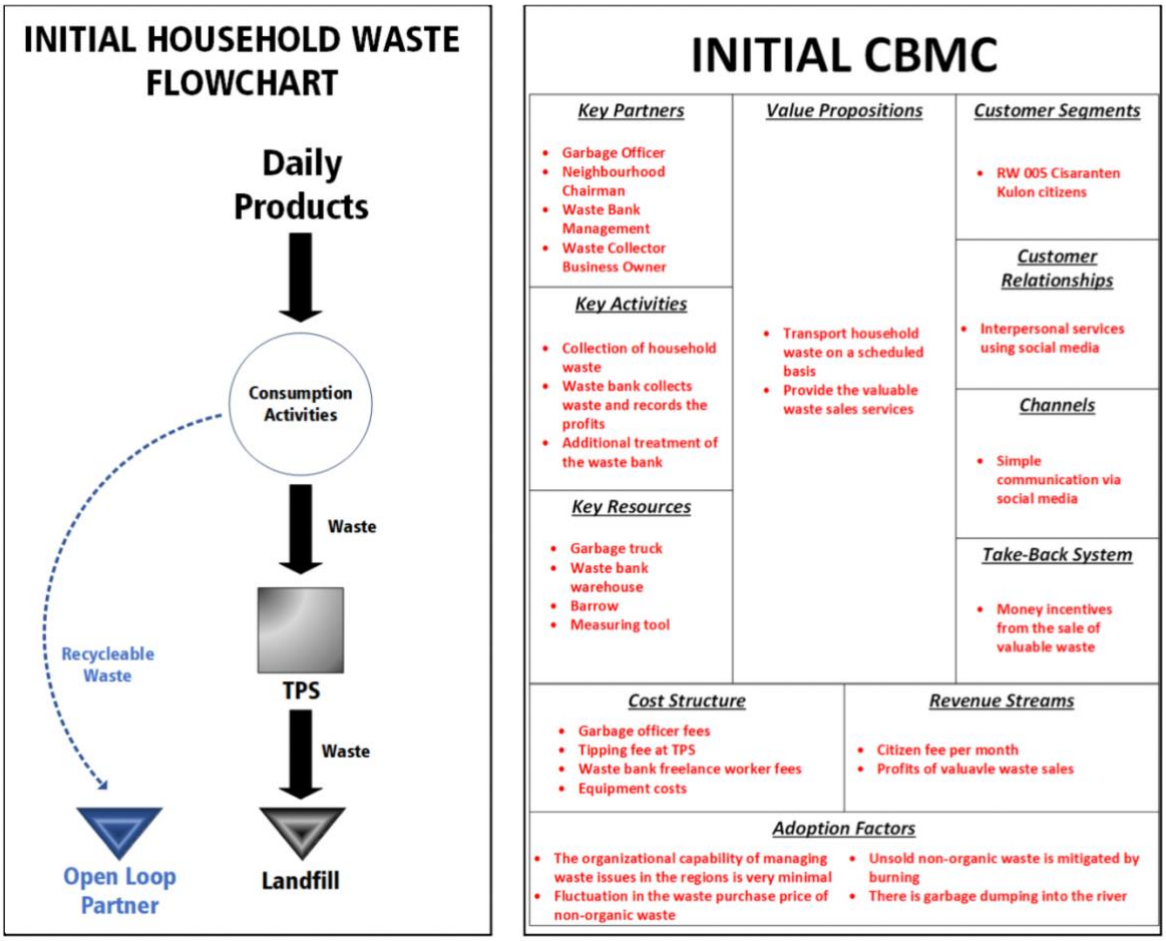


Figure 4: (a) Initial household waste flowchart; (b) Initial CBMC

As a result of the identification process, this RW produced 858 kg of household waste every day. This research found that this location has not applied for the KangPisMan program; however, this location has a waste bank in which 12.5% of 400 houses have already separated their household waste and delivered their recyclable waste to the waste bank. For that reason, this area's waste management system was still adopting a linear pattern of a waste cycle with a little improvement in the non-organic wastes, see Figure 4(a). Specifically, this RW only gives waste transport service to the local citizens, either scheduled transport household mixed waste or by-request transport for recyclable waste, see Figure 4(b).

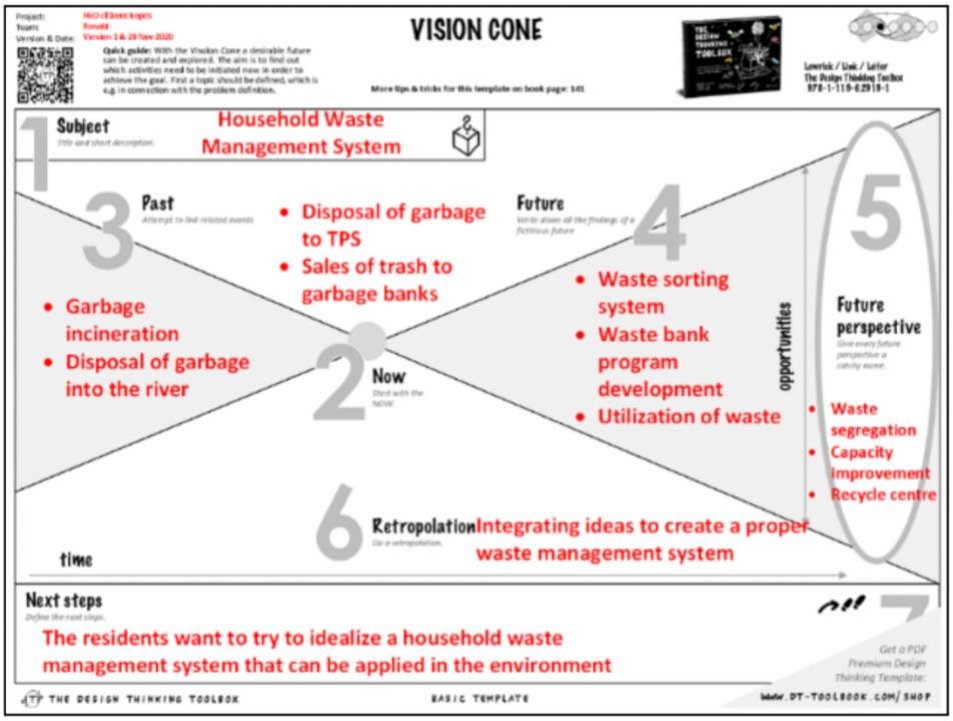


Figure 5: Vision cone map

At last, the local citizens held a meeting to conduct a retrospective and prospective reflection together using a vision cone map (Lewrick, Link & Leifer, 2020), see Figure 5. Previously, this community had struggled to maintain their household waste since this area is a new residence. Currently, this community has already improved the service which households have arranged to transport to the TPS every day and provide recyclable waste sales service. Subsequently, this community had visions to implement a proper waste management system, such as regulates waste separation programs and facilitates a recycling center.

Reconstruction of the new waste management system

Ahead, this community's dream to realize a proper waste management system in their neighborhood was led to the participatory movement in RW 005 Cisaranten Kulon village. The movement started from the action of this community to explore one of many ongoing pilot areas for the waste management system in Bandung city - Cibunut village, see Figure 6(a). Lessons learned from this benchmarking session were obtained, such as a great vision can be achieved from small acts even maintained by a small group at the first time.

Figure 6: (a) 10 Jan 2021 Study visit; (b) 16 Jan 2021 Ideation meeting; (c) 23 Jan 2021 System approval; (d) 27 Jan 2021 Door-to-door education

Following this spirit, this community held a brainstorming session, see Figure 6(b). From this ideation session, there were 52 ideas generated. These ideas were classified into 14 clusters in which all clusters were plotted into 2x2-matrix and voted by the local citizens, see Table 1. As a result, this community agreed to establish a Sanitation Division in which, complemented with the organization programs from clusters 5, maintain the biopore installation program.

Afterward, those ideas were prototyped using a prototype-to-test map (Lewrick, Link & Leifer, 2020), see Figure 7. To complement the Sanitation Division, 7 ideas were generated. Those ideas were selected by analysis of community characteristics and environmental conditions. Accordingly, three ideas, consisted of waste separation, composting with Lumbricus Rubellus, and door-to-door education were selected to be an integrated and comprehensive system.

Table 1: Cluster of Ideas

No.	Cluster Name	Quantity of Ideas	Quadrant
1	Establishment of the Sanitation Division	4	2
2	Plastic waste minimization programme	1	2
3	Reuse cooked oil	1	2
4	Scheduled waste bank	1	2
5	Biopore installation	1	2
6	Transportation of residual and B3 waste to TPS	7	3
7	Installation of residual waste storage	1	3

8	Programme for making handicrafts from non-organic waste	12	1
9	Utilization of organic waste into animal feed	1	1
10	Utilization of organic waste into compost	12	1
11	Utilization of organic waste into biogas	1	1
12	Door-to-door educational programme	1	1
13	Waste sorting programme	7	1
14	Ecobrick making programme	2	1

Eventually, the process of prototyping ideas generated a new waste flow that attempted to minimize waste to the landfill, see Figure 8(a). The transformation design of the new waste management system attempted to treat both recyclable waste and organic waste. Hazardous waste from the system was the only waste that is desired to go to the landfill. The residual waste from the system can be used as material to produce eco-brick. For organic waste, the waste was expected to be raw materials in urban farming. In any case, if the system cannot treat all kinds of wastes, those wastes are transported to the landfill. Indeed, the new system gives many value propositions to the community, such as generating a new income for the community, see Figure 8(b). First, the local citizens can generate business ideas to sell high selling value products from the non-organic waste treatment. Second, the local citizens also can generate business ideas to sell permaculture products from the organic waste treatment. Lastly, the sales of non-organic waste can be increased since the whole area is targeted to separate their household wastes.

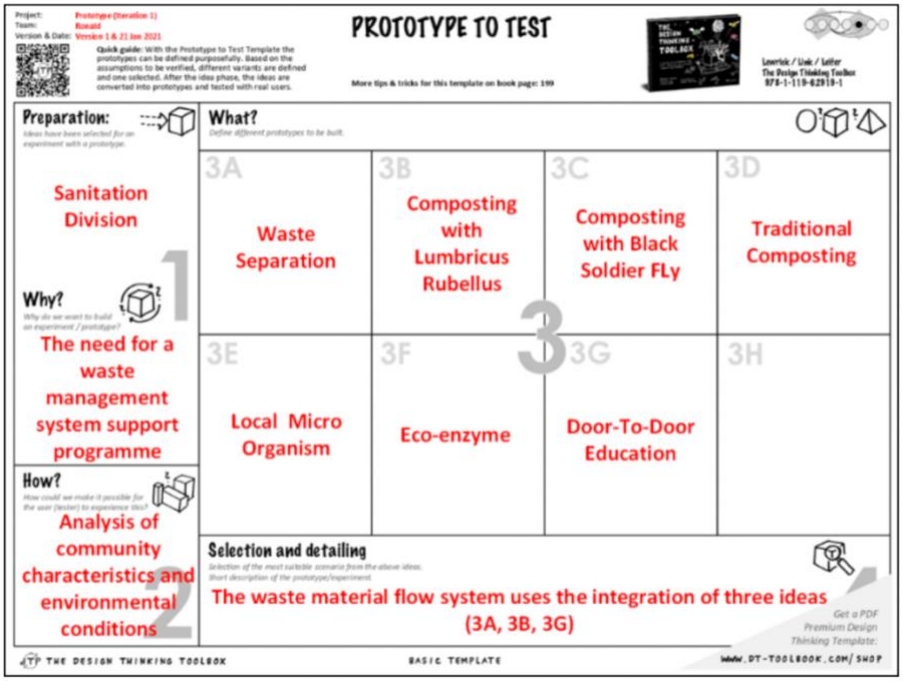


Figure 7: Prototype to test map

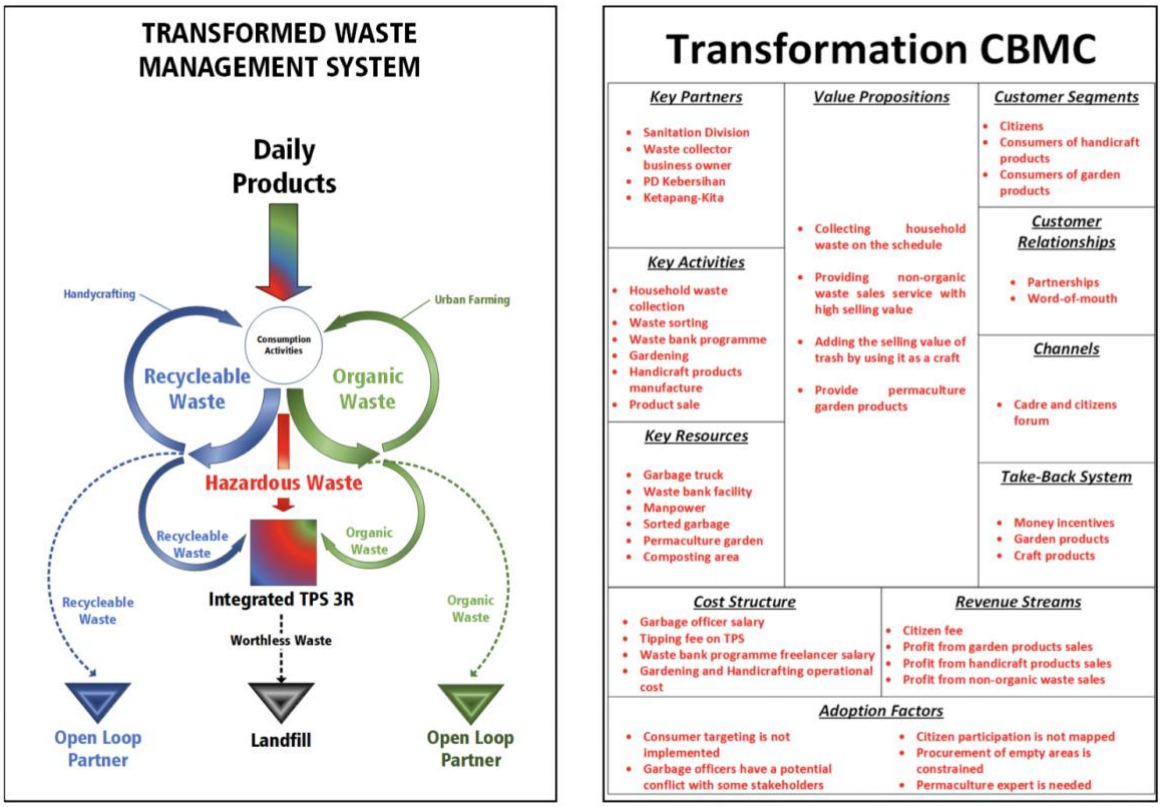
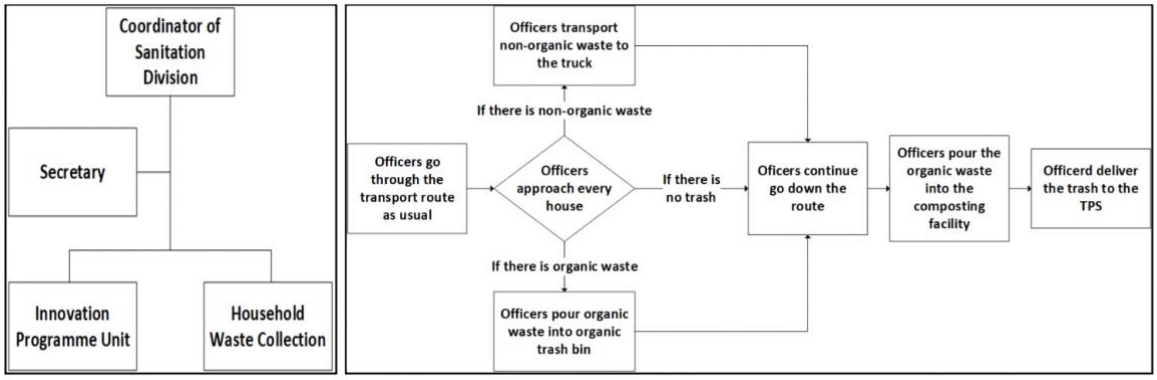


Figure 8: (a) Transformed waste management system; (b) Transformation CBMC

Over and above, this system needs the supporting caretaker which is done by the Sanitation Division. Therefore, a new organizational structure was formed to support a new waste management system, see Figure 9(a). Along with this, there was an additional workload in the SOP of waste collectors to transport the organic waste, see Figure 9(b). However, this process is beneficial for the waste collectors due to the collected waste being dryer. Thus, the waste collectors can obtain a better recyclable waste quality overall.



Together with, the local citizens themselves were prepared to adopt the new waste management system. There are two approaches used during this adoption process. Initially, the community

agreed to run a door-to-door education movement to socialize the program to the local citizens, see Figure 6(c). Moreover, several chosen local citizens from the community are advocating to join the door-to-door education movement, see Figure 6(d). The program has objectives to persuade local citizens to separate their wastes. Along, the local citizens also included the waste collectors to join the process of advocation to the local citizens using a visual campaign displayed on the garbage truck.

Figure 10: (a) Education media; (b) Programme campaign

Bringing to a close, the citizens of RW 005 Cisaranten Kulon village have a constant spirit from the beginning of FGD until the prototyping process. They tend to be active in all meetings to share what they want and voice what they think. Meetings and participatory actions are still continued until right now. The next move, the movement of the community will be tested and implemented immediately.

CONCLUSION AND FURTHER RESEARCH

How might designs play a role in dealing with the household waste issue in society nowadays? The municipal solid waste (MSW) issue is a multidimensional social problem (McAllister, 2015). This problem concatenates social, economic, and environmental aspects. Besides, the MSW issue has constraints in political and institutional aspects. The complexity of this issue also can be categorized as wicked problems – a social phenomenon that triggers conflicts since it has many stakeholders within it (Buchanan, 1992). While the issue is significantly crucial to the whole aspect, the creative approach is essential to be applied to solve this waste management issue.

Through the design thinking approach, all stakeholders in the system participatory construct a new waste management system. A robust waste flow has been created to minimize the waste transported to the landfill. The new system only distributes worthless waste from the system to the landfill. Besides, other waste categories are maintained to not of the system instead it is utilized to generate incomes within the process. Therefore, the new waste management system offers a waste management system that is beneficial for the environment, society, and economy.

In addition, this research also has several limitations. The first limitation of this research uses time constraints. This research period is limited from October 2020 until March 2021. The other limitation that affects this research is location constraint. This research location is limited only to RW 005 of Cisaranten Kulon village. Last but not least, this research is limited until the prototype phase in the design thinking iteration. Furthermore, the prototypes will be implemented and evaluated for prototype improvement.

Towards a resilient and well-being living environment, it is essential to provide a proper waste management system to society. If we are trapped in the nowadays waste management condition, we are threatened to not have access to the landfill and other environmental damages in the future. Thus, mitigation action is essential to do. This research has already found a new waste management system in which this system can minimize waste distributed to landfills and generate incomes for the community in the system. Finally, yet important, the robust waste management system design can be replicated in other areas in Bandung city.

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