



Could Group Model Building boost environmental awareness on Solid Waste Management in Lebanon?

An exploratory field experiment that explores the effects of GMB on university students regarding the topic of SWM.

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Abstract

The solid waste management crisis that occurred in 2015 in Lebanon was not its first and will not be its last. To solve this problematic issue, an integrated solid waste management strategy is proposed. Citizens' awareness is integral for successful implementation of such a strategy. Accordingly, this exploratory study was conducted to examine whether group model building can be used to raise awareness about solid waste management among Lebanese students. To measure the components of environmental awareness (cognitive affective and conative), some of the GMB outcomes that were found in literature were used. The process and outcomes of GMB in terms quality of communication, cognitive change, consensus and commitment were measured during a field experiment. Students from the Notre University in Lebanon participated in a field experiment consisting of four workshops. All four sessions had the same agenda but different participants. The total number of participants was 58. The experiment results showed that three out of four GMB outcomes were achieved; the results for commitment were inconclusive. To increase the robustness of these results, it is recommended that future works include a larger number of participants and a bigger research team.

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Dedication

I would like to dedicate this work to my home country Lebanon, and to its youth, specifically. I strongly believe in the potential of the Lebanese youth and I hope this work inspires and supports any other initiatives that aim at building the country that Lebanon deserves to be.

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List of Abbreviations

AC	Asking for Clarification
AS	Alternative/Solutions
AWMA	Air and Solid Waste Management Association
C	Causes
CDR	Council for Development and Reconstruction
CI	Criticizing and/or diminishing other participants' ideas
CLD	Causal Loop Diagram
CM	Criticizing and/or diminishing the method
Co	Convergent
CP	Criticizing and/or diminishing other participants
CSu	Clarifying/Summarizing
D	Divergent
DA	Disagreement
DRI	Democracy Reporting International
GMB	Group Model Building
HH	HouseHold
MoE	Ministry of Environment
MP	Mission and Process
MSW	Municipal Solid Waste
N	Negative
NDU	Notre Dame University
NGO	Non-Governmental Organization
NGT	Nominal Group Technique
OMSAR	Office of the Minister of State for Administrative Reform
O	Obstructing the process
P	Prioritizing
PD	Problem Definition
Ra	Ranking
S	Supporting
SD	System Dynamics
SFD	Stock and Flow Diagram

Chapter 1. Introduction

Growing up in Lebanon, a Middle Eastern country, I have heard about and faced many complex social and environmental problems. Although some may see it as a curse, I believe it turned into a gift as it fueled my interest in learning about complex problem-solving methods. This led me to my master's degree where I learned about Group Model Building (GMB). The more I learned about it, the more I felt that this method is not only useful in solving business problems but may be used for other purposes such as raising awareness about complex socio-environmental issues in Lebanon. One prominent and interesting application for GMB is the Solid Waste Management (SWM) sector in Lebanon. Indeed, this is where the idea of conducting this research was established.

1.1. Background Information

Lebanon is a small developing country in the Middle East, but the socio-political conflicts that the country faces are by no means considered small. As in many developing countries, SWM is a complex issue due to the lack of sustainable policies which often leads to crises (Kumar, 2016, pp. 6-8). SWM is the process of collecting and processing any type of solid waste generated by humans (McDougall, White, Franke, & Hindle, 2008, p. 1).

One example is the SWM crisis that happened in Lebanon starting July 2015; the country's solid waste started piling up on its streets and soon, it was literally submerged in garbage. At that time, the company contracted by the government for waste collection of the two largest districts in the country stopped collecting waste. There were two reasons for that. First, the contract between the government and the appointed company at that time (Sukleen) had ended and there was no replacement, mainly due to political conflict between the different parties in the government (Kraidy, 2016). The second reason was that the Naameh landfill – which is where most of the collected waste was dumped – had reached its maximum capacity. It is notable that although it might be perceived that these two reasons are technical, the actual underlying reasons were socio-political – both will be discussed in the next chapter (Awwad, 2017). The country stayed in that state for 8 months, after which the government opted for a series of temporary solutions (Francis, 2018). The problem of SWM in Lebanon has been present for decades, however the ruling political class has been

able to keep it away from the public's attention. In fact, the crisis of 2015 is not the first; the first crisis was in 1997 (Awwad, 2017). The crisis of 2015 prompted a civic movement known as #YouStink which subsequently lead to all political parties adding the issue of SWM at the top of their electoral agenda (Kraidy, 2016). Until today, the government has not come up with a long-term solution, and the country is on the verge of yet another crisis ("Lebanon: Beirut Landfill Near Capacity", 2019).

In addition to its technical and political aspects, the issue of SWM encompasses the three pillars of sustainability: environmental, economic and social making it all the more complicated (Kumar, 2016, p. 1). Thus, short-term fixes and opting for piecemeal solutions that only solve symptoms of the problem is not enough, but more often than not leads to even bigger problems (Vennix, 1996, p. 25). A suggested approach would be to lay out the different components of the SWM crisis and all the problems behind it that have been accumulating for years. This is a typical case of a messy problem as defined by Vennix, where different people have divergent views on what the problem is (Vennix, 1996, p. 40). Another definition of a messy problem by Rouwette and Franco (2015) is one that has many interconnections between the different aspects of a system, which inevitably causes high levels of uncertainty thereby making any attempt to solve part of the problem generate one or more new problems. One proposed technique to untangle messy problems is GMB.

GMB is a method that uses System Dynamics (SD) and systems thinking concepts to create models with stakeholders facilitating decision-making (Vennix, 1996, p. 4). SD and systems thinking are used to study problems through a holistic systemic lens to understand the underlying structure in order to find out where an intervention in the system is most likely to solve the problem (Vennix, 1996, p. 107). Researchers showed that GMB has several benefits to participants. These benefits are achieved by fostering communication, enhancing learning and building up consensus and commitment (Hovmand, 2014; Andersen & Richardson, 1997; Van den Belt, 2004; Vennix, 1996). While GMB is used mainly to design strategies for client organizations (Scott, Cavana & Cameron, 2015), GMB may also be used for other purposes. Indeed, as Vennix explains, the main goal of GMB is not merely to build a SD model for strategy design, but also to:

“increase problem understanding and to devise courses of action to which team members will feel committed” (Vennix, 1996, p. 3).

As such, improved communication, enhanced learning and building up consensus and commitment that are tools in GMB, may also be considered as ends themselves and are particularly useful in raising awareness by encouraging citizen participation and engagement. In fact, Stroh discusses the role of systems thinking in regard to awareness raising:

“From a systems thinking perspective, the key is to help participants cultivate a deep awareness of current reality as something they have created instead of as something that exists outside of and independent of them.” (Stroh, 2015, p. 5).

Indeed, it is a common misperception in Lebanon that the issue of SWM is technical and political, and citizens tend to blame it fully on the government (“Cabinet not to blame for ongoing trash crisis”, 2016). Keeping this in mind, it would be interesting to explore whether GMB can be a tool to raise awareness among citizens about their own role and impact on the environmental aspect of SWM in Lebanon. Subsequently, this research aims to find out what kind of contribution GMB offers when it is used in the context of social and environmental awareness within the field of SWM.

To achieve this, a field experiment was conducted at a university in Lebanon, where students were invited to participate in a workshop about SWM using GMB. The GMB sessions involved a role play where participants were given different stakeholder roles and invited to solve the SWM problem in a town in Lebanon. The data collected from this workshop was used to study whether there were any changes in the participants’ awareness on the topic.

1.2. Research Objective

To explore how GMB contributes to raising awareness about the SWM issue in Lebanon by conducting an experiment with university students and measuring four of the GMB outcomes: communication quality, cognitive change, consensus and commitment.

1.3. Research Questions

To achieve the abovementioned objective, I will discuss the topic of SWM with university students through GMB workshops. My study is exploratory where students are part of an experiment involving role play. They are given different stakeholder roles and a problem description to model and solve during a GMB workshop. As such, I aim to answer the following research questions and sub-questions:

- 1) What preparatory research is needed when GMB is applied as a role play to raise awareness?
- 2) In what ways could GMB contribute to students' environmental awareness about SWM?
 - a) Which of the GMB outcomes are achieved in a controlled setting where GMB is used to raise awareness?
 - b) What is the added value of using GMB for awareness raising on SWM in Lebanon?

1.4. Theoretical Relevance

Many of the outcomes of GMB are highlighted and researched, but the mechanism behind these outcomes are still not clear (Rouwette, 2016; Rouwette, Bleijenbergh, & Vennix, 2016). The research that this thesis will present will study some of these underlying mechanisms.

As such, one contribution of this study is the comparison between the results of the experiment which is a made-up GMB scenario against the results of actual GMB scenarios. It is interesting to measure if the benefits that GMB normally offers still apply in a controlled setting where acting SHs (stakeholders) or agents - as Van den Belt refers to them - are given roles of actual SHs (Van den Belt, 2004, p. 33).

In addition, Scott et al. report that not much is discussed in the literature on when it is not appropriate to use GMB and that it has been applied in the same fields of policy and strategy design (2015). This study will explore the use of GMB in a different context and the findings of the experiment would show if GMB may be used for awareness raising or not.

Also, researchers mention that there is not much that is reported in the literature on the use of GMB with students (Rouwette, Vennix & Mullkeom, 2004, pp. 13-16). The findings of this research will contribute to the body of literature on that.

1.5. Practical Relevance

The literature presents the several benefits of GMB that have so far been used with organizations in the business world; in both the public and the private sector. But what if the benefits of GMB were extended to a different field; that of education? Not only would that provide students with new knowledge on the method used (SD), but it would also contribute to educating them into better citizens. Even though the sessions will have agent SHs involved, in the future, they will be actual SHs, and engaging them in such preparatory activities could be a preventive technique to avoid potential mistakes that lead to crises.

1.6. Research Challenges

As mentioned earlier, one research challenge is that there is not much reported on the effects of using GMB in an academic setting. A couple of courses GMB at Radboud University in the Netherlands introduce GMB to students using role play. Research on the benefits of GMB in such a setting is presented in the literature (McCardle-Keurentjes, Rouwette, Vennix & Jacobs, 2018), however, there is no clear guideline on how to prepare the roles descriptions. Additionally, although students are involved in role play sessions, the aim of the course is to teach them about GMB facilitation or SD, not to raise awareness as is the aim of this research. Therefore, the preparatory work that needs to be done is not available. Based on that, it is important that the research process accounts for this. Also, the results of this exploratory process could be the beginning of establishing a framework for such activities with students.

Another research challenge lies in defining what are the measures of success of this project, and how they relate to awareness and how such data can be collected then analyzed.

To start tackling those challenges, I will start by establishing a theoretical basis for the research to make way for its methodological design. First, it will consist of defining the theoretical concepts of the topic discussed (SWM) and the method used (GMB) and how environmental awareness is related to both. Then, the research methodology will be presented. It is split into two parts: the pre-experiment process and the experiment itself. Data collection methods and analysis techniques that will be used in both parts will be explained. The results of both parts will be presented afterwards to reach the discussions and conclusions that aim to answer the research questions presented.

Chapter 2. Theoretical Background

After giving a general overview of this research in the previous chapter, the current chapter will go more in depth by defining the theoretical concepts that will be explored. Since this research involves a role play, then the stakeholders participating in the sessions will not have the information as the actual SHs in a regular Group Model Building (GMB) sessions. Therefore, an extensive research about the topic of SWM in Lebanon is required to get as much information as possible; information that would have otherwise been revealed by actual SHs during the session. After having examined the topic, an overview of the method Group Model Building (GMB) will be given. Finally, the choice of participants will be discussed along with its relevance to the method and topic choices.

2.1. The Topic: Solid Waste Management

Waste is defined as any material that cannot be used anymore and is produced by any living being either naturally or artificially. Waste is divided into many categories ranging from Municipal Solid Waste (MSW), to chemical waste, wastewater, etc. Solid waste is any type of waste that is found in solid or semi-solid state. MSW specifically is the everyday waste that is generated by citizens and includes residential, commercial and municipal services waste (Kumar, 2016; Links, 2006). Solid Waste Management (SWM) is defined as the process of managing the disposal of the waste generated by a community. This starts by collection of waste, transport, disposal and/or treatment. A few examples of the latter are open dumping, landfilling, sorting and recycling, biotreatment or incineration (Hamer, 2003).

SWM is considered an environmental, economic and social concern. As such multiple players are involved giving it a multi-faceted and complex nature (Guerrero, Maas & Hogland, 2013).

2.1.1. Solid Waste Management in developing countries

Solid Waste Management (SWM) is a complex and multi-disciplinary process, and it is particularly critical in developing countries (Kumar, 2016, p. 1). As Figure 1 shows, developing countries have higher urbanization and population growth rates, meaning that waste generation in big cities of developing countries could constitute a serious hazard if not managed sustainably (Kaza, Yao, Bhada-Tata & Van Woerden, 2018, pp. 1-3).

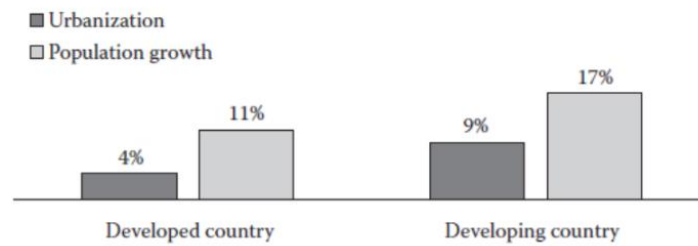


Figure 1: Population and urbanization growth 1990–2010 (Kumar, 2016, p.3)

It is suggested that SWM should have decentralized operations and be the responsibility of local governments (such as municipalities). However, this is rarely the case in low and middle-income countries due to the absence of an integrated SWM management plan with clear laws and regulations that are consistently monitored by central authorities (Kaza et al., 2018, p. 88). An integrated SWM strategy plans for the entire cycle of waste generation, starting from consumption by encouraging prevention, reduction, re-use, recycling and then adequate processing of solid waste that remains (Kumar, 2016, p. 5). If an integrated SWM plan is implemented, solid waste turns from a burden to a resource (Kumar, 2016, p. 4).

2.1.2. Solid Waste Management in Lebanon

Lebanon's SWM crisis in 2015 was not the country's first and it probably will not be its last one either according to recent local news sources (Azhari, 2019). This shows that the solutions that have been implemented so far are not durable. In fact, back in 1997, the first waste crisis occurred, and the government's emergency plan was the opening of the Naameh landfill, located in the district of Mount Lebanon. This landfill received the waste of Beirut and Mount Lebanon. The emergency plan, which was supposed to be followed by a sustainable solution, lasted 17 years ("Lebanon: Beirut Landfill Near Capacity", 2019; Awwad, 2017; Azzi, 2017). Upon its closure, the company Sukleen which was contracted by the central government to collect Municipal Solid Waste (MSW), ceased all collection activities and as a result, the streets of Beirut and Mount Lebanon district were piled with bags of waste. This pushed citizens and municipalities to take matters into their own hands. Some options included burning the waste, which is a serious health hazards due to toxic emissions (Fakih, 2018). Some municipalities had gone for open dumping in lands within

their region, while other municipalities implemented a sorting and recycling scheme for their towns (Awwad, 2017). Eventually, citizens got fed up with inefficient short-term fixes, which started a group of rebellions and protests in the capital Beirut. Due to the protests and civic movements that arose, the government was pressured to come up with a temporary solution, claiming that in the meantime it would develop an integrated SWM plan (Kraidy, 2016).

The failure of the government to come up with a long-term SWM plan is due to several reasons, some of which will be summarized in categories and sub-categories as per Azzi (2017):

Table 1: SWM issues in Lebanon

Category	Sub-category	Problem
Institutional	National laws, regulation, responsibilities	Outdated laws on SWM Law 118 (dated 30/06/1977) stating that municipalities are responsible for SWM is not enforced
	Monitoring & supervision	No third-party companies monitoring the contractor's record data Three SWM plans prepared in 2006, 2010 and 2014 but not followed through due to political reasons
Financial	Financing System	The country's centralized waste system dictates that money for SWM is allocated through the government budget by means of an Independent Municipal Fund that is underfunded due to investments in other infrastructure fields
	Corruption	The civic society claims that the price per ton in Lebanon is overpriced and that there is no transparency on the operations of the waste collection company
Inclusivity	Users	Public awareness on SWM exists only in upper class and while the 2015 crisis increased the awareness, there was no change in behavior observed due to the government's unclear plans
	Provider	Affiliation of private waste collection company to political officials

Source: Azzi, (2017, pp. 18-20)

Azzi (2017) gives a good overview of the issues that the SWM sector in Lebanon faces, Although the categorization is different from the one defined earlier (with the three pillars

of sustainability), these still fall under social, environmental and economic but with further zooming in on the details. Azzi (2017) does not discuss another crucial problem which is the multitude of stakeholders (SHs) involved in the decision-making process of matters related to SWM. To explore this, Table 2 from Ghadban, Shames & Mayaleh (2017) presents the different SHs and their roles in the SWM sector. As can be seen, several governmental institutions oversee drawing a national SWM plan. Usually, every different institution is part of a different political party that are not allies. This could explain why there were political obstacles that caused the previous plans not to be carried out. The multitude of political parties in the government and their historical conflicts makes coming into an agreement on any policy or law a truly cumbersome task (Hall, 2015).

Table 2: Duties of different stakeholders

Stakeholder	Main Responsibilities
Waste Management Board	Developing waste strategy and authorizing waste management plans
Ministry of Environment	Initiating waste management standards and guidelines and implementing waste management programs
Ministry of Interior and Municipalities	- Participation in the National Strategy and plan and implementation of local waste management plans - Establishing/ implementing waste management programs
Municipalities	- Participation in the National strategy and plan through the Waste Management Board - Proposing and implementing local waste management plans for non-hazardous municipal waste - Establishing / implementing waste Management programs - Management of waste collection
Council of Development and Reconstruction	- Assistance in procurement of WM projects upon request - Assistance in the development of WM plans upon request
Private Sector / the Public	- Abiding by laws, regulations and guidelines on waste management - Prohibition of littering, illegal dumping and burning - Participation in the National strategy and plan through the Waste Management Board - Participation in the development and implementation of local waste management plans - Participation of facility and generator management plans

Source: reprinted from Ghadban et al. (2017)

In October 2018, law No. 80 drafted by the Ministry of Environment (MoE) regarding SWM was approved by the parliament. Although law No. 80 clearly suggests a decentralized SWM process to municipalities (or coalition for smaller towns) it does not provide any instructions or evaluation and monitoring plans. Articles 10.1 and 10.2 specify that the MoE should issue a national plan for SWM no later than six months after the law is ratified. Article 11.1 states that municipalities have three months once the plan is issued to come up with a local strategy for waste collection and present it to the MoE for approval (“LAW Number 80”, 2018). However, the MoE has not officially announced anything regarding an integrated SWM plan.

Hence, this law is not being enforced, and a new contractor Ramco has been granted the duties of its predecessor (Sukleen) and SWM is still a centralized process (Marsi, 2017).

2.1.3. Cases of Pseudo-Decentralization of Solid Waste Management in Lebanon

Following the crisis, several municipalities had to deal with it on their own and had to come up with emergency plans to discard the waste that had been on the streets of their cities and towns for eight months. Some municipalities opted for open dumping, and a picture of this process went viral all over the world news broadcast and the internet.



Figure 2: Pile of garbage creating a "river" of trash near the Lebanese capital Beirut

(www.edition.cnn.com/2016/02/24/world/gallery/lebanon-waste-crisis/index.html)

On a more positive note, several municipalities also established sorting and recycling programs in partnerships with local Non-Governmental Organizations (NGOs). Examples of such towns are: Roumieh, Zalka, Jeita, etc. (Mitri, 2015). Unfortunately, many of those municipalities did not continue these programs when the central government initiated a new emergency plan. However, there were some success stories such as the town of Beit Mery where the municipality has a public-private partnership with Cedar Environmental. The town claims to be the first zero waste town in Lebanon, where all the waste is taken to a solid

waste treatment plant operated by Cedar Environmental (Dubin, 2016). Another town that established its own SWM scheme is Bikfaya. The municipality worked in partnership with local NGOs BiClean and Arcenciel (Alkantar, 2016).

In summary, SWM is an issue that is especially problematic in developing countries such as Lebanon. This is due to political and legislative conflicts but also to the outdated centralized SWM process. Following the crisis of 2015 in Lebanon, some SWM decentralization took place forcefully in some towns where municipalities willingly took matters into their own hands. However, this change was not durable and many of those towns went back to business as usual as soon as the crisis ended.

2.1.4. Awareness on SWM

An integrated SWM plan must encompass several requirements in multi-disciplinary sectors. Table 3 shows the different sectors with their respective elements. At the top of the list is user awareness and participation. Indeed, A German not-for-profit organization “Democracy Reporting International” (DRI) specializes in topics of local governance in Lebanon, one of which is SWM. In 2017, DRI published a brief explaining that decentralization is the only hope for a long-term sustainable strategy (Geagea & Sleiman, 2017). In addition, DRI recently held a workshop with local Lebanese experts on SWM in Lebanon. During the workshop it was confirmed that decentralization of SWM to the municipal level is a must. The workshop also emphasized on citizen engagement and participation in order to achieve the required awareness at the citizen level (“Decentralisation of Waste Management”, 2019).

While Table 1 gives a good overview of the areas with problems in the SWM sector in Lebanon, Marmolejo-Rebellón (2013) provide a better categorization presenting all the sectors that need to be covered with their corresponding elements. As shown in Table 3 which is reprinted from Marmolejo-Rebellón (2013), awareness on SWM in developing countries is a requirement for a successful implementation of any planned strategy. This point is important, since in developing countries in general (Shekdar, 2009) and in Lebanon specifically, there is a misconception on the aspects that need to be improved. There seems

to be too much focus on the technical, economic and legal requirements (Sweepnet, 2014). However, a successful SWM strategy requires public participation (Hasan, 2004).

Table 3: Key elements for Solid Waste Management

Key Aspects	ELEMENT
Sociocultural	Users awareness
	Users participation in management phases and SWMF functioning
	Contextualized research and conceptual development
Technical and Environmental	Source separation
	Selective collection
	Quantity and quality of the materials received in the SWMF
	SWMF contextualized technological development
	Easiness in SWMF operation and maintenance
	Product quantity and quality
	Reducing needs in final disposal, area and by-product management (gases and leachates)
Institutional, Economic, and Financial	Contextualized research and conceptual development
	Establishment of an administrative organization
	Business management
	Operator training and personnel working equipment availability
	Creating a relationship between solid waste management institutions/ organizations and informal waste-pickers
	Material quantity and quality
	Knowing and opening markets for SWMFs products
	Products sale
	Availability of economic resources for SWMFs Operation and Maintenance
	Contextualized research and conceptual development
Policy, legal and political	Contextualized regulative framework that encourages material recovery
	Political will that encourages material recovery

Source: reprinted from Marmolejo-Rebellón (2013)

In fact, the Human Rights Watch published a feedback on Law Number 80. The feedback report strongly emphasizes on the participation of the community and the civil society (“LAW Number 80 Integrated Solid Waste Management”, 2018). Nevertheless, one study showed that awareness through general knowledge alone is not enough; reaching the citizens at the behavioral and practical levels is crucial (Desa, Kadir & Yusoooff, 2011). This calls for a process with higher level of citizen engagement such as GMB. The next section will show how and why GMB is suited for this endeavor.

2.2. The Method: Group Model Building

As mentioned in the previous section, the change that occurred due to the trash crisis in Lebanon did not last. Hence, this shift in behavior of some citizens and a few municipalities

was not durable. Group Model Building (GMB) is a technique used with SHs to design and support durable decision-making (Scott, 2018). To understand more if GMB and SWM are complementary, a definition of GMB is given next starting with systems thinking and System Dynamics (SD) which are at the basis of GMB. Following that, there will be more focus on GMB and its applications.

2.2.1. Systems Thinking and System Dynamics

(i) Systems Thinking

Systems thinking is an approach to viewing the world around us through a systems lens. A system is a set of elements which works together towards a specific purpose (Meadows, 2000, p. 11). At the core of systems thinking is the belief that understanding how a system works and analyzing its structure, allows us to understand patterns of (most of the time unwanted) behavior that this system produces. Most notably, systems thinking provides a clear view of the most impactful points of interventions in solving a problem (Meadows, 2000, p. 145). Once a problem and its component influences can be reliably understood a model and improvements to the system can be proposed.

Systems thinking is utilized in a variety of fields, ranging from biology to engineering, however it has most recently made a move from its foundation in the hard sciences to form a useful component of understand social structures as well as the internal workings of various organizations (Riess & Mischo, 2010; Leveson, 2011; Arnold & Wade, 2015). Overall more and more fields are seeing a move towards systemic thinking. Specifically, the fields of government and health, fields which generally have shunned the more analytical approach, are taking a second look and using it to model complex problems (Hamid, 2009; Schuster, 2003).

(ii) System Dynamics

One of the most popular applied methods of systems thinking is system dynamics (SD). SD aims to utilize a set of tools in order to model a complex issue or problem (Forrester, 1961). SD aims to evaluate past events in order to form a model upon which future events can be

built. Once the underlying system is identified and its causative effects are understood, system analysis takes place. SD is used to understand multi-faceted issues with underlying factors and influences not immediately visible to the observer (Forrester, 1992). The system dynamics approach involves creating and applying a model to a specific problem in order to better understand it in an interconnected light. To that end, system dynamics researchers incorporate graphs (referred to as reference mode of behavior) in modeling the problem, to completely understand the behavior of the system based on its various components. Problems are generally thought of in terms of feedback loops, which are in their own way subservient to the various stocks in the system, as well as its inflows and outflows (Sweeney & Sterman, 2000).

System dynamics utilizes many of the main tools underlying systemic thinking, most notably causal loop diagrams (CLD) as well as Stock and Flow Diagrams (SFD).

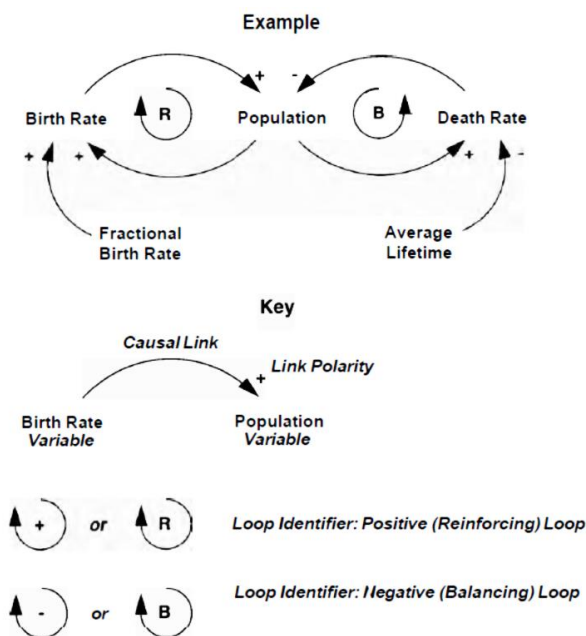


Figure 3: Causal Loop Diagram notation
(Sterman, 2000, p. 138)

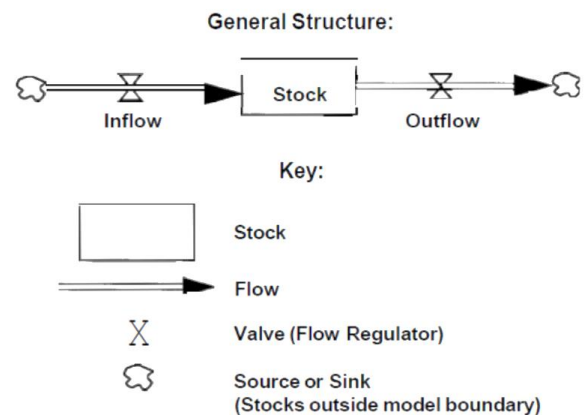


Figure 4: General Structure of Stock and Flow Diagram
(Sterman, 2000, p. 193)

CLDs show the causal relationships between different elements in the system. Figure 4 gives an overview on CLDs and an example of the population model (Sterman, 2000, pp. 137-140). Stocks and flows are another tool that can represent more information than CLDs. Stocks are

controlled by inflows and outflows. They incorporate numerical input that simulate a given behavior assigned to those flows by the means of mathematical equations based on differential equations. SFDs also represent accumulation and delays that occur in a system which deem quite powerful and useful in simulation models (Sterman, 2000, pp. 191-196).

As system dynamics and its incredible use of models becomes more prevalent, it is critical that new adopters of its principles understand the underlying structures and implications of the various inputs into a system, in order to accurately use its findings to make good policy decisions and widespread changes. Used correctly, system dynamics provides clear insight into the inner workings of a system not clearly visible upon observation (Coyle & Coyle, 1977).

2.2.2. Outcomes of Group Model Building

As useful as system dynamics modeling can prove across arenas, even more crucial is ensuring that after the model has been built stakeholders fully understand its implications. As such, group model building, or GMB, an approach which actively invites stakeholders to participate in the model-building process, was born (Andersen & Richardson, 1997). This method contrasts to the commonly accepted approach of modeling projects, in which those familiar with the field are simply inventories of relevant information. In the group model building approach, these experts assist systems model builders in creating the relevant models. In turn, the model builders facilitate the model building process through one or more group sessions. This model is more collaborative, and it additionally ensures that the model is both useful and relevant (Vennix, 1996). The approach also assists in making sure the model accurately addresses the entirety of the system at play. Participants in the process gain improvements on their (previous) mental models as they work to ensure the system accurately reflects the scope of their knowledge (Vennix, 1996).

Group model building is particularly impactful at addressing so-called “messy problems”. These are problems for which there is little consensus among stakeholders, and which are, as a result, poorly defined (Vennix, 1999). GMB helps to investigate the various aspects of the participants’ mental models and compare them to reality. Group model building also

helps to ensure that solutions reached in the session are fully committed to and implemented by all parties involved. GMB can be used to create consensus as to the boundaries of the problem, as well as be used to incorporate the formed mental models of the various participants into a whole and useful solution (Vennix, 1996).

Overall, group model building is an important variation on the system dynamics approach. It ensures that various stakeholders are truly involved in the process of creating the various models. Although the workshop process may not always result in a completed model, benefits accrue to participants long after it is over (Vennix, 1996).

Research has shown that GMB outcomes are most likely dependent (Scott, 2018, p. 36). Namely among which the most frequent are: consensus, commitment, communication quality, process efficiency, shared understanding, enduring alignment, insight, mental model change, etc. (Scott, 2018, p.35). An example of outcomes dependency is discussed by Rouwette (2016) where the outcomes of GMB and their underlying mechanisms are explored. One proposed finding shown in Figure 5 shows that quality of communication is imperative to any system change, and to reach consensus and mental model refinement, a good quality of communication is required. These can be reached through facilitation and modeling which is at the core of GMB (Rouwette, 2016).

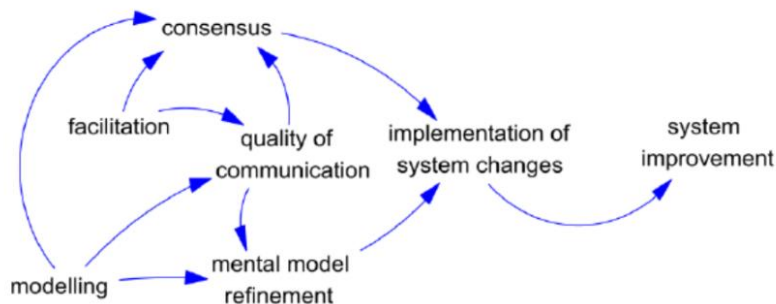


Figure 5: A possible causal mechanism relating group model building process and goals

Source: reprinted from Rouwette (2016)

Prior to that, Rouwette, Vennix & Mullekom (2002) linked group model building outcomes to the theory of planned behavior which suggests that better communication supports greater insights and increased consensus. Later, Rouwette (2003) showed that greater insights and increased consensus contribute to participants' commitment to conclusions.

The outcomes of GMB that we be focused on in this study are: communication quality, cognitive change, consensus and commitment.

Akkermans & Vennix define quality of communication as the quality of the process that takes place between two or more individuals having a conversation (Akkermans & Vennix, 1997, p.6). Scott gives another definition for communication quality as the extent to which group members are able to understand the information and actions exchanged during an interaction (Scott, 2018, p. 14). Scott (2018) also mentions that participants appreciate good communication and contribute it to learning and insights.

Indeed, it was found that GMB interventions resulted in a healthy amount of learning about the problem. Additionally, insight was increased in many studies (Rouwette et al., 2002). Many cases also report learning as a specific outcome noted by participants. This is in line with other published research on the subject, which notes that learning occurs best when participants participate in the process of building the model itself (Vennix & Gubbels, 1994). This is what will be referred to as cognitive change throughout this study.

Many studies reported improvements in the system itself, and widespread impacts on organizational policies. Commitment and consensus were also positively impacted by the GMB interventions (Scott, 2018), although these terms have broad meanings which could confound the findings. Consensus is defined as a state that is reached when all members of a group agree that the idea(s) presented are aligned with their own views on what needs to be done (Tideman, 2006, p.10). Scott (2018, p.13) considers commitment dependent on how intensely the participants are dedicated to the conclusions made during the workshop.

“a belief that something matters sufficiently to justify the sacrifice of self interest in order to prioritize and contribute to the future” (Ackermann & Eden, 2011, p.20).

2.2.3. Group Model Building and Environmental awareness

In the previous sections, SD and GMB were defined, but when were they used with SWM and specifically with awareness raising? To answer that, first, awareness will be defined.

According to Ham, Mrčela, & Horvat define environmental awareness as:

“the attitude regarding environmental consequences of human behavior” (Ham et al., 2016, p. 160).

As such, behavior is embedded within environmental awareness, giving it a social aspect and showing that environmental awareness implies social responsibility. Consequently, the practice of environmental awareness answers the call for user awareness in SWM in Lebanon defined earlier.

Ham et al. (2016) then proceed by giving an operational definition of environmental awareness that helps measuring environmental awareness. It includes three components: cognitive component, affective component and conative component. The definitions are provided in Table 4:

Table 4: Components of environmental awareness

Component	Definition
Cognitive	“Cognitive variables comprise knowledge, memory processes, intelligence, decision-making and behavior regarding problem solving. Knowledge (cognition) basically pertains to understanding – how meaning is formed, applied and stored within an individual’s mind.” (Ham et al., p.163)
Affective	“Affect is a general term denoting feelings or emotions. The emotional or affective component of attitude pertains to a person’s feelings about the attitude object. The affective component is most often expressed verbally as good – bad, positive – negative, to love – not to love, etc. The affective component of environmental awareness includes all anxieties, expectations, feelings and emotional reactions relating to environmental issues. It also includes an individual’s emotional judgement about the consequences of his/her own impact on his/her biophysical surroundings.” (Ham et al., p.165)
Conative	“The conative component of environmental awareness includes behavioral intentions that result in personal contribution to solving environmental issues. Some authors [...] refer to this variable as “willingness to act”, while [others] call it “verbal commitment” and define it as a measure of probability of an individual’s future actions.” (Ham et al., p. 167)

Source: adapted from Ham et al. (2016)

Looking back at the GMB outcomes defined in an earlier section, cognitive change’s definition aligns with the cognitive component of environmental awareness. Communication quality also goes side by side with the affective component since it is measured by expressions of one’s feelings and emotions. Finally, the conative component, by definition, is split into two aspects. The “willingness to act” is valid when the individual’s own mental model is in line

with the topic in question thereby implying consensus. The second aspect is referred to as verbal commitment which is equivalent to commitment in GMB outcomes.

In fact, in a recent paper, Stave, Dwyer and Turner (2019) explore the added value of using GMB in two studies related to sustainability. One of the topics discussed is related to SWM where a group of participants participated in a facilitated SD session (in the article it is equivalent to GMB) versus a traditional meeting (Stave et al., 2019, p.164). Data was collected through pre and post questionnaires including both open ended and closed questions ranked on a 5-point Likert scale (“strongly disagree” to “strongly agree”) (Stave et al., 2019, p.166). The results showed that the group that participated in the GMB session provided more effective solutions and were more focused on the topic discussed during the session when compared to the traditional meeting group. However, the results also showed that participants of the traditional meeting were more satisfied with the process and the outcomes of the traditional meeting (Stave et al., 2019, pp.167-168). Stave et al. conclude that GMB does have an added value but in specific areas and under certain circumstances (2019).

These results show an important contribution to the components of GMB to environmental awareness, but it also shows that GMB is not satisfactory in terms of process and outcomes. This is not in line with what previous GMB research presented in the previous section. Some of the findings of this study aim to answer this contradiction.

To summarize, this chapter examined the looming trash issue of Lebanon and the need of an integrated SWM plan to solve it. Citizen awareness is a big part of that plan, and it was shown that participation enhances it. In addition, environmental awareness and GMB outcomes have overlapping aspects. As such, the use of SD to approach the integrated SWM plan with SHs participation gives way to the use of GMB in this research.

Chapter 3. Methodology

In this chapter, the research strategy, experiment design, and data collection and analysis methods will be presented. The design of the experiment consists of empirical research prior to the experiment. This requires its own share of data collection which contributes to answering the first research question. The second research question along with its sub-questions are explored through data collection and analysis from the experiment itself. Hence, this chapter is divided into two main parts: data collection and analysis at the pre-experiment stage and data collection during the experiment and analysis afterwards.

3.1. Research Strategy

The research done examines the effects that a GMB (Group Model Building) workshop has on university students. Hence, a field experiment was conducted to collect and analyze data and meet the research objectives presented in the first chapter. The GMB intervention has the form of an exploratory field experiment. It is considered a field experiment since it is conducted within the university campus and given as a workshop that students would attend. Therefore, it is not designed in an artificial or laboratory setting, otherwise it would be considered a laboratory experiment (Babbie, 2012, p. 285). It is also not occurring in a natural setting where students go about their usual lecture routine which means that it is not a natural experiment either (Denscombe, 2014 pp. 68-69). The study has an exploratory nature since it is based on a suggestive proposition that I was curious about. As will be shown next, given the small sample size of the experiment, no statistical results can be implored thus this research is exploratory and can be the basis for subsequent studies (Babbie, 2012, p. 90).

It is important to note that although the students will be in a made-up scenario where they are given different SH (stakeholder) roles, the purpose of the workshop is not to design a policy or a strategy. The goal is to learn more about the problematic issue and understand how this experiment affects the students' awareness about SWM. Namely, the focus will be on measuring whether this intervention will allow students to experience open communication and change in insight (also referred to as cognitive change). It will also

investigate building consensus and commitment among participants towards the topic in question.

As was in the previous chapter, these GMB outcomes are linked to achieving environmental awareness which is an important component of an integrated SWM plan. To make sure participants have an enhanced learning experience, a role play was embedded into the experiment design. In fact, Van den belt discusses the importance of role play and how it helps participants achieve deeper understanding of complex issues (2014, pp.32-33).

The experiment involves two major groups of participants, but the differences are minor and thus the setting does not involve a control versus experimental group, especially since this study is at an explorative level. More details on this will be given in the following section.

3.2. Measures

To answer the research questions, some measures need to be defined. In this research, the process and outcomes of GMB will be measured. As shown in the previous chapter, literature reports that GMB sessions improve the quality of communication among participants, achieve cognitive change and foster consensus and commitment (Scott, 2018, p.35).

To evaluate the process, the quality of the communication between participants will be measured according to their content and their type.

As for the outcomes, quality of communication, cognitive change and consensus will be measured.

Detailed definitions of these measures were provided in Chapter 2, but further elaboration is presented hereafter.

The quality of communication that takes place during the workshops is used to assess the process and the outcomes of the sessions. The process will be measured according to two dimensions: the type of the

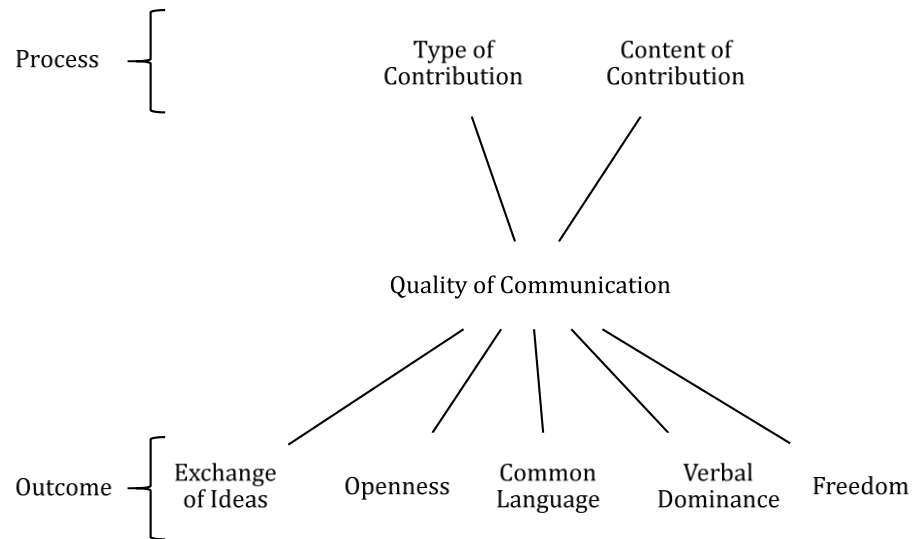


Figure 6: Dimensions of the quality of communication

contribution and the content of the contribution.

Rouwette (2011) proposes five dimensions for communication that will be used in this research to measure the outcome of communication. These are reproduced from Herrera's research (2014). They are shown in Figure 6 and defined in Table 5 below.

Table 5: Quality of communication dimensions

Dimension	Description
Exchange of ideas	The extent to which the participants perceived different perspectives were included in the model
Openness	"The degree to which discussions are felt to be open, without hidden agendas" (Akkerman & Vennix, 1997, p.6)
Common language	The extent to which the language used in the meeting is understood by all the participants.
Verbal dominance	The degree to which the conversation was dominated by only one participant or a small group of participants.
Freedom	The degree to which the participants felt they were free to express their own opinions and perspectives about the issue

Note: Adapted from Rouwette, 2011, p.881 and Akkermans & Vennix, 1997, p.6

Source: reprinted from Herrera, 2014, p.27

3.2.1. Cognitive Change

Herrera considers cognitive change as the change in participants' mental models and distinguishes between two types as show in Figure 7 (2014).

The definitions of these dimensions are adapted from Herrera et al. (2016):

Perceived cognitive change is the extent to which the participants feel that the workshop contributed to changing their ideas about what the problem is and what the solutions are.

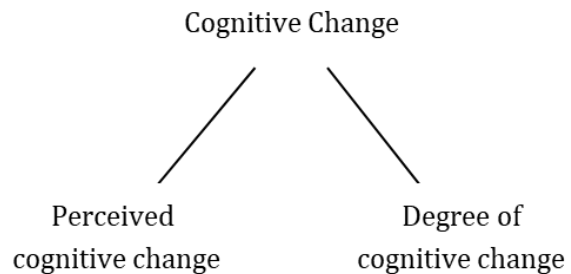


Figure 7: Dimensions of cognitive change

Degree of cognitive change is the extent to which participants changed their ideas about which are the best alternatives to solve the problem.

3.2.2. Consensus

Although there are four dimensions for consensus presented in Figure 8, this research only focuses on degree of consensus and the content of consensus Markoczy (2001, p.1015).

Rouwette (2011) defines degree of consensus as “how strongly the people agree on the content” of the decision reached and content of consensus as “the actual beliefs the people agree on” (Rouwette, 2011, p.881).

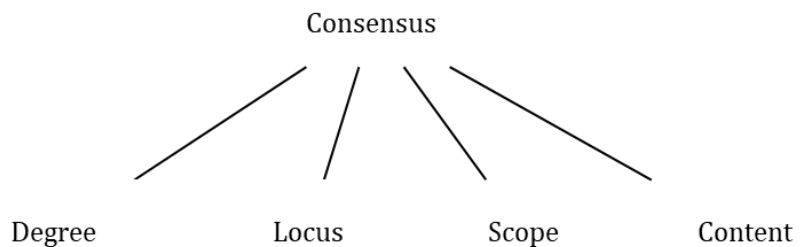


Figure 8: Dimensions of consensus

3.2.3. Commitment

In addition to the definition given in chapter 2, it is important to explain why commitment is crucial. As Herrera (2014) explains, any decision or conviction reached by a group is only

successfully implemented when these people believe in it and are ready to be fully committed to incorporating it into their daily lives.

Next, the data analysis procedure will be explained.

3.3. Experiment Description

Now that the measures used in this research have been defined, the experiment through which data will be collected is described in this chapter. All details about the field experiment that was conducted will be explained, including all the necessary arrangements in terms of empirical research and logistics.

3.3.1. Pre-experiment preparations

In a regular Group Model Building (GMB) setting, there are two parties involved: the modeling team and the client. The client defines the project and the modeling team's mission is to solve the client's problem within the scope of that project (Vennix, 1996). However, this project is not a typical GMB project in the sense that there is no actual client that hired the modeling team. The client was virtually identified by the researcher to be the municipality of a town in Lebanon. Other stakeholders (SHs) involved in the GMB session would also need to be identified by the researcher. To do so, the scope and boundaries of the project need to be defined, as shown below.

(i) Project scope and boundaries

One very important step of the experiment design was defining the scope and boundaries of the project. The topic of SWM may be studied on a national scale especially that this is the way things are operating currently in Lebanon as was shown in the previous chapter. The central government appointed a private company to manage the solid waste of the country. However, in October 2018, the Lebanese parliament ratified law No. 80 which specifies that the Ministry of Environment (MoE) is expected to come up with an integrated SWM strategy for the country based on decentralization. This implies that the responsibility of waste collection will be that of town municipalities or union of municipalities once the law No. 80 comes into effect ("Lebanon: Beirut Landfill Near Capacity", 2019). Subsequently, the project was defined within the boundaries of one town in Lebanon and the 'virtual' client is the municipality of that town. The scenario of the project suggests that this town would like to design a SWM strategy and invited a consultancy company to assist in the process. This idea was inspired by the course Group Model Building (GMB I), by Dr. Vincent de Gooyert. The

researcher attended that course in the fall semester of 2018 at Radboud University in Nijmegen in the Netherlands. Like the GMB I course, role descriptions need to be prepared and handed out to students to give them some background information on the content thereby supporting and inspiring their contribution during the sessions. A detailed description on how the role descriptions were formulated follows in the next section of this chapter.

3.3.2. Modeling Team

Based on Andersen & Richardson (1997) and Scriptapedia, the roles of the different team members were defined and assigned to acquaintances of the researchers who volunteered to assist in the workshop. Table 6 shows the different roles and to whom each role was assigned. More details about the roles and the members of the team are given next.

Table 6: Modeling team members

	March 30, 2019	April 6, 2019
Modeler Facilitator	Cynthia Kreidy	
Gate Keeper	Dr. Sophia Ghanimeh	
Wall Builder	Dicran Demirdjian (AWMA)	
Recorder	Marilou Kreidy	
Process Coach	Rachel El Hayek	Serena Ibrahim

A detailed description of each team member of the modeling team is given in: Appendix C, Modeling team roles.

3.3.3. Workshop Agenda

There were four sessions in total. All sessions had the same outline. Two sessions were conducted on Saturday March 30, 2019 and two others on Saturday April 6, 2019. The dates were chosen in coordination with Dr. Ghanimeh according to the course's schedule. The agenda of the session is based on the first part of Herrera, McCardle-Keurentjes, & Videira's GMB session design (but with some alterations) (2016). In their experiment, there were two GMB sessions, only the first part utilizes qualitative modeling. This part of their research was used as a basis for experiment design. Herrera et al. (2016) will also be used for data analysis,

along with the original research results shown in Herrera's master thesis (Herrera, 2014). Each session is in total three hours, hence, not much time is available to develop a quantitative model. Therefore, a qualitative model was built, specifically a CLD (Causal Loop Diagram).

In addition, the general approach to building a SD (System Dynamics) model known as P'HAPI was used as a basis to determine which scripts will be selected for the sessions (Moxnes, 2017). A detailed description of P'HAPI is available in Appendix C.

At the beginning of the session, an introductory presentation (also shown in Appendix C) was given to provide some background information on the research, the method used (SD and GMB) and the topic (SWM). At the end of the presentation, a quick excerpt of the newly ratified law No. 80 was explained to set the boundaries and define the project's scope. The participants were told that they will be assigned different SH roles and that they will have to embody them throughout the GMB sessions. As SHs concerned with a Lebanese town X (kept unidentified to avoid any prejudice and bias), they were answering the municipality's invitation to assist in designing a SWM strategy for said town.

Following the introduction, a series of four GMB scripts were used in the workshop. The logic behind the choice of the scripts was based on the P'HAPI approach and coordinated by the inputs and outputs expected of each script. Table 7 below shows what each script requires as input and the expected outputs. These were extracted from the original script descriptions available in Appendix D.

Table 7: Inputs and expected outputs of scripts

Script	Inputs	Outputs
Variable Elicitation	None	Prioritized list of variables
Presenting the Reference Mode	Dynamics identified from previous activity (e.g., graphs over time)	Reference modes
Initiating and Elaborating a Causal Loop Diagram	A list of variables	• Increased consensus on dynamic hypothesis, or a possible structural explanation for observed behavior • A causal loop diagram
Action Ideas	Causal loop diagram or stock and flow diagram	Prioritized list of potential actions

Source : <https://en.wikibooks.org/wiki/Scriptapedia>

The sequence of the scripts was based on the inputs and the expected outputs of each script. As shown in the Table 7 above, the output of the first script “Variable Elicitation” is a prioritized list of variables which is the required input for both the second and third script. The second script specifies “dynamics identified in previous activity” and specifically the example of graphs over time as input, however, it is worth noting that the example is only a suggestion. It can be considered that the dynamics identified are the variables elicited during the first script. As for the last script “Action Ideas”, the required input is CLD which is a product of the previous script. As such, the chronology of the scripts used is justified.

The detailed agenda based on the above is shown in: Appendix C, Agenda of GMB workshop.

3.3.4. Participants

Ideally, all stakeholders involved in the SWM issue in Lebanon would participate in the GMB workshop. However, due to the lack of time, only one SH group was targeted through a role play activity. However, this SH group is an important target. Since the youth play an integral role in the SWM crisis scene, their involvement is imperative; the #YouStink movement was mostly a youth-led initiative (Kraidy, 2016). Despite that, after the trash crisis of 2015 discussed in the previous chapter, a youth-led civic movement emerged. This movement went by the name of #YouStink. Although this movement led to new electoral candidatures in both local and regional elections, it was not organized in an ideal way. Many other smaller movements started emerging too, which made the entire process chaotic (Cham, 2018; Khalil, 2017). In fact, youth participation in Lebanon is still absent. In 2012, a Youth Forum with the support of the council of ministers published a report aiming at creating Youth Policies in Lebanon. In the report, the absence of the Youth Engagement (YE) is clearly highlighted. The report mentions that this is the older generation's lack of trust in them which led to the youth losing confidence in themselves and in their capacity to produce any tangible change (The Document of the Youth Policy in Lebanon", 2012).

Hence, the choice of university student as a target group for this experiment emerged from the hope that this workshop will create a ripple effect into society. In fact, all these students which are now household users (one of the SH groups identified) will later become part of the other SH groups in their professions.

Students from local university Notre Dame University in Lebanon were the participants in the sessions. The participants are grouped into two main categories. The first category consists of the students enrolled in the environmental engineering course with Dr. Ghanimeh. They were asked to attend the workshop as part of their coursework. However, since regular lectures are only fifty minutes long, it was not possible to use the lecture time for the workshop. Therefore, students were asked to attend a three-hour session on a Saturday. For those students, attendance was mandatory and part of the course's participation grade. Since the class consists of thirty students, two sessions with fifteen

participants each were set up. In fact, it is recommended that a GMB session does not exceed 12 to 15 participants (Andersen & Richardson, 1997). The other two sessions were an open invitation to students from different majors and faculties. However, the workshop was advertised for mostly in the engineering and science faculties through colleagues of Dr. Ghanimeh. Participants from group 2 were asked to fill out a registration form specifying some personal information and the time of the session they wish to attend. The registration form also informed the participants that the session will be recorded, and that data will be collected for research purposes. It was prepared using the online platform for surveys and questionnaires: Qualtrics¹. A copy of this registration form is available in Appendix E.

To sum up, there are two main groups: the first one consists of the students from the environmental engineering course that attended sessions 1 and 2, on Saturday March 30, 2019. The second major group consists of the students that attended sessions 3 and 4, following an open invitation for Saturday April 6, 2019. All students from group 1 are students majoring in civil engineering. As for group 2, there was a mix of students from other majors. The distribution of majors was as follows: 38% student majoring in engineering, 38% in biology, 10% in architecture, 10% in business and 4% in environmental science.

The difference between group 1 and group 2 is summed up next:

Table 8: Demographics of the students attending the GMB sessions

	Group 1: March 30, 2019	Group 2: April 6, 2019
Attendance	Mandatory	Voluntary
Background	Homogenous	Heterogeneous
Number of participants	Session 1: 15 Session 2: 14	Session 3: 17 Session 4: 12
Average age	22	21
Gender	55% Male, 24% Female, 10% Prefer not to say, 11% Blank	24% Male, 62% Female, 14% Blank

Source: Appendix I, All sessions, Questions on demographics

¹ Copyright © 2019 Qualtrics. Qualtrics and all other Qualtrics product or service names are registered trademarks or trademarks of Qualtrics, Provo, UT, USA. <https://www.qualtrics.com>

3.3.5. Questionnaires

For ethical and privacy purposes, the participants were informed at the beginning of the sessions that the data collected from the sessions and the questionnaires will be anonymous and that their personal information will only be accessible to the project's researcher. Three different questionnaires were designed and handed out for participants to fill out. Only one of the questionnaires was anonymous, the reason behind till be revealed next.

(i) Pre- and post- questionnaires

Before the start of the session, a consent form was distributed to the participants to inform them of their rights with regards to data collection, anonymity and their right to refuse participation in the experiment. A sample of the form is attached in Appendix E.

A pre-questionnaire was then handed to participants to fill out. It was not anonymous, but it only asked for basic personal information, such as names and email addresses. There was also one closed question followed by two open-ended questions. The same questionnaire was also given post-session to track if there are any changes in the participants' answers. The purpose for this will be elaborated in further sections of this chapter and the next one.

(ii) Anonymous post-questionnaire

In addition to the previous questionnaire, an anonymous questionnaire was given at the end of the session. This one was anonymous and aimed at evaluating the session and the facilitator's performance. The questionnaire was anonymous to provide space for honesty and correct feedback; the idea was to allow participants to express their opinions without any (positive or negative) intention. The questionnaire has a mix of open-ended and closed questions and is based on Midgley et al. (2013).

All the sample questionnaires may be found in Appendix E.

3.4. Data Collection

It is important to distinguish the two stages of data collection in this project: before the GMB sessions and during the GMB sessions. The first is necessary to define the case, the problem

and the stakeholder roles. The second stage of data collection took place during the sessions using questionnaires, documenting the sessions and observations. As will be seen next, triangulation in data collection is used since there are three sources of data for data analysis: documentation, questionnaires and observations. Having three data collection sources improves the reliability and robustness of the results (Franco, 2007; Rouwette, 2011)

3.4.1. Data Collection PART I

(i) Literature Search

At this stage of the research, the role descriptions for the GMB workshops were being formulated. As a Lebanese citizen, the researcher was living in Lebanon during the time of the trash crisis and followed the news and events of the protests very closely which guided the research process. In addition to that, a search on the internet was conducted to get more information and accurate facts to include in the different roles. Scholarly articles as well as news articles were read, some blog posts by activists and Non-Governmental Organizations (NGOs) were consulted as well. Both scientific and non-scientific sources of information were consulted since many of activists used social media platforms or were mentioned in local news. The first section of Chapter 2 includes a summary of those findings. This procedure helped not only in determining the content for the roles, but also in the identification of the different roles as well. To support this secondary data collection, a primary data collection technique was also followed: interviews - which are discussed next.

(ii) Interviews

As recommended by Luna-Reyes and Andersen for qualitative data collection in SD projects at the conceptualization stage, interviews with actual stakeholders will be conducted (Luna-Reyes & Andersen, 2003). Based on the results found in the literature search, a few stakeholders were contacted to request interviews. They were contacted either through email or by phone call. These interviews were conducted face-to-face as the research traveled to Lebanon to conduct them. Several SHs as identified from the literature were contacted. A list of the contacted SHs are found below:

Table 9: Stakeholders contacted for interviews

Stakeholder contacted	Response	Comment(s)
Minister of Environment	None	The minister and other employees in the ministry were contacted several times through emails and calls but no meeting could be established
Minister of Municipalities and Interior Affairs	None	The minister was contacted once but no reply was received
Mayor of the town of Jal El Dib	Meeting	Refused to be recorded Did not require transcript to be sent
Ziad Abi Chaker from private sector	Interview	Recorded and transcribed No reply on sent transcript
Mario Goraieb from sorting and recycling NGO	Interview	Recorded and transcribed Replied with comments on sent transcripts
Andre Sleiman from awareness NGO	Interview	Recorded and transcribed No reply on sent transcript

The interviewees were informed that the interview is being recorded and that it will be used solely for the purposes of this research and will not be distributed. They had the opportunity to refuse before the start of the interview. Brief information about the interviewees is present next, but more information can be found in the transcripts in Appendix A. Mr. Ziad Abi Chaker is an industrial and environmental engineer, owner of the company Cedar environmental which specialized in building and managing zero-waste treatment plants. Mr. Mario Goraieb is head of the environmental department at a renowned local NGO “Arcenciel” in Lebanon that works in waste sorting and collection (among other activities). Dr. Andre Sleiman is the country representative of German NGO “Democracy Reporting International” that researches and conducts awareness workshops on several public issues among which SWM. In addition to the interview, an informal discussion was held with the mayor of a medium sized town Jal el dib. The mayor refused to be recorded but stated that anything that he says may be used as source of information. A summary of the most important discussion points is also available in Appendix A. The interviews were sent to the interviewees for transparency and adequacy purposes. Only one of them replied (as shown in Table 9).

During the interviews, one of the questions asked was about whom the interviewee considers to be the SHs in the SWM sector. Based on this answer and on the results found in the literature search, a SH identification analysis was conducted to determine the SH roles that were included in the sessions. The main takeaways from the interviews, the meeting with the mayor and recent posts on blogs and social media platforms were also consulted, in addition to what was found in the scientific literature. These were synthesized into the SH role descriptions that are in Appendix B.

3.4.2. Data Collection PART II

(i) Experiment Documentation

GMB scripts typically include evaluation criteria that give the modeling team an idea on what to expect at the end of the session. The recorder documented all the activities during the workshop both in writing and photography. This documentation will be used as a form of assessment and support for data analysis. The photography documentation is grouped by session in chronological order and may be found in Appendix F. The notes of the recorder were not included because they contain personal information about participants; sharing such information is against the ethical agreements of this research

(ii) Questionnaires

Another data collection method used is questionnaires. In fact, there were three questionnaires used; one pre-questionnaire and two post- questionnaires. The pre-questionnaire was re-used as a post-questionnaire and is referred to as simply: post-questionnaire. It is used to compare the answers of participants and check if and what kind of changes occurred. The second post-questionnaire is based on Midgley et al. (2013, p.149) and is referred to as anonymous post-questionnaire. It was adapted to the topic of the sessions; however, these modifications were minor. The anonymous post- questionnaire includes four parts:

- Section 1 – Usefulness of Workshop; one closed question and 4 open-ended questions
- Section 2 – Purposes Achieved by the Workshop; 14 closed questions

- Section 3 – Negative Aspects of the Workshop; 13 closed questions and 2 open-ended questions
- Section 4 – Demographic Data; 3 closed questions

The original questionnaire includes an additional section entitled “cultural viewpoints”. However, the questions of that questionnaire are not relevant for the topic of SWM, so they were not excluded.

(iii) Observations

All sessions were recorded using video and audio devices. The participants were informed beforehand that the sessions are recorded. They were asked to sign a consent form stating that the data collected will only be used for research purposes. Any personal data will not be shared and will not be accessible to the researcher. The interventions and interactions of participants were coded deductively following a similar coding scheme to that used in Herrera et al. (2016). Each contribution will be coded based on its type and content. This coding will serve as an evaluation of the sessions’ process. More details on the coding scheme is presented in the data analysis section.

3.5. Data Analysis

The data analysis for this research is divided into two parts: pre-experiment and post-experiment. Most of the data analysis will be qualitative, however, some quantification will also be part of the procedure. The quantitative data will be statistically described but no statistical tests will be applied. This is in line with the exploratory nature of the research given that the sample is not big enough to infer any statistical results. As such, no causality can be established from the analysis. Thus, the data will be analyzed only descriptively.

The analysis done before the experiment is needed to generate the role description of the different SH roles that will be used during the experiment. It answers the first research question posed in chapter 1. The analysis of the data collected in the second part (during the experiment) will support the answers to the second research question and its two sub-questions.

3.5.1. Data Analysis PART I

To feed into the experiment design and content, a data collection was required when preparing the role description of the different SHs. In chapter 2, a literature search regarding historical and recent events in the SWM sector in Lebanon was done by looking at papers, news articles and publications of NGOs. To make the content closer to reality, interviews were conducted with actual stakeholders. As a first step, the identification of SHs was conducted by looking in the literature and then by using the snowballing technique throughout the interviews (Reed et al, 2009.). A SH identification analysis was done based on the power-interest matrix of Ackerman & Eden (2011, p.183). The matrix is shown in Figure 9 herein.

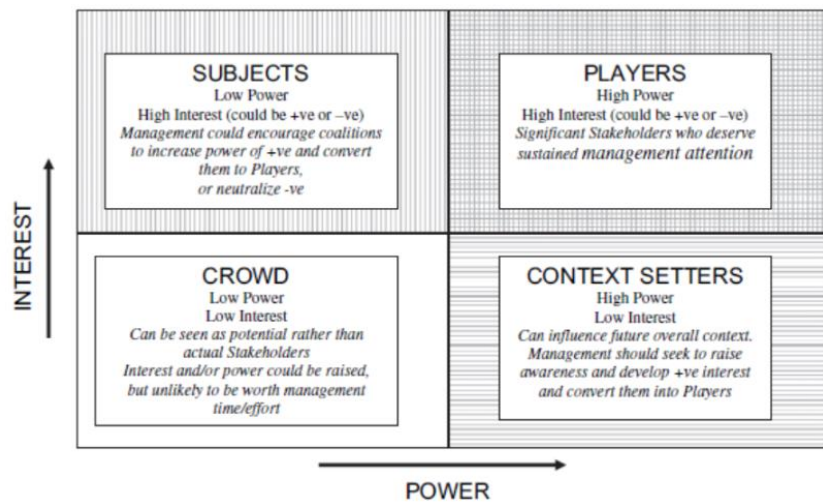


Figure 9: Stakeholder power-interest grid Ackermann & Eden, 2011, p.183)

After the SHs were identified, the roles were narrated by the researcher and were read and reviewed by three colleagues from the researcher's master's program and seven friends and family members from Lebanon. This was done to receive feedback on the information given. Their feedback was also useful to check if the content was enough to get the participants started on the discussion and get some insights of their SH roles. The feedback given by colleagues was helpful because they had taken part of the GMB I course. Thus, they are familiar with this kind of session setting, making their comments relevant to the structure of the description. As for friends and family members from Lebanon, since they know about the issue of SWM, they could give suggestions regarding the content. More details on this will be elaborated in the next chapter.

3.5.2. Data Analysis PART II

The distinction between the process and the quality of communication in GMB was made earlier in this chapter and the previous chapter. As such, the results will be presented and analyzed separately for the process and the outcomes.

(i) Process evaluation

To evaluate the process, three data sources will be used: the documentation, the observations and the anonymous post-questionnaire.

The documentation will be analyzed through comparison with the criteria of evaluation that are included in the scripts followed (Scriptapedia, 2018). They are summarized in Table 10.

Table 10: Evaluation criteria of scripts used

Script	Evaluation Criteria
Variable Elicitation	• Identification of key variables and stocks
Presenting the Reference Mode	• A reference mode has been identified • There is an initial consensus on what the dynamic problem is
Initiating and Elaborating a Causal Loop Diagram	• Improvement in quality of communication, insight, consensus on the problem, and commitment with regard to actions • Improved causal loop diagram
Action Ideas	• The exercise has led to a rich list of potential actions prioritized by the ease of implementation and potential impact • Participants have high energy and express enthusiasm in finding potential solutions • The group has developed a shared understanding of each intervention and how it maps into the system

Source: Appendix D

This comparison to the evaluation criteria will be specifically useful to measure whether the content of the contributions corresponds to the intended output of the scripts.

As for the observations, they will be coded deductively by content analysis. Content analysis is a method that evaluates any type of documented human interaction like text, graphs, pictures, audio or video. It examines the content of the interactions between participants

(Babbie, p. 295). The coding scheme used is like the one used in Herrera (2014)², since the measures compared are similar in both studies and the results of this research will be compared to Herrera's.

As in Herrera (2014), the contributions will be coded by type and by content. Table 11 and Table 12 show the coding scheme used with descriptions.

It must be noted that Herrera's experiment differs from the experiment of this study in both the design and the goals. Herrera (2014) compares GMB to other techniques. Three facilitation techniques are used in his experiment among them GMB (Herrera, 2014). The GMB workshop conducted consists of two types of sessions: a qualitative and another quantitative session. In the qualitative session a CLD was built while in the quantitative a Stock and Flow Diagram (SFD) was used (Herrera, 2014). Since this research includes only qualitative SD, the results of the first GMB session from Herrera (2014) will be used in the data analysis.

The content coded is the video recording of the sessions. The software program ATLAS.ti (Version 8.4.18) was used to code the contributions. The participants' interventions were coded by type as per Table 11 and by contribution as per Table 12. The results were exported to Microsoft Excel where the data was analyzed using tables, charts and pivot tables.

As a final step in the process evaluation, the answers to some of the open questions in the post-questionnaire will be used as evaluation. In some of the closed questions, the participants were asked to evaluate different aspects of the workshop based on a 5-point Likert scale (ranging from "Strongly agree" to "Strongly disagree"). This serves as a general evaluation of the process based on the participants' feedback. The questions used are marked "workshop evaluation" in Table 13.

² Permission to use and compare the data of this research to that of Herrera (2014) was granted by Dr. Herrera through contact via email correspondence.

Table 11: Coding scheme: type of contribution

Primary type	Sub-type	Description
D- Divergent		Participant proposes new ideas (issues or variables), without linking them directly to previous ideas in the discussion
Co- Convergent		Participant proposes new ideas (issues, variables or causal relations), linking them to previous ideas in the discussion
AC- Asking for clarification		Participant asks for more detailed explanation about an idea previously presented
CSu- Clarifying/summarizing		Participant contributes to summarize ideas provided by other participants, link them together, clarify objectives or proposals or check the progress of the task
P- Prioritizing	Ra- Ranking	Participant provides statements expressing his/her preferences or personal criteria about which issue, variable, alternative or causal relation it is more important
	S- Supporting	Participant provides statements expressing his or her support for or agreement with other participants' previous interventions
	DA- Disagreement	Participant provides statements expressing his or her disagreement with one or more of the participants' interventions
N- Negative	CM- Criticizing and/or diminishing the method	Participant casts doubt or provides a negative statement about the effectiveness, importance, usefulness or suitability of the approach used to conduct the workshop
	CI- Criticizing and/or diminishing other participants' ideas	Participant casts doubt or provides a negative statement about the effectiveness, importance, usefulness or truthfulness of one or more ideas or evidences presented by other participants
	CP- Criticizing and/or diminishing other participants	Participant casts doubt or provides a negative statement about the personal competences, personal capabilities, integrity or right intentions of one or more participants
	O- Obstructing the process	Participant provides statements to intentionally delay the process and block the group in its movement to the next stage in the task

Note: Adapted from Folger et al. (1984), Franco and Rouwette (2011), Herrera (2014) and Herrera et al. (2016)

Table 12: Coding scheme: content of contribution

Code	Content Description
MP	Mission and process
PD	Problem definition
C	Causes
AS	Alternative/Solutions development
Other	Other

Note: Adapted from Dwyer and Stave (2008), Herrera (2014) and Herrera et al. (2016)

(ii) Outcome evaluation

For the outcome evaluation, the outcome of the quality of communication, cognitive change, consensus and commitment will be measured by analyzing three sources of data: documentation, pre and post-questionnaires and the anonymous post-questionnaires.

The documentation of three out of the four scripts will be used to assess cognitive change and consensus. In the first script, participants were asked to come up with variables they think should be included in the model and in the last script they suggested solutions or action ideas to solve the problem. A deductive coding was applied to those propositions. The coding scheme applied is based on the categories identified by the wall builder during the sessions which are also aligned with the categories for integrated SWM defined in chapter 2 (Table 3). The four categories are: social/behavioral, technical, economic and legislative. This will measure any occurrence of cognitive change among participants by comparing their contributions in the first script against those of the last script. Another script that will be used is the third script (elaborating a CLD) which will measure consensus in each session and between different sessions.

The same coding categorization is also applied to the answers that participants gave in the pre and post-questionnaires. Before the start of the workshop the participants were asked two questions. The first was to state three reasons for the SWM issue in Lebanon and the second question asked them to suggest three solutions for the crisis (Appendix E). The same two questions were asked again at the end of the sessions to assess if there are any changes in the answers. A comparison of the categories generated by the coding will assess any signs of cognitive change among participants.

The third source of data used to evaluate the outcomes is the anonymous post-questionnaire. The answers to the closed questions were ranked based on a 5-point Likert scale. Each question was assigned one of the four measures defined (communication quality, cognitive change, consensus and commitment) and the corresponding dimension where applicable. The codebook for this evaluation can be found in Table 13.

A final score for each measure will be calculated and compared to previous studies. Scott (2018, pp. 49-51) presents the results of several studies that measured the same GMB outcomes. Although another questionnaire was used (the CICC questionnaire), it is a comparison to the results of those studies is interesting. Numerous studies were aggregated by Scott (2018) and the agendas followed in those sessions are the same. According to Scott the scripts used in those studies are (2018, p. 47):

1. defining the problem or situation
2. identifying variables
3. describing behavior over time of the main variables
4. constructing causal loop diagrams
5. identifying leverage points

Leverage points are locations in the system where even the smallest intervention is impactful (Meadows, 2000, p.145). This step was part of the last script “action ideas” of this study. However, the script goes an extra step by also suggesting solutions in those leverage points. This difference is minimal thus the comparison may still be conducted.

Table 13: Anonymous post-questionnaire codebook

Section	Question	Variable	Dimension
Section 1 - Usefulness of Workshop	1.1. How useful was this workshop for you?	Workshop evaluation	
Section 2 – Purposes Achieved by the Workshop To what extent do you agree or disagree that the workshop has helped you to ...	2.1. Put forward ideas for discussion	Communication	Exchange of ideas
	2.2. Recognize that there are many different points of view on solid waste management	Communication	Exchange of ideas
	2.3. Gain a better idea of the possible options for tackling solid waste management	Cognitive change	Perceived cognitive change
	2.4. Change your mind on what ought to be done about solid waste management	Cognitive change	Perceived cognitive change
	2.5. Think more creatively about solid waste management	Cognitive change	Perceived cognitive change
	2.6. Learn more about the issues surrounding solid waste management	Cognitive change	Perceived cognitive change
	2.7. Gain a better understanding of how people’s values relate to their views on solid waste management	Communication	Openness
	2.8. Better understand my own values as they relate to solid waste management	Cognitive change	Perceived cognitive change

Section	Question	Variable	Dimension
Section 3 – Negative Aspects of the Workshop	2.9. Challenge your previous way of thinking about solid waste management	Cognitive change	Perceived cognitive change
	2.10. Gain a better understanding of ethical issues relating to solid waste management	Cognitive change	Perceived cognitive change
	2.11. Focus on what was really important	Consensus	Content
	2.12. Have confidence that the outputs generated by the workshop will make a difference	Commitment	
	2.13. Think more clearly about positive and possible changes	Consensus	Degree
	2.14. Express your own viewpoint	Communication	Freedom
	3.1. The purposes of the workshop were clear	Workshop evaluation	
	3.2. What was expected from me during the workshop was not clear		
	3.3. There was too much talk (Negative)	Communication	Verbal dominance
	3.4. Workshop discussions were free and open	Communication	Openness
	3.5. Issues of solid waste management were made more complex than they actually are	Workshop evaluation	
	3.6. This workshop was different from my previous experiences with workshops	Workshop evaluation	
	3.7. My views were not listened to (Negative)	Communication	Openness
	3.8. People worked well in a team	Communication	Common language
	3.9. I had sufficient information to take part in workshop discussions	Workshop evaluation	
	3.10. There were issues that could not be discussed (Negative)	Communication	Exchange of ideas
	3.11. My viewpoints were acknowledged by others within the workshop	Communication	Openness
	3.12. I felt pressured to agree with the group (Negative)	Communication	Freedom
	3.13. Significant issue(s) were missed in workshop discussions (Negative)	Communication	Verbal dominance

All data resulting from any coding activity is exported to excel and analyzed using spreadsheet tables and pivot tables.

3.6. Reliability and Validity

3.6.1. Reliability

“In the abstract, reliability is a matter of whether a particular technique, applied repeatedly to the same object, yields the same result each time.” (Babbie, 2012, p.188)

As such, the use of data triangulation in the data collection was a major constituent of reliability within this study. Triangulation is integral to achieve a deep understanding of the topic or issue studied thereby insuring reliable results (Denscombe, 2014, p. 148). Triangulation is particularly important for qualitative data in system dynamics. In fact, Sterman calls for the use of triangulation in studies that involve qualitative data to increase the reliability and validity of the data used (Sterman, 2018).

In addition to the above, some threats are identified that might compromise the reliability of the research. Those threats take the form of biases that either the researcher, the interviewees or the participants have.

For example, the interviewer and interviewee biases as defined by Saunders, Lewis, & Thornhill (2016, p. 397). During interviews, the interviewer’s questions or interventions might cause the interviewee to answer in a biased way; that is known as the interviewer bias. The interviewee bias occurs when they are affected by their perception of the interviewer and thus their answers are changed (Saunders et al., 2006, p.397). The interviewer followed the same questions during all interviews to avoid interviewer bias. To avoid interviewee bias, the questions of the interviews were open, singular, precise and non-steering.

As for the GMB sessions, participants and coders are subject to threats. Participant’s bias refers to how a participant answers the questions of a questionnaire based on what they think is expected of them (Saunders et al., 2006, p. 149). To avoid such bias from participants, the post-questionnaire which contains most of the evaluative questions was anonymous.

Also, the experiment was blind, meaning that the participants were not aware of the research objectives of the experiment (Rothbauer, 2009). They were only told that the experiment is done to evaluate the effectiveness of GMB, but the part about environmental awareness about SWM was left out. Regarding the coder's threat, it is possible that the coder applies the coding poorly, especially if done during the session. To work out this problem, the sessions were recorded, and the coding took place after the session. Thus, the coder had the opportunity to pause and rewind when needed.

3.6.2. Validity

Maxwell (1992) defines five criteria for validity in qualitative research: descriptive validity, interpretive validity, theoretical validity, generalizability and evaluative validity.

Descriptive validity is defined by the accuracy of the data (Maxwell, 1992). In this research, the interviews and the sessions were recorded and documentation in the form of pictures and recorder's note were available to make sure that the data used is accurate.

Interpretive validity refers to how accurate the researcher's interpretation of behaviors or events is (Maxwell, 1992). In this research, triangulation in data collection and data analysis ensured that interpretive validity is maximized.

Theoretical validity is the extent to which the concepts used by the researcher are valid (Thomson, 2011). All the concepts used whether in data collection or data analysis are based on previous studies and research found in scientific literature.

Generalizability means the extent to which the results of this study may be used in future research (Maxwell, 1992). Although the results of this research are not statistically tested, the measures and questionnaires used are however standardized to examples from previous research such as (Midgley et al., 2013) and Rouwette (2011). Thus, future experiments may compare to this one if the same questionnaires and measures are used.

Finally, evaluative validity refers to the extent to which the researcher's interpretation of the results is unbiased and non-judgmental (Anderson, Herr & Nihlen, 1994). The researcher tried to be as objective as possible in all interpretations that were made. All the coding

processes are attached to this report's appendices for the reader to check for any possible biases.

3.6.3. Research Ethics

During the interviews with actual stakeholders, all interviewees were informed of the recording of the interviews, and some refused to be recorded and as such their request was granted. The transcripts of the interviews were sent for them to review before using any of the data in the project. This is important since the stakeholders are not actually participating in the sessions, and whatever is being communicated through their voice needs to be as authentic as possible. Still, no names of organizations were mentioned in the roles description that were based on these interviews – but were rather referred to generally by the industries they are part of.

As for the GMB sessions, participants will be informed that the discussions during the workshop will not be published but only the results of the tests will be used for a research project and that they are anonymous. They will have the option to withdraw from any part of the process if they wish (Denscombe, 2012). Participants will be informed that the sessions will be recorded through oral and written communication. Their right to withdraw from the session will be made very clear to them before the start of the session. They will be given a consent form to read and sign (available in Appendix E), in addition to the verbal explanation. No personal information was shared in any form throughout this project. Subjects were not be referred to using their names, but if needed, they were assigned codes during data analysis. Data protection will follow the rules and regulations of the methodology department at Radboud University's School of Management.

Chapter 4. Results

This chapter presents the results of this research. As mentioned in the previous chapter, data collection took place at two different stage: before the experiment to support its design, and during the experiment. The analysis for both is detailed in this chapter. The analysis of data collected during the experiment is divided into two parts: analysis of the process and analysis of the outcome.

4.1. PART I: Experiment Design

This stage of data collection was crucial to the design of the experiment. Since the participants are not actual SHs (stakeholders), their role description was a critical task to prepare. First, a literature search was conducted, but this did not deem enough to narrate the roles. As such, the researcher decided to conduct interviews with SHs in the SWM sector in Lebanon to come up with a more accurate description.

4.1.1. Stakeholders Identification

As mentioned earlier, the participants in the Group Model Building (GMB) sessions are not the actual SHs of the project. After a preliminary literature search, it was decided that interviews will be needed with actual SHs to get an accurate description of their concerns and demands. The interviews would also serve as a snowball in the SH identification process since

Table 14: Interviewees' stakeholder identification

Interviewee	Answer
Zaid Abi Chaker	Municipalities Various government ministries Non-Governmental Organizations (NGOs)
Mario Goraieb	The ministry of environment The ministry of administrative reform OMSAR The ministry of interior The ministry of works The Council for Development and Reconstruction (CDR) Operators such as Ramco, CityBlu Citizens Civil societies and political parties NGOs active in the environmental field
Andre Sleiman	Citizen Institutions (like hospitals) Municipalities The ministry of environment Council of ministers and the parliament Businesses and Civil Society Organizations Donors' community

interviewees were asked to identify the SHs in the SWM sector (Reed et al, 2009.). As such,

the interviews supported both the SH identification process and the redaction of SH roles. During the interviews, the interviewees were asked who they consider are the SHs in the SWM sector in Lebanon. Their answers are summarized in Table 14.

Based on the information gathered through literature search and the interviews, the following SHs were identified and shown in Table 15:

Table 15: Results of stakeholder identification

SHs of the SWM sector in Lebanon
The Ministry of Environment
The Ministry of Public Health
The Ministry of the Interior and Municipalities
Office of the Minister of State for Administrative Reform (OMSAR)
The Council for Development and Reconstruction (CDR)
Municipalities/Municipal unions
Non-Governmental Organizations (NGOs)
Citizens

Source: Chapter 2 and Appendix A

4.1.2. Roles description

To support the identification of the SHs and to analyze the dynamics of their interactions, a SH analysis was done as suggested by Ackerman & Eden (2011). In their paper, the authors classify SHs into four types according to a power-interest matrix that was presented in the previous chapter. Such an analysis allowed the authors to understand the complexities between the SHs in the case of their research, and although they develop it further, even at this simple stage they were able to draw up some insights on the dynamic of the conversation between the different SHs (Ackerman & Eden, 2011, p.184). This matrix was used to speculate what kind of discussions and interactions would take between the actual SWM SHs if they were discussing the matter. This was quite helpful in the next step when writing the role descriptions. A filled out matrix with the SHs identified in Table 15 is shown in Figure 10. The different ministries are in the “PLAYER” quadrant of the matrix since they have the most power and interest in the issue, especially after the crisis of 2015. As the original matrix specifies, it is not necessary that this power has a positive impact on the situation, it just represents the idea that this group of SHs are legitimately responsible for the issue at hand (Ackerman & Eden, 2011). The “SUBJECTS” which are awareness NGOs and NGOs that collect

and recycle waste are trying to move to the “PLAYERS” category by reaching out to municipalities, thus trying to influence the latter to move from “CONTEXT SETTERS” to “PLAYERS”. As for the citizens, they are considered among the “CROWD” category since their power and interest is minimal. However, as seen before, an integrated SWM plan aims at involving citizens since they are a crucial factor in the success of such a strategy. Which means that awareness NGOs aim at moving them at least to the “CONTEXT SETTERS” category. However, citizens do have an implicit high power since they are the voters and they have a say in who reaches positions of authority. This issue also falls in the awareness of enabling citizens to understand that they do have this implicit power and that not only should they use it, but also use it wisely. This analysis not only allowed the narration of the role description, but it also allowed the research to be framed more cohesively and to better define one of its founding objectives: raising awareness.

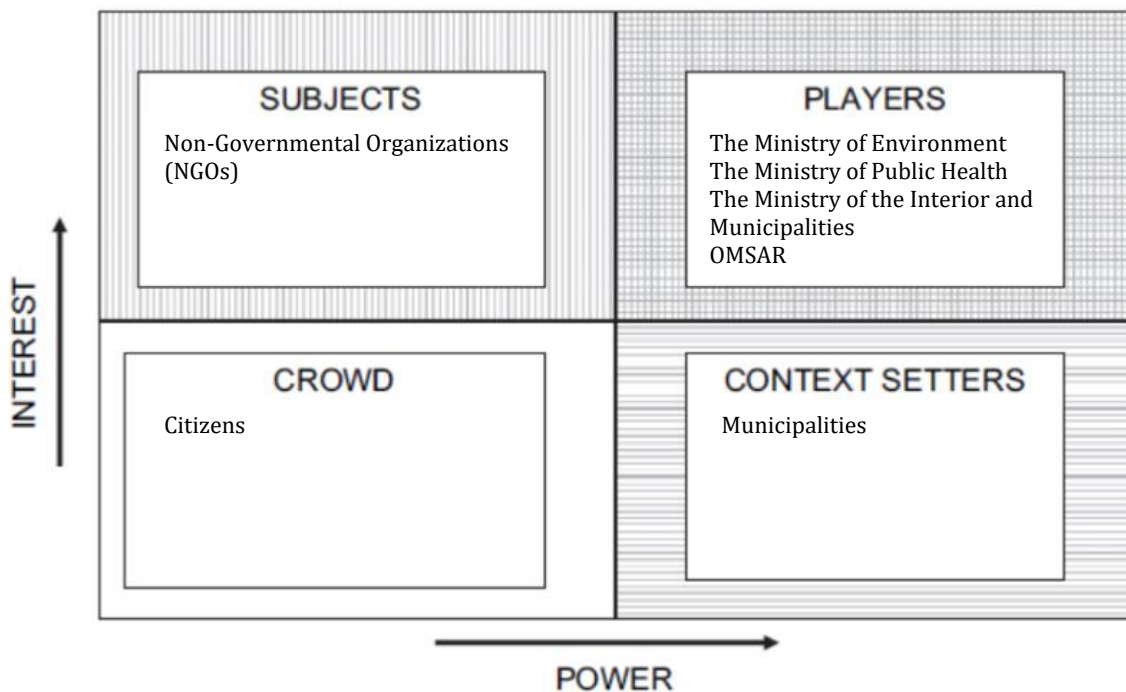


Figure 10: Power-interest grid of the SWM sector in Lebanon (Ackerman & Eden, 2011, p.183)

Given the defined boundaries of the project, the ministries, OMSAR and CDR were excluded since their responsibilities fall on a national level, while the GMB sessions tackle the case of

one town. It was also decided that it is important to distinguish between two types of NGOs that were active in the SWM sector. The first is sorting and collection NGOs, which emerged following the absence of the central government to provide this service to the public. Another type of NGOs worked on raising awareness on the importance of sorting and recycling and intervened at the social aspect of SWM rather than the technical – such as the former.

The different SH roles in the session are show in Figure 11 below. This figure is adapted from Andersen & Richardson (1997) and used during the initial presentation to explain the process to the students.

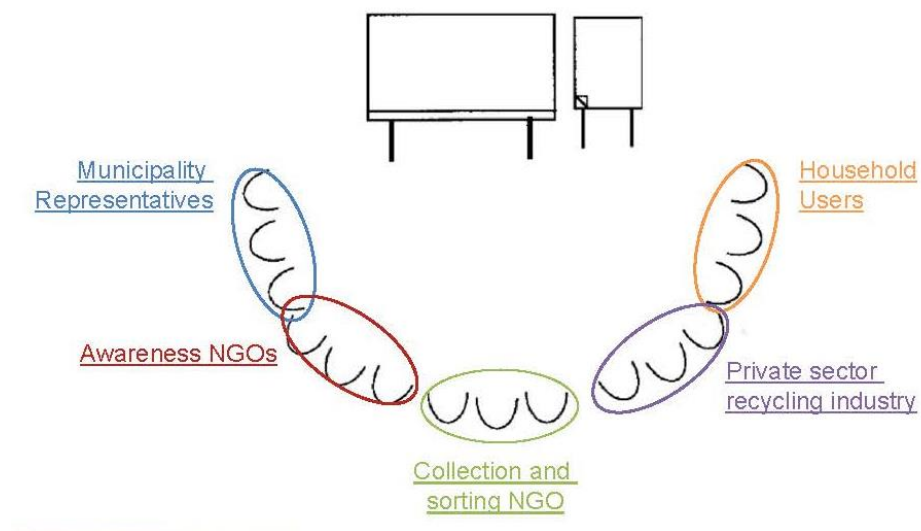


Figure 11: Stakeholder groups (Andersen & Richardson, 1997)

As can be seen in the Figure 11, there are five SH groups, however, the students are themselves household users so there was no need for data collection for that specific role; they just expressed their own experience. This was mentioned in the role description that was handed out to them – all role descriptions may be found in Appendix B.

4.2. PART II: Process Evaluation

The second set of data collection took place during the workshop. For this stage of data analysis, the process and the outcomes will be examined separately. In this section, the results regarding the process evaluation are reported.

4.2.1. Documentation

As seen in Table 10, the different GMB scripts used specify criteria of evaluation. Appendix F shows the different results of every script used during the four sessions. Since four scripts were used, four products are expected: a list of variables, a reference mode of behavior, a Causal Loop Diagram (CLD) and an action matrix. As can be seen in Appendix F, all four sessions had the expected products. Additionally, each product of one script was used to start the following script; for instance, the list of variables elicited in the first script was useful to brainstorm and move to the second script which is the reference mode of behavior. Once the reference mode of behavior was graphed, the variable that was plotted served as a guide to start the CLD. As for the last script, each action idea suggested was associated with a variable or a causal link from the CLD which helped in synthesizing the session's activities. Also, during the last two scripts, the level of enthusiasm of students was remarkably high, students were more engaged, participating and starting discussions and even disagreements. More information on the interactions will be given in a later section when observations will be discussed. Below, the outputs of every script are shown and described.

(i) Variable elicitation

During the first script, students were asked to generate a list of variables; they were given some time to come up with a list in their own sub-groups of SH types and then shared with the

Table 16: List of variables used and not used

			Variable Elicitation	
			Used	Not used
March 30th	10 AM - 1 PM		10	14
	2 PM - 5 PM		13	14
April 6th	10 AM - 1 PM		13	13
	2 PM - 5 PM		13	12

bigger group. This is known as the Nominal Group Technique (NGT). Due to time restrictions not all the variables were shared on the board, however, the papers that the students used to write their answers on were collected and counted. A summary of all the variables is

shown in Table 16 herein. The term “used” refers to the variables shared during the NGT part of the activity and thus shown on the board. The term “unused” refers to the other variables that students came up with but that were not displayed on the board.

As shown in Table 16, the differences between the four sessions are not major, except for the action ideas of the fourth session, where fifteen ideas were proposed and used and twenty were not used. As for the numbers themselves, they show that the students were able to generate more than what was required since there were five SH groups and the NGT requires two rounds of sharing of variables. This means that at least ten ideas need to be generated. This was the case for all sessions where at least ten propositions were made (in some cases more) and there were even unused propositions.

(ii) Reference mode of behavior

As for the second script, the same reference mode of behavior was built during the four workshops. The words used to describe the variable plotted over time are not the same, but they refer to the same variable. The different names used were:

- Session 1: Quantity of solid waste sent to landfills
- Session 2: Untreated waste sent to landfills/dumps
- Session 3: Solid waste sent to landfills
- Session 4: Waste to landfills



Figure 12: Reference mode - Session 1

The trends of the different scenarios (“Do nothing”, worst case scenario and best case scenario) were the same in all sessions too. An example of one of the reference modes produced is shown in Figure 12 and all four are available in Appendix F.

(iii) Causal Loop diagram analysis

All four groups came up with CLDs which are shown in Appendix F. Table 17 below shows an overview of the content of these CLDs in terms of number of variables, causal links and identified loops. It must be noted that the number of loops identified shown in the table are those which were pointed during the sessions; it is highly possible that there are other loops that were missed by the participants and/or the facilitator.

Table 17: Number of variables, causal links and loops identified in the CLDs

	Variables	Causal links	Loops identified
Session 1	19	26	5 (1 B ^a + 4 R ^b)
Session 2	19	25	5 (3 B + 3 R)
Session 3	19	28	2 (1 B + 1 R)
Session 4	15	19	2 (1 B + 1 R)

(a) Balancing loop

(b) Reinforcing loop

The last session has the smallest number of variables and causal links, this could be due to the significantly smaller number of participants during that session. Interestingly, session 3 has the highest number of participants (17), but the resulting CLD has only a couple more causal links and the same number of variables as sessions 1 and 2. Although the number of participants is higher. This is due to the time restriction; the limited time for the activity allows only so much interaction to take place. Another possibility could be that due to the higher number of participants, more disagreements or longer discussions were taking place, which could have resulted in less variables. As for the measures, not much can be derived from this data source. However, more insights can be reached by analyzing the interactions between participants during the building of those CLDs, which will be done in the observations section later in this chapter.

(iv) Action ideas

As in the first script, the NGT was used in the action ideas activity and the results are reported similarly. Table 18 showing the propositions that were shown on the board labeled as “used”

and the others that were not shared due to the time restriction. Again, the differences between the four sessions are not major, except for the action ideas of the fourth session, where 15 ideas were proposed and used and 20 were not used. This is significantly larger than the previous sessions, even though this session had the smallest number of participants. In fact, the smaller number of participants meant less time spent on discussions which left time for more suggestions.

Table 18: List of action ideas used and not used

		Action ideas	
		Used	Not used
March 30th	10 AM - 1 PM	10	7
	2 PM - 5 PM	11	7
April 6th	10 AM - 1 PM	11	11
	2 PM - 5 PM	15	20

To summarize, according to the documentation, all the goals of each script were met. The evaluation criteria shown on Scriptapedia were used to evaluate it (2018).

4.2.2. Observations

The results of the deductive coding performed through observations and content analysis of the four sessions are shown in Appendix K. A summary of the results grouped by session, script and contribution type then content type is also available at the end of that appendix. These will be compared to the results of Herrera (2014). Herrera (2014) compares GMB to other facilitated methods and even though the research scope is different, the measures and codes used are the same. For the sake of simplicity and ease of comparison with Herrera (2014), some of the contribution type codes were aggregated. As per Table 11 the sub-types Ra- Ranking, S- Supporting and DA- Disagreement are all under the primary type: P- Prioritizing. So, all the codes within these sub-categories were summed up under P- Prioritizing. The same was done for the primary type N- Negative, which includes all sub-types: CM- Criticizing and/or diminishing the method, CI- Criticizing and/or diminishing other participants' ideas, CP- Criticizing and/or diminishing other participants and O- Obstructing the process. Also, the contribution type AC- Asking for Clarification was

discarded from the comparison. The reason is that AC is not in the results of Herrera (2014). This is not a problem for this research's results since the values are negligible, ranging between 1% and 4% in all sessions (Appendix K, Table K-9).

Figure 13 shows the results of sessions 1 and 2 and Figure 14 shows the results of sessions 3 and 4. Figure 15 shows data from Herrera (2014); to note that only the red line is of interest as it represents the results of the qualitative GMB session which is the baseline against which the sessions will be compared to. Sessions 1 and 2 were grouped together in the same figure since they show similar distribution, as is the case for sessions 3 and 4.

Starting with the total number of contributions, sessions 1 and 2 have a total of 349 and 354 contributions coded respectively while sessions 3 and 4 have 196 and 216 contributions coded. Herrera (2014) shows that 467 contributions were coded in the qualitative GMB part of his sessions. The number of contributions for sessions 1 and 2 is closer to that of Herrera (2014). However, this does not necessarily imply that the results of sessions 1 and 2 are better. A closer look at the type and content of contributions is needed.

To aid the comparison process, the different contributions are ranked in descending order of frequency for each session. The results can be found in Table 19 and Table 20.

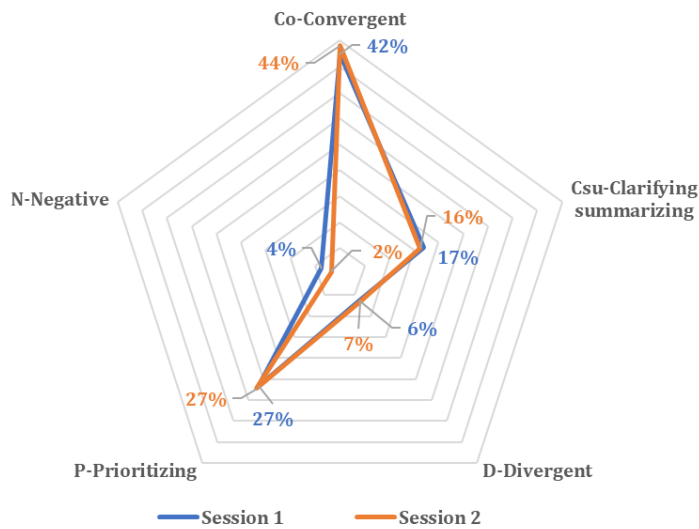


Figure 13: Contributions by type of session 1, n = 349, and session 2, n = 345

Source: Appendix K

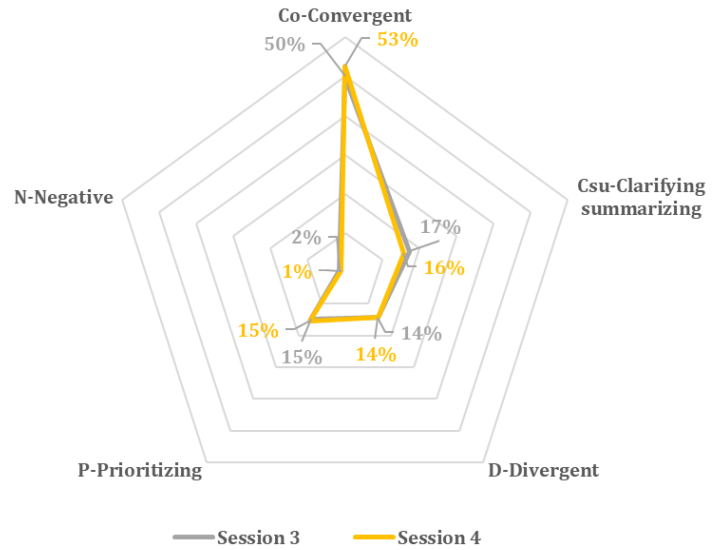


Figure 14: Contributions by type of session 3, n = 196, and session 4, n = 216

Source: Appendix K

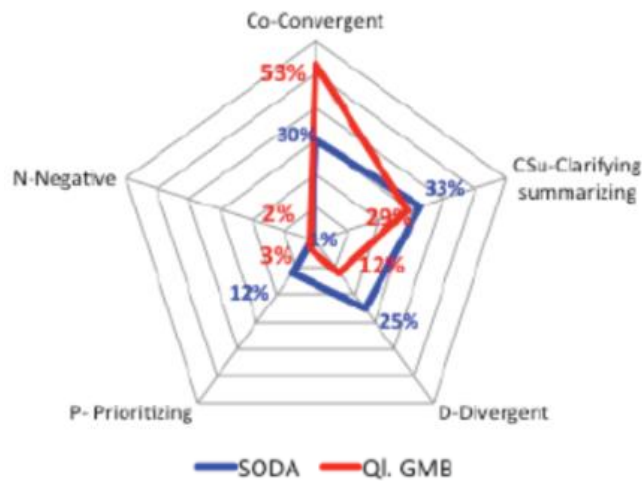


Figure 15: Contributions by type, n = 467, from Herrera (2014)

Table 19: Frequency of contribution types

Session 1 (n = 349)		Session 2 (n = 354)		Session 3 (n = 196)		Session 4 (n = 216)		Herrera (2014) (n = 467)	
Type	Frequency	Type	Frequency	Type	Frequency	Type	Frequency	Type	Frequency
Co	42%	Co	44%	Co	50%	Co	53%	Co	53%
P	27%	P	27%	CSu	17%	CSu	16%	CSu	29%
CSu	17%	CSu	16%	P	15%	P	15%	D	12%
D	6%	D	7%	D	14%	D	14%	P	3%
N	4%	N	2%	N	2%	N	1%	N	2%

Source: Table K-9, Appendix K and Herrera (2014)

(i) Contributions type

As can be seen from the figures or the table above, sessions 1 and 2 show similar distributions of contribution types. In both sessions, convergent contributions have the highest share with 44% for session 1 and 42% for session 2. Sessions 3 and 4 as shown in Figure 14, also have the highest contribution type as convergent with 50% for session 3 and 53% for session 4. The results of sessions 3 and 4 are closer to those observed in Herrera (2014) where convergent contributions account for 53% of the total contributions.

Second most frequent in sessions 1 and 2 is contribution type P with frequencies equal to 27%. However, the second most contribution type for sessions 3 and 4 is CSu-Clarifying/Summarizing, with 17% in session 3 and 16% in session 4. The results of sessions 3 and 4 are similar in ranking to Herrera (2014) however the values are far, where Herrera (2014) recorded 29% of CSu contributions.

The third most frequent contribution type is in sessions 1 and 2 is CSu with 17% in session 1 and 16% in session 2. For sessions 3 and 4, P is the third most frequent; 17% of contributions were CSu in session 3 and 16% in session 4. In this case, D- Divergent is the third most frequent contribution in Herrera (2014) of 12% (Herrera, 2014). Thus, neither sessions 1 and 2 nor 3 and 4 share any similarities with Herrera (2014) for this entry.

Fourth most frequent contribution is D for sessions 1, 2, 3 and 4, with values 6%, 7%, 14% and 14% respectively. These results differ from Herrera (2014) where the fourth most frequent contribution type is P with a value of 3%.

Finally, the fifth and least frequent contribution type is N for all sessions and Herrera (2014). The values are 4% and 2% for sessions 1 and 2, 2% and 1% for sessions 3 and 4, and 2% in Herrera (2014). The values are relatively close to each other, however, results of sessions 2, 3 and 4 are the closest to Herrera (2014).

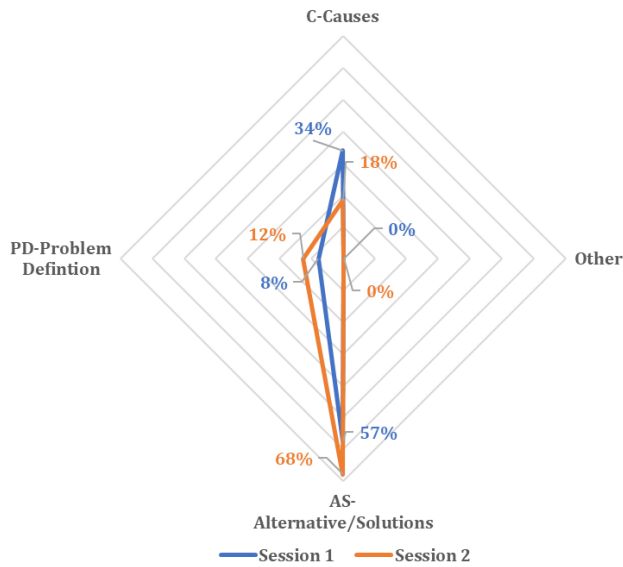


Figure 16: Contributions by content of session 1, n = 349, and session 2, n = 345
Source: Appendix K

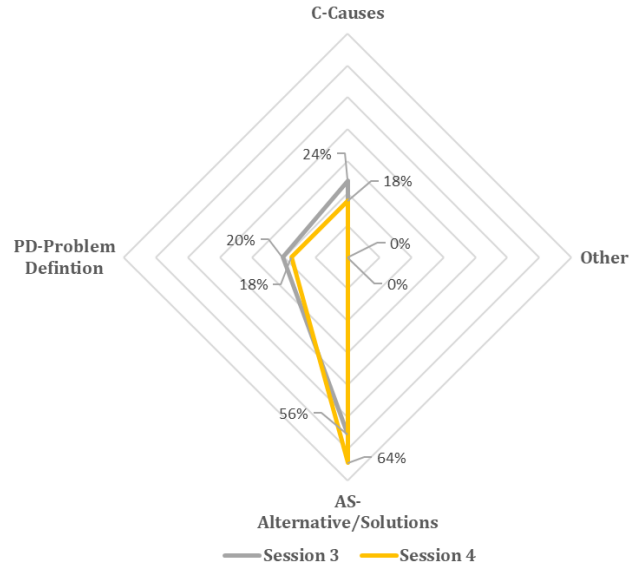


Figure 17: Contributions by content of session 3, n = 196, and session 4, n = 216
Source: Appendix K

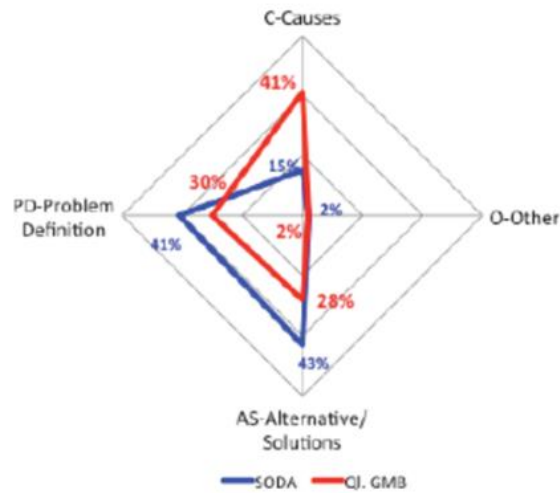


Figure 18: Contributions by content, n = 474, from Herrera (2014)

Table 20: Frequency of contribution content

Session 1 (n = 349)		Session 2 (n = 354)		Session 3 (n = 196)		Session 4 (n = 216)		Herrera (2014) (n = 467)	
Content	Frequency	Content	Frequency	Content	Frequency	Content	Frequency	Content	Frequency
AS	57%	AS	68%	AS	56%	AS	64%	C	41%
C	34%	C	18%	C	24%	C	18%	PD	30%
PD	8%	PD	12%	PD	20%	PD	18%	AS	28%
Other	0%	Other	0%	Other	0%	Other	0%	Other	2%

Source: Table K-9, Appendix K and Herrera (2014)

(ii) Contributions content

All four sessions from this research experiment have the same ranking of contributions content: AS- Alternatives/Solutions most frequently, C-Convergent second most, PD- Problem Definition third most and Other least frequently. However, the value distribution is different. In session 1, most of the discussions were AS or C (PD has a very small portion of 8%). Sessions 2 and 4 had a dominance in AS contributions with values higher than 60% and the rest distributed between C and PD. Session 3 had a slightly higher contribution content allocated towards C and PD discussions compared to sessions 2 and 4. As for the baseline case of Herrera (2014), the ranks of the contributions content are relatively more evenly distributed between C, PD and AS when compared to this research's experiment. It must be noted that the contribution content MP- Mission and Process was excluded from this comparison because it is not part of the results of Herrera (2014). Once again, this exclusion was possible because the values were negligible (between 0% and 1%) (Appendix K, Table K-10).

To summarize, in terms of content type, sessions 3 and 4 seem to have closer results than sessions 1 and 2 when compared to the baseline results of Herrera (2014). Nevertheless, the results of sessions 1 and 2 are relatively close and the differences are minor. One possible reason behind the difference between sessions 1 and 2 when compared to 3 and 4 is due to the familiarity of the participants with each other. Participants from sessions 1 and 2 are part of the same major and were taking the same course at the time. Therefore, these sessions had more discussions since participants were already acquainted with each other. However, in sessions 3 and 4, participants were more reluctant to engage in heavy discussions. Some of them were shy and only participated when the activity required them to or when the facilitator invited them to speak.

As for the contributions content, the results were internally homogenous within the scope of this study, but not close to Herrera's results (2014). This could be caused by several reasons, like the different workshops' agendas and different participants, implying a different socio-cultural context. Also, an important difference is the nature of the participation; this research's participants were part of a role play while Herrera (2014) was with actual

stakeholders. Another reason for the difference in both content and type of contributions is coders' bias. Indeed, this could be due to the difference in how the coders interpret an intervention and what code they attribute to it. Herrera's research accounts for intercoder reliability while this research does not, which is one of the limitations of this study.

4.2.3. Anonymous post-questionnaire

Another source of data that gives insights on the process of the workshop is some of the closed questions in the anonymous post-questionnaire. These questions give an overview of the participants' feedback on the workshop. In Table 13 the questions that are labeled "Workshop evaluation" will be used for this purpose. The first question is 1.1. where participants are asked to evaluate the usefulness of the workshop.

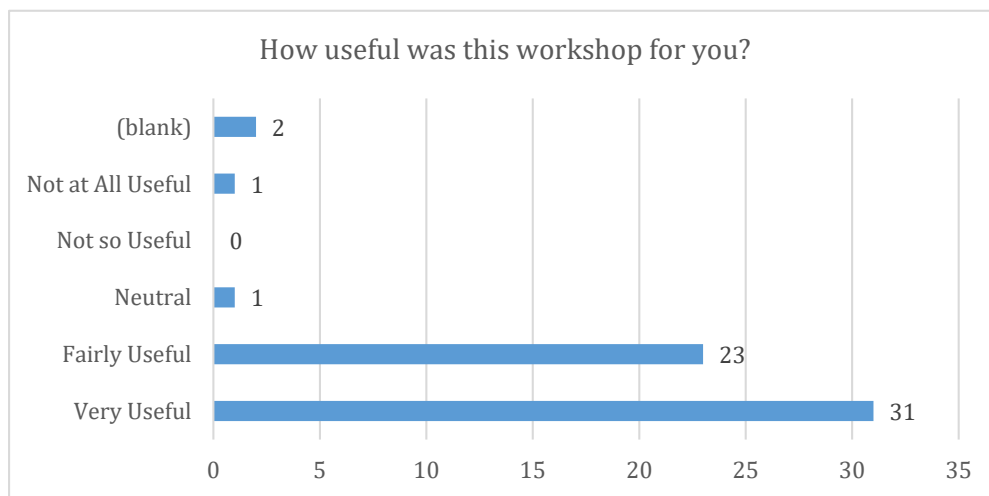


Figure 19: Usefulness of the workshop - All sessions

Source: Appendix I, All sessions – Closed questions

From Appendix I, and shown in Figure 19, it can be seen from all sessions that 31 participants found the workshop very useful, 23 found it fairly useful, one person said they felt neutral about it. Another person also said it was not useful at all and two had blank answers. All in all, the results are positive since 54 out of 58 participants found the workshop useful, and that is satisfyingly good result.

Another question that for workshop evaluation is question 3.1. asking participants if they found the purposes of the workshop clear. Their answers are shown in Figure 20.

Out of 58 participants, 28 said they strongly agree that the purposes of the workshops were clear, 25 agree and 5 felt neutral about it. Again, the results of this evaluation are positive,

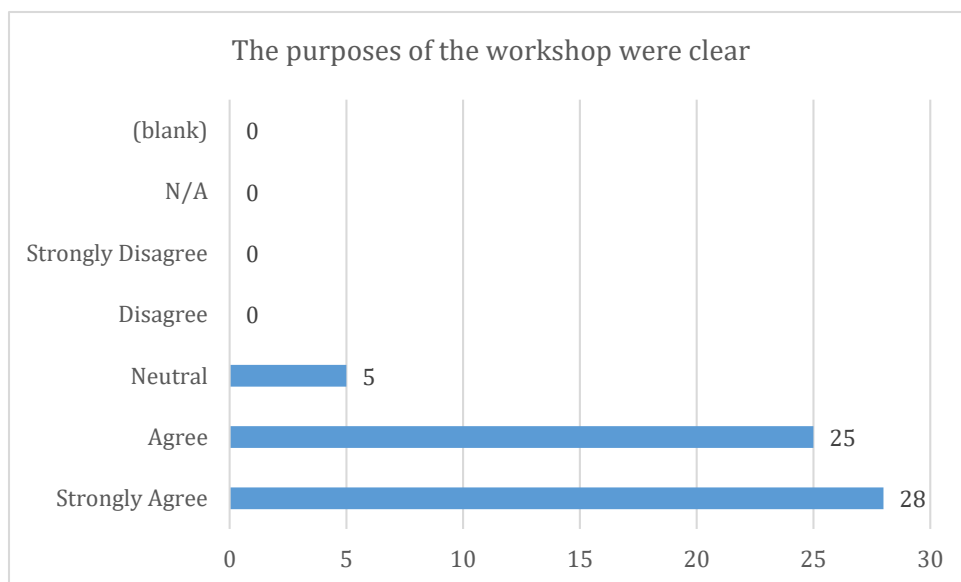


Figure 20: Clarity of the workshop purposes - All sessions

Source: Appendix I, All sessions – Closed questions

showing that the participants mostly had a clear view on the goals of the workshop. This shows that the workshop was well organized and clear.

Question 3.5. also used for workshop evaluation shows that participants were not all in agreement about how complex the issues discussed were made to be. The answers are shown in Figure 21.

A big portion (20) felt neutral, 11 said they felt the issues were made more complex than they actually are and two strongly agreed to that statement.



Figure 21: Complexity of issues discussed during the workshop - All sessions

Source: Appendix I, All sessions – Closed questions

Although no conclusions can be made from these results as to the source of this feedback, two possible reasons could be behind it. Either the discussion taking place went into more details than it should have due to the structure of the workshop or that some participants were focused on issues that other participants did not agree with.

Finally, question 3.6. asking participants whether this workshop was different from any other workshop they had is not indicative without the follow-up question “in what ways?”. Since the follow-up question is an open question, it will be discussed in a later section of this chapter.

4.3. PART II: Outcome Evaluation

After the data regarding the process was presented, the outcomes of the sessions in terms of cognitive change, consensus, commitment and quality of communication will be shown next. These were defined in the previous chapter along with their respective dimensions where applicable.

4.3.1. Documentation

From the data available through documentation, it is possible to compare the variables elicited in the first script and the action ideas proposed during the last script of each session. By grouping them into clusters as identified by the wall builder that coincide with those found in the literature Table 3, any change between the results of the first and last script is an indication of cognitive change. Another measure is possible through the choice of the variable to be plotted during the second script and the resulting trends for the different scenarios. The agreement (or lack thereof) is a measure of consensus occurring within each session and in general when comparing the resulting graph of the four sessions.

(i) Variable elicitation and action ideas

The variables suggested by students were grouped into clusters by the wall builder during the first GMB script. Table 21 shows the different clusters and how many variables in each cluster there are. These are also shown in Appendix F as pictures that were taken by the recorder during the sessions.

Table 21: Clusters of variables identified by the wall builder

	Economic	Social/Behavior	Technical	Legislative
Session 1	3	2	5	-
Session 2	3	4	6	-
Session 3	-	5	7	1
Session 4	2	3	6	2
Total	8	14	24	3

Source: Appendix F

It is notable that most of the variables identified are either technical or related to social behavior. The highest frequency is in the technical category in all four sessions; this shows that the students attribute the failure of the SWM sector mostly to lack of technical expertise

and availability of equipment in the field. It is important to keep in mind that this is the first script, which is a brainstorming script where their previous knowledge on the topic and the information they got from the role description are the primary sources of information. However, it is still noteworthy that the second most frequent category is social behavior. As for economic and legislative, they appear with the lowest frequency. Now looking at the results of the last script “actions taken”, a clear shift in the categories targeted is observed. The same clustering was applied to the actions suggested by the participants and the clusters are shown in Table 22. The original action ideas suggested are shown in Appendix F.

Table 22: Clusters of action ideas generated

	Economic	Social/Behavior	Technical	Legislative
Session 1	-	5	1	5
Session 2	0	6	3	3
Session 3	1	7	3	3
Session 4	2	9	1	3
Total	3	27	8	14

Source: Appendix F, Table F-1

Table 22 shows that the most frequent suggestions are focused on the social or behavioral aspects of SWM as well as the legislative. This is a remarkable shift, especially that social and behavioral suggestions lead the way and are almost doubled. Indeed, this result shows a shift in the mental models of participants, as they are now more focused on the core issues of the problem that are within the boundaries of the problem, rather than blaming the lack of technical expertise. Indeed, they are now aware that there is a lot of effort that needs to be invested in having more engaged citizens and proper legislation to establish a successful SWM strategy. These are clear signs of cognitive change that occurred during the sessions. The change is in both the degree and content of cognitive change since participants changed their views about the areas that should be targeted, and the number of propositions provided also changed. This is true for problem definition and problem solving – visible by comparing the first and last activities.

(ii) Reference mode of behavior

As observed in Figure 12, three scenarios were plotted during the second script: the “do nothing” scenario where no intervention is taken from any party in the SWM sector, and it

was agreed in all four sessions that this would be as case where solid waste is still sent to landfills without sorting and every time a landfill reaches its full capacity there is another crisis for a certain period of time where waste is not collected anymore (represented by the flat parts of the graphs), meanwhile the government tries to find a new landfill to use again. The “worst case scenario” where participants imagined what is the worst that could happen, and this was the case where no replacement for new landfills is found and the waste keeps accumulating on the streets. The “best-case scenario” would be to stabilize the waste sent to landfills and eventually reduce it by applying other waste treatment solutions. In general, there was unanimous agreement on these plots, even if some disagreements did emerge, they were quickly resolved.

This shows that consensus was reached on the problem definition and on what the central variable is, among all four groups.

4.3.2. Pre vs. Post questionnaires

The second source of data used is the questionnaires. There were three questionnaires that participants filled. Two of them are identical and we filled before and after to compare and detect any cognitive change. These were not anonymous; the names of the participants were recorded to keep track of the answers. The third questionnaire, based on Midgley et al. (2013), was anonymous and was designed to evaluate the process and outcomes of the sessions.

In these questionnaires, the participants were asked three questions:

- Do you think there is solid waste management problem in Lebanon today?
- Please identify one or more reasons behind the solid waste management problem
- Please suggest one or more solutions to the solid waste management problem

The answers of the participants were coded based on the same clusters used in the previous section: economic, social/behavior, technical or legislative. The answers of the participants are presented in Appendix G and the coding in Appendix H. At the end of Appendix H a summary of the results per session is shown and Table 23 below shows the results for all sessions.

Table 23: Pre vs. post questionnaire coding results (total)

	Pre (problem)	Post (problem)	Pre (solution)	Post (solution)
Economic	7	13	2	5
Social/Behavior	33	63	34	67
Technical	26	35	23	17
Legislative	16	36	10	35
Total	82	147	69	124

Source: Appendix G, Table G-1

As observed in Table 23, the number of answers given by students increases significantly from the pre to the post questionnaire. For the problems suggested it increases from 82 to 147 and for the solutions from 69 to 124. In the pre-questionnaire, the focus of the answers falls in social and technical clusters for both problem and solution questions. However, in the post-questionnaire, a remarkable increase in the answers given is concentrated in the social/behavioral aspects of the problem (from 33 to 63). Another significant increase is in the legislative aspect of the problem, from 16 to 36. Although the other two clusters show an increase in answers, the change is relatively small when compared to the other clusters. A similar change is observable also in the solution related question with one exception – there is a decrease in the number of answers given in the technical cluster.

These results are aligned with the findings of the previous section, where it was shown that most of the ideas suggested before the activities were within the technical and social clusters. However, after the activities, the focus of the participants shifted towards the social and legislative aspects of the topic. In fact, this data source allows for an even more detailed inspection since students answered the pre-questionnaire before the introductory presentation, the reading of the role description and the discussion in the small groups. This implies that the answers were unbiased and not subject to group agreement or peer pressure (Vennix, 1996). Also, the answers were separated into problems and solutions, while this distinction was not explicit in the first data collection source.

To summarize, in this section, the documentation collected from the four sessions showed a shift in the mental models of participants between the first and last activities. Participants were focused on the technical issues (and subsequently also proposed technical solutions) while in the last activity, their focus shifted to the social and legislative sectors of SWM. This

shows that cognitive change was achieved during the sessions. In addition, the reference mode of behavior plotted was the same during the four sessions, including the trends of the three different scenarios. This is a sign of consensus between participants of each session and across the four sessions as well. Finally, the CLDs from the sessions, although not providing any tangible deductions, already show positive signs of communication and commitment.

4.3.3. Anonymous post-questionnaire

The anonymous post-questionnaires included two types of questions: open and closed. The open questions were coded following a deductive coding technique by using the different dimensions of the four measures defined in the previous chapter. A detailed coding table is available in Appendix J and an overview of the results is shown next.

All closed questions were based on 5-point Likert scale ranging from strongly agree to strongly disagree. The results of the closed questions were grouped per session and presented in Appendix I. To analyze these results, every answer was assigned a score from 1 to 5. Every question was assigned a measure and dimension where applicable. Based on the scoring and the assigned dimension, a total score was calculated. The calculations are shown in Appendix J. The results are summarized in Figure 22.

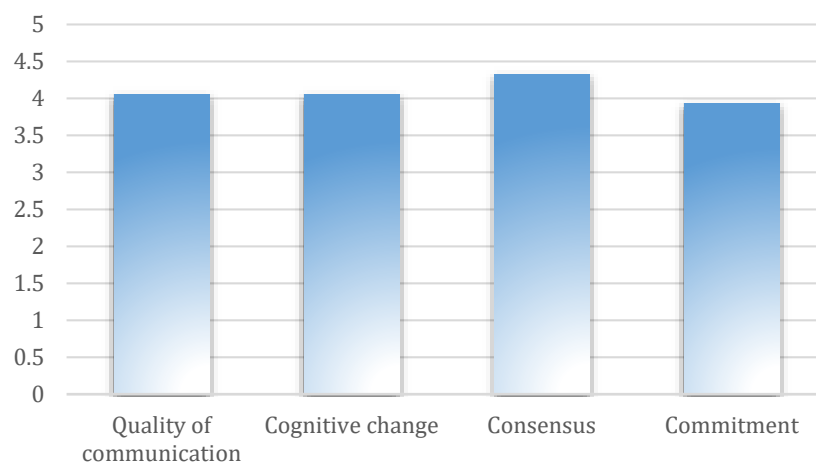


Figure 22: Results of closed questions scores by outcome measures

To understand the significance of these results, they will be compared to those from Scott (2018) shown in Figure 23.

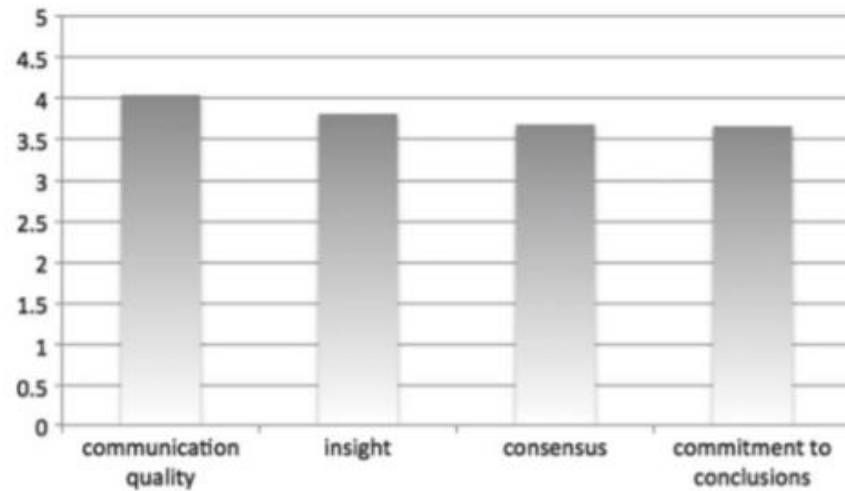


Figure 23: Likert questionnaire results by outcome-area

Source: reprinted from Scott, 2018, p. 51

As can be seen, in both cases the result scores are between 3.5 and 4 which shows that the results of the experiment are consistent with previous research. However, it must be noted that the questionnaire used in Scott (2018) is not based on Midgley (2013) but on the “CICC” questionnaire which stands for Consensus, Insight, Communication quality, Commitment to conclusions developed by Jac Vennix and colleagues (Scott, 2018, p. 40). The CICC questionnaire is the most widely used in previous GMB research – thus explaining why it was used as baseline comparison. However, there are some limitations and reservations expressed by researchers regarding its use (Scott, 2018, p. 39) – which is why it was not used in this research.

Chapter 5. Conclusions and Discussion

The dangers of piecemeal solutions (Vennix, 1996) are currently manifested in the SWM sector in Lebanon as a new crisis hits the Northern district of the country (“Terbil landfill between political agreement and popular refusal”, 2019). To date, no solution has been reached for neither the Northern district nor the remaining districts of the country. As was discussed in chapter 2, political clashes have been the main obstacle for the legislative requirements of a SWM strategy for the country. However, in the case of the northern district’s crisis, even though political consensus was reached, public resistance is inhibiting the implementation of any solution in the country (“Terbil landfill between political agreement and popular refusal”, 2019). This reinforces the adoption of inclusive techniques for SWM strategy planning and design in Lebanon. Indeed, Group Model Building (GMB) is powerful in ensuring successful implementation by raising public awareness through participation which is much needed at this stage in Lebanon (Hovmand, 2014). As was seen, this study tackles the use of GMB to raise on the SWM issue in Lebanon, and the results are shown hereafter by answering the research questions posed in chapter 1.

5.1. Answers to research questions

5.1.1. What preparatory research is needed when GMB is applied as a role play to raise awareness?

Chapter 2 includes two sections; one related to the topic and the other to the method. The first section was paramount to the research, specifically to the experiment design. A deep understanding of the topic is required in the case of a role play, even more than in the case of a regular GMB session. When GMB involves actual SHs, their mental models are a source of information that is integral to the session. However, when role play is incorporated into GMB session, the roles need to be carefully narrated by the modeling team since they would constitute the resource for participants into the mental models of actual SHs.

That said, the extensive literature search about the topic of SWM, in general, and in Lebanon, in specific, was presented in chapter 2 and was helpful in designing the experiment. It also

inspired the researcher to perform two important tasks that were not initially within the plan of the research: SH identification and interviews. The SH identification process revealed a very important finding: household users are often neglected as SHs in the SWM issue in Lebanon. This was found in both the literature search and the interviews. Only two interviewees considered citizens central SHs in the SWM sector in Lebanon (as shown in Table 14 and Appendix A). Also in the literature, a paper published by Lebanese researchers considers citizens to be only involved in terms of awareness and abiding to laws (Table 2) (Ghadban et al., 2017). Ghadban et al.'s proposition for SH participation in drawing up a national plan is proposed to be only through a waste management board, that normally only experts are part of (2017). That kind of level of SH participation in the design of strategies is shallow (Nutt, 2008). Such is the case of the waste management coalition that was formed in Lebanon not long after the crisis of 2015 (<http://wmclebanon.org>). However, the rest of the citizens are still distanced from the happenings which is risky as it could create policy resistance, as is the case now in the northern district of Lebanon. Indeed, a local television news station reported recently that the suggested solution for the crisis of the northern district is prone to massive resistance from citizens. After the government had finally reached political consensus over a plan for the SWM of the northern district, the citizens of the town where a sanitary landfill is proposed are outraged and refused to have the bear the burden of the entire district's waste ("Terbil landfill between political agreement and popular refusal", 2019). This phenomenon is known as the NIMBY (Not In My Back Yard) syndrome (Awwad, 2017) and was part of one of the role descriptions in the workshop of this research.

As such, the above shows that the background literature search and interviews proved that household users are rarely given the importance they deserve in the SWM planning process. Hence this preparatory research was not only useful to prepare the sessions' design, but also to understand an important underlying issue of the problem. This finding adds to the practical implications of this study. It shows how important it is that all SHs and citizens need to be made aware that they have a crucial role in the SWM issue in Lebanon. It also justifies once more the use of GMB for SWM in Lebanon. In fact, research and previous applications have shown that GMB is powerful in diminishing policy resistance through consensus and

commitment building (Ghaffarzadegan et al. 2011; Hovmand, 2014; Nutt, 2004; Rouwette et al., 2016).

5.1.2. In what ways could GMB contribute to students' environmental awareness about SWM?

To answer this question, the following two sub-questions need to be answered.

- (i) Which of the GMB outcomes are achieved in a controlled setting where GMB is used to raise awareness?*

In PART II of chapter 4, the results of the process and the outcome are mostly positive. Except for commitment, the remaining measures were successfully achieved. Commitment was not measured through all three data sources; it was measured through one closed question in the post-anonymous questionnaire. In fact, commitment is better measured after some time has passed or through interviews after the workshop. However, due to time restrictions, interviews could not be held with workshop participants. Thus, the results regarding commitment are inconclusive.

Overall, the results of this research are not statistically significant due to the small sample size. However, they do show promise for future explorations. The use of GMB to raise awareness in this study has showed that similar outcomes are reached when compared to previous studies where GMB was used for policy or strategy design.

One very important point that contributed to the positive results of the GMB process and outcomes is the language factor. The use of three languages (Arabic, English and French) in every day conversations is common among Lebanese people. Although English was the main language used during the sessions, the participants were free to communicate in any language they chose. This was possible because the researcher and all people assisting in the workshop were also Lebanese and language was not an issue. This contributed to the openness and freedom of participants to speak comfortably in any language they wish. This was one of the shortcomings that Herrera (2014) faced in his study. In fact, the participants were not able to express themselves comfortably and reported that they would have preferred the workshops to be held in their native language (Herrera, 2014).

(ii) *What is the added value of using GMB for awareness raising on SWM in Lebanon?*

In addition to the outcomes reached, the process analysis showed that GMB did boost the awareness among participants. The three components of environmental awareness defined in chapter 2 are: cognitive, affective and conative (Table 4) (Ham et al., 2016).

The cognitive component is directly connected to the cognitive change measured as a GMB outcome. The results of chapter 4 showed a clear cognitive change among participants. To showcase this also, one of the participants' feedback on the workshop is shown next:

"It involved more interventions from the audience [than other workshops], we contributed, and we learned" (Appendix I, Session 3 – Open questions).

The affective component may be examined through the contributions coded through the content analysis of the experiment observations. Regarding the contributions, the discussion was especially intense between participants who were familiar with each other (sessions 1 and 2). They did not need some time to get acquainted and needed less time to feel comfortable enough to voice their opinions. However, this does not mean that the workshop was any less impactful for participants from sessions 3 and 4. In fact, one of the respondents mentioned that the workshop was especially helpful and encouraging for shy people. The participant's answer to the question regarding what they liked best about the workshop was:

"The methods that were used to engage all the audience in the discussion. We didn't get bored and it is a method that is friendly for shy people as well" (Appendix I, Session 3 – Open questions).

Therefore, the results show that participants are engaged in either session setting.

The conative component of awareness is linked to commitment which was not rigorously measured in this study. As discussed in the previous section, only one question examined commitment thus not much can be derived from that result. However, participants' engagement is a positive sign which contributes to the conative component of awareness. In fact, the word awareness was used many times in the feedback that the students gave about the workshop. Some examples are:

“The purpose was met because personally I'm more aware” (Appendix I, Session 2 – Open questions).

“I'm more aware of solutions that can be implemented” (Appendix I, Session 3 – Open questions).

Some also expressed that the workshop helped them understand other people's viewpoints. For example:

“The workshop was interactive which helped in seeing others' points of view and coming up with solutions” (Appendix I, Session 4 – Open questions).

Another pertinent finding is that participants enjoyed the interaction, especially the openness and freedom of communication of the workshop. Some of the feedback given was:

“The interaction between participants and Cynthia [the facilitator]. The workshop was interesting/not boring” (Appendix I, Session 1 – Open questions).

“The best [thing] I liked in this workshop is our way of interfering in it and our agreement and disagreement on issues in a polite way using dialogue” (Appendix I, Session 1 – Open questions).

“Expressing my opinion and listening to others.” (Appendix I, Session 3 – Open questions).

To conclude and to answer the second research question “In what ways could GMB contribute to students' environmental awareness about SWM?”, the study showed that GMB outcomes and process contributed to environmental awareness. The experiment demonstrates that using GMB to raise environmental awareness on SWM in Lebanon with students has promising results. Students were overall satisfied with the process and they participated interactively in all four sessions. By using the GMB outcomes (cognitive change, communication quality, consensus and commitment) as measures, it was shown that cognitive and affective components of environmental awareness were reached. However, more data was needed to conclude on any impact regarding the conative component of environmental awareness.

5.2. Research limitations

One of the limitations of this research was that the entire GMB workshop was conducted by one person. Although there were the modeling team members who volunteered to help, however, they had no previous knowledge of System Dynamics (SD) or GMB which limits both their input and feedback.

In all coding analyses, whether it is the contributions content analysis coding or the open-ended questions, the coder's bias is a limitation. When coding the content of the observations, intercoder reliability was not considered (Cho, 2008, p. 345). A better approach would be to follow the one used in Herrera (2014) where there were two coders. Their results were compared, and a percentage of agreement was calculated between the results of the two coders.

5.3. Recommendations for future research

Since this was an exploratory study, future research may include a control group in their experiment where a traditional approach for workshops is used. Then, the results of the GMB workshop would be compared to those of the control group and then the results would possibly be more conclusive.

Another recommendation would be to have more people who are familiar with SD and GMB on the modeling team, especially if the number of sessions and/or participants is high. In this research, it would have been much more helpful to have colleagues who are experienced in GMB. First, to prepare for the sessions and to assist in the facilitation and the modeling during the sessions. Second, they would have assisted in the coding process and then the results would have taken intercoder reliability into account.

Finally, a bigger sample – if more people are available in the research team – would be a good next step. In fact, with a bigger sample size, statistical analyses and tests may be conducted.

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