A system dynamics approach for enhancing social behaviours regarding the reuse of packaging

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There have been many attempts to reduce the amount of waste packaging through open dumping and burning, recycling, landfill, incineration, etc. However, there has been little attention paid to reuse as the simplest way to reduce waste. In order to motivate consumers to perform reuse behaviour, it is essential to understand how this behaviour can be influenced and what variables predict it. This paper aims to study the effectiveness of improving social aspects of reuse behaviour and investigate the variables that lead to increased reuse behaviour in a short time period. This paper selects a quantitative approach, the System Dynamics (SD) method, which offers a means by which to highlight the dynamics and interrelationships among the different social aspects in reuse behaviour. Different social aspects are extracted from Cognitive Behaviour Theory (CBT) as a basis with the Theory of Planning Behaviour (TOPB). The authors develop a Social Behaviour Aspect Model (SBAM) with three predictors: information values, awareness-changing variables and behavioural adaptation variables. The paper demonstrates its utility with a report on recent empirical study that has used the model to provide important new findings about different social aspects to enhance reuse behaviour. These findings have clear implications for the packaging industry who intend to enhance reuse behaviour amongst consumers, encouraging them to take corrective and preventive actions at an early stage.

Keywords: Waste packaging, reuse packaging, system dynamics, personal and social values, behaviour control.

1 Introduction

Waste in general threatens the survival of humans, and most types of plants and animals, as well as throttling all the natural resources that are necessary for human existence. As a consequence, public concern has been raised over waste and pollution problems (Williams 2005). In the last few decades, social behaviour together with development of lifestyles and consumption patterns have resulted in a problematic situation which increases the amount of waste produced (Oweis, 2005). It was found that, out of the 146 kg of household waste generated per capita in the EU in 2013, an average of 45.3% went to landfill (Eurostat Statistics Explained, 2015). Moreover, social behaviour towards waste affects the industrial sector, in which they make efforts to design new systems or develop existing systems to overcome the issues of increased waste. Take, for instance, the recycling system: the main goal of recycling is to allow the production of secondary materials which can be used instead of primary materials. This system saves money, reduces the production of new material and reduces environmental impact (Banar et al., 2009). Dealing with waste packaging as a part of all waste is essential. The use of packaging is increasing and the annual production of packaging is also increasing. In China, the volume of packaging is still increasing each year, and in 2010 packaging waste represented approximately 15% of municipal solid waste (Xie, Qiao, Sun, & Zhang, 2013). The main reason for this issue is that both the packaging waste recycling system and the composite packaging reuse technologies are undeveloped (Li, Yang, & Wang, 2005). In Germany, two main problems still face packaging waste treatment. First, high costs accrue during the recycling process, and sometimes there are limited resources and a lack of

willingness to make environmental improvements. Second, there is uncertainty about the exact environmental improvements to be made (Neumayer, 2000).

A significant number of studies have examined the various dimensions of waste treatment such as open dump, burning, recycling, landfill and incineration. (Al-Khatib & Sato, 2009; Banar, Cokaygil, & Ozkan, 2009; Coker et al., 2009; Hossain, Santhanam, Nik Norulaini, & Omar, 2011). There are many advantages of these waste treatment approaches if they are used in a proper way; otherwise, they are not useful for the environment and do not benefit waste management systems. For instance, recycling has been identified as a major way to reduce waste (Anquilar-virgen, Armijo-de vega, Taboada-gonzalez, & Ojeda-benitez, 2010; European Environment Agency, 2007). However, limitations with recycling have emerged, partly because some materials remain non-recyclable (Rigamonti, Grosso, & Giugliano, 2009). Further, the materials produced after recycling have changed in their properties owing to a lack of reprocessing efficiency. Inappropriate separation of materials at the recovery plant prior to reprocessing is another issue (Rigamonti, Grosso, & Giugliano, 2010). Landfill is a solution to most non-recyclable waste but countries, mainly developing counties, need to reduce their reliance on it (Brunner & Fellner, 2007). Additionally, although there are many techniques to minimise the risks from landfill sites (Cossu, Lai, & Pivnenko, 2010; Siddiqui, Richards, & Powrie, 2012), they still pose a threat to both people's health and the environment.

Reuse, as another waste treatment, is a primary solution, which should be considered before any other approaches. In England and Wales, the regulations rank the priority for waste management options according to what is the best for the environment. Priority is given when the waste is generated for 'preparing for re-use', then recycling, recovery and, finally, disposal (Department of Environment Food and Rural Affairs, 2011). The reuse of packaging has become a well-known attitude amongst communities, such as using different types of packaging material: glass, cartons, plastics, etc. (Langley, Turner, & Yoxall, 2011; Peattie & Shaw, 2007; Verdugo & Figueredo, 1999). Being able to identify social aspects influencing reuse behaviour which might have an impact on diverting waste from landfill is very important. Hence, this paper aims to study the effectiveness of improving social aspects of reuse behaviour and investigation of the variables that lead to increased reuse behaviour in a short time period. The novelty of this study lies in two points. The first one is integrating Cognitive Behaviour Theory (CBT) with Theory of Planning Behaviour (TOPB) in order to identify the social aspects that are relevant to enhancing reuse behaviour. The second one is the employment of a System Dynamics (SD) approach, which is not currently used, to present the social aspects of any waste treatment approaches. The paper consists of four parts. It provides a brief description of a conceptual model of social factors after reviewing the current literature. This is followed by a model description of the SD approach together with an analysis of results. Finally, the paper concludes with the findings within the model, along with some recommendations, before moving to a conclusion.

2 Literature review

As this research concentrates on waste packaging, it will use the definition of 'reuse' from the Packaging Waste Directive 94/62/EC (Environmental Regulations, 2005): an "Operation by which packaging, which has been conceived and designed to accomplish within its life cycle a minimum number of trips or rotations, is refilled or used for the same purpose for which it was conceived with or without the support of auxiliary products present on the market enabling the packaging to be refilled: such reused packaging will become packaging waste when no longer subject to reuse".

Many studies have found some advantage in using reusable packaging in relation to many kinds of waste issues, such as high volume of solid waste, frequency of product damage, inefficient storage or warehouse space, worker safety, ergonomic issues and hygiene demand. For example, the research conducted by the

Foundation for Reusable Systems assessed whether disposable or reusable packaging can save food from spoilage (Karst, 2013), and found that reusable packaging has an advantage of reducing the amount of packaging going to waste schemes and recycling processes due to its strength, consistent size and compatibility compared to one-way packaging. Langley et al. (2011) confirmed that any products that fell into the reuse route were not thought of as waste by consumers. With regard to the environment, reuse is advantageous in several ways, according to the Industry Council for Packaging and the Environment (2009). As stated by Carter, Kale and Grimm (2000), firms' revenues can be positively affected if there is increasing demand for environmental products. The number of times a product/packaging can be reused will help to decide cost factors and minimise any additional cost for recycling, waste disposal and management (Dubiel, 1996). Although a reusable product might be twice as thick as a single-use product, and thus cost more to make, a multi-use product can compensate the cost with increased utilisation and the overall reduction of consumption of materials. Therefore, reuse is a significant saving for materials and manufacturing, and for the collection and disposal operation (Jarupan, Kamarthi, & Gupta, 2011).

This paper will present a literature review about packaging reuse. In the past, there have been a few attempts to use reusable packaging in a traditional way but these met with little success. For instance, in Canada, the average number of refillable beer bottles reduced from 47% in 1985 to 5% in 1997 due to the industrial use of non-refillable bottles (Grimes-Casey, Seager, Theis, & Powers, 2007). In Western Europe, there is a high prevalence of refillable packaging used for beverage containers. However, the average overall number of refillable bottles has slowly fallen across Europe. In 1979, around 81% of the beer bottles sold in Europe were refillable, whereas in 1997 this was only 60%. The main reason behind this is that the European beer market has favoured one-way packaging (Rowe & Platt, 2002). In the United States, reusable packaging for soft drinks has declined from 100% in 1947 to 1% in 2000 due to increased use of metal cans and plastic (PET) bottles (Rowe & Platt, 2002).

There are many recent examples of companies implementing reusable packaging in consumer products. In 2010, Kentucky Fried Chicken introduced a reusable side container. This reusable packaging is made of polypropylene and uses a "ventless vent technology", which allows moisture to escape without requiring a hole in the lid. According to the company, this reusable packaging is safe to wash and microwave (Kentucky Fried Chicken, 2010). Pizza Hut Enterprise has introduced a new pizza box design that allows the box to be broken down into plates and a smaller box for leftovers. The company states that the packaging is eco-friendly, highly functional, and easy to store and dispose of. This new packaging design was developed under partnership with Central American Packaging Manufacturer SigmaQ and uses Ecovention's patented Green Box technology. The inventor of this idea is Scott Wiener, who states that believes that designing reusable packaging has the power to solve waste conflicts and make the world a better place in which to live (Kelley, 2013). Another company, PUMA, also introduced a new packaging design in 2010 called 'Clever Little Bag' and a 'Half-size Clever Apparel Pack' in 2012 (PUMA, 2012). It is a red, reusable shoe bag used to package its footwear. Moreover, Coca-Cola produced refillable packaging with a lower price than one-way packaging as motivation for consumer to use reusable cups (Rowe and Platt, 2002). The Starbucks reusable cup is another example of a reusable cup in the market. As stated in the Starbucks annual report (Starbucks, 2013), there is a need to increase the number of customers who reuse their personal reusable cup. As shown in the Starbucks annual report, in 2013, an increasing number of beverages were served in reusable cups (49.9 million beverages) compared with 2012, which was 35.8 million beverages. The annual report highlights the need for more improvement in order to achieve a 5% increase in the number of users of reusable cups. Hence, these reusable packaging examples are trying to increase the prevalence of reuse behaviour amongst societies but people are paying little attention to it. Hence, there is a need to understand how to enhance consumers' reuse behaviour and what kind of social aspects can predict it.

Many studies have investigated how to enhance recycling, waste reduction, waste incineration and other waste treatment approaches amongst societies (Joos, Carabias, Winistoerfer, & Stuecheli, 1999; Vicente

and Reis, 2008; Bratt, 1999; Chu & Chiu, 2003; DeYoung, 1986; Larsen, 1995; Lima, 1996); however, there are also a few studies that have investigated reuse behaviour. For instance, a study conducted by Barr et al. (2001) of differences between household waste behaviours concluded that one strong predictor of reuse behaviour is whether people believe it makes a difference environmentally and believe that reuse can make a difference are more motivated and more likely to reuse items. Moreover, the study found that, if people with no access to recycling bins are aware about environmental values and issues, they will be more willing to minimise and reuse packaging in order to obtain a clean environment, as mentioned in some case studies (Barr, Gilg, & Ford, 2001). Later on another study was conducted by Barr (2007) to investigate the factors influencing environmental attitudes and behaviour. The study found that behaviour intentions play a primary function, influencing consumers to carry out reuse and giving them some degree of satisfaction from reuse, and this is likely to provide a positive feeling and encourage them to maintain their behaviour. Also, Barr (2007) found that people with experience of recycling represented only half of those willing to reuse and reduce the amount of waste. In 2009, a project conducted between Loughborough University and the Boots Company investigated the potential benefits a refillable packaging system for a body wash can offer customers and the environment. The main aim of the project was to improve the sustainability performance of the packaging. The project found that incentive is one of the important factors, together with the quality of packaging to be refilled, which can enhance reuse behaviour and that, as long as there is a good reason behind the reuse approach, consumers will not mind participating in the activity (Lofthouse et al., 2009). Langley et al. (2011) conducted a real case study in the UK to determine how different packaging can encourage and discourage the consumers' reuse behaviour. The study focused on transition of packaging and observed consumers' behaviour and found a relationship between shopping for goods and disposal of waste packaging. The study found that consumers thought that waste packaging that seemed suitable for reuse should be reused rather than thrown away or recycled.

As shown above, no previous studies have comprehensively investigated reuse behaviour, but some have studied reuse behaviour by concentrating only on some aspects or a comparison with other treating waste approaches. Therefore, this paper aims to study the effectiveness of improving social aspects of reuse behaviour and investigate the variables that lead to increased reuse behaviour in a short time period. The paper's specific research question is: Are the social aspects able to encourage people to reuse packaging?

2.1 Conceptual framework of social factors on packaging reuse

In order to address social aspects, it is essential to conceptualise a set of aspects and provide a suitable framework. The conceptual framework of social aspects on waste reuse is formulated from a review of the literature and it identifies different aspects at different levels, i.e., TOPB, Perceived Behaviour Control (PBC) and CBT. TOPB allows relationships among five relevant predictors identified in the existing research in the field of recycling: (a) the attitude towards the act; (b) subjective norms; (c) perceived behaviour control; (d) specific knowledge and communication; and (e) perceived convenience of the provided service (Valle, Rebelo, Reis, & Menezes, 2005). This theory is concentrated on specific attitudes towards the behaviour rather than general attitudes. This theory does not take into account the influence of social-demographic attributes. PBC demonstrates consumers' beliefs in terms of the difficulty and controllability of performing a specific behaviour (Ajzen, 1991; Ajzen & Fishbein, 1980).

CBT is the concept that understands the importance of behaviour changes; more specifically, the understanding of a participant's impact behaviours, and the negative beliefs that can make it particularly difficult for a participant to make positive behaviour change (Wright, 2006). CBT combines cognitive and behavioural strategies to solve a variety of behavioural and psychological problems. The theory seeks to change a participant's irrational thinking and behaviours by educating the participant and reinforcing positive experiences that will lead to fundamental changes in the way that the participant copes. In other

words, by learning to change thinking processes, participants can think more clearly about the choices they make and the behaviours in which they engage (Beck, 1964).

3 System dynamics method

This paper investigates the social aspects of reuse behaviour. Most of the previous studies that investigated social aspects used exploratory research as it has a flexible research design, which allows researchers to consider and define various aspects of the problem, according to Kothari (2004). Hence, this paper used exploratory research. Several methods have been used in many studies such as case studies, questionnaire, interviews, survey, experiments, experts' opinion, observation and photography. Some of these methods are suitable to answer a specific research problem and others are not. There is not one specific design that can fit all the research purposes. Many studies combine more than one method to answer their research questions. In this paper, the authors used a questionnaire in order to extract the most desirable data. Prior studies have used various methods to analyse social aspects. Many have used statistical approaches such as factor analysis, path analysis, Chi-square test, structural equation modelling, or confirmatory factor analysis (Barr et al., 2001; Bratt, 1999; Chu & Chiu, 2003). These methods only evaluate each aspect individually and make comparisons between them. In this paper, the authors decided to use the SD method in order to deal with the interaction between social aspects and evaluate them. This method can provide insights into the effects of a wide range of social aspects on reuse behaviour. The SD method studies the knowledge of the real world, and assesses the hypotheses and effectiveness of policy and can handle complex and nonlinear structures (Richmond, 1989). The SD method is suitable for identifying the real state of social aspects in reuse behaviour and get close to the desired state of producing positive behaviour towards reusable packaging. Compared with other methods, the SD method provides understanding of the structural causes of a system's behaviour, which increases the knowledge of each element in the system (Wolstenholme, 1990). The SD method links between the qualitative and quantitative models (Qudrat-Ullah & Seong, 2010). Many studies that have utilised a system dynamics methodology for investigating various topics in relation to waste management (Dyson & Chang, 2005; Karavezyris, Timpe, & Marzi, 2002; Richardson, 1991; Sudhir, Srinivasan, & Muraleedharan, 1997) and construction and demolition waste management (Chaerul, Tanaka, & Shekdar, 2008; Hao, Hills, & Huang, 2007; Wang & Yuan, 2008).

System dynamics consists of causal loop diagram and stock flow diagram. The causal loop diagram is constructed based on a conceptual framework. The causal loop diagram is a system theory loop which has two kinds of loop: 'Balance loop' and 'Reinforcing loop', as shown in Figure 1. Each arrow in a causal loop is labelled with '+' or '-', where '+' means that if the first variable changes then the second variable will be changed in the same direction, whereas '-' means that if the first variable changes the second variable will change in the opposite direction. In this paper, the causal loop comprises one positive feedback loop (R) and one negative loop (B). In negative loop B in Figure 1, it can be seen that increasing practitioners of packaging reuse has a direct impact on decreasing non-practitioners of packaging reuse. The research used the CBT concept to construct the positive loop R in Figure 1. CBT can help to change people from cognition to behaviour. Hence, this research used this concept to design the positive loop, which consists of people who are informed about packaging reuse, people who aware about packaging reuse and practitioners of packaging reuse. The TOPB predictors are used to enrich the positive loop as follows: if there is more information given to people about packaging reuse, it would increase the number of people who know about packaging reuse but not change their attitude. That is, they know about packaging reuse but do not care or are not bothered about the incentives. Then increasing awareness would increase the number of people who are aware about reuse of packaging and change their attitude although they are not actually doing anything yet. After that, increasing behavioural adaptation would increase the number of packaging reuse participants.

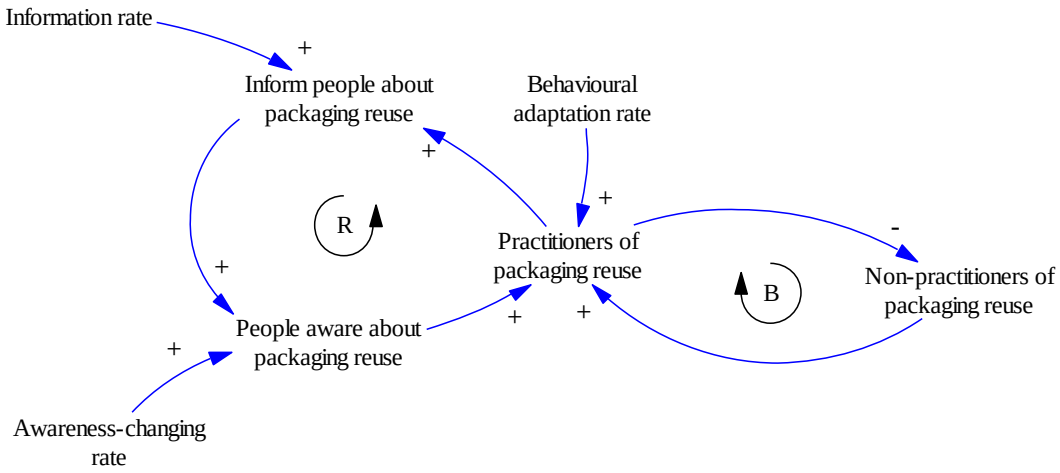

Figure 1: Causal Loop Diagram of Social Behaviour Aspect

The stock flow diagram consists of three main elements, as shown in Figure 2: stock, flow, and convertor. The level (stock) is the element that shows the state of the model. The flow is the element that can be defined as a time function. The flows describe the variations of the levels as flow-in, which is increasing the main element in the model, and flow-out, which is decreasing the main element in the model. Flow behaviour is a driver, which delivers information from stock. The convertors are auxiliary variables that allow a better visualisation of the variables that are influencing the behaviours of flows. The connector, which is a transmitter, connects between elements as an arrow (Garcia, 2006; Yuan, Shen, Hao, & Lu, 2011). The causal loop diagram has assisted building the formulation and building the stock flow diagram. The most appropriate way of converting a causal loop diagram into a stock flow diagram is by using software simulation such as Vensim.

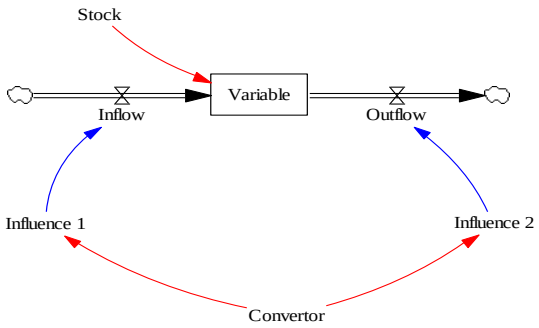

Figure 2: A simple system dynamic model by software VENSIM

As illustrated in Figure 3, the model concentrates on three main predictors: information values, awareness-changing variables and behavioural adaptation variables. The model identifies the variables that affect uninformed people so that they become informed about packaging reuse. This is achieved by enhancing general environmental concerns, perceived knowledge about packaging reuse, and personal and social values behind reuse of packaging which affect non-practitioners of packaging reuse. After that, the model continues investigation of what makes people become aware of reusing packaging. The model identifies that the influence from relatives and friends' norms with the effect of practitioners of packaging reuse can lead uninformed people to become aware of packaging reuse. The last stage in the model is to

investigate people's behavioural adaptation to become practitioners of reusing packaging through the value of better conditions of product packaging and perceived convenience.

As the change of consumers' behaviour from being non-informed about packaging reuse to becoming practitioners of reusing packaging could take more time, the model considers the delay function in information rate, awareness-changing rate and behavioural adaptation rate, as shown in the equations presented in Appendix 1. Moreover, the model also focuses on the effect when someone who is uninformed about packaging reuse encounters someone who is a practitioner of packaging reuse. This leads to increasing the information rate, awareness-changing rate and behavioural adaptation rate. Having a combination of non-practitioners and practitioners of packaging reuse increases the influence of the latter in the area. This depends on the total number of practitioners versus people uninformed about packaging reuse. In addition, the model uses time rate to influence information rate, awareness-changing rate and behavioural adaptation rate. Time rate is the amount of time to influence practitioners, which is calculated per day or per week. The domain experts in the area set the time rate for the basic model, which is 30 days.

In addition, after the model is completely constructed, it needs the set of approximate values in order to obtain an initial idea about its behaviour. These values were obtained from a questionnaire. The stock flow diagram also needs to define the interrelationships with the whole model mathematically. The SD model uses simple mathematical equations and some functions of mathematical equations such as integration. All equations contained in this model are presented in Appendix 1 and the lists of variables used in SD model are in Appendix 2. The simulation output will be a graph explaining the relationship between the variables and time. The validation process is a very important task in order to test the model. According to Qudrat-Ullah and Seong's study (2010), an SD model can be validated through various validation test steps including a boundary test, structure verification, dimension consistency, parameter verification, extreme conditions and structurally oriented behaviour test. Based on these tests, the model can be trusted and used for further simulation during the application of the empirical study.

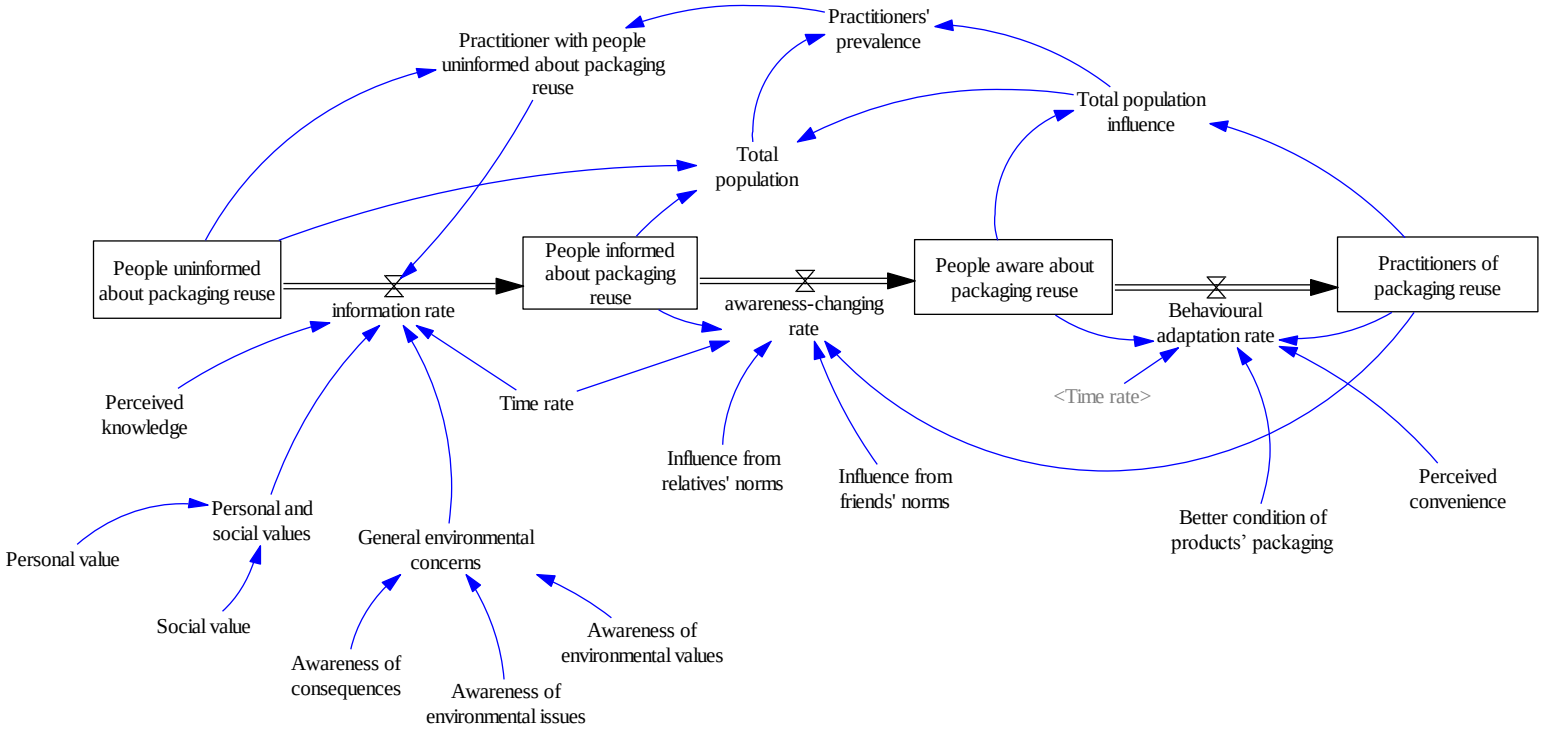

Figure 3: Social Behaviour Aspect Model

4 An empirical study on the relation between people's behaviour and reusable packaging

An empirical study was conducted by designing a questionnaire. The questionnaire was piloted with five participants. The questionnaire was designed online and the questionnaire link was distributed. The questionnaire strategy used is the snowball sampling concept, 'who-knows-who', which asks participants who else should participate (Malhotra & Birks, 2006). The questionnaire was designed on a 5-point Likert scale [0:5]. Some studies in SD have various variables units. For example, a model for hospital waste management (Chaerul et al., 2008) measured health risks on a scale [0:2]. Some 300 questionnaires were distributed during the empirical study period (April 2013 to May 2013). Of these, 101 were returned.

4.1 Statistical results

From the questionnaire, the research found that there are 10 people who practise reuse of packaging while there are 91 people who are uninformed about packaging reuse. Most of the participants are male and well educated. Approximately 55% of people did reuse glass and steel packaging. Some of them mentioned that they reused cartons and plastics waste. The disposal behaviour is a prevalent attitude amongst the participants and a quarter of them performed waste recycling. The participants' level of job is from new employee to senior employee, which represents around 70% of the whole sample. Approximately 70% of participants have resided within the same community for less than 7 years, while the number of family members is between 2-5 persons, which represents 64.29% of the total. According to the participants' behaviours obtained from the questionnaire, the participants are rarely committed to reusing packaging and seldom reuse packaging for its original use; however, they occasionally reuse packaging for other uses. In addition, according to the participants' attitudes, the participants agreed that reusing packaging adds value for them and creates pleasant feelings; further, participants disagreed that reusing packaging is meaningless; rather, they strongly agreed that reuse of packaging is a good approach to tackle packaging waste before disposing of it. The average number of people who were influenced to reuse packaging is shown in Table 1. The results from the questionnaire show that there is good awareness amongst participants about environmental issues and values, and also knowledge about the consequences of reuse of packaging; however, there is low knowledge about packaging reuse itself. In addition, participants are little influenced by norms whereas they are normally affected by personal and social values. Finally, perceived convenience about reuse of packaging also has low influence on people becoming practitioners of packaging reuse.

Table 1: Data of average number of people who were influenced to reuse packaging

Average number of people who were influenced to reuse packaging by	Influence from	Friends' Norms is 2.31 Relative' Norms is 2.18 Knowledge is 2.90 Awareness about environment issues is 3.46 Awareness about environment values is 3.46 Awareness about environment consequence is 3.46 Personal value is 3.12 Social value is 3.27 Perceived convenience is 2.86 Better condition of products' packaging is 3.10

4.2 Results of the SD model

The simulation time of the proposed SD model is set as 120 days with a Time Step of 1 day. The SD model generates the behaviour as shown in Figure 4. The results show the interaction between the variables in the model with regard to people moving from being non-participants to participants in the

reuse of packaging diverges after day 31 with exponential growth. The number of people participating in reuse behaviour is only 104.

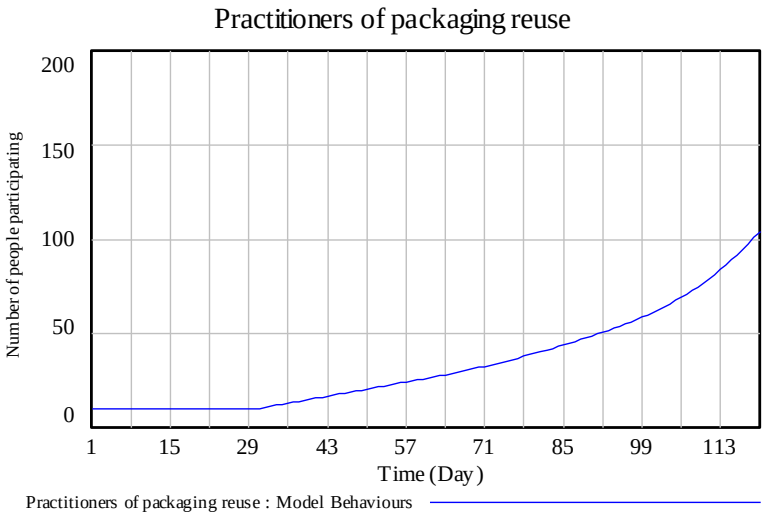

Figure 4: Results of model behaviours

4.3 Scenario analysis

The low values of variables that have an impact on the social behaviour during the simulation period were investigated further, by creating scenarios that allow some control of these variables. The created scenarios help in determining which variable is less dependent on others. However, according to the model results, the scenarios encompassing three variables (influence from friends' and relatives' norms), influence from knowledge about packaging reuse and influence from behaviour control (perceived convenience and better condition of product packaging) that have low values were designed as follows:

- Scenario 1 (S1): To investigate whether concentrating on increasing the perceived knowledge about packaging reuse would enhance the uninformed people to be aware about packaging reuse.
- Scenario 2 (S2): To consider whether a focus on increasing relatives and friends' norms would contribute to an increase in people who are aware about packaging reuse.
- Scenario 3 (S3): To look at whether concentrating on increasing the better condition of product packaging, perceived convenience to reuse packaging and S1 & S2 would be helpful in convincing people to participate in packaging reuse.

It is shown that S1 and S2 are single-policy scenarios whereas S3 is a multi-policy scenario. In each scenario, the time rate is reduced to 25 days from 30 days, and the average of every considered variable is increased to 5. The results show that in S1, after increasing people's perceived knowledge about packaging reuse and reducing the time rate for people to be informed, it would slightly increase the number of people who were informed about packaging reuse. As shown in Figure 5, although all the participants gained more knowledge about packaging reuse than usual, there was not that much difference from participants with existing knowledge about packaging reuse. This is because the condition of product packaging, perceived convenience to reuse packaging and influence of relatives and friends' norms on packaging reuse are not improved simultaneously. The results show that there are 140 participants in reusing packaging, which is an increase compared to 104 participants in the basic simulation.

The results demonstrate that in S2 (shown in Figure 5), the number of people influenced to be aware about packaging reuse has grown. The results show that the number of people who are practising packaging reuse reached 153 participants at the end of the simulation period (120 days); whereas in the basic simulation this had reached 104 persons at the end of the same day. In scenario 3, the results in Figure 5 show that the number of practitioners who reuse packaging increased from 104 to 169 people at the end of the simulation period (120 days). This is a significant improvement in the number of practitioners after educating people about packaging reuse, enhancing norms and facilitating packaging to be reused. Although the above scenario results provide valuable insights into the importance of enhancing packaging reuse, it is worth highlighting that these scenarios are by no means exhaustive since there are several scenarios that can be devised and simulated using the model.

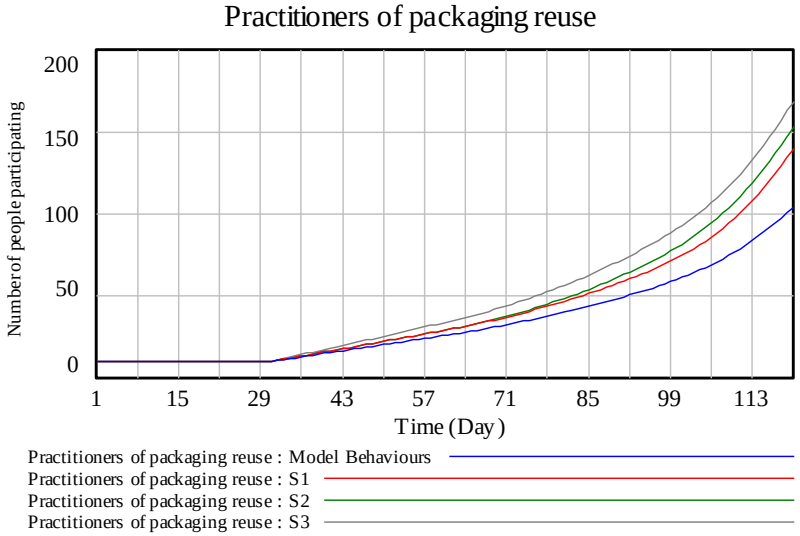

Figure 5: Results of Scenarios

5 Implementation and discussion

Reuse behaviours have different results from other waste treatment approaches, as will be shown later in this section. According to the model results, knowledge about packaging reuse is tantamount to demonstrating people's participation in reusing packaging regardless of the experience; however, it is one of the variables that merge with other variables which could lead to high participation among the consumers. The results from the model can confirm that perceived knowledge about packaging reuse raised people's understanding about packaging reuse within a short period. This result corresponds with the results from recycling: people who have information about recycling are willing to recycle waste, around 14.1% (Vicente & Reis, 2008). Having information on reusing packaging not only aids greater motivation but can make reuse of packaging less difficult, which attenuates the feeling of being inconvenienced. The knowledge about packaging reuse is not less important than other variables. It can influence people's attitude behaviour, as found in various recycling studies (Chu & Chiu, 2003; Scott, 1999; Valle et al., 2005; Vicente & Reis, 2008).

Therefore, policymakers should establish a social centre which would improve people's knowledge of reusing packaging. Policymakers should make enormous efforts to develop social marketing strategies in terms of informing people how to participate in reuse programmes, which can be achieved by television advertising, mailshots, magazines, newspapers, flyers, SMS messages, emails and also by social networks such as Facebook and Twitter, providing information on the effectiveness of participants' actions such as the amount of reduction of waste among the community by reusing packaging. In this way, any misinformation that might be influencing people's unwillingness to participate could be investigated and

people could be helped to make the connection between their contributions at home and the environmental improvement.

Moreover, it can be seen from the model results that participants' increased awareness of environmental issues, environmental values and consequences of packaging reuse has a significant impact on willingness to reuse behaviour. This result supports the previous studies which have shown that consumers do seem to care about the environment (Bech-Larsen, 1996). Also, this result corresponds with recycling studies that concluded that people are aware of recycling's benefit to the environment, which might encourage consumers to try recycling (Bratt, 1999). These findings about people's belief in conservation and product nature all have a significant effect and suggest positive reinforcement. According to Pooley and O'Connor (2003), public environmental education leads to changing environmental attitudes, emotions and beliefs rather than knowledge.

The results from the basic model show the participants have high general environmental concerns, and the weak knowledge amongst participants about packaging reuse required a long time period to change into reuse of packaging practices. However, in S1 it was proved that increasing the average of perceived knowledge about packaging reuse contributes to reducing the time period and increasing the number of people who reuse packaging. Therefore, policymakers should pay attention to improving householders' environmental responsibilities and awareness amongst people. This can be achieved by governments and non-government organisations which can outline environmental topics in education campaigns such as school courses and government programmes.

Moreover, personal and social values would also influence people's awareness about packaging reuse. As the literature review has shown, intrinsic rewards play an important role in people's behaviours because they derive satisfaction through their participation in an activity. From the questionnaire's results, it is true that people engage in environmentally responsible behaviour as a way of reflecting their benefits from the engagement. However, social benefits also have an effect on people's participation, as shown in the basic model results. This refers to the reason that people's commitment to an activity will be observed and expected by the community, and another reason is to reduce societal costs.

The subjective norms have a greater ability to influence reuse behaviour if there is awareness about the community's attitudes, which helps to change personal norms through influence from parents, neighbours and friends. Individual participation in reusing packaging has a more essential effect than recycling of waste due to the reuse perspective, which is created by consumers, and obviously reuse is more customary than recycling. Moreover, in S2 the results showed that, when personal norms were encouraged, there was an increase in the number of participants. Also, this research's results correspond with Valle et al. (2005), which found that, in recycling, the subjective norms have a direct effect on recycling behaviours. However, the model's results could not predict the relationship between an individual's behaviour and personal norms as per Bratt's research (1999), which found that actual consequences of recycling on an individual's behaviour might reduce the probability of personal norms inducing environmentally friendly behaviour. Therefore, it is time for policymakers to make all efforts towards disseminating reuse of waste programmes amongst society, such as designing a campaign to tell families, neighbours and friends or arranging a training programme to educate people, and then they will influence their families, friends and neighbours to reuse waste. For instance, in Nepal the Women's Environment Preservation Committee Organisation undertook a project with local communities to create clean and hygienic environments. The major focus was on educational campaigns and running school environmental training in order to raise awareness of waste issues. After these campaigns, the residents were aware that municipalities could not handle the problem of solid waste without people's co-operation (Practical Action Nepal, 2008).

In recycling behaviour, people who felt recycling was difficult had a negative feeling about participation – recorded at 11.6% (Vicente & Reis, 2008). Some studies found that people who felt it was easy to

access recycling bins had a higher percentage of participation than people who felt they were too distant from recycling bins (Barr et al., 2003). However, as the results from the model showed, the better condition of product packaging and perceived convenience to reuse packaging, which focuses on behaviour control, indicated a high impact on packaging reuse behaviour owing to the low numbers of practitioners whose packaging can be reused. Reuse of waste is planned behaviour by the consumers when they purchase the product: they intend to reuse it for the original use or for other purposes whereas recycling is not further planning behaviour: consumers may or may not participate in recycling schemes, which depends on the variability of the facilities provided. Reuse of packaging is not affected by the variability of facilities compared with recycling, e.g., see how kerbside recycling bins affect consumers' behaviours. This result puts the emphasis on industry, which should consider reuse of product packaging during manufacture. Condition of product packaging to be reused must be maintained because, when the condition of product packaging is suitable to be reused, the ability of consumers to participate becomes higher and easier as well. Therefore, policymakers should focus on product attitudes that are related to reuse in some way; for example, purchase of products in reusable packaging has a direct influence on consumers' behaviours owing to its having a particular environmental benefit and it enables people to easily engage in conservation behaviour. From the psychological point of view, given the theory of cognitive dissonance, Festinger (1957) suggests that our attitudes and beliefs move in harmony and avoid dissonance. It is still possible for reuse behaviour to influence attitudes and norms when reusable product packaging is present; otherwise, when reusable packaging functions are absent, the reuse behaviour would imply a significant dissonance. Therefore, this study confirms that, if there is concentrated effort on developing behaviour control of reusing packaging, reuse behaviour has a direct connection between personal norms and attitudes and between personal values and attitudes, as shown in S3.

6 Conclusions

There are a number of significant theoretical, empirical, and practical conclusions that can be drawn from this paper. First, from a theoretical standpoint, as was noted in the literature review, most studies have tended to focus on a few predictors to analyse reuse behaviour. This study has attempted to successfully design and develop these variables into one theoretical model, and test and analyse the variables that lead to increased reuse behaviour. From an empirical standpoint, the research has demonstrated that the reuse behaviour is defined by variables that is fundamentally awareness, values and motivation. As would be expected, knowledge and communication in favour of reuse, personal and social values, social norms and availability of reusable packaging can all enhance reuse behaviour. From a practical point of view, this paper developed the conceptual model to provide insights into the variables that affect reuse behaviour and the degree to which reuse behaviour amongst communities can be enhanced. Overall, this conceptual model is beneficial for industries, policymakers and researchers. For industries, this conceptual model has implications for packaging companies who intend to enhance reuse behaviour amongst their consumers, to take corrective and preventive actions at an early stage. This conceptual model can also be implemented in any activities or products that support pro-environmental behaviour. For policymakers, the model can provide an indicator on how the public frames waste-packaging issues and to what they ascribe their behaviour regarding reusing packaging. This can be helpful to policymakers to reflect these results in the programmes and campaigns that are run to support pro-environmental behaviour. For researchers, this model can bring more opportunities to conduct more research on reducing waste as it is considered a part of the waste management system. This model can be combined with any other SD models dealing with treating waste approaches or waste management systems.

This paper's scope is the packaging industry as it is a suitable example by which to demonstrate the reuse of waste because of the flexibility of packaging that is designed to be reused. The types of packaging that this paper has investigated are primary packaging and secondary packaging. As reuse is planned behaviour, yet more research and effort are needed to encourage reuse behaviour in societies and to design reusable packaging in industries. Future studies into reuse behaviour may seek to use the social

perspective to examine other variables such as social demographics, personal values of frugality, environmental attitudes and policy perceptions. These additional variables are required to be developed into the model and tested to ascertain their suitability for implementation. Although there are many standards regarding the reuse of packaging, there is a need to design a model or checklist to provide guidance or explanation for industries on how to effectively apply reusable packaging thinking to non-reusable packaging.

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APPENDIX 1: System dynamic model equations

People uninformed about packaging reuse = INTEG (-information rate, 91[1])

General environmental concerns = Awareness of consequences + Awareness of environmental issues + Awareness of environmental values.

Personal and social values = Personal value + Social value

Behavioural adaptation rate = DELAY FIXED ((Practitioners in packaging reuse + Aware people about packaging reuse + Perceived convenience + Better conditions of product packaging) / Time rate, 30[2], 0.01[3])

Information rate = DELAY FIXED ((Practitioner with Non inform people about packaging reuse + Perceived knowledge + General environmental concerns + Personal and social values) / Time rate, 30, 0.01)

Awareness-changing rate = DELAY FIXED ((Practitioners in packaging reuse + people Informed about packaging reuse + Influence from friends' norms + Influence from relatives' norms) / Time rate, 30, 0.01)

Total population influence = Practitioners in packaging reuse + people aware about packaging reuse

Practitioners' prevalence = Total population influence / Total population

People informed about packaging reuse = INTEG (Information rate – Awareness-changing rate, 0)

People aware about packaging reuse = INTEG (Awareness-changing rate - Behavioural adaptation rate, 0)

Total population = people uninformed about packaging reuse + people informed about packaging reuse + Total population influence.

Practitioners in packaging reuse = INTEG (Behavioural adaptation rate, 10[4])

Practitioner with people uninformed about packaging reuse = practitioners' prevalence * people uninformed about packaging reuse.

Time rate = 30 days.

[1] Number of people uninformed about packaging reuse. This number is extracted from the questionnaires.
[2] The domain experts in the area set the time delay, which is 30 days.
[3] 0.01 is the initial value of the delay function. Initial value of the delay function should be much smaller than 1; as a result 0.01 was used in the study.
[4] Number of participants who practise reuse of packaging. This number is extracted from the questionnaires.

APPENDIX 2: Variable units in the system dynamic model

Name	Units
People uninformed about packaging reuse	Person
People informed about packaging reuse	Person
People aware about packaging reuse	Person
Practitioners in packaging reuse	Person
Awareness-changing rate	Person/ Day
Behavioural adaptation rate	Person/ Day
Information rate	Person/ Day
Time rate	Day
Total population influence	Person
Total population	Person
Practitioners' prevalence	Dimensionless
Practitioner with people uninformed about packaging reuse	Person
Perceived knowledge	Person
Personal and social values	Person
General environmental concerns	Person
Influence from friends' norms	Person
Influence from relatives' norms	Person
Better condition of product packaging	Person
Perceived convenience	Person
Personal values	Person
Social values	Person
Awareness of consequences	Person
Awareness of environmental issues	Person
Awareness of environmental values	Person