CAUSAL LOOPS IN AUTOMOTIVE RECYCLING

Ezzat El Halabi, Matthew Doolan
Research School of Engineering, The Australian National University
Acton ACT 2601 AUSTRALIA
ezzat.elhalabi@anu.edu.au

ABSTRACT

Each year in Australia, more than 610,000 cars reach the end of their use cycle; termed End of Life Vehicles (ELVs). The market-driven recycling of ELVs in Australia is done by operators in the automotive industry with no ELV-specific policies governing their operations. System Dynamics is applied to the automotive recycling sector. Across three Australian states, thirteen stakeholder interviews were conducted to identify the flows of materials in the system and the influencing factors driving these flows. This paper presents a discussion of the causal loops and scenarios identified from interview data and field observations around the dynamics of ELV Sourcing, Workforce, and Premises relating to the automotive recycling business.

Keywords: System Dynamics, Causal Loop Diagrams, Recycling

INTRODUCTION

Automotive dismantlers or parts recyclers[1] are an important link in the reverse supply chain of cars. They seek to purchase End of Life Vehicles (ELVs) that are then dismantled and sold as parts or materials for profit. The recycling of ELVs is a market driven activity involving several sectors in the automotive industry. In Australia there are no ELV-specific policies or standards in place (Total Auto Recyclers, 2007).

In recent years environmental awareness has brought attention to the industry practice when dealing with pollutants contained in the ELVs such as hazardous fluids and chlorofluorocarbons (Environment Australia, 2002). Also of concern are the issues of car theft and car rebirthing[2]. The industry in Australia remains largely unregulated. In other parts of the world like Europe and Japan, laws were adopted to help tackle the environmental issues through industry regulations - albeit with mixed results (El Halabi, Doolan, & Newell, 2008).

This project attempts to create a policy decision tool that helps stakeholders in the automotive recycling sector discuss policy options and their implications. System Dynamics (SD) as a systems thinking approach is used to model the ELV processing system in Australia. We are adapting the Modeling Process (Sterman, 2000), the Group

[1] Vehicle dismantling and parts recycling are two different but closely related activities. The first one is the process of taking a vehicle apart. The latter refers to the trade of used parts. Some parts recyclers purely trade used parts. Some do not completely dismantle vehicles themselves, like the 'You-Pull-It' wrecking yards where the customers do it. Both terms are used interchangeably in this paper.
[2] Car rebirthing is an activity which involves re-registering a stolen vehicle by using another vehicle's identity (Crimes Act 1900).

Model Building (GMB) technique (Vennix, 1996) and the qualitative research guidelines (Richards, 2009) in engaging with the stakeholders.

The ELV processing systems in other industrialised countries like Europe and Japan are ahead of the Australian system in terms of policy and standards (Hedayati & Subic, 2008). However, the issues that led to adopting ELV policies in other countries, such as limited landfill space, energy recovery opportunities and abandoned vehicles (Johnson & Wang, 2002) (Gerrard & Kandlikar, 2007) (Cassells, Holland, & Meister, 2005) are insignificant in Australia.

This raises the question of whether or not a formal ELV policy is needed. And if so, what sort of policy will best suit our system? To be able to answer this question, we first need to understand how the current system is operating or behaving. We also need to study its structure so that leverage points responsible for this behaviour can be identified.

To date, however, the majority of studies about Australia have focused on the automotive industry as a producer / importer of cars and parts (Australian Automotive Intelligence, 2010), (Industry Commision, 1990), (Conlon & Perkens, 2001). Despite some effort over the past decade (Environment Australia, 2002), (Hyder Consulting, 2007), (McNamara, 2009), (VACC and Accenture, 2005) more is needed in documenting and analysing the end of life sector which is a vital component of the industry.

Furthermore, limited information is available in the public domain about the Australian automotive dismantling business. This paper attempts to address this gap by providing a qualitative snapshot of the main influences in the Australian automotive recycling business.

In this paper we first look at this system using available information and data. Then briefly explain our research process which revolved around interviewing a subset of stakeholders as part of the model conceptualisation stage of SD. The main findings from the interviews are then analysed and discussed.

BACKGROUND

Defining an ELV

The end of life of a vehicle is the stage at which the used vehicle is termed unusable (i.e. unsafe and/or uneconomical) according to the norms or laws. A vehicle could reach this stage naturally (after 10 or more years of use) or prematurely (damaged).

Data on actual ELVs processed in Australia is patchy at best. The only official figure is the vehicle attritions published each year (Australian Bureau of Statistics, Various, 2003-2010). Figure 1 shows the data for the last decade.

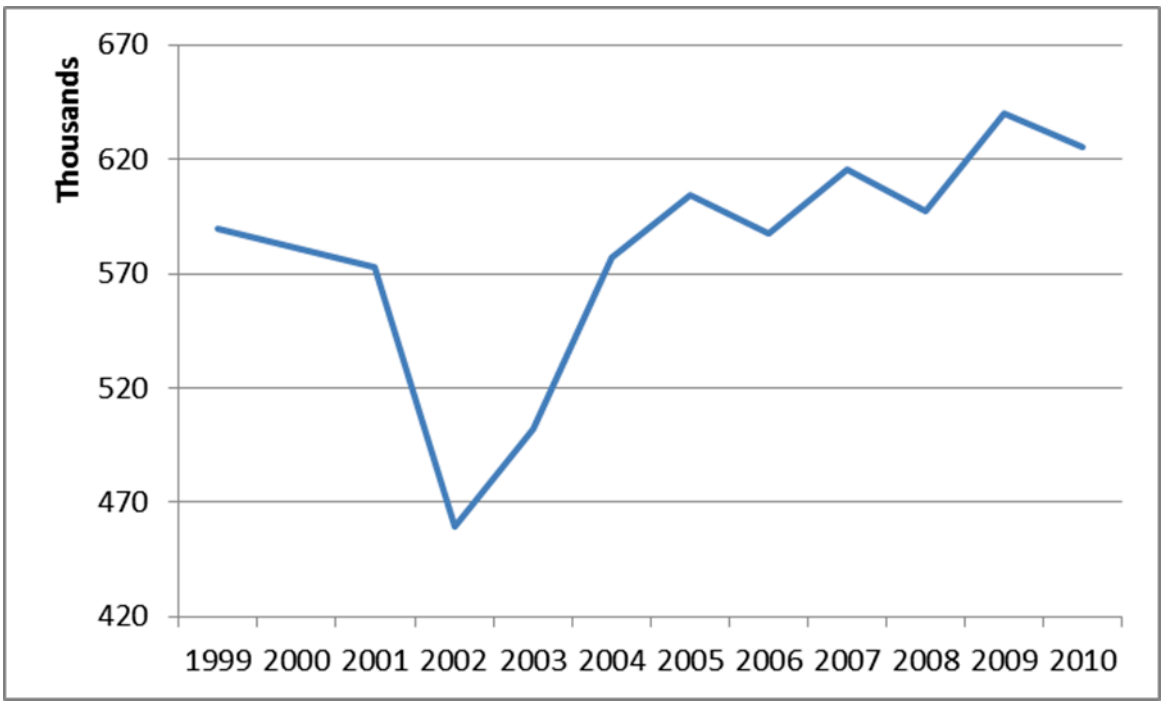

Figure 1: Estimated Vehicle Attritions in Australia (ABS 2003-2010)

ELV Recycling System

We decided to name the system that handles ELVs as ELV Recycling System, even though its function is not limited to the recycling of ELVs. The system spans several industries and stakeholders:

- The consumer: the driving force behind demand for motor vehicles and its parts. The consumer influences the rate of disposal of vehicles by making decisions about whether to replace or repair an old/damaged vehicle.
- The second-hand car dealers (including auction houses): this is where the trade of used and damaged vehicles takes place.
- The car insurance industry: providing insurance services for the motorists. It also plays a key role in determining whether a damaged vehicle is sent for repair or sold as scrap.
- The automotive repairs industry: a significant demand stream for parts. The repairers also play a role in assessing whether a vehicle can be repaired economically (which keeps it on the road) or not (which destines it for wrecking).
- The automotive recycling industry: the focus of this work. With 793 firms all over Australia, 3410 employees and a turnover of $1.1 Billion Australian dollars (IBISWorld, 2011a); this niche industry which has been in decline plays an essential

role in the recycling of vehicles. Over the past five years, it handled 610,000 ELVs annually, which is about 4% of the Australian automotive fleet (Australian Bureau of Statistics, 2011).

- The scrap metal recycling industry: purchasing and recycling scrap metal and ELV hulks from automotive recyclers
- The tyre recycling industry and fluids recycling industry: providing (at a cost) waste collection/recycling services to the automotive recyclers and repairers.
- The logistics operators (towing services): engaged primarily in the transport of damaged vehicles and ELVs among other stakeholders.

Within the system, there are interacting groups of stakeholders from various industries and government levels with each group pursuing their own goals and interests. A variety of factors (economic, social, environmental, policy) influence the flows of ELVs and its parts through the recycling sector.

The auto makers and importers are also stakeholders in the system even though their role is understated and delayed. They nevertheless play an important role because their design and materials' choice (and choice of models to bring into the market for importers) influence the recyclability and economics of ELVs.

From the policy perspective, stakeholders include law enforcement, local councils, state governments and authorities and the federal government. The industry associations have an important policy role because they bring forward the concerns of their members and industries.

There are no legislations that enforce any of the stakeholders to take responsibility of ELVs; rather this is left for market forces. Similarly, there are no incentives for the last owner of a vehicle to deregister it and to ensure that the ELV is processed in an environmentally sound manner (Hyder Consulting 2007).

Literature on the ELV processing system in Australia

Environment Australia's information paper in 2002 remains the most comprehensive study to date. It focuses on the environmental impacts of ELVs in Australia while highlighting some of the ELV processing issues that cause pollution such as the lack of standards and the inadequacy of premises and practices of the operators.

Another study commissioned by the Victorian Automotive Chamber of Commerce in 2004/2005 looks at the different sectors of the automotive industry (VACC and Accenture, 2005). The most relevant section relating to the dismantling and recycling industry – within the state of Victoria, is summarised as follows:

Current landscape

- Automotive dismantling and recycling industry experienced steady growth (13% in revenue and 7% profit) between 1999/2000 to 2003/2004.

- Operators are either general or specialist. They are clustered around major industrial zones throughout metropolitan Melbourne.
- Main cost drivers for operators are purchases, wages, rent, depreciation, warehousing and stock control.

Challenges

- Legitimate operators are faced with competition from unregulated (backyard) operators as a result of few barriers/licensing requirements for establishing operations.
- Operators are venturing into parts importation to meet local demand. Low tariffs on imported parts encourage public to opt for new instead of used.
- Lack of national strategy and insufficient enforcement for the correct and safe disposal of vehicles (Lack of Government support through policy or incentives for vehicle depollution).
- Additional capital investment required to meet changing vehicle composition.

More recently, Sustainability Victoria' consultation paper (Hyder Consulting, 2007) on ELVs in the state of Victoria presents an ELV market snapshot while highlighting the impacts from a broader perspective, that of sustainability (environmental, economic, social).

Despite the information provided in these reports, many questions remain about the inner workings of the Australian automotive recycling business, namely the dynamics that underline the business and the industry. This paper attempts to address this information gap by providing insights into three focus areas (Premises, workforce and sourcing of ELVs).

APPROACH

This project follows an adapted method (El Halabi, Doolan, & Cardew-Hall, 2012) that combines the Modeling Process (Sterman, 2000), the GMB (Vennix, 1996) and the qualitative research guidelines (Richards, 2009). Across three Australian states thirteen semi-structured stakeholder interviews were conducted between December 2010 and March 2011 (Tables 1 & 2 below). Interview transcripts and field observations were processed then analysed to extract variables and causal links. The CLDs presented in this paper (drawn using Simtegra Mapsys 4.0) were devised using these variables and causal links.

Table 1. Summary of Interview Questions and/or [Themes]

General	• Challenges facing the industry and business: Industry Challenges, Policy Challenges, Business Challenges].

	• Outlook of the industry and business [Industry Outlook, Business Outlook]. • [Effects of affordability of new cars on the automotive recycling industry and business]. • [Effects of emerging automotive fuel technologies] (such as hybrids, diesels, Liquid Petroleum Gas, etc.) on industry and business. • [Effects of possible policies on industry and business].
Business Focused	• Business characteristics [Years in business, Links with industry association, Premises, Specialisation, Workforce size, Turnover, Business hours] • Business input [Factors considered when sourcing ELVs, Sources of ELVs]. • Business operations [Handling of incoming ELVs, Handling of hazardous waste, Factors for deciding on parts suitability for resale/recycling, Stock labelling, Use of ICT]. • Business output [Types of customers/revenue streams, Export streams].

Table 2. Participants Grouping and Location

Stakeholder Group	Number of Interviews and Location (State)	Notes
Automotive Recyclers	5 in Victoria, 3 in South Australia, 1 in New South Wales	Interviews followed planned questions.
Auction Houses	2 in Victoria	Interviews used part of the planned questions to gather information about the flow of damaged cars at auctions.
Industry Associations	1 in Victoria, 1 in South Australia	Unstructured Interviews to gather information on the associations' role in the system.
Law Enforcement	1 in Victoria	Unstructured interview to gather information the law enforcement agency's role within the system.

RESULTS AND DISCUSSION

CLDs were identified from interview data in five key areas. These are Premises, Workforce, ELV sourcing, Industry connections, Parts and scrap sale.

For this paper the emerging theory and CLD for the first three areas (Premises, Workforce, ELV sourcing) is explained over the following subsections.

1. Premises

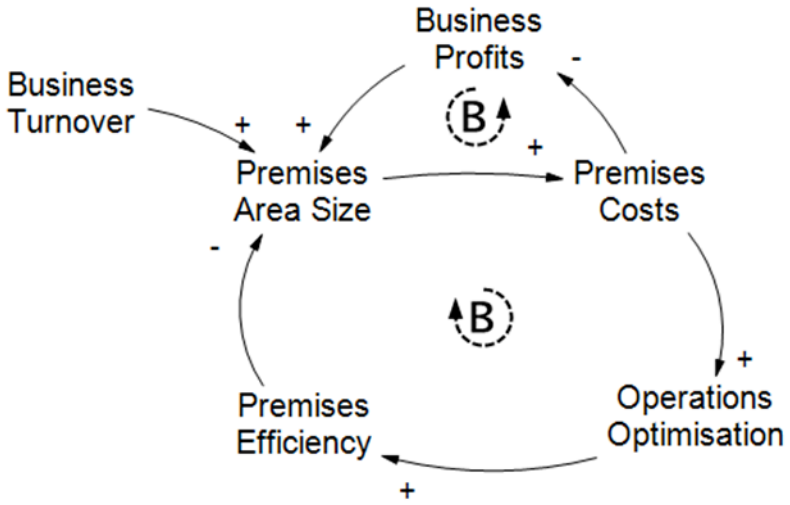

Figure 2 Premises Dynamics

One of the main business characteristics questions focused on premises area size (Figure 2) as operating an automotive recycling business is space demanding. Interview data indicate that auto recyclers who are able to adapt their premises to changes are more likely to stay longer in business. The average business age of the eight auto recyclers is 20.25 years.

Auto recyclers indicated that as their turnover and profits grow over time so does the need to expand their business premises. This growth, through renting an extra block of land next door or opening a branch across town meant, however, that their profits are significantly affected. This leads them to think of new business processes, or ways to optimise their operations so they that maximise on their investment costs. In some cases this leads them to downsize their premises while achieving a higher turnover. This simple feedback structure highlights an important dimension in the business of auto recycling which for long has been associated with the need for a large block of land.

The rising costs of premises through increases in property taxes or rental costs was originally considered as a limiting growth factor prior to conducting the interviews. But participants have indicated that while premises costs remain significant and are constantly on the rise, they have adopted changes in their business structure through business optimisations to weather the increasing costs.

Operations optimisation which will also appear over the next subsections is used as an umbrella term to describe changes that business owners make in one or more of the following business areas in order to minimise costs or maximise revenue:

- Premises: Expand, Shrink, and/or Relocate.
- Workforce: Grow, Reduce, and/or Retrain.

- Practice: Restructure Business (add or remove products and/or services), Invest in Information and Communication Technologies (ICT), and/or Invest in Marketing.

2. Workforce

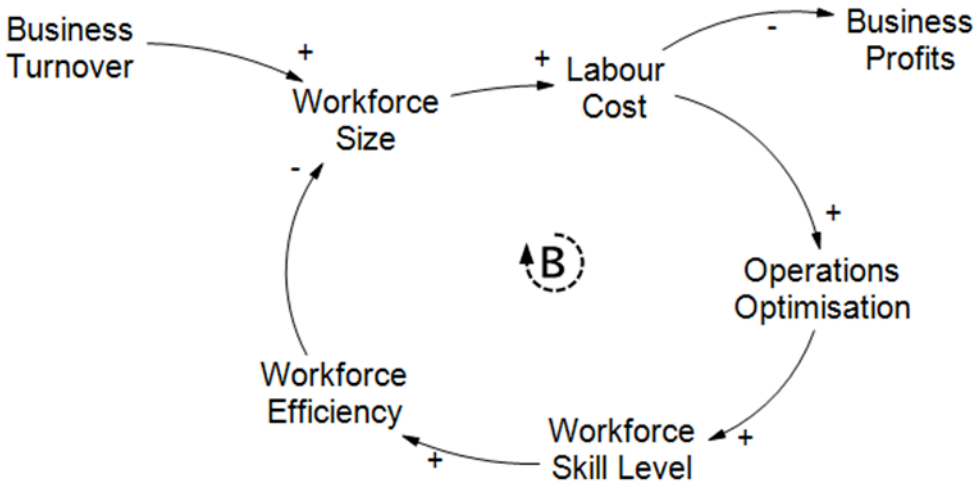

Figure 3. Workforce Dynamics

Automotive recycling is a labour intensive operation. The emerging theory from interview data was that operators able to adapt their workforce (size, cost, skill level) to changes are more likely to stay longer in business.

As Business Turnover increases, auto recyclers increase their Workforce Size to keep up with the increased workload. Labour Cost is one of the main costing factors that affect the auto recyclers' profitability. As costs grow, auto recyclers tend to look for ways to optimise their business operations. They do so by adjusting their Workforce Skill Level in order to maximise the efficiency of their workforce. This includes hiring new skilled workers, retraining current workers, or dismissing unskilled workers. As a result, their Workforce Size dynamically changes. With the exception of a recycler who has been in business for less than 2 years, all participants indicate that their workforce size is constantly changing.

3. ELV Sourcing

This subsection first brings into context the factors that auto recyclers consider when sourcing ELVs before highlighting the dynamics of ELV sourcing at salvage car auctions. As deduced from interview data, in order to determine the suitability of ELVs for their operations, several auto recyclers assess vehicle specific factors (cost, location, condition) and business related factors (available cash, yard space).

In terms of sources, auto recyclers rely primarily on salvaged car auctions to locate stock for their operations. They also rely on other sources, such as the public and crash repairers, depending on their nature of their business (You-Pull-It dealing with generally old vehicles, or specialised etc.). There is also an emerging stream which is direct from insurance companies that bypasses auction houses.

3.1 Factors considered for sourcing of ELVs

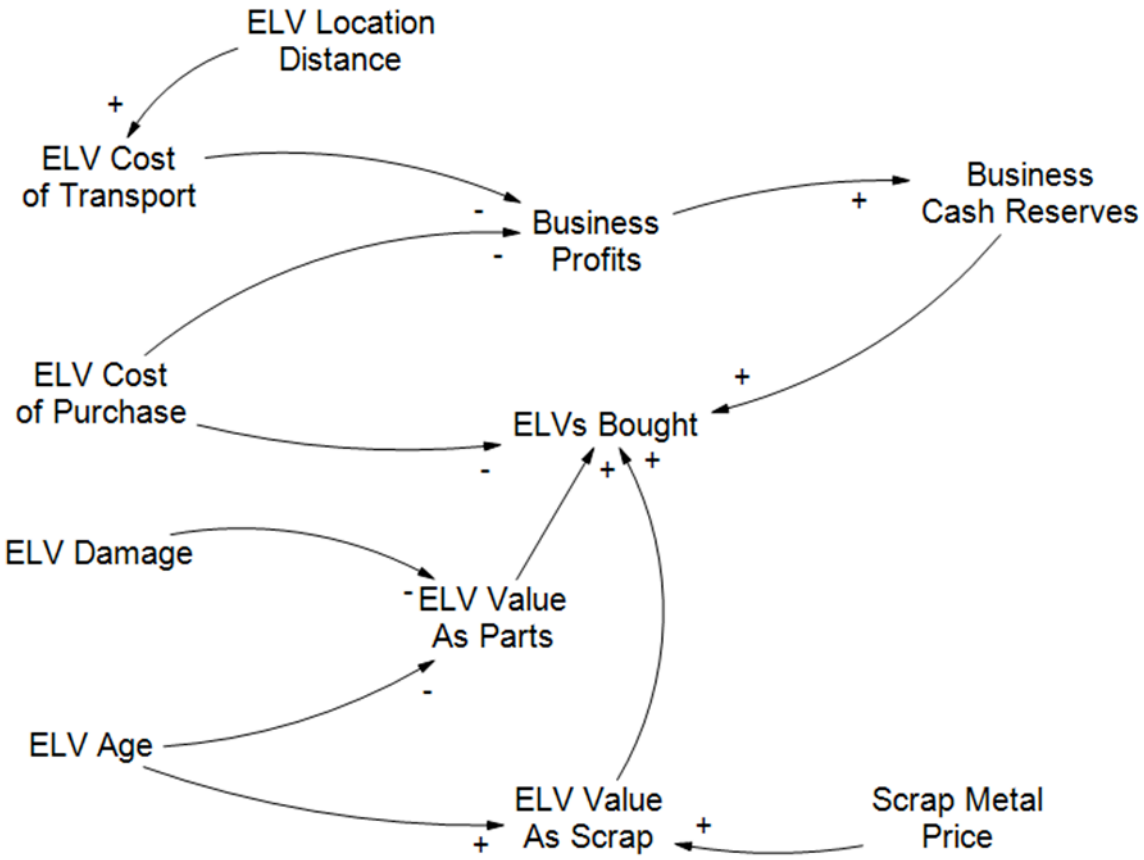

Figure 4. Overview of Factors Considered when Sourcing ELVs

When prompted for the factors that auto recyclers take into consideration when deciding on acquiring ELVs (Figure 4) the following ELV specific factors were identified:

- ELV Cost of Transport: As most ELVs are either unregistered or unroadworthy, there is a significant towing cost involved to bring them to the premises. This cost, which is dependent upon the ELV Location Distance, varies widely from as little as 50 dollars per vehicle (Interview 5) to several hundred dollars if the ELV is interstate. Auto recyclers view this cost as a factor that negatively impacts their Business Profits, Cash Reserves, and subsequently the number of ELVs bought.

- ELV Cost of Purchase: It is perhaps the most important factor in the process of sourcing ELVs. In most cases Auto recyclers decide on whether an ELV is worth buying or not based on this factor along with the inherent ELV Value as Parts and as Scrap. Similar to the ELV Cost of Transport, this factor also impacts on the Business Profits as it ties significant amounts of their Cash Reserves. This factor varies in value from as little as 0 dollars (as vehicle removal service) to several thousands of dollars (at salvaged car auctions).
- ELV Damage: The extent to which an ELV is damaged determines its value as parts. For most auto recyclers this value is highly tied to the condition of mechanical components. This value is also seen differently by different auto recyclers. Those that operate in a niche market (specialising in specific brands/models etc.) may see more value in an ELV than a You-Pull-It type recyclers. This is because they leverage on their market presence and business connections to meet specific demand from trade customers.
- ELV Age: Similarly to ELV Damage, this factor impacts the ELV Value as Parts. It also influences the perceived ELV Value as Scrap. An older ELV may be seen by the You-Pull-It type recyclers that rely on low profits high volume to derive their profits, as their baseline revenue stream: In the worst case scenario, if the ELV provides little or no revenue for parts, it would still be sold as scrap metal to metal recyclers. Note that this value as scrap is contingent upon the scrap metal price which fluctuates according to the global scrap metal price.

Most participants noted that the price that metal recyclers are willing to pay for scrap depends on two factors:

- The first factor is the currency exchange rates that affect the willingness of metal recyclers to purchase more scrap feedstock as it has a large effect on their revenue.
- The second one is the nearing deadline of an export shipment of scrap metal, as the metal recyclers revenue is chiefly created when scrap metal is taken onto the vessel.

While this area of interest may lie outside the scope of this work, the observation made by the auto recyclers about the metal recyclers provides another insight into the business of recycling.

Regardless of the product being recycled, the willingness of businesses to acquire more feedstock for their operations highly depends on the business ability to meet demand and create revenue for the business.

Causal Loops in Automotive Recycling

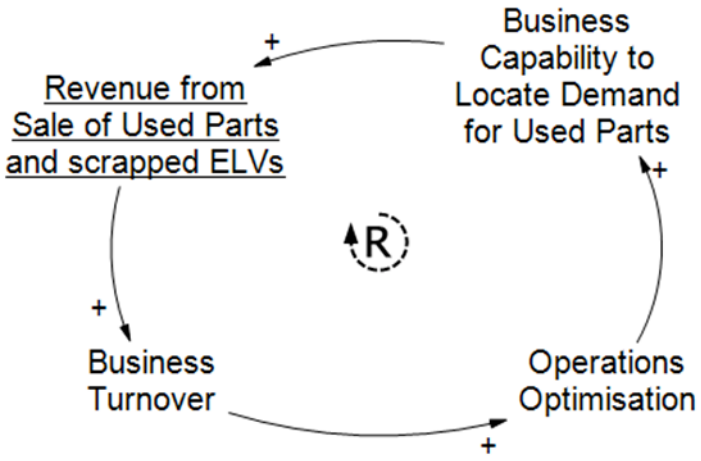

Figure 5. A High Level Perspective of Auto Recycling Business

Put differently, if demand for a certain product suddenly stops then businesses are less likely to go after more feedstock as the potential to create more revenue is suddenly abolished. This generalisation does not negate the possibility of finding other markets for the same product. In essence, auto recyclers can be seen operating under this very paradigm (Figure 5).

3.2 Sources of ELVs

When discussing the sources of ELVs with auto recyclers (Figure 6), it was established that the top three sources in terms of volume were: the public, salvaged car auctions, and crash repairers. It is essential to point out the limited importation activity from Japan; this will be discussed at a later stage.

With the public and crash repairers wanting to dispose of old vehicles, the cost of ELV purchase in these situations is usually low to almost zero dollars (as pointed out in the previous section). ELVs sourced from the public and repairers tend to be older models/makes with mechanical failures that negatively impact on the value of an ELV as parts. Quality ELVs having a high value as parts, however, are sourced primarily from salvage car auctions. While some large scale auto recyclers rely heavily on sourcing from the public with little cost, some specialised auto recyclers source almost 100% of ELVs from these auctions where cost of purchase amounts to several thousands of dollars.

Based on the above, it becomes clear that sourcing of ELVs from auctions is an important activity for auto recyclers from a business standpoint. Despite being the costly option, sourcing stock from salvage auctions is essential as it provides them with quality feedstock that can be dismantled and sold as quality parts. But where do these ELVs arrive to the auctions in the first place? As established from the auction houses interviews, 99% of their stock comes from auto insurance companies. Insurers write off a damaged vehicle when it is deemed uneconomical for them to repair it as they pay out the policy holder.

Causal Loops in Automotive Recycling

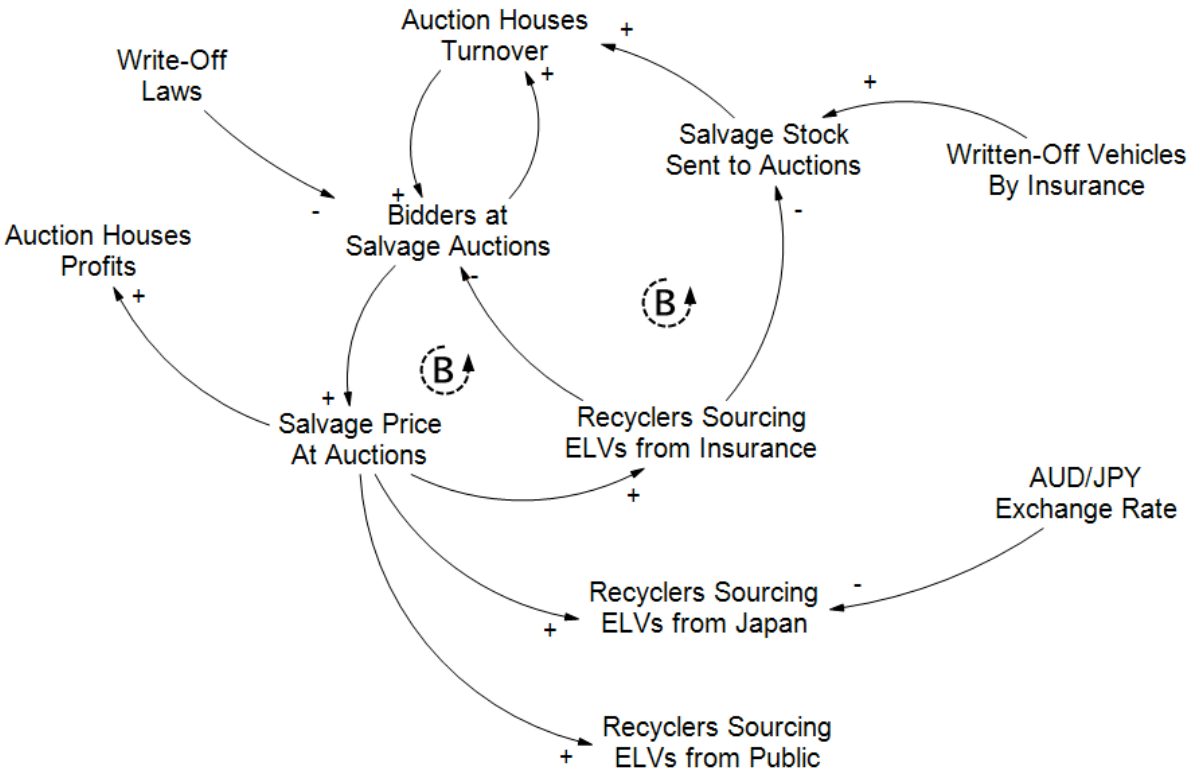

Figure 6. Sources of ELVs Dynamics

The business model that auction houses follow means that their turnover is highly coupled with the number of cars they turnover and the hammer price on the cars. This model means that that their suppliers (insurers) would benefit from higher return on the salvaged stock, consequently making them the preferred option for disposing of damaged vehicles. It also means that in order to push the final bidding price on vehicles, a large number of bidders needs to be present during auctions.

These bidders can be any person that presents a valid form of ID and pays a bidder registration fee. These non-trade bidders are seen as backyarders by auto recyclers. They attempt to source damaged vehicles from auctions, for parts and to possibly repair them to sell them on the market as used vehicles. They compete with the legitimate auto recyclers bidding at the auctions, driving the final price upwards, a desired outcome by the auction houses. Recently laws passed in NSW (Written-Off Act) that made it impossible to re-register a written-off vehicle is seen by auto recyclers as a policy devise that can deter these non-trade bidders from entering the auctions in the first place.

This stiff competition at auction houses has led some auto recyclers to bypass the current arrangement by sourcing their stock directly from auto insurers through strategic alignment. This recent trend, combined with the new laws mentioned earlier, is seen to lower the price of salvaged vehicles at auctions as less bidders turn up for auctions. The

trend will also divert potential salvage stock from being sent to auction houses. This will negatively impact the auction houses turnover as they will be dealing with less stock.

It is unclear from the interviews the extent to which this trend (auto recyclers sourcing stock direct from insurers) is prevalent in the industry. Revisiting the collected turnover data, it can be established that approximately 8% of the total ELVs reported by all participants are handled by recyclers having special arrangements with an auto insurance company though sourcing of ELVs from insurers is not exclusive (the recyclers reported they still source some of their stock from salvage auctions).

Importation is another important source of ELVs. Several participants have indicated that they have tried to import from overseas, but Japan was seen as most viable due to the accessibility of quality stock for all brands including European makes. It was established that the Australian Dollar/Japanese Yen (AUD/JPY) exchange rate is the most important motivating factor for this activity. When JPY is relatively cheap, sourcing ELVs from Japan becomes cost effective as it cheapens the ELV cost of purchase. Even after adding the agent fee and shipping costs, sourcing ELVs from Japan is highly competitive with the local sourcing from auctions where the competition highlighted above has been driving ELV prices upwards.

A NOTE ON PRELIMINARY SCENARIOS

Scenarios define the SD model envelope and its relevance. In this section, the plausible scenarios based on the interviews' challenges questions are presented. The challenges that the participants highlighted during the interviews were grouped and analysed by impact areas. They are then sorted by their scope level (Tables 3 and 4). Challenges that are found too broad and do not impact an identified area are classified as General Business. The preliminary scenarios (Table 5) identified from these challenges serve as a precursor to what the future might hold for the industry. We intend to discuss them in detail with the stakeholders to narrow down and define the purpose of the SD models.

Table 3. Business Challenges Categorised by Impact Area

Impacted Area	Challenge
Premises	Land rental/tax costs
	Upgrade of facilities
	Business location
Workforce	Labour costs
ELV Sourcing	Increasing ELV purchase costs
	Competition from unlicensed traders
	Competition from other recyclers
	Lack of stock to meet demand
General Business	Viability of auto recycling as a business
	Business growth/expansion
	Reducing costs
	Become more efficient (more revenue, less costs)

Table 4. Policy Challenges Categorised by Impact Area

Impacted Area	Challenge
Workforce	Work laws
ELV Sourcing	Lack of policy in the trade of ELVs
	Economic write-off
	Different vehicle legislations across states
General Business	Licensing requirements/costs

Table 5. Preliminary Scenarios by Focus Area Identified from Challenges

Focus Area	Scenarios
Premises	Increasing land rental costs, upgrading facilities/relocate as market changes
Workforce	Tightening of work laws (dismissal, compensation) and increasing labour costs (Labour price index)
ELV Sourcing	Increasing ELV purchase costs coupled with strong competition, reduction in available and suitable ELV stock, economic write-off implemented, strong policing on illegal ELV trade, harmonisation of laws across states

CONCLUSIONS

This paper discussed ELV Sourcing, Workforce, and Premises dynamics that were identified from stakeholder interviews. Prior to this work, little information was available about these important aspects of the automotive recycling business in Australia. It is hoped that these areas of interest along with other areas identified in the process (not discussed in this paper) such as Industry Connections, and Parts and Scrap Sale will help guide the SD modelling effort in the model formulation stage.

This research confirms other participative modelling projects where the driving question gets revisited and refined as the process moves forward (Eden, Jones, & Sims, 1983), (Sterman, 2000). Upon embarking on this investigation, the main goal was to find how the auto recycling industry in Australia is operating to be able to understand how and by how much the environment is affected. It was hoped that once the existing decision and flow structures are identified, through modelling and simulation, policy options could be formulated and tested to find out the most beneficial for the environment. The model conceptualisation step was hence devised and applied. It can be seen as an effective grounded approach for problem identification and structuring.

The insights gained from the results come as significant. When cross examining the preliminary findings of this work with industry intelligence reports (Australian Automotive Intelligence, 2010), (IBISWorld, 2011b) little or no reference was found to the several problem areas that emerged.

As a result of following the adapted SD approach, the impending issues for the automotive recyclers were identified. Those discussed in this paper are centred on the viability of staying profitable while dealing with the dynamics of fluctuating ELV supply, labour and premises.

ACKNOWLEDGEMENTS

This original research was proudly supported by the Commonwealth of Australia through the Cooperative Research Centre for Advanced Automotive Technology (AutoCRC) and the Australian National University (The ANU). We thank the Victorian Automotive Chamber of Commerce (VACC), the Auto Parts Recyclers Association of Australia (APRAA) and the Auto Recyclers Association of Australia (ARAA) who helped putting us in touch with most of the stakeholders. We also thank all the stakeholders who invested their time and effort in these interviews. Finally thank you to Maha Zohbi for providing feedback on this paper.

REFERENCES

Crimes Act 1900 . (2006). (NSW) - Sect 154G Facilitating organised car or boat rebirthing activities.

Australian Automotive Intelligence. (2010). *Australian Automotive Intellegence Report. Yearbook*, Melbourne.

Australian Bureau of Statistics. (2011). *Motor Vehicle Census, Australia* 9309.0.

Australian Bureau of Statistics. (Various, 2003-2010). *Motor Vehicle Census, Australia* 9309.0.

Cassells, S., Holland, J., & Meister, A. (2005). End-of-life vehicle disposal: Policy proposals to resolve an environmental issue in New Zealand. *Journal of Environmental Policy & Planning*, 107-124.

Conlon, & Perkens. (2001). *Wheels and Deals*. Aldershot: Ashgate Publishing Limited.

Eden, C., Jones, S., & Sims, D. (1983). *Messing About in Problems: An Informal Structured Approach*. Pergamon Press.

El Halabi, E., Doolan, M., & Cardew-Hall, M. (2012). Extracting Variables and Causal Links from Interview Data. Model-based Management: *The 30th International Conference of the System Dynamics Society*.

El Halabi, E., Doolan, M., & Newell, B. (2008). *A Global Comparison of End-of-life Vehicle Policies. Meeting the Challenges to Sustainable Mobility, - International Conference on Sustainable Automotive Technologies*. RMIT University.

Environment Australia. (2002). Environmental Impact of End of Life Vehicles: An Information Paper. Commonwealth Department of Environment and Heritage.

Gerrard, J., & Kandlikar, M. (2007). Is European end-of-life vehicle legislation living up to expectations? *Journal of Cleaner Production*, 17-27.

Hedayati, M., & Subic, A. (2008). Indicative Comparison Between the End-of-Life Vehicle Recovery Rate in Australia and the International Best Practices. *Meeting the challenges to sustainable mobility - International Conference on Sustainable Automotive Technologies*. RMIT University.

Hyder Consulting. (2007). End of Life motor vehicles: Market snapshot. Melbourne: Hyder Consulting.

IBISWorld. (2011a). Motor Vehicle Dismantling and Used Part Dealing in Australia - Industry Report F4624.

IBISWorld. (2011b). Motor Vehicle Dismantling and Used Part Dealing in Australia - Industry Risk Rating Report F4624.

Industry Commision. (1990). The Automotive Industry. Commonwealth Australia.

Johnson, M., & Wang, M. (2002). Evaluation policies and automotive recovery options according to the European Union Directive on end-of-life vehicles (ELV). Proceedings of the Institution of Mechanical Engineers, Part D: *Journal of Automobile Engineering*, (pp. 723-739).

McNamara, N. (2009). Vehicle Recycling and Sustainability. ISS Institute.

Richards, L. (2009). *Handling Qualitative Data: A Practical Guide - Second Edition*. London: Sage.

Sterman, J. D. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston: McGraw-Hill.

Total Auto Recyclers. (2007). End of Life Vehicle Industry Sustainability.

VACC and Accenture. (2005). Horizon 2015: *Changes and Challenges for the Australian Retail Automotive Industry*. Melbourne.

Vennix, J. A. (1996). *Group Model Building*. Chichester: Wiley.