How do vehicle automation and vehicle sharing relate?
Exploring causalities between vehicle automation and vehicle sharing in the Netherlands

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ABSTRACT
A combination of two developments in personal mobility—vehicle automation and vehicle sharing—might become reality, but qualitative research into the potential impact of vehicle automation on vehicle sharing (and vice versa) is currently scarce. This thesis aims to fill this gap by exploring the potential impact through literature research and a series of expert interviews. This resulted in eight causal models, five of which require full vehicle automation to be possible. The causal models require validation through future research.

KEYWORDS: Vehicle automation; vehicle sharing; socio-technical system; literature review
1. INTRODUCTION

Our car-based society causes a lot of undesired effects, such as accidents, congestion, and air pollution. According to experts and media, vehicle automation and vehicle sharing are two developments that could reduce—or even completely mitigate—these undesired effects. For example: vehicle automation will supposedly increase safety on public roads while decreasing traffic congestion, gas emissions, and fuel consumption [1]. Next, sharing vehicles requires less vehicles to satisfy the same transport demand, resulting into less congestion and air pollution.

Vehicle automation is currently a highly uncertain development. Little is known in the literature about when automated vehicles will reach the market, how penetration rates will evolve and to what extent this new transport technology will affect transport demand and planning [2]. Despite the lack of research, vehicle automation is a very beneficial development from a societal standpoint. Automated vehicles will supposedly increase safety on public roads while decreasing traffic congestion, gas emissions, and fuel consumption [1].

Vehicle sharing is less uncertain because its success (or lack thereof) and effects have been studied for decades (see: [3]–[7]). Advocates for vehicle sharing promise various benefits for society in general and for end-users in particular. It makes better use of idle vehicles and thereby lowers vehicle demand in general. Secondly, payments by vehicle sharing users are closely tied to actual vehicle usage because vehicle sharing transforms fixed costs of vehicle ownership into variable costs [7]. Moreover, vehicle sharing addresses some of the classic problems of car ownership, such as ‘arranging permanent parking, vehicle inspection, maintaining insurance coverage and repair costs that can be both uncertain and large’ [8].

Interestingly, a combination of both developments could also become a reality. Since vehicle automation and vehicle sharing are two developments which are currently in its infancy, literature in the area of synergy between the two remains sparse [9]. However, synergy might be expected. For example, simulation studies show that shared AVs (SAVs) have the potential to reduce generalised transport costs, satisfy more trips and result in overall beneficial emissions impact (see: [10], [11] and [12]). This article explores possible impact of vehicle automation on vehicle sharing and vice versa.

Next to filling this scientific gap, research in this field is also relevant from a societal standpoint. Increasing the understanding of the implications of vehicle automation on vehicle sharing and the other way around could be relevant for policy-making to address these undesired effects. The main research question of this article is: “What could be the impact of vehicle automation on vehicle ownership, vehicle sharing and vice versa?”

2. RESEARCH METHODOLOGY AND METHODS

This research project consists out of three phases: (1) concept exploration and demarcation by means of literature research and unstructured interviews, (2) a case study by means of semi-structured interviews, and (3) interpretation and discussion by literature comparison. The principles from Grounded Theory (GT) [13] form the starting point for a tailored research framework. Adopted principles for this study are:
keeping an open-mind as researcher, comparison of theories, and iteration between
and within project phases.

The output of the literature study consists of two types of information: formulating
definitions of the research subjects and finding key factors for the future development
of the subjects.

- **Formulating definitions of research subjects**: definitions and key factors
  are both essential for finding possible causalities between the subjects. Key
  factors drive or hinder the future development of the research subjects, which
  have to be defined first. Definitions in turn determine the scope of the research
  project.

- **Finding key factors for future development of research subject**: the
  search for key factors is because it adds a layer to the search for causalities
  between the research subjects. Vehicle automation and vehicle sharing might
  not be directly related, but via several (key) factors.

The first part of the literature study started with the references in the study by [14].
Several online search engines were then used to find more relevant research
articles. These search engines include: Scopus, JSTOR, and Google Scholar.
Keywords that were used as input for the searches include a combination of the
following (see Table 1). For the purpose of this article, vehicle ownership was defined
as the opposite of vehicle sharing. Therefore, it was also included in the literature
study.

<table>
<thead>
<tr>
<th>Object of study</th>
<th>Vehicle automation</th>
<th>Vehicle ownership</th>
<th>Vehicle sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Keywords</strong></td>
<td>Automated driving</td>
<td>Car use</td>
<td>Car use</td>
</tr>
<tr>
<td>Autonomous driving</td>
<td>Travel behaviour</td>
<td>Sharing economy</td>
<td>Peak car</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Car sharing schemes</td>
</tr>
</tbody>
</table>

Table 1 - Literature study: keywords
Criteria for selecting proper articles out of the search query results were based on
the specific relevance to the subject. In addition to regularly checking news websites,
I enabled a ‘Google Alert’ in order to stay informed on the state of all three research
objects throughout the study.¹

In addition to studying literature, I conducted interviews with experts in the field.
Since both subjects are still in their infancy and qualitative research on the
intersection of both subjects is lacking, I opted for interviews. The interviews in this
first phase were unstructured. Interview contacts for an academic angle were first
obtained from existing collaborators at Delft University of Technology (TU Delft).
Additionally, the Netherlands Institute for Transport Policy Analysis (KiM) and Utrecht
University were contacted to increase the diversity of the interviewees. Furthermore,
interviewees in this phase were selected based on their predetermined willingness to
participate and provide feedback. These interviews were used to broaden the scope
of the research, to see whether anything was missing from the literature study and to
validate the concept topic list used for the case study. This first round also helped in
finding the first candidates for the second phase of interviews.

Phase 1 unstructured interviews were conducted with familiar participants that
have similar interests to those who participated in Phase 2 interviews. This helped
the interviewer to practice doing interviews in general. A pilot test was conducted for
the Phase 2 interview. This helped me determine if there were any flaws, limitations,
or other weaknesses in the interview design, and further allowed me to make the
necessary revisions prior to the implementation of the study [15].

In Phase 2, I conducted semi-structured interviews. This type of interview allowed
me to encourage an informal conversation covering certain themes and questions.
Semi-structured interviews allow for variation of questions from one interview to the
other. The order in which questions are asked may vary also and is highly depended
on the flow of the conversation. My experience with conducting interviews for this
research project confirms this.

### 3. DATA COLLECTION

The semi-structured interviews proved more difficult to arrange than the
explorative interviews, especially with regard to experts in business. Eventually, I
managed to interview 9 out of 19 experts from a business perspective.² Except for
interview number 19, no companies in active in vehicle sharing were willing to
participate.

As said, the data collection proceeds until the so-called theoretical saturation is
achieved. This means that new data does not add new information. Because data

¹ See [https://support.google.com/alerts/answer/4815780?hl=en](https://support.google.com/alerts/answer/4815780?hl=en) for an explanation of the workings of Google Alerts. The same keywords as in the literature study were input for the Google Alert.

² This number includes Carlo van de Weijer who works for both Eindhoven University of Technology and at TomTom.
was derived from literature study and expert interviews, it applies to both. This is a subjective decision. One can never know if further interviewing would give more information. In the absence of an objective criterion, [16] suggests ‘not to start theoretical sampling too early in the data collection process. Rather, the researcher should continue open sampling to maximize variations, and theoretical sampling should be used late in the process’. Open sampling refers to maximizing variations in experiences and descriptions by using participants from contrasting milieus and backgrounds. On top of that, I adopted the theoretical perspective a priori. This ensured variation by frontloading the topic list with different analytical dimensions. Next it enabled me to reveal the direction of the theoretical sampling ex post.

4. Results

The first result is that eight key factors determining the development of vehicle automation were found through the interviews. Interestingly, the factors differ from an earlier study among Dutch experts (see [2]). This comparison is summarized below (Table 2).

Table 2 - Literature comparison: case study vs. [2]

<table>
<thead>
<tr>
<th>This study</th>
<th>Similar research [2] ↓</th>
<th>Legislation</th>
<th>Liability</th>
<th>Consumer Acceptance</th>
<th>Safety</th>
<th>Technological Development</th>
<th>Legacy</th>
<th>Mixed traffic</th>
<th>Purchase Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV technology trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
<td>Relates to</td>
<td></td>
<td>Relates to</td>
<td></td>
</tr>
<tr>
<td>Interoperability among AV technologies</td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
<td></td>
<td></td>
<td>Relates to</td>
<td></td>
</tr>
<tr>
<td>Costs/benefits of AV technology</td>
<td></td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
<td></td>
</tr>
<tr>
<td>Development of AV in EU</td>
<td></td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AV ownership structure (public vs private)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not mentioned as key factor in this case study</td>
</tr>
<tr>
<td>Transition steps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not mentioned as key factor in this case study</td>
</tr>
<tr>
<td>Incidences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy, emissions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not mentioned as key factor in this case study</td>
</tr>
<tr>
<td>Legal/institutional context (national and European)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public/private expenditures on infrastructure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stability of policies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessibility, social equity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
</tr>
<tr>
<td>Psychological barriers (Citizens and customers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relates to</td>
</tr>
</tbody>
</table>
This research project is aimed at exploring possible causalities between vehicle automation and vehicle sharing. That means exploring the common ground between the two subjects. Key factors for vehicle automation could be influenced by vehicle sharing or the other way around. Interestingly, Dutch experts in this project did not mention AV ownership structure (public vs private) as a key factor for the development of vehicle automation.

The eight key factors determining the development of vehicle sharing that were found in the case study also differ from an earlier study (see [17]). A two by two matrix is used to make these differences explicit. This comparison is summarized below (Table 3).

Table 3 - Literature comparison: this study vs. [17]

<table>
<thead>
<tr>
<th>This study → Similar research</th>
<th>Accessibility of SVs</th>
<th>Availability of SVs</th>
<th>Status of a Privately Owned Vehicle</th>
<th>Urbanisation</th>
<th>SV fleet size</th>
<th>Consumers' Willingness to Consume by Sharing</th>
<th>Parking Costs and Parking Space</th>
<th>Total Cost of Vehicle Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political and administrative support from the municipality</td>
<td>Not mentioned as key factor in this case study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big fleet size and variety of vehicles and providers</td>
<td>Relates to</td>
<td>Relates to</td>
<td>Partly the same</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urbanisation</td>
<td></td>
<td></td>
<td>Exactly the same</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of use</td>
<td>Relates to</td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coordination and integration of the vehicle sharing to public transport</td>
<td>Not mentioned as key factor in this case study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing and profiling.</td>
<td>Relates to</td>
<td></td>
<td>Relates to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The experts in this project did not mention Political and administrative support from the municipality nor Coordination and integration of the vehicle sharing to public transport as a key factor for the development of vehicle sharing. However, although

3 Based on [17]. Because the second key factor according to [17] consists of two separable concepts, it was split into (1) a big fleet size and a variety of vehicles and providers was separated and (2) urbanisation.

4 Not explicitly mentioned as a key factor in this case study, but it was mentioned in narrative 5.
the latter was not explicitly mentioned as key factor, it should be noted that narrative
5 links to public transport.

Secondly, *Parking costs and space* and *Total cost of ownership* are two key
factors that were not mentioned by [17]. The project and thereby the interviews are
focused on private ownership versus vehicle sharing, whereas the study by [17] is
only focused on vehicle sharing. The first factor was also found by [18] as
determinant factor for vehicle use – that is, if we interpret *Parking costs and space* as
a dimension of convenience. *Total cost of ownership* was also found in a previous
study as determinant factor for car ownership (see [19]).

5. Impacts

The potential impact of vehicle automation on vehicle sharing and vice versa, took
shape through eight narratives, describing several relationships between the
subjects. Broadly speaking, in most narratives the highest level of vehicle automation
is conditional for the potential impact to appear.
### Table 4 - Causalities: an overview

<table>
<thead>
<tr>
<th>Narrative</th>
<th>Start</th>
<th>+/-</th>
<th>End</th>
<th>Key factor</th>
<th>Interpretation of causality</th>
<th>Level 5 automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
<td>SVs</td>
<td>+</td>
<td>Vehicle automation</td>
<td>Empty trips (new)</td>
<td>Replacing privately owned vehicles with AVs requires more time than replacing privately owned vehicles with SAVs. The reason is that a single SAV can satisfy more trips in one day than a privately owned vehicle. Vehicle Sharing therefore could increase the speed of adoption of Vehicle Automation technology.</td>
<td>Required</td>
</tr>
<tr>
<td>N2</td>
<td>Vehicle automation</td>
<td>+</td>
<td>Vehicle ownership &amp; vehicle sharing</td>
<td>Comfort (new) Safety (new) Gadget appeal (new)</td>
<td>With increasing levels of vehicle automation, comfort, safety and gadget appeal also increase, making vehicle usage in general more appealing.</td>
<td>Not required</td>
</tr>
<tr>
<td>N3</td>
<td>Vehicle sharing</td>
<td>+</td>
<td>Vehicle automation</td>
<td>Average vehicle lifespan (new)</td>
<td>Wear &amp; tear causes shorter life cycles</td>
<td>Required</td>
</tr>
<tr>
<td>N4</td>
<td>Vehicle automation</td>
<td>-</td>
<td>Shared vehicles</td>
<td>Empty trips (new)</td>
<td>Fully AVs could make the use of SAVs as automated taxis possible. This requires fewer vehicles than conventional taxi services to service the same transport demand.</td>
<td>Required</td>
</tr>
<tr>
<td>N5</td>
<td>Vehicle automation</td>
<td>+</td>
<td>Vehicle sharing</td>
<td>Cost of usage (new)</td>
<td>This causal relationship is implicit. When the last mile solution can become much cheaper with fully automated vehicles</td>
<td>Required</td>
</tr>
<tr>
<td>N6</td>
<td>Vehicle automation</td>
<td>+</td>
<td>Vehicle sharing</td>
<td>Availability Cost of usage (new)</td>
<td>Fitting SVs with level 5 Vehicle Automation – resulting in SAVs – enables sharing companies to stabilise their imbalanced fleets. This results in higher availability and lower costs, because it requires fewer vehicles for the same amount of trips. This attracts more Vehicle Sharing users.</td>
<td>Required</td>
</tr>
<tr>
<td>N7</td>
<td>Vehicle sharing</td>
<td>+</td>
<td>Vehicle sharing</td>
<td>N.A.</td>
<td>Increase in centralized ownership makes sharing these ‘private’ vehicles easier.</td>
<td>Not required</td>
</tr>
<tr>
<td>N8</td>
<td>Vehicle automation</td>
<td>+</td>
<td>Vehicle ownership</td>
<td>Total cost of ownership</td>
<td>Vehicle Automation on different levels is assumed to prevent accidents and thereby increasing Safety in general. With fewer accidents, Insurance costs</td>
<td>Not required</td>
</tr>
</tbody>
</table>
From the literature study, the unstructured and semi-structured interviews, and the interpretation as depicted in the above, the following was concluded:

- **Vehicle automation could have a positive impact on vehicle sharing,** because of three reasons:
  
  One, vehicle automation makes vehicles in general more appealing because it increases comfort, safety, and “gadget appeal”. This applies to personal vehicles in general, both private and shared. The higher the level of comfort, the stronger this relationship becomes. When vehicle sharing companies add vehicles to their fleets equipped with automated vehicle technology it thus increases the appeal of the shared vehicle.

  Second, with level 5 vehicle automation becoming available, unprofitable bus services might become profitable again. The number of bus drivers can be decreased and thereby lowering the variable costs and thus exploitation costs. Such automated bus service allows for flexible time schedules and stops, lowering the exploitation costs and potentially giving new passengers access to the service. Lower costs and new users increases the service utilisation and thus vehicle sharing.

  Third, fitting shared vehicles with level 5 vehicle automation enables sharing companies to stabilize their currently imbalanced fleets. This results in higher availability and lower costs, because it requires less vehicles to satisfy the same transport demand. This attracts more users and thus increases vehicle sharing.

- **Vehicle automation could have a negative impact on shared vehicles:** In case fully automated vehicles become a reality, it will enable empty trips. Empty trips are trips executed by the vehicle without a passenger (nor driver). Less shared vehicles will be needed to satisfy the same transport demand. Full vehicle automation thus leads to a decrease in the volume of shared vehicles—not vehicle sharing.

  Vehicle sharing could also impact vehicle automation. A negative impact of vehicle sharing on vehicle automation was not found.

- **Vehicle sharing could have a positive impact on vehicle automation,** because of two reasons:
  
  One, less shared vehicles can fulfil the same transport demand as private vehicles do now. If vehicle sharing increases, the total number of vehicles needed for the same transport demand can go down. Assuming the growth of vehicle sharing requires new vehicles, these vehicles could be fitted with automated vehicle technology. If both are true, replacing existing private vehicles with new automated shared vehicles increases the total miles driven with a shared vehicle that is equipped with automated vehicle technology.

  Second, similar to the previous causality, less shared vehicles can fulfil the same transport demand as private vehicles do now. These shared vehicles are utilised more than private vehicles on average, which causes wear and
treatment. The lifecycle of a shared vehicle is therefore shorter than a private vehicle. Replacing shared vehicles more often allows for new automated vehicle technology to be adopted faster. This does make the vehicle more expensive.

Apart from the possible causalities between the research subjects, the study revealed additional findings. These findings are listed below.

- **Vehicle automation could have a positive impact on private vehicle ownership:** Vehicle automation makes vehicles in general more appealing because of increased comfort, safety, and gadget appeal. This applies to private and shared vehicles. The higher the level of comfort, the stronger this relationship becomes. This is the same causality as mentioned before.

- **Full vehicle automation is conditional:** Full vehicle automation (level 5) is conditional to four out of five narratives describing a positive causality from vehicle automation to vehicle sharing. The opposite was not found in this study; the positive impact of vehicle sharing on vehicle automation does not require level 5. Full vehicle automation could strengthen the causality though.

- **Evolution of the personal automobile vs vehicle sharing:** Eight out of nineteen experts think that the scenario towards fully automated driving is an evolutionary one in which vehicles will be complemented with technology assisting and eventually replacing the driver. Six out of nineteen had no opinion on the matter. The five remaining experts were divided over combinations of scenarios. Vehicle sharing is part of the second and third scenario, which were not popular. This means that the experts consulted in this study were more optimistic about the future of vehicle automation than vehicle sharing or a combination of both developments. This suggestion is further supported by the fact that the AV ownership structure (public vs private) was listed as the fifth most important key factor by a previous study, but was not found in this study.

- **Evolution of the personal automobile vs human factors at level 3:** A small majority of the interviewees thinks that the scenario towards fully automated driving is an evolutionary one in which vehicles will be complemented with technology assisting and eventually replacing the driver. This is interesting because other experts find a evolutionary transition path of vehicle automation dangerous. This was also found in literature. At one point halfway the levels of automation: “the system can relinquish control with no advance warning and the driver must be ready to control the vehicle safely” [20]. “Overtrust describes a system in which the user’s trust in the automation exceeds the actual capabilities. “Overtrust” can lead to misuse of the automated system, where the driver applies the automation to a roadway environment that is outside the automation operational scenarios. Distrust describes a scenario in which the user believes that the automation performance is less than it actually is” [20].

Some experts in the interviews did express their concern for this occurrence.

### 6. CONCLUSIONS

The aim of this research project was to increase the knowledge about the potential impact of vehicle automation on vehicle sharing and vice versa. Next to filling this scientific gap, this study is also relevant from a societal standpoint. Increasing the understanding of the impact of vehicle automation on vehicle sharing
and the other way around could be relevant for policy-making to address the undesired effects caused by non-automated and non-shared vehicles. Given that vehicle automation and vehicle sharing are still emerging, literature in the area of synergy between the two remains sparse. Therefore, the research question central to this thesis that was answered is explorative: “What could be the impact of vehicle automation on vehicle sharing and vice versa?”

Based on expert interviews, this study concludes that vehicle automation could have impact on vehicle sharing. Moreover, the opposite seems also possible: vehicle sharing having impact on vehicle automation.

7. DISCUSSION

Methodologically speaking, one cannot simply generalise the findings from this study based on the Netherlands. However, the results of this study do not indicate any “uniqueness”. The initial focus of the research is on the Netherlands. Apart from one, all interviewees were working in the Netherlands at the time of the interviews and the interview questions were aimed at the Netherlands. However, the interview findings as listed in this chapter are not unique for the Netherlands. That means that the possible causalities between vehicle automation and vehicle sharing might not be unique for the Netherlands, and perhaps also apply for other countries.

The relevance of the results of this study from a societal standpoint needs some elaboration. As I pointed out, understanding possible causalities between the research subjects can be relevant for policy-making. However, the results of this study as such do not directly offer grounds for policy-making. The study offers specific leads consisting of hypothesis articulated by experts and based off my own interpretation. In other words, this research project resulted into the one of the first—or even the first—attempt to systematically map possible causalities between vehicle automaton and vehicle sharing. Its value lies not in its generalisability nor in its capability to accurately predict the future of personal car mobility. What this study does, is shedding a first light on how two developments could relate to each other. I believe, that the next steps in better understanding possible causalities should be taken through follow-up research.

8. FUTURE RESEARCH

The first recommendation for future research relates to an expansion of the scope. Both definitions of the research subjects were narrower than how other scholars tend to define the subjects. Vehicle automation for the purpose of this thesis is only defined by ‘the extent to which the human driver monitors the driving environment and executes aspects of the dynamic driving task’ [2]. The second axis, relating to “autonomy” of the vehicle was left out. Second, vehicle sharing was demarcated by a commercial definition only. Private vehicle sharing such as peer-to-peer sharing was not included in the scope of this project. Expanding the scope by explicitly including the aforementioned dimensions allows for more key factors for future development and causalities to be discovered. It should be noted that one increases the complexity of the research by expanding the scope. This could require different methods or adoptions to the used methods in this study.

Concluding on perhaps the most important recommendation for future research: validation of causal models. The causal models as designed for the purpose of this
study were based on expert interviews. Possible relationships between variables are at the core of each model. Such relationships are considered possible by one or more experts interviewed during this research project. Research to verify each specific relationship has yet to be started.

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REFERENCES


