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## Effects of Variable Vehicle Occupancy

Summary



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### Motivation, objective and research question

In recent years, regional fire departments have adopted a variable occupancy policy for their fire-truck fleet (hereafter: variable vehicle occupancy). The reasoning behind this being that not every incident requires a basic fire-brigade unit<sup>1</sup>; some requests for assistance can be adequately dealt with by using an alternative vehicle and/or fewer firefighters.

The legal basis for variable vehicle occupancy lies in the 'Besluit veiligheidsregio's' (2010). Article 3.1.5, paragraph 1 grants local governments the ability to deviate from the basic fire-brigade unit (also called a TS-6), provided an *equivalent level of fire services* can be guaranteed and there are no negative consequences to the *health and safety of the firefighters*. At present, however, it remains unknown how variable vehicle occupancy may affect the health and safety of firefighters and at which point an acceptable level of fire services is provided.

Therefore, the Minister of Security and Justice has approached the WODC with the task to develop a clear framework to accurately measure the effects of variable vehicle occupancy. On the one hand this framework will enable the systematic collection of empirical data on variable vehicle occupancy in the short term. On the other hand, this framework will make it possible to construct evidence-based statements on the effects of variable vehicle occupancy in the long term.

Following the request from the Minister of Security and Justice, the WODC charged Berenschot with the development of this framework. The central research question of the WODC is formulated as follows:

*"What does an assessment framework look like which will measure the effects of variable vehicle occupancy and the consequent safety repercussions for both firefighters and citizens?"<sup>2</sup>.*

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<sup>1</sup> The basic fire-brigade unit is defined in Article 3.1.2. of the Decision security regions and consists of 6 people on a water tender, otherwise known as the TS-6.

<sup>2</sup> The conditions for exception stipulated in the *Besluit veiligheidsregio's* for the deviation from the basic fire-brigade unit, affect the safety of the fire fighting staff. In the research and in the WODC's research question, health is seen as an integral part of the safety of fire fighting staff. Therefore, when the report speaks of the safety of the fire fighting staff, we are referring to the staff's health.

## **Focus of the research**

This research is divided in the following focus fields:

- Focus on effects

The legal conditions for exception are still not sufficiently explicit; how local governments can determine an 'equivalent level of fire services' and to what extent the introduction of variable vehicle occupancy affects the safety of firefighters is unclear. The objective of this research is to fill this gap and therefore focuses on these two conditions.

- Basic fire services

To map out and weigh the effects of variable vehicle occupancies, a comparison with the basic fire-brigade unit (TS-6) is needed. This involves making the effects of variable vehicle occupancy and of the basic fire-brigade unit visible. Therefore, the research focuses on the tasks of the basic fire-brigade unit, the so-called basic fire services. For research-technical reasons, only the elements firefighting and technical assistance will be taken into account in the research.

- The first vehicle on site

There are laws stipulating the arrival times of firefighters in case of an accident. The standardization of the time of arrival in the 'Besluit veiligheidsregio's' only applies to the first basic fire-brigade unit on site. Therefore local policy makers make their decision whether or not to introduce variable vehicle occupancy based upon occupancy of the first vehicle on site. In line with this, the study focuses only on the effects of the first basic fire-truck on site (with or without a variable occupancy).

## **Starting point: the conceptual framework**

In order to make fire-brigade performance measurable and to provide insight into the effects, an initial conceptual framework was constructed based on the results of a literature study. The conceptual framework contains indicators which are assumed to affect fire-brigade performance. The conceptual framework consists of input, context, throughput, output and outcome indicators.

An important assumption is that the input (the vehicle and number of people occupying it) determines which activities can or cannot be performed during deployment. The activities performed and the manner in which these take place (e.g. the time taken), in turn influence the overall fire-brigade performance.

## **Validation of the conceptual framework**

In order to ultimately determine the effects of variable vehicle occupancy and to compare and explain differences in the effects between various vehicle occupancies, firstly relationships between the indicators from the conceptual framework must be theoretically proven and hypotheses formulated on the content of these relationships.

### *Validation based on available empirical data and statistical analysis*

In order to map out the effects of variable vehicle occupancies and compare different vehicle occupancies, it is necessary to operationalize the indicators from the conceptual framework into measurable variables, creating a measuring instrument with which data can be collected.

Firstly, it was researched whether the operationalization of indicators from the conceptual framework had already taken place in practice and whether valid empirical data was readily available. As the research process progressed, it became apparent the necessary empirical data was lacking, partly due to the fact that data on fire-brigade performances is not collected in a systematic or uniform manner. This empirical data was lacking for both the aspect of basic fire-brigade unit performance and the performance of variable vehicle occupancies. Operationalizing fire-brigade work uniformly is hindered because the fire-brigade practice is ambiguous and effects (such as the consequences to fire-brigade performance and the safety of personnel and civilians) are difficult to measure objectively.

### *Validation by means of an expert opinion*

The second approach entails an expert's assessment of the relationships between indicators and their effects in the deployment of variable vehicle occupancies. In other words: experts in the field cooperated in exploring whether the conceptual framework could be developed into a model which assesses the relationships between indicators and between indicators and effects.

To this end three national expert sessions were organized. The sessions were of a heterogeneous composition, meaning firefighters from different regions. Collaboratively, they systematically studied the relationship between the deployment (vehicle), the activities to be carried out (e.g. how long this took) and the outcome (effects). This was done by categorizing fire-brigade deployments for different types of incidents, based on the main activities described in the national teaching and learning material for firefighting and technical assistance. The expert sessions resulted in three major findings:

- Experts did not reach a shared consensus on the performance of different vehicle occupancies in theory and/or practice. One realization was that there is no national standard for TS-6 deployment. The national teaching and learning material is clear on the tasks to be performed by a basic fire-brigade unit in case of a fire and/or deployment for technical assistance, as well

as the order in which this takes place. In practice, however, substantial differences exist between (and sometimes within) fire-brigades.

- Experts do not share an opinion about which tasks vehicle occupancies other than the TS-6 should and could perform. These variable vehicle occupancies are deployed in different ways (depending on the type of incident and the varying combinations with other vehicles). Every fire-brigade corps manages their own deployment methods (how vehicles are operated and packed), making it impossible to map out the research in a general way.
- Estimating the effects of fire-brigade performance and comparing the effects of various vehicle occupancies is a difficult task. There is no shared consensus on the effects of fire-brigade performance.

It can be concluded that a model in which the relationships between the indicators from the conceptual framework and the effects of fire-brigade performance are placed, cannot be reached via expert opinion, especially since there is no clear picture of the consequences of different vehicle occupancies on the throughput (activities) and the influence on performance and safety effects. Personal (subjective) assessments of situations also play a major role in this case. As a result the preparation of hypotheses on the expected relationships between indicators is complicated.

To explore whether certain regions do have a clearer picture of fire-brigade performance, it was decided to organize one expert session within a so-called 'safety region'. This safety region employs both variable and regular vehicle occupancies, enabling a comparison. It is worth noting that, despite differences in personal situational judgments, it is easier to form a clear common opinion about the activities to be carried out within one department and to reach a common opinion about the (im)possibilities of different vehicle occupancies. However, no binding conclusions can be drawn on the supposed links between indicators in the conceptual framework from this single session.

## Conclusions

Below, each sub-question of the research is answered individually and concisely.

1. *What are the indicators which measure the effects of variable vehicle occupancy, where possible categorized by input, throughput, output, outcome and impact?*

The survey reveals that little research has yet been done into fire-brigade performance and its subsequent effects as available empirical data is limited. The literature study also shows that the unambiguous operationalization of indicators requires further effort and discussion.

In order to make the fire-brigade performance for firefighting and technical assistance measurable, a conceptual framework has been developed which is included in paragraph 3.1. The conceptual framework contains indicators which are assumed to affect fire-brigade performance itself as well as the effects on (various types of) fire-brigade performance. These indicators were primarily taken from the existing empirical studies into fire-brigade performance included in the literature study. Subsequently, the indicators were supplemented based on

reports of the expert sessions. Aided by the conceptual framework, a measurement instrument can be developed which examines the existence of relationships between indicators and between indicators and subsequent effects.

The conceptual framework consists of five types of indicators, namely: input, context, throughput, output and outcome indicators (the latter category includes impact indicators).

2. *How can the outcome/effect and impact/security be discounted both objectively and subjectively?*

The conceptual framework enables examination of the results of different vehicle occupancies, after operationalization of the indicators and based on empirical data. Only when empirical data is available which can demonstrate relationships and effects, is it possible to determine how the effects and security can be discounted or reviewed (including in terms of weighing and acceptance), which requires a normative judgment.

3. *Which criteria determine the variation in vehicle occupancy, both in a legal sense as practically?*

The research does not directly answer this question, due to the lack of empirical data on the effects of variable vehicle occupancies. The law (Besluit veiligheidsregio's) contains two criteria which assess the acceptance of variable vehicle occupancy: the standard of fire-brigade performance and the health and safety of staff. These criteria are part of the conceptual framework. In addition, the study (the executed literature study and expert sessions) demonstrates the necessity to link these criteria to the fire risk profile.

4. *How can the indicators and conditions be integrated into an assessment framework equipped to formulate empirical statements on the effects of variable vehicle occupancy and the consequences for the safety of firefighters and citizens?*

This study provides a conceptual framework which assumes the existence of relationships between these indicators. The opinion derived from existing literature and interviewed experts is that certain contextual conditions will affect fire-brigade performance. In order to process conditions in this future assessment framework, context indicators are added to the conceptual framework. The conceptual framework can then be further developed into an assessment framework, by first operationalizing the indicators into a codebook, allowing them to be objectively measured and thus creating a measuring instrument. What will follow is empirical research into the existence of relationships between indicators and effects and into the working of proven relationships. Only then can measurement and comparison of the effects of variable vehicle occupancies become possible.

5. *To what extent and in which way can variable vehicle occupancy affect previous links in the security chain (pro-action, prevention and preparation)?*

This study focuses on variable vehicle occupancy as part of repression or incident control. The effects of variable vehicle occupancy can however, also affect other links in the security chain such as risk management and preparation. In order to create room for innovation in a repressive organization, including variable vehicle occupancy, the use of new deployment techniques and

extinguishing methods, an investment in other links of the security chain must be made. Examples of such investments include focus, methods and personnel. To achieve this, a balance between the different chains must be found.

## Recommendations

On the basis of the research, the following recommendations can be offered to the Ministry of Safety and Justice:

- *Develop a national vision on variable vehicle occupancy*

In the Netherlands, many forms of variable vehicle occupancy can be recognized. Each region has its own vision and has executed the method according to their own preferences and needs. A lack of a shared view on the possibilities and impossibilities of variable vehicle occupancy in the fire department sector. Furthermore, the last few years regional fire departments invested in the innovation of the profession, mostly within their own department. This resulted in a multitude of views on variable vehicle occupancy and its (im)possibilities. Acting from a nationally shared conception of variable vehicle occupancy, with a clearly defined framing of the possibilities and innovations would benefit the sector. By improving the practical equality between fire departments, will encourage and simplify the measurement of effects.

- *Develop a national and uniform operational method for the fire department, enabling the collection of empirical data on the effects of fire-brigade performance at the national level*

A national and uniform operational method must be developed to gather and compare information on the effects of fire-brigade performance (whether or not related to variable vehicle occupancy). To this end, it is imperative to develop uniform methods for the various forms of variable vehicle occupancies and to apply these. Without this uniform application, it will remain impossible to compare results and effects. It is therefore recommended to work towards more uniformity in fire-brigade performance, in order to efficiently measure effects of variable vehicle occupancies. It should be noted that absolute uniformity is unachievable, due to the inevitable human element of the fire department profession.

- *Start small by initially only measuring the input, output and outcome of fire-brigade performance*

Given the current organization of the fire department sector and the desire to employ empirical data collection in the short term, it is possible to start collecting data related to the input, output and outcome indicators (and possibly also context indicators). This data interprets and identifies the effects and relationships between the various links. The relationships discovered in this way can most likely still not be fully explained (assuming this requires understanding of the activities/throughput, which remains somewhat of a 'black box'), but may offer sufficient tools for assessing the effects of variable vehicle occupancies. It is important that all variations of fire-brigade performance (i.e. the regular occupation and variable vehicle occupancy) are included, otherwise no comparisons can be drawn.

- *Initiate the national and systematical collection of data*

As previously mentioned, there is a current lack of systematic data collection on fire-brigade performance at a national level, including data on variable vehicle occupancy. To map out the effects of variable vehicle occupancies this must be resolved. Data collection and management should be carried out in a systematic manner and at the national level, with attention for administrative consistency. It is advisable to connect with other initiatives on data registration, such as CBS Brandweerstatistiek and RemBrand as well as drawing from recent activities on fire research.

- *Use the conceptual framework of this study to evaluate regional practices with variable vehicle occupancy (and collect this data nationwide)*

Although the developed conceptual framework is not equal to an assessment framework (it lacks a measuring instrument and no relationships are proven between indicators and effects), it does provide tools for the evaluation of current practices with variable vehicle occupancy. We therefore recommend the use of the indicators from the conceptual framework (possibly without including the throughput indicators) as evaluation framework. This can of course be supplemented by regionally formulated indicators. When all the regions using variable vehicle occupancy also use the conceptual framework as an evaluation framework, data on variable vehicle occupancy will be collected in a uniform manner. This can eventually help in the study and analysis of relationships between vehicle occupancies, indicators and effects.

## **Other findings**

During the course of this research, some findings emerged which are relevant to the fire department service, in the operational field, for administrators as well as for the Ministry of Security and Justice. The findings concerned are not (directly) related to the research questions, but may assist regions, administrators and the Minister of Security and Justice regarding variable vehicle occupancy:

- *Preconditions for introducing variable vehicle occupancy*

The expert sessions organized in the context of this study, showed that it is in the interest of the fire department profession to (continue to) research variable vehicle occupancy. Many regions have already begun deploying variable vehicle occupancy in some way or another. This development has made clear the need for clear agreements and procedures related to variable vehicle occupancy. An important result of the study (based on the expert sessions), is a gained insight into some important conditions to be adhered to at the regional level before introducing variable vehicle occupancy. It concerns the following preconditions: making *clear agreements and procedures* in relation to variable vehicle occupancy, offering a regional program of *training and exercises* with specific focus on variable vehicle occupancy, a good *selection of employees* for the new occupation and a *phased introduction* of variable vehicle occupancy.

- *Administratively motivated deviation by local governments*

Despite the formulated research questions and contrary to the expectations in the field, the research does not offer insight into the effects of variable vehicle occupancy at the level of fire services and regarding the safety of firefighters. However, the research has shown that it is possible to estimate the effects of variable vehicle occupancy at the regional level (instead of at the national level). Note: this does not pertain to demonstrable relationships between vehicle occupancies and effects. Instead, this relates to professional estimates based on experience and region-specific characteristics and based on preconditions for variable vehicle occupancy determined by the region (such as agreements and procedures and the choice of material and material). This may help local governments to motivate their decision for deviating the basic fire service and introducing variable vehicle occupancy.

These findings result in to two additional recommendations for the Ministry of Safety and Justice:

- *Determine the effects of variable vehicle occupancy on a regional level (instead of at the national level) to motivate the decision for introducing variable vehicle occupancy.*
- *In the case that a local government decides to deviate from the basic fire-brigade unit occupancy, apply the offered preconditions for the introduction of variable vehicle occupancy.*