THE IMPACT OF THE MORATORIUM ON THE REGULATION GOVERNING VEHICLE HEIGHT RESTRICTION: A SOUTH AFRICAN HIGH CUBE CONTAINER CASE

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ARTICLE INFO

Article details
Submitted by authors 21 Apr 2020
Accepted for publication 30 Sep 2020
Available online 14 Dec 2020

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DOI
http://dx.doi.org/10.7166/31-4-2353

ABSTRACT

The South African National Road Traffic Act stipulates a legal vehicle height of 4.3 metres. The standard flat deck trailer fleet used in South Africa, combined with the international standard high cube container stands at 4.5 metres, thus breaching this limit. The complexity of the transport system involves aspects of road infrastructure, transport haulage equipment, road safety, and export economies of scale, leaving this issue unresolved for a decade. A stakeholder analysis, industry survey, analytic hierarchy process method, and semi-structured interviews were conducted to determine the best outcome from a risk and financial perspective. The research outcome indicates that legislation should be adjusted.

OPSOMMING

Die Suid-Afrikaanse Nasionale Padverkeerswet bepaal ’n wettige voertuighoogte van 4,3 meter. Die standaard platbak vragmotor wat in Suid-Afrika gebruik word, gekombineer met die internasionale standaard hoë-volume houer is 4,5 meter hoog en oortree dus hierdie beperking. Die kompleksiteit van die vervoerstelsel behels aspekte van padinfrastruktuur, vervoertoerusting, padveiligheid, en uitvoer ekonomie-van-skaal-voordele, wat dit vir ’n dekade onopgelos gelaat het. ’n Analise van belanghebbendes, industrie opname, die analitiese-hiërargie-proses metode en semi-gestruktureerde onderhoude is gebruik om die beste uitkoms vanuit ’n risiko- en finansiële oogpunt te bepaal. Die navorsingsuitslag dui aan dat wetgewing aangepas moet word.

1 INTRODUCTION

In South Africa, regulation 224 (b) of the National Road Traffic Act of 1996 legislates that the maximum legal height limit for vehicles without an abnormal permit in South Africa is 4.3 metres. No vehicle, other than double-deck buses, may exceed an overall height limit, including load projections, of 4.3 metres [1] unless deemed an abnormal load. Since 2009 there has been an increase in the number of high cube containers in use internationally [2]. A 2.9 metre high container on a flat deck trailer standing at a 1.60 metre deck height has an overall height of 4.5 metres, thus exceeding the legislative limit of 4.3 metres. Between September and December 2009, the KwaZulu-Natal road traffic authorities clamped down on flat deck trailers carrying high cube containers, causing havoc at the Port of Durban, with truckers refusing to pick up containers from the port. Carriers were detained and fined for this lapse in regulation, road-blocks were set up, and containers were confiscated.

The National Department of Transport (NDoT) then intervened and began to issue abnormal load permits for high cube containers. In 2011 the NDoT put into place a moratorium, exempting the operation of vehicles transporting International Organisation for Standardisation (ISO) containers from the provisions of

regulation 224 (b) for a period of seven years. The moratorium came to an end on 31 December 2018, but was extended until 31 December 2019, and it is likely to be extended further until 30 June 2021. This article describes data that was collected in 2019, during the first extension of the moratorium, when it was unsure whether the exemption for ISO containers would be extended into 2020.

The overall height of a flat deck trailer with a high cube container seems to be a small matter, being a mere 0.2 metres above the regulation height. However, the national government and the freight transport industry have been at loggerheads over this unresolved issue for the last decade. To understand why this issue has been unresolved for this long, the systemic nature and complexity of the matter will be briefly explained in the literature review section.

South Africa's export industry is dependent on shipping for its economic development. Many countries trade goods with trade partners worldwide, and this has been done more and more using standardised ISO containers as the unit of shipment. The world has become interconnected, and international trade has increased the volume of perishable products being transported globally. South Africa is dependent on international trade and on oceanic transportation; 96 per cent of the country's exports are transported by sea, with South African ports being regarded as the gateway to Southern Africa [3]. About 90 per cent of South African fruit is exported to international markets via refrigerated (reefer) containers. These containers are used for the entire shipment of the fruit to ensure that it is delivered in a good condition. The most commonly used refrigerated containers in South Africa are the 20 foot (6m), 40 foot (12m), and 40 foot (12m) high cubes [4]. This research focused on the 40 foot high cube reefer container, as those containers provide 15 per cent more space and volume [5], decreasing the unit cost per carton.

2 LITERATURE REVIEW

2.1 Introduction

The literature on similar types of situations, locally or internationally, is sparse. None of the South African parties involved have ventured into any studies to justify their arguments; they have waited for the other parties to move first. Some similar international situations were found with initial searches, but on further investigation, most of the studies relate to public transport vehicle stability [6], small freight vehicles [7], or heavy mining vehicles [8]. Only one had a related research problem; the Falcon project [9]. This study evaluated height-related centre of gravity issues with road high-capacity trucks in Europe. The purpose was to address ambitious carbon emission reduction targets set by the European Commission by defining a potential performance-based standard (PBS) framework for cross-border road freight transport [9]. Selected important literature aspects will, however, be highlighted, before the chosen research methodology is explained and the results presented. One limitation of the research was the lack of access to insurance data for high cube containers.

2.2 Systemic nature of the problem

The two opposing views, from the government and the freight transport industry, are the financial implications of changing vehicle configurations versus the transportation risk of allowing the legal height to be adjusted. The different views and facts involved are as follows. First, the ISO container height of 2.9 metres for a high cube container is an international standard and, in fact, is mostly preferred by shipping lines, international customers, and freight owners. Most new containers of 20 foot and 40 foot lengths are manufactured at the high cube height, replacing the old 'normal' height containers of 2.6 metres [10].

The complexities at the freight transport industry level involve truck trailers, road infrastructure, and supply chain equipment. Trailer heights are standardised to accommodate infrastructure dimensions related to the truck-tractor fifth wheel height standards, supply chain infrastructure, and freight handling equipment used in South Africa. On the transport equipment side, this includes body structural integrity and vehicle stability during transport, horse-and-trailer wheel size implications, and transport economies of scale. The height interfaces between trucks, trailers, and supply chain infrastructure should be standardised across all truck body configurations and infrastructure to ensure that the equipment can be used seamlessly across the country. Transport equipment is also standardised to accommodate warehouse and distribution centre loading bay dimensions and forklift types in operation at these facilities, and to ensure efficient operations for port quay side loading equipment.

Government's perspective is that bridge height and overhead cabling crossing roads is a serious concern at these higher vehicle heights. News channels often report on trucks getting stuck under metro bridges, resulting in traffic congestion and infrastructure damage [11]. Another concern about the additional height

is the potentially higher centre of gravity, causing vehicle instability of the truck-trailer and container combination. South Africa is one of the countries with the highest number of road fatalities, and this should not be taken lightly [11].

Government's position is that seven years has been ample time for the freight transport industry to adjust their trailer heights to carry these containers within the legal limits. The freight transport industry claims that seven years has been ample time for government to investigate whether their issues with stability and bridge height are well-founded [12]. The freight industry also claims that the cost of new skeletal trailers (R300 000) at a lower height would be unjustified, that they would be unusable for transporting other freight types, and thus they are not affordable [13].

2.3 The National Department of Transport (NDoT) and the National Road Traffic Act

The NDoT is the authority that regulates and coordinates transportation in South Africa — namely, road transport, public transport, rail transportation, civil aviation, maritime transport and integrated transport planning (ITP) [14]. The NDoT believes that transport is the heart of South Africa's economic growth and social development.

The Department of Transport implemented Regulation 224 (b) of the National Road Traffic Regulations 2000 under the National Road Traffic Act of 1996. Regulation 224 (a & b) is drawn from Part 3, 'Dimensions of vehicles', in Chapter 5, 'Fitness of vehicles'. This section states [14]:

"Overall height of vehicle and load
No person shall operate on a public road a motor vehicle together with any load thereon, the overall height of which—
(a) In the case of a double-deck bus exceeds four comma six five metres; and
(b) In the case of any other motor vehicle exceeds four comma three metres."

One argument from the NDoT not to change this policy is the additional infrastructure cost to design and build all national and provincial roads to accommodate this height. A second argument, among others, is the risk of vehicle rollover owing to a higher centre of gravity causing vehicle stability issues.

2.4 Performance-based standards

The performance-based standards (PBS) or 'smart truck' pilot project is a national research initiative that is trialling the introduction of high-productivity road freight transport in South Africa [15]. The PBS project was implemented as a result of South Africa's constantly high death toll on the roads, which relates to the transportation risk aspect. The NDoT and the Council for Scientific and Industrial Research (CSIR) have identified South Africa as a research area as a result of the possible benefits in transport efficiency, road/vehicle safety, emissions reduction, and the protection of road infrastructure. The technical vehicle stability aspect is outside the scope of this paper, but it should be addressed by the government in considering adjusting the policy. Despite being out of scope, a short discussion is necessary to highlight the importance of this concept.

Nordengen [15] states that the PBS approach includes setting standards to specify the performance required from the operation of a vehicle on a network, and then determining the achieved performance level. The PBS pilot project in South Africa has been running for about ten years, and the following benefits have been highlighted [15]:

- Reduced number of heavy vehicle trips on the road network;
- Reduced crash rates;
- Reduced fuel use, resulting in a reduced cost per tonne-km of payload transported;
- Reduced greenhouse gas emissions (CO_2) per tonne-km of payload transported;
- Reduced overloading and speeding; and
- Improved driver skills and training.

There has been progress in developing the framework, policy, and procedures; but there is a need to formalise these and develop recommendations for national implementation. This might provide a solution for all trucks and trailers to be designed as PBS-certified.

The configuration of a trailer—high-cube container combination with a height of 4.5-metres should be tested for stability and safety, and then be PBS=certified. Such a study would include dynamic vehicle

simulations of worst-case centre of gravity height analysis. This would ensure that the transportation risk identified by the authorities could be quantified and sufficiently negated through-PBS certified standards.

2.5 Rail transport

Rail transport has the potential to provide a cost-effective freight transport option, making the economy more efficient and providing access for freight and passenger movements [16]. However, most freight in South Africa is transported by road rather than by rail. It would be a viable option to move the transportation of long-distance, high-volume freight from road to rail for the long-distance section, but not for door-to-door delivery.

Traditionally, rail transport was the preferred method of transporting freight in South Africa, but following the deregulation of the transport sector, the rail market share of general freight progressively decreased [16]. This led to a decrease in infrastructure investment in the general freight business segment which, in turn, posed a significant challenge: the shortage of rail capacity for general freight. Rail transportation can help to reduce risk on roads, but it is not a complete door-to-door solution. Currently, the necessary rail infrastructure for intermodal rail terminals and rolling stock — which would allow the transportation of a significant market share of high cube containers by rail, whether door-to-door or long distance — is non-existent. Delivery to and from rail terminals would still have to be by road.

2.6 The analytic hierarchy process (AHP)

AHP is a systematic decision-making approach developed by Thomas L. Saaty in 1971 [17]. It is a theory of measurement, in which pairwise comparisons are drawn, and the judgements of experts are sought, for priority scaling [18]. This method allows decision-makers to weigh the coefficients and easily compare alternatives. Tendayi and Fourie [14] state that this method is widely used because of its simplicity, ease of use, and flexibility. Tendayi and Fourie [17] also state that the AHP approach was used to evaluate the judgements from a survey to determine consistency and to provide the criteria for the importance weighting that is required. This method generates a weight for each evaluation criterion, based on the decision-makers pairwise comparisons. The higher the weight, the more important the criterion. This allows for a better performance of the option with respect to the criterion.

3 RESEARCH METHODOLOGY

3.1 Introduction

This article analyses data that was collected from stakeholders with insight into the moratorium and the regulation governing vehicle height restrictions. The data was obtained through semi-structured interviews and a survey that was sent out to the relevant stakeholders. The data was analysed using the AHP model to produce an impact analysis. The AHP method allowed the researchers to determine a score of how ‘valuable’ the choices are and how the decision-maker ‘feels’ about the choices. Two impacts were identified: a financial impact and a transportation risk.

The targeted population of subject matter experts (SME) for this study was all the organisations and stakeholders in South Africa with a particular interest and concern with the regulation of vehicle height restrictions. The fruit industry, the shipping industry, government officials, the road transport industry, the rail transport industry, independent consultants, and various other stakeholders were included in the sample. A non-probability form of purposive sampling was used to select the SMEs for this study. According to Bryman and Bell [19], purposive sampling is used to sample cases or participants strategically so that those who are sampled are relevant and knowledgeable about the research questions that are posed. Table 1 depicts the credentials of the SMEs that were selected to take part in the survey.

Table 1: Credentials of SME stakeholders

ID	Positions	ID	Positions	ID	Positions
1	Logistics managers	5	Analysts	9	Operations managers
2	General managers	6	Research economists	10	Chief executive officers
3	Managing directors	7	Project managers	11	Chief operating officers
4	Engineers	8	Financial advisors	12	Reefer managers

3.2 The AHP process

The AHP method measures pairwise comparisons drawn and the judgements of experts through priority scaling. This method is favoured because it provides objectivity for the researchers, and prevents any subjectivity or bias in the research. The AHP process followed four steps:

(1) **Modelling**: This allowed the researchers to determine the top-to-bottom form as a hierarchy of different criteria, sub-criteria, and alternatives. The main criterion for this research was the impact analysis. From this, the researchers identified two sub-criteria: financial impact and transportation risk. Each of the sub-criteria was taken into account for the three height alternatives: the current legal height of 4.3m, the recommended height of 4.6m, and any height between 4.3m and 4.6m. The researcher conducted exploratory interviews in which the three height alternatives were considered and proposed by the interviewees. Figure 1 depicts the modelling hierarchy followed for this study.

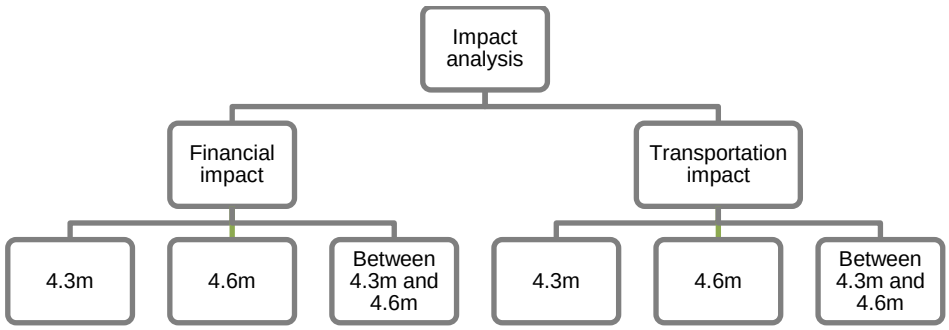

Figure 1: Modelling hierarchy

(2) **Evaluation**: The second step in the process was the evaluation of the judgements received from the stakeholders and respondents, and how they ranked the importance of certain statements in the survey. A scale of 1—9 was used to construct comparison matrices. It provided unbiased judgements, and allowed the researchers to determine what the stakeholders and respondents deemed important. The researchers used 1, 5, and 9 to assign numbers to the judgements. Table 2 shows the importance ratings used to measure the judgements of the respondents.

Table 2: Importance ratings used to measure the judgments

Intensity of importance	Definition	Response
1	Equal importance	Neutral
5	Strong importance	Normally agree/disagree
9	Extreme importance	Strongly agree/disagree

These three importance ratings were used to show a greater spread of the collected data and not to have the ratings and answers close to each other. The inverse numbers of 5 and 9 were used when the respondent answered 'normally disagree' or 'strongly disagree'.

(3) **Prioritisation**: Prioritisation methods were used to provide the priorities of the objectives in each level of hierarchy. The researcher assigned 1, 5, and 9 and their respective inverses to determine the preference of the respondents. Table 3 depicts the scale used to assign the numbers to the responses.

Table 3: Scale used for answers

Answer	Scale
Strongly disagree	0.11
Disagree	0.2
Neutral	1
Agree	5
Strongly agree	9

(4) **Synthesis**: The data was synthesised to provide aggregates of the priorities of the alternatives. Once the scale had been assigned to the responses, the average was taken for each stakeholder group to provide the pairwise comparison matrices. The questions of the survey were grouped according to financial impact and transportation risk. From this, the two groupings were subtracted from each other to ensure the distance between the two and prevent granularity. The results obtained from this were inserted into the pairwise comparison matrices to determine the preference weight for each stakeholder group.

4 RESULTS

The AHP method was used to identify whether there would be an impact on South Africa's economy if the regulations governing vehicle height were not amended to allow road transport operators to transport high cube containers on normal trailers at a height of 4.6 metres. Theoretically there would be a negative financial impact if the regulation remained at 4.3m. This is because all major stakeholders would be impacted owing to higher shipping costs per product, investments in new trailers, and/or loss of market share owing to customer preferences. The total number of stakeholders in the sample included in this study was 247, with a response rate of 31.2 per cent for the survey. The method behind the AHP is discussed in the research methodology of this study.

The financial impact aspect of transporting high cube containers on South African roads has a preference weight of 0.72 at the height of 4.3m; at the height of 4.6m it has a preference weight of 0.06; and between the heights of 4.3m and 4.6m it has a preference weight of 0.22. Table 4 depicts the relevant literature on the impacts of transporting a high cube container.

Table 4: Relevant literature on impacts

	Financial impact			**Normalise**	***Financial impact***				
A	**4.3**	**4.3-4.6**	**4.6**		**4.3**	**4.3-4.6**	**4.6**	**Preference weight**	
4.3	1	5	9	**4.3**	0.76	0.81	0.60	**4.3**	0.72
4.3-4.6	0.20	1	5	**4.3-4.6**	0.15	0.16	0.33	**4.3-4.6**	0.22
4.6	0.11	0.2	1	**4.6**	0.08	0.03	0.07	**4.6**	0.06
Sum	1.31	6.20	15						
A	***Transportation risk***			**Normalise**	***Transportation risk***				
	4.3	**4.3-4.6**	**4.6**		**4.3**	**4.3-4.6**	**4.6**	**Preference weight**	
4.3	1	0.20	0.11	**4.3**	0.07	0.03	0.08	**4.3**	0.06
4.3-4.6	5	1	0.2	**4.3-4.6**	0.33	0.16	0.15	**4.3-4.6**	0.22
4.6	9	5.00	1	**4.6**	0.60	0.81	0.76	**4.6**	0.72
Sum	15	6.20	1.31						

The second impact that was considered was transportation risk. This was not the main concern for many of the industries surveyed, as to date there has been no known or recorded evidence that the transportation of ISO high cube containers poses a risk [10]. Since 2010 there has been no apparent increase in the frequency of goods-in-transit (GIT) insurance-related claims as a result of the use of ISO high cube containers in moving goods in South Africa, and no general industry-wide underwriting exclusions have been implemented [20]. If insurers saw an increase in the frequency of claims from the use of high cube containers, there would have been an underwriting adjustment to correct the portfolio for exposure and profitability. These adjustments would have included policy premium (price) adjustments, specific policy exclusions, or explicit warranties. The data in Table 5 seems to support this statement, as the surveyed industries would have responded differently (a higher level of importance ratings for transportation risk) if insurers (as risk management experts) had made underwriting adjustments nationally. As shown in Table 4, the transportation risk is identified to be the greatest at a height of 4.6m, as many industries currently transport high cube containers with a height of 4.5m. Theoretically, transporting at 4.3m has a preference weight of 0.06, as it is believed to pose no risk to any individual, container, or road infrastructure. Transporting between 4.3m and 4.6m has a preference weight of 0.22, which is higher than 4.3m, but it does not pose a significant risk.

The researchers conducted exploratory interviews in which the three height alternatives were considered, and these three possible outcomes were identified. A comparison was drawn between the relevant literature articles from the Internet and the results obtained from the survey. The survey also asked respondents from various industries to provide their viewpoints on the outcomes and impacts. The sections below present the various industries' viewpoints on the two impacts.

4.1 The shipping industry

The shipping industry was the first to be analysed. The eleven respondents from the shipping industry were more than twice as concerned about the financial impact as they were about the transportation risk. Table 5 depicts the shipping lines' preference weight. Because they were twice as concerned about the financial impact as about the transportation risk, their financial impact preference weight is 0.70, indicating that there would be a perceived negative financial impact if the vehicle height restriction were not amended.

Table 5: Shipping lines preference weight

A	Combined opinion		Normalise	Combined opinion			
	Financial impact	Transportation risk		Financial impact	Transportation risk	Preference weight	
Financial impact	1	2.37	Financial impact	0.70	0.70	Financial impact	0.70
Transportation risk	0.42	1.00	Transportation risk	0.30	0.30	Transportation risk	0.30
Sum	1.42	3.37					

Based on the relevant literature's preference weights in Table 4, and the shipping lines' preference weights in Table 5, the final score for keeping the vehicle height restriction at 4.3m indicates a negative impact on South Africa's economy. Shipping lines understand the international transport system and the global transition to high cube containers. Therefore, they would prefer a height between 4.3m and 4.6m as the vehicle height regulation to support their international shipping operations because it has the lowest financial impact. Table 6 shows the final scores for the shipping lines.

Table 6: Shipping lines' final scores

Height	Final score
4.3m	0.53
4.3-4.6	0.22
4.6m	0.26

The lowest final score determines the preference of the stakeholder groups, as it has the lowest negative financial impact.

4.2 Road transport industry

The 14 respondents from the road transport industry were twice as concerned about the financial impact as they were with the transportation risk. Table 7 depicts the road transport industry's preference weight. The road transporters had a preference weight of 0.67, and the financial impact was of greater concern than the transportation risk. One might think that road transporters would prefer normal height containers, because having 15 per cent more trips would add to their revenue. However, they understand the impact on them if the fruit industry suffered losses in export volumes owing to higher transport costs, which would reduce international competitiveness on a per unit cost level.

Table 7: Road transporters' preference weight

A	Combined opinion		Normalise	Combined opinion			
	Financial impact	Transportation risk		Financial impact	Transportation risk	Preference weight	
Financial impact	1.00	2.00	Financial impact	0.67	0.67	Financial impact	0.67
Transportation risk	0.50	1.00	Transportation risk	0.33	0.33	Transportation risk	0.33
Sum	1.50	3.00					

Based on the relevant literature's preference weights in Table 4, and the road transport industry's preference weights in Table 7, the final score indicates that the regulation restricting vehicle height to 4.3m would have a negative impact on South Africa's economy. Therefore, the road transport industry would prefer a height of between 4.3m and 4.6m because it would have the lowest financial impact on the economy. Table 8 shows the final scores for the road transport industry.

Table 8: Road transport industry's final scores

Height	Final score
4.3m	0.50
4.3-4.6	0.22
4.6m	0.28

4.3 Government officials

The four government officials who responded were twice as concerned about the financial impact as they were about the transportation risk. Table 9 depicts the government officials' preference weight. A large number of government officials were not willing to participate in the survey owing to a conflict of interest; so, this is a poor representation of the government's viewpoint. The four officials who did answer the survey considered that there was a preference weight of 0.68 and that there would be a greater financial impact than a transportation risk.

Table 9: Government officials' preference weight

A	Combined opinion		Normalise	Combined opinion			
	Financial impact	Transportation risk		Financial impact	Transportation risk	Preference weight	
Financial impact	1	2.17	**Financial impact**	0.68	0.68	**Financial impact**	0.68
Transportation risk	0.46	1	**Transportation risk**	0.32	0.32	**Transportation risk**	0.32
Sum	1.46	3.17					

Based on the relevant literature's preference weights in Table 4, and the government officials' preference weights in Table 9, the final score indicates that the regulation restricting vehicle height to 4.3m would have a negative impact on South Africa's economy. Therefore, the government would prefer a regulated height of between 4.3m and 4.6m, as it would have the lowest financial impact on the economy. Table 10 shows the final scores of the government officials.

Table 10: Government officials' final score

Height	Final score
4.3m	0.51
4.3-4.6	0.22
4.6m	0.27

4.4 Fruit industry

The 19 respondents from the fruit industry were almost four times as concerned about the financial impact as they were about the transportation risk. Table 11 depicts the fruit industry's preference weight. The fruit industry's preference weight was 0.79, and indicated a greater financial impact than a transportation risk. One might argue that the fruit industry is biased, and does not take into account the true transportation risk. However, they are conscious of the risk exposure of their products through the entire supply chain.

Table 11: Fruit industry's preference weight

A	Combined opinion		Normalise	Combined opinion			
	Financial impact	Transportation risk		Financial impact	Transportation risk	Preference weight	
Financial impact	1	3.85	**Financial impact**	0.79	0.79	**Financial impact**	0.79
Transportation risk	0.26	1	**Transportation risk**	0.21	0.21	**Transportation risk**	0.21
Sum	1.26	4.85					

Based on the relevant literature's preference weights in Table 4, and the fruit industry's preference weight in Table 11, the final score indicates that the regulation restricting vehicle height to 4.3m would have a negative impact on South Africa's economy. The fruit industry would thus prefer a regulated height of 4.6m, because it would have the lowest financial impact on the economy. Table 12 shows the final scores of the fruit industry participants.

Table 12: Fruit industry's final score

Height	Final score
4.3m	0.59
4.3-4.6	0.22
4.6m	0.20

4.5 Rail transport industry

The two respondents from the rail transport industry were almost twice as concerned about the financial impact as they were about the transportation risk. Table 13 depicts the rail transport industry's preference weight. The rail transport industry had a preference weight of 0.61, indicating a greater financial impact than a transportation risk.

Table 13: Rail transport industry preference weight

A	Combined opinion		Normalise	Combined opinion			
	Financial impact	Transportation risk		Financial impact	Transportation risk	Preference weight	
Financial impact	1	1.56	**Financial impact**	0.61	0.61	**Financial impact**	0.61
Transportation risk	0.64	1	**Transportation risk**	0.39	0.39	**Transportation risk**	0.39
Sum	1.64	2.56					

Based on the relevant literature's preference weights in Table 4, and the rail transport industry's preference weight in Table 13, the final score indicates that the regulation restricting vehicle height to 4.3m would have a negative impact on South Africa's economy. The rail transport industry would thus prefer a regulated height of between 4.3m and 4.6m because it would have the lowest financial impact on the economy. Table 14 shows the final scores of the rail transport industry participants.

Table 14: Rail transport industry's final score

Height	Final score
4.3m	0.46
4.3-4.6	0.22
4.6m	0.32

4.6 Independent consultants

The twelve respondents from the independent consultants were three times as concerned about the financial impact as they were about the transportation risk. Table 15 shows the independent consultants' preference weight of 0.77, indicating a greater financial impact than a transportation risk.

Table 15: Independent consultants' preference weight

A	Combined opinion		Normalise	Combined opinion			
	Financial impact	Transportation risk		Financial impact	Transportation risk	Preference weight	
Financial impact	1	3.37	**Financial impact**	0.77	0.77	**Financial impact**	0.77
Transportation risk	0.30	1	**Transportation risk**	0.23	0.23	**Transportation risk**	0.23
Sum	1.30	4.37					

Based on the relevant literature's preference weights in Table 4, and the independent consultants' preference weight in Table 15, the final score indicates that the regulation restricting vehicle height to 4.3m would have a negative impact on South Africa's economy. Therefore, the independent consultants would prefer a regulated height of 4.6m because it would have the lowest financial impact on the economy. Table 16 shows the final scores of the independent consultants.

Table 16: Independent consultants' final score

Height	Final score
4.3m	0.57
4.3-4.6	0.22
4.6m	0.21

4.7 Other stakeholders

The 15 respondents from the other stakeholders were almost three times as concerned about the financial impact as they were about a transportation risk. Table 17 shows that the other stakeholders' preference weight was 0.73, indicating a greater financial impact than a transportation risk.

Table 17: Other stakeholders' preference weight

A	Combined opinion		Normalise	Combined opinion			
	Financial impact	Transportation risk		Financial impact	Transportation risk	Preference weight	
Financial impact	1	2.73	Financial impact	0.73	0.73	Financial impact	0.73
Transportation risk	0.37	1	Transportation risk	0.27	0.27	Transportation risk	0.27
Sum	1.37	3.73					

Based on the relevant literature's preference weights in Table 4, and the other stakeholders' preference weight in Table 17, the final score indicates that the regulation restricting vehicle height to 4.3m would have a negative impact on South Africa's economy. Therefore, the other stakeholders would prefer a regulated height of between 4.3m and 4.6m because it would have the lowest financial impact on the economy. Table 18 shows the final scores of the other stakeholders.

Table 18: Other stakeholders' final score

Height	Final score
4.3m	0.55
4.3-4.6	0.22
4.6m	0.24

The stakeholder responses indicate that most of the stakeholders gravitated towards either a height somewhere between 4.3m and 4.6m or a height of 4.6m. However, the process followed by the researchers determined that the preferred height was somewhere between 4.3m and 4.6m, as many transporters currently operate with a height of 4.5m.

5 INTERPRETATION OF RESULTS

Based on the respondents' comments, there is a perceived negative financial impact if the regulation were to remain at 4.3m. If the regulation were to be enforced without any phasing in, the cost of each new trailer would be about R300 000 [13] — a substantial investment. The local trailer manufacturing industry would not have had the capacity to build all the new trailers required by 1 January 2020. The government has since extended the moratorium for a further period of 18 months, on the condition that they would investigate the safety aspects [21]. As long as the regulation remains in place, the financial impact could have a debilitating effect on the South African economy, especially if the extension were allowed to expire on 30 June 2021. Thus, government needs to consider all inputs from the various industries, and determine the best course of action for the economy and for society from a safety perspective.

A 2.9 metre container on a flat deck trailer standing on a 1.60 metre deck height has an overall height of 4.5 metres — the height at which most high cube containers are currently transported. The moratorium that expired on 1 January 2019 showed that, for roughly the seven years that it was allowed, few or no issues arose when transporting high cube containers on the roads [13]. In addition, the interviewees stated that so far there had been no known or recorded evidence that transporting ISO high cube containers posed a risk to any individual. Accidents had occurred on the roads owing to reckless driving, the load shifting during transit, and the high cube container (or any other container) being loaded incorrectly [10 & 13]. This, however, is not unique to high cube containers: it occurs with all freight that is transported.

The challenge with transporting containers is that they come in different sizes. Thus, many companies need a transport solution that is able to adapt to different sizes and types of containers, and potentially other freight types. Most countries have adjusted their road legislation [11] and raised the height to accommodate the inevitable growth in the volume of high cube container movement. South Africa has yet to determine a solution to the issue. Interviewees commented that, in a larger transport system, one has to decide whether to pack the containers at the port and/or change the vehicle dimensions, which would allow for changes in the regulation to be phased in, or to change the regulation; either way, high cube containers

cannot be banned from South African roads. One solution suggested by the interviewees could be a 'smart trucking' project or performance-based standard (PBS) that specifies the performance required when operating a vehicle. In early 2019 the NDoT put out a request for a quotation (RFQ) for such a project; however, it was never awarded to a service provider [22]. This would ensure that the stability of the vehicle was evaluated, along with transport efficiency, road safety, and protecting road infrastructure.

South Africa has the best rail infrastructure in Africa. However, many interviewees have stated that both freight and passenger rail capacity shortages remain a severe constraint on South Africa's trade. Rail transportation could be suggested as an alternative that would move high cube containers off the roads for the long-distance section; but the last and first mile movements to and from terminals would still need to be done by road trucks. Thus, in order for roads to be safer, fewer trucks could be used to transport high cube (and other) containers over long distances, and the costs of maintaining national roads would be reduced. However, the necessary rail infrastructure — rail-road terminals with sufficient capacity — does not currently exist. Thus, it is necessary for upgrades to be made to South Africa's rail infrastructure before this could become a viable option. Table 19 provides the main findings of this study, and the reasons or causes underlying them.

Table 19: Summary of main findings and reasons for main findings

	Findings	Reasons
1	The industry perceives a negative financial impact of transporting high cube containers at the height of 4.3m.	Replacing trailers and equipment to align with the current regulation of 4.3m, including the height of loading and unloading bays, would have to change, and would carry a significant cost and would require major investment.
2	There is no evidence of transportation risk, as high cube containers have been transported at a height of 4.5m for 10 years.	Various stakeholders argue that no risk or threat is posed during the transportation process, as there have been no recorded accidents arising from the height of high cube containers on the roads.
3	Implementation of a smart trucking project or performance-based standards as a best practice to mitigate any potential risk of operating above 4.3m.	PBS could improve the stability of vehicles on roads, and thus the safety of citizens. The technical vehicle stability aspect was excluded from the scope of this article; it requires a dynamic vehicle simulation study.
4	In the future, move high cube (and other) containers via rail transport when and where possible.	The infrastructure required for rail transport does not currently exist.

6 RECOMMENDATIONS

6.1 Amend the regulation governing vehicle height restriction

The interviewees were concerned about the regulation remaining in place because it would have a greater financial impact on the economy, and various stakeholders would need to change all of their equipment and their loading and unloading dock heights to meet the current legislation. Government could consider amending the regulation to a height of 4.5m or 4.6m, as the fruit industry currently operates at the height of 4.5m. These two options could be considered as they would have the lowest financial impact on the stakeholders, the industries, and government. Thus, the economy would not lose out on trade with other countries and so not lose money. Operations and productivity would continue as normal for all. Likewise, the fruit industry was concerned that the transportation of high cube containers would become illegal, because transporting fruit in a standard height 40-foot container costs a substantial amount of money; and South Africa's international competitors only use high cube containers. The unit cost per carton of fruit transported inside a 40foot high cube container is lower, as 15 per cent more cartons can be packed on a pallet in a high cube container.

6.2 Extend the moratorium by ten years

Government is likely to extend the moratorium for a further period of 18 months until 30 June 2021 [21]. The extension of the moratorium would allow the NDoT to commission a study on the safety of transporting high cube containers. This would ensure that the study was completed and that recommendations were made to the Minister of Transport.

Suggestions from the interviewees were that, depending the outcome of the safety study, the moratorium be extended by ten years, but with a very specific directive on what should happen during those ten years. The researchers believe that the ten years could be broken down as follows:

- Use 18 months to investigate the regulation and PBS design projects, and define the PBS policy;
- Use 18 months to shift the policy into practice; and
- Use seven years to allow for a gradual phasing-in of any new equipment and infrastructure that has to adhere to the PBS standards during this time.

This would allow industries to operate efficiently for the time being, but also gradually to obtain the necessary new equipment to meet the current legislation, should it remain in place when the moratorium expires. Once the suggested new moratorium has expired, the regulation must stipulate that all new equipment brought into the industry and economy must align with the new certified PBS regulation. The regulation must also require any new vehicle to operate within the legal height.

The industry waits with anticipation to see when the intended study will be advertised by government. However, at the time of writing this article, three months into the latest extended moratorium, no RFQ had been advertised.

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