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Overview

A new approach to cross-sector cooperation in road safety through a comparison of policies in selected countries

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ABSTRACT

Statistics from the databases of various countries and international organizations show that road accident rates and fatalities have fallen since the 1970s. With demographic changes taking place in many developed countries, however, accident and accident-risk patterns have changed in the last two decades. This study aims to introduce a new approach to cross-sector cooperation with the hope of making road safety more holistic and sustainable. The authors compare the road safety policies of three selected countries based on various categories, using a simple quantitative method. The results show some fragmentation within the policies, illustrating the need for a new road safety approach. The effort to reduce road traffic accidents by 50% by the year 2020 has also increased the pressure on stakeholders to meet this goal. This paper's contribution toward the 2020 goal lies in its recommendation of a new approach to road safety that will enlighten stakeholders on probable missing links in road safety.

1. Introduction

The World Health Organization (WHO) [1] predicts that by 2030, road traffic accidents will be the seventh-leading cause of death in the world if there is no sustained action. Road accidents currently account for about 1.25 million causalities and 50 million severe injuries per year. They also are the leading cause of death among individuals between 15 and 29 years of age. In recent years, vulnerable road users such as elderly individuals, pedestrians, and cyclists have accounted for an increasingly larger portion of both causalities and severe injuries.

According to the accident databases in various countries, the rate of accidents involving elderly individuals seems to be either decreasing very slowly, stagnant relative to other road user groups, or increasing. In addition, the proportion of the elderly individuals relative to other age groups is growing very fast. By 2050, observers estimate that individuals over 65 years of age will make up almost 21% of the world's population. This is part of the reason why the nature of accidents and accident-risk patterns has changed over the years.

The context has led organizations like the United Nations (UN) and the European Union (EU) to set stringent traffic safety targets for its member states. Both the UN and the EU are looking at achieving a 50% reduction in road accidents among their respective member countries. The UN has included road safety under the newly adopted 2030 agenda for Sustainable Development Goals (SDGs). SDG no. 3 (Target 3.6) stipulates an objective to "halve the number of global deaths and injuries from road traffic accidents" by 2020. SDG no. 11 (Target 11.2), meanwhile, sets out the aim to "provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" by 2030.

With these ambitious goals in place, governments, researchers, and all other stakeholders need to come up with new and innovative ways to meet the corresponding targets. The effort thus calls for explorations into "non-traditional" road safety approaches that the relevant parties have not fully utilized in previous years. Over the years, the 3Es approach (Education, Engineering, and Enforcement) has been the main approach to road safety; however, it focuses primarily on role assignment and tends to overlook other participants' contribution. This criticism does not serve to refute the contributions of the traditional approaches to road safety but rather intends to foster an openness to the positive impact of many other unexplored "non-traditional approaches."

Using the current trends in road safety as a foundation, this study aims to illustrate the extent to which the road safety policies in three countries have embraced cross-sector cooperation and thereby introduce a new approach to cross-sector cooperation in improving road safety.

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2. Literature review

Technological advances represent one of the key factors that have enhanced road safety, enabling safer vehicles and safer road environments. In spite of this, the UN has asked governments to take holistic action by encouraging multi-sector collaboration among all road safety players, so as to foster sustainable road safety.

Many researchers have taken it upon themselves to look into designs, concepts, and ideas that will create safer road environments, especially for the most vulnerable users. The concept of "Link and Place" street planning and design, proposed by Peter Jones et al. [3], is one such idea that encourages people-friendly road environments by moving away from car-dominated ones.

Prelovskaya and Levashev [4] proved that non-traditional concepts of street design can lead to sustainable development. Rahman et al. [5] carried out a study that showed how fruitful it was to involve the general population in decision-making processes related to traffic calming. In addition to the residents agreeing to the traffic calming-prioritizing method used, the authors also gathered input about which methods were more effective. The authors also pointed out that "resident's perception regarding the traffic calming priority ranking system seems important for phasing the programs in Japan." This is a clear example of the importance of a bottom-up approach in achieving road safety.

Sunagawa et al. [6] evaluated the role of social usability in reducing accident rates, especially at road crossings. The authors emphasized the importance of managing social usability (Priority), road speed management (Speed) and road space management (Compactness), as part of a holistic framework to improve the road crossing facilities not just as road facilities but also as public spaces.

Yoh et al. [7] further explored a slightly different PSC concept (Priority, Speed, and Comprehension) by studying the driving characteristics of foreign drivers in Japan. The authors proved that drivers from particular regions tended to violate traffic rules related to either Priority, Speed, or Comprehension. By successfully identifying the specific kind of road accidents that drivers from particular regions were prone to cause, Yoh et al. suggested measures to counteract certain types of accidents for each driver category.

Goldenbeld and Noorzij [8] argued that Engineering, Education, and Enforcement measures should be complementary measures; the three elements produce better results when working as a unit than they do in isolation, which was the common approach at the time Goldenbeld and Noorzij made this suggestion.

Other researchers, such as Nakagawa et al. [9], stated that in order to improve the quality of road user's needs, road policies should favor the corresponding residents and various stakeholders.

Two separate papers by Peter Jones also discussed the need for "policy-making" changes. In one [10], Jones concluded that continued economic growth and increasing urbanization would put further pressure on transport systems and demand new policy responses. These would likely come to fruition through new technologies and further expansion of the academic disciplinary base to provide new policy perspectives.

In another paper [11], Jones pointed out that policies in non-transport sectors may have a negative impact on the achievement of sustainable transport policies. Drawing on those findings, he suggested that cross-sector synergies might benefit from efforts to make major, intragovernmental policy change a "cross-sector activity."

Doi et al. [12] provided a set of logical ideas and arguments for changing the way we address traffic safety. The authors also pointed out that changes in social conditions call for a holistic approach that enable a transition to safer streets. This, the authors argued, should accompany conventional approaches like traffic engineering, vehicle engineering, psychology, education, and medical science. The paper also underlined the growing need for a trans-disciplinary, integrated approach that reconciles the conflicting regimes and diverse demands of traffic participants.

Many non-traditional methods explore sectors that indirectly affect transportation. In order to make road safety more inclusive and holistic, we explore the PSC concept (Priority, Speed, Compactness/Comprehension) in this paper to expand the traditional understanding of road safety.

3. Methods

3.1. Data and keywords for comparing the policies

We selected the road safety policies in three countries based on their guiding principles. The following Table 1 lists the selected road policies.

We classified the measures in the policies into 5 categories (PSC, 3Es, Hard and Soft measures, Top-Down and Bottom-Up measures, Technological, Political and Technical measures) and 15 components, as the safety hexagon in Fig. 3 below shows. The classification of each measure under the various categories was based purely on the policy statement and not the impact or time of the measure's implementation.

In order to make a tangible comparison across the selected road safety policies, we calculated the percentage proportion for each component under a given category for each country. For instance, we calculated the percentage of priority-related measures under the PSC and "Other" categories, the percentage of Engineering-related measures under the 3Es cluster, and so on (see Tables 3 and 4).

We decided to use this simple method because each country's situation is unique, which means that the measures are very diverse and thus complicate scientific comparison. However, the measures' respective proportions within each policy provide a basis that paves the way for the new road safety cross-sector cooperation approach. The study uses the following abbreviations and definitions (Table 2).

We use the results from the above method described to demonstrate cross-sector cooperation within each country and thereby illustrate the type of cross-sector cooperation that this paper aims to introduce.

3.2. The relationship between the PSC principle and the 3Es approach in road safety

The roots of the cross-sector cooperation approach lie in the relationship between the PSC principle and the 3Es approach. Fig. 1 shows the 3Es approach and PSC principle as stand-alone approaches, while Fig. 2 illustrates how the 3Es approach and PSC principle can merge to create a unified approach.

Goldenbeld and Noorzij [8] defined the 3Es in road safety as follows; "Engineering" measures are "all physical changes to vehicles, road, road side or road environment"; "Education" measures are "all activities of teachers, educators, publicity agents to inform, advise, teach or instruct road users"; and "Enforcement" refers to "all activities by the police aimed at deterring road users from committing traffic violations." If all three operate in synchronization, the road safety of traffic participants increases.

Table 1
Road policies for comparison.

Country	Guiding principle of road safety	Pertinent road safety policy
Germany	The principle is that every road fatality is one too many.	Road Safety Programme 2011 [14]
Japan	Under the transport safety school of thought, people are prioritized so that the number of traffic accidents fatalities can be reduced to a quarter the number of the highest fatalities ever recorded.	The 10th Transportation Safety Plan, 2016 [15]
Netherlands	Road safety is everyone's responsibility because it affects everyone, benefits everyone, and depends on everyone (Road safety from, for, and by everyone).	Road Safety Strategic Plan 2008–2020 [18]

Table 2
Definitions of keywords.

Abbreviation	Unabbreviated equivalent	Definition
P	Priority	Measures aimed at prioritizing a particular traffic participant in the road space
S	Speed	Measures aimed at speed management
Cct	Compactness	Measures aimed at road space management
Cr	Comprehension	Measures aimed at motivating or enabling traffic participants to understand road safety rules and regulations, or measures/activities that demonstrate that the traffic participants understand the road safety rules and regulations
O	Other component	Measures not directly related to PSC but rather auxiliary measures aiding in attaining road safety
Edu	Education	Activities that either inform, advise, instruct, teach, or motivate traffic participants to follow traffic rules and regulations
Eng	Engineering	Measures that bring about physical change to vehicles, roads, roadside environments, or road environments
Enf	Enforcement	Measures designed to bring about road safety by either imposing a law or fostering the use of new technological devices or systems
Sf	Soft	Intangible methods or systems used to enhance road safety
H	Hard	Physical items or devices installed in vehicles or road space to foster road safety
Tec	Technological	Inventions that use technology to realize safer roads, safer vehicles, or safer movement of traffic participants
Pol	Political	Measures passed or enforced by a government or representative authority
Tekn	Technical	Measures that are neither technological nor political in nature but used as suggestions from scientists, doctors, academics, or other professionals
BU	Bottom-Up	Measures suggested or implemented by target groups, communities, or special-interest groups not directly run by a government
TD	Top-down	Measures suggested or implemented by a government or a representative body; the chain of command is from government toward the community or a particular target group

* The measures considered for the study represent what the policies intend to implement, not the actual implementation thereof.

Sunagawa et al. [6] defined PSC as follows: "Priority" (P) denotes prioritization of various users of the road in question by clearly defining its function. "Speed" (S) and "Compactness" (C) denote speed management and space management, respectively. A study by Yoh et al. [7] concluded that many foreign drivers in Japan had tendencies to violate traffic regulations related to "Comprehension" (C). From this study, one can define "Comprehension" as the ability of a road user to interpret road signs and follow traffic regulations.

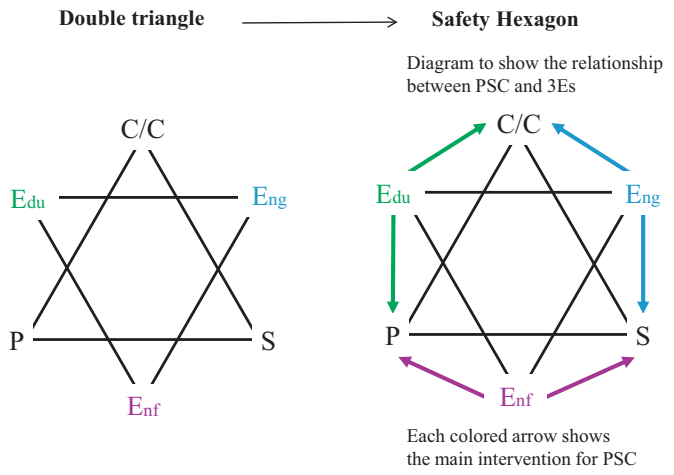

Fig. 2. PSC and 3Es in a double-triangle format and a safety hexagon.

The relationship between the PSC principle and the 3Es stems from the classification of the state of safety in Doi et al. [12]: inherently safe and functionally safe traffic systems. An inherently safe traffic system is one where hazards are curtailed from the source. This can be achieved through prioritizing (P) certain road users or making sure that drivers are qualified to drive (Edu).

A functionally safe traffic system is one where the probability of an accident occurring or the magnitude of damage caused is reduced; examples of such measures include ensuring that road rules and regulations are enforced (Enf) and regulating speed (S) by providing humps or rumble strips. This shows that road safety is in fact a mixture of aspects from both the PSC principle and the 3Es approach. Therefore, one can combine the two to develop the safety hexagon in Fig. 2.

Each of the colored arrows shows the main intervention for PSC. Priority in the road space can be achieved through Education and Enforcement. For example, in Japan, pedestrians have the right of way even when the traffic lights are in favor of left-turning vehicles. This is not only a law but also a point of emphasis during driving lessons.

Speed management can be achieved through Engineering and Enforcement. Many countries have designated numerous residential places as "zone 30" areas. "Zone 30" is a form of speed management where the maximum speed in these areas is 30 km/h. In some other countries, traffic-calming methods such as rumble strips help reduce speeds at desired road locations.

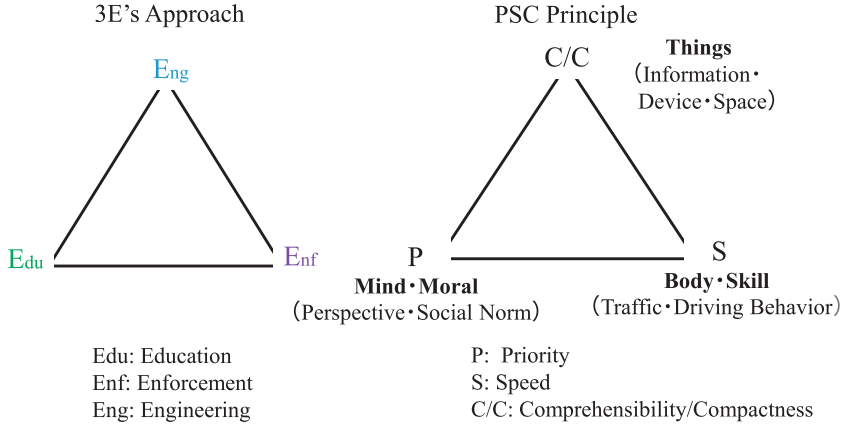

Fig. 1. The 3Es approach and PSC principle in road safety.

Compactness in the road space can be achieved through Engineering, while Comprehension can be achieved through Education. Constructing medians on roads is an example of achieving compactness on a road. An example of Comprehension, on the other hand, is holding campaigns about traffic rules and regulations.

One can also interpret the safety hexagon to highlight the diversity in road safety-related problems and their solutions, as well as role sharing (who is responsible for what as regards road safety). See Fig. 3 for an illustration of these possibilities.

The above figure can be explained as follows.

- Politicians are responsible for measures that are political in nature, while Engineers are responsible for those that are technological in nature. For example, in Japan road strategies are formulated by the Central Traffic Safety Policy Council that is chaired by the Prime Minister; in the Netherlands, motorcycle-friendly guardrails have been developed and installed on various roads with dangerous curves.
- Enforcement measures are better implemented via the top-down approach, while Education measures are more effective via the bottom-up approach. According to the German Road Safety Programme 2011, considerable emphasis was placed on road safety and mobility education for children starting from preschool. The aim was to ensure that children would grow up to be responsible road users in the future. The road safety program also stated that novice drivers were more prone to cause accidents, and, in order to reduce that risk, the government converted the "Accompanied Driving from 17" campaign into permanent legislation.
- Soft (intangible) road safety measures are usually Educational in nature, while Hard (physical) measures have close ties to Engineering. An example of a soft measure is Japan's move toward providing road safety information to its citizens through the internet; one hard measure is the installment of ETC 2.0 service across the country.

From the above explanations, we can conclude that some countries are already embracing the logic behind the safety hexagon (see Fig. 3) to improve road safety. To establish the extent to which this is happening, we evaluated each country separately using the method from Section 2. The following section discusses the results.

4. Results and analysis

This section provides the results of the above country-specific categorization process and a corresponding analysis.

4.1. Analysis

Table 3 shows an overall percentage comparison of PSC components and 3Es components by country policy, while Table 4 shows a similar breakdown of Soft and Hard components, Technological, Political, and Technical components, and Bottom-Up and Top-Down components. The values in the Tables 3–4 are the component percentages per category. For example, the total numbers of Education (Edu)-related measures were calculated as percentages of the total numbers of measures that fell under the 3Es category. The same was done for the other 13 components under the 5 categories. Compactness-related measures were not tabulated because the percentage of this component, across all the countries, was almost zero. Sections 4.2–4.4 provide additional illustrations of Tables 3 and 4 via graphs, which provide the basis for our analysis of each country's situation.

4.2. Germany

One of Germany's biggest concerns is an anticipated demographic change [2] whereby senior citizens (65+ years) will significantly outnumber young people (18–29 years) by the year 2050. This transformation, in itself, alters the dynamics of road accident risks and countermeasures. In addition to traditional road safety measures, other non-traditional measures have to be formulated. This explains why the ratio of the "Other" component is the highest among the various components of the PSC category (see Fig. 5).

German policymakers believe that people are willing to follow rules once they understand them, a process possible through the dissemination of traffic safety-related information. This partly accounts for the Education measures representing more than 25% of the 3Es category (see Fig. 4).

Germany is a highly technologically advanced country, but that reality is not entirely evident in the share of Engineering among the 3Es or the share of Technology in the Technological, Political, and Technical category (see Fig. 6). This is partly because the German government's main aim is to support research that will ensure that the existing technology is safe, efficient, and environmentally friendly. In addition, the government would like to foster the spread of standardized technological methods on a broad, countrywide basis and also across EU member states. These two conditions explain why the Enforcement and Political ratios are relatively high in their respective categories.

According to the Road Safety Programme 2011, the German government is setting aside a budget to upgrade and/or convert its roads

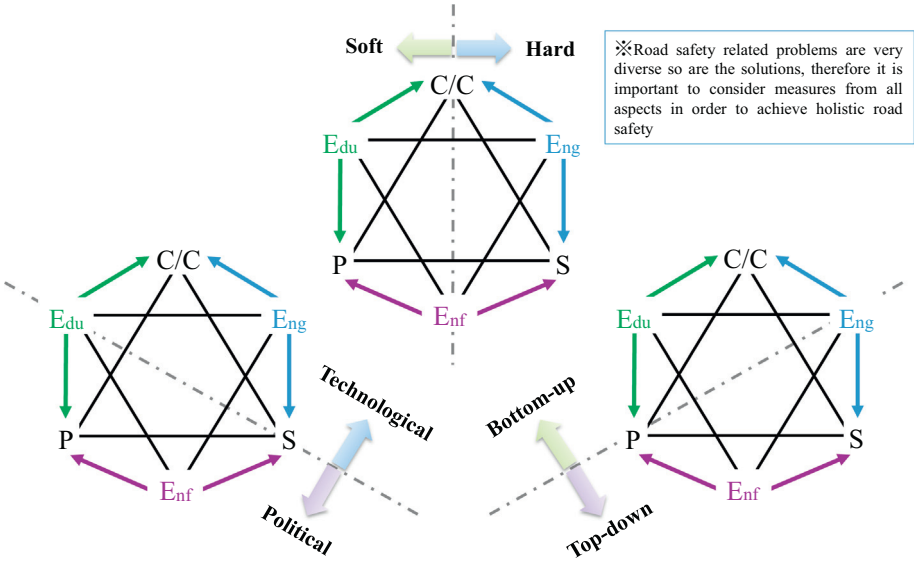

Fig. 3. Safety measures and role sharing based on the safety hexagon.

Table 3
Percentages of safety measures in country road safety policies (I).

Category	PSC measures				3Es measures		
Component (%)	P	S	Cr	O	Edu	Eng	Enf
Germany	2	12	21	63	28	27	45
Japan	0	0	12	88	31	50	19
Netherlands	6	10	29	54	32	30	38

(especially rural roads) to standards that are more "forgiving" toward people. While pursuing this initiative, it is also focusing on various road safety campaigns tailored to improving the safety of vulnerable road users. This explains the slight gap between the Soft and Hard measures (see Fig. 7).

The Ministry of Transport and Digital Infrastructure, the Federal states and the German Road Safety Council (DVR) are responsible for formulating the national road safety strategy [13]. Germany being a federal state means that each state has to make an input toward the formulation of the road safety strategy, based on the unique situation in each state. This might explain why the top-down measures are significantly greater than the bottom-up measures in Fig. 8.

4.3. Japan

As a country, Japan's three main concerns are its aging society (and infrastructure), the need to prepare for natural disasters, and the improvement of road service through ITS. The first two concerns dictate the implementation of many non-traditional methods for ensuring a sustainable society. This explains why the "Other" component has a greater weight than Priority, Speed, and Comprehension-related measures do (see Fig. 10).

In addition, the "*machizukuri* concept" has been widely implemented across the country. *Machizukuri* refers to community-government engagement whereby technical personnel such as engineers work hand in hand with local residents to create solutions for problems in society. This approach explains:

- Why Engineering and Education measures occupy larger proportions than Enforcement measures do, as Fig. 9 shows;
- The great disparity between Soft and Hard measures, as Fig. 11 shows; and
- Why the Technical aspect (see Fig. 12), as compared to conditions in other countries, has a bit of weight, as various professionals play roles in the implementation of *machizukuri*.

Relative to the situations in Germany, Japan's gap between the bottom-up approach and the top-down approach is considerably small (see Fig. 13).

The government of Japan is looking to maximally utilize the existing infrastructure through the use of ITS [16], which makes the Engineering and Technological components the largest components of their respective categories.

The results also show that although Japan is still lagging behind in terms of its fundamental road safety education in schools and homes,

Table 4
Percentages of safety measures in country road safety policies (II).

Category	Soft and hard measures		Technological, political, and technical measures			Bottom-up and top-down measures	
Component (%)	Sf	H	Tech	Pol	Tekn	BU	TD
Germany	55	45	17	65	18	27	73
Japan	72	28	40	37	23	41	59
Netherlands	77	23	29	58	14	40	60

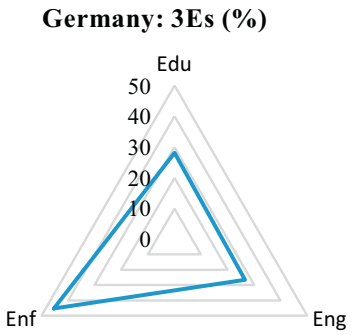

Fig. 4. 3Es ratios.

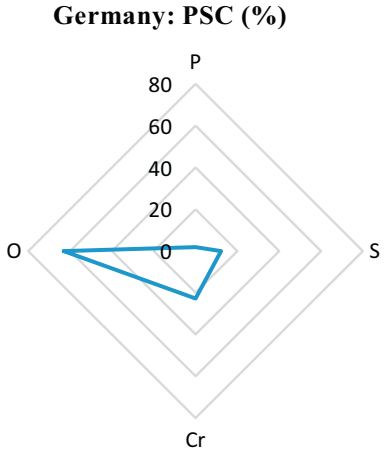

Fig. 5. PSC ratios.

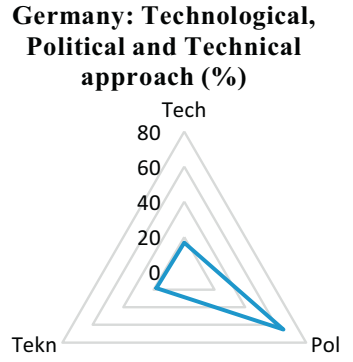

Fig. 6. Technological, political, and technical ratios.

the Education component plays a relatively large role in the country's policy. This is mostly due to the substantial investments going toward research that will enable citizens to understand road rules and regulations more fully. Therefore, the Education component for Japan is not a direct effect like in the case of the Netherlands or Germany.

4.4. The Netherlands

The Netherlands, like Japan and Germany, is facing the problem of an aging population [2] and increasing fatalities of vulnerable road users such as children, cyclists, and motorcyclists. There are also great

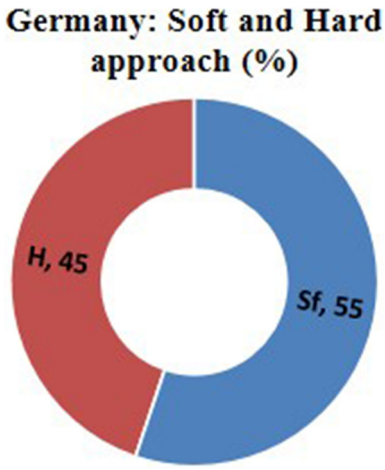

Fig. 7. Hard and soft ratios.

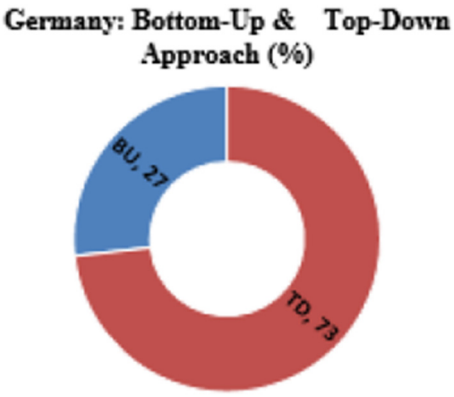

Fig. 8. Bottom-up and top-down ratios.

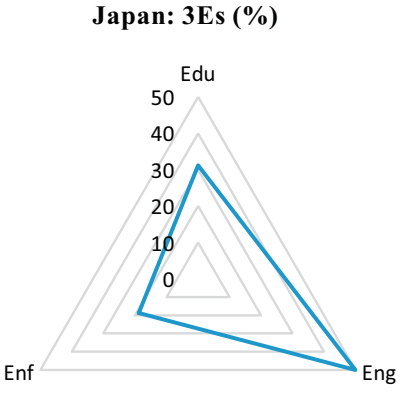

Fig. 9. 3Es ratios.

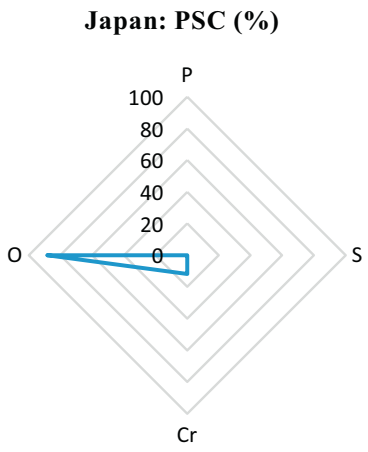

Fig. 10. PSC ratios.

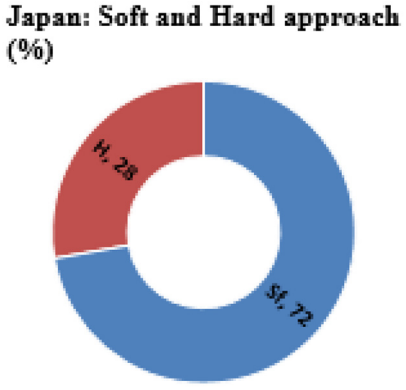

Fig. 11. Soft and Hard ratios.

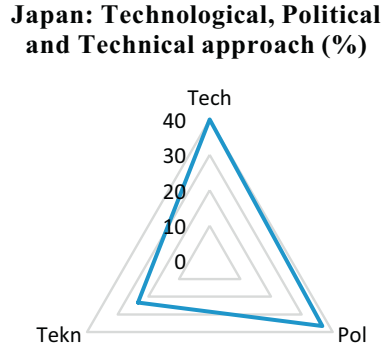

Fig. 12. Technological, political, and technical ratioschnical ratios.

concerns about individuals who jeopardize the safety of road environments, including novice drivers and drunk drivers.

The Netherlands decided to focus on vulnerable groups by extending traffic safety lessons in and out of schools, mainly aiming to make sure that each citizen would realize that road safety is everyone's responsibility and that failure to comply with traffic rules would lead to more direct consequences for offenders. The Comprehension aspect is larger for the Netherlands, therefore, than it is for the other two countries.

The process of formulating and implementing road safety policies [17] involves various professionals and organizations (engineers, politicians, associations for cyclists, associations for the elderly, academicians, etc.). This approach, one of the most outstanding characteristics of policymaking in the Netherlands, is a main reason for the following results:

- Relative to the conditions in other countries, the 3Es ratio is almost equal in magnitude (see Fig. 14);
- When compared to other countries, the "other" component among the PSC components is not as high because the remaining components are relatively higher (see Fig. 15)
- The ratio of Soft measures is more than triple that of the Hard measures (see Fig. 16); and

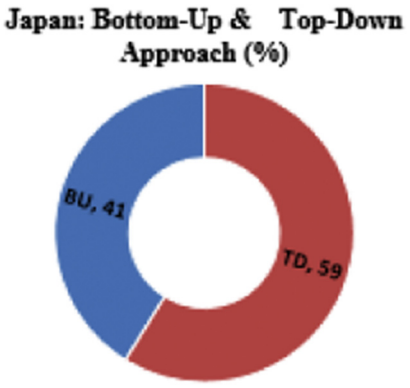

Fig. 13. Bottom-up and top-down ratios.

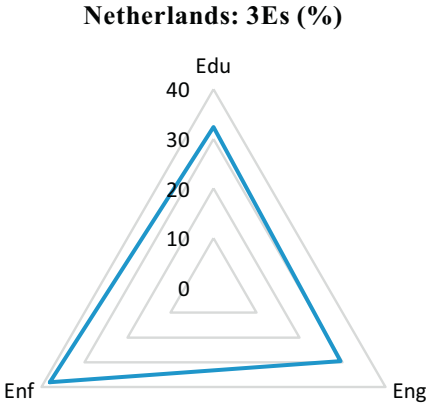

Fig. 14. 3Es ratios.

- The margin between Bottom-Up and Top-Down measures is smaller than the same margin in Germany (see Fig. 18).

The Political component occupies a larger-than-expected share, while the Technical component is surprisingly small (see Fig. 17). This might be attributable to the fact that the Netherlands realized that international cooperation (through the European Commission) was vital in order for various road safety innovations to take root. Secondly, the then minister for Transport, Public Works and Water Management issued a letter to parliament suggesting people who cause unsafe situations on the road should be subject to stricter consequences. This meant tightening the rules and regulations on road users such as novice drivers.

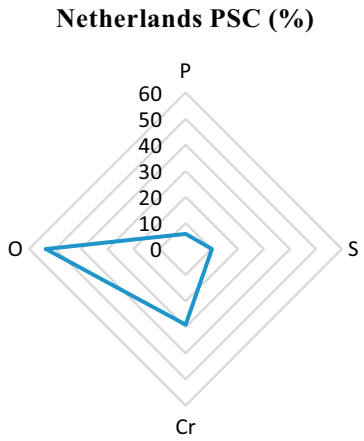

Fig. 15. PSC ratios.

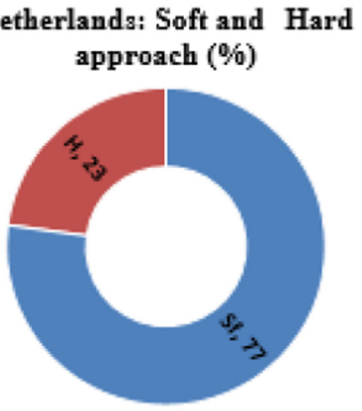

Fig. 16. Soft and hard ratios.

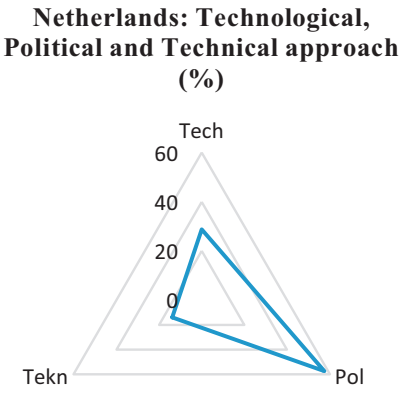

Fig. 17. Technological, political, and technical ratios.

4.5. The new approach to holistic road safety

Section 2 describes the relationship between PSC and the 3Es and how other approaches, such as "soft and hard measures," have been incorporated into the road safety policies of various countries. The concept of cross-sector cooperation described here uses the relationship between PSC and the 3Es as a basis to show how the components in the safety hexagon (see Fig. 2) can be synchronized to work together as a seamless mechanism in achieving holistic road safety.

Drawing on the explanation for Fig. 2, we calculated the number of Education measures targeting either Priority or Comprehension as a percentage of all Education measures by country. We then did the

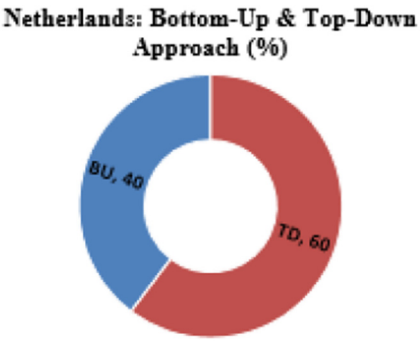

Fig. 18. Bottom-up and top-down ratios.

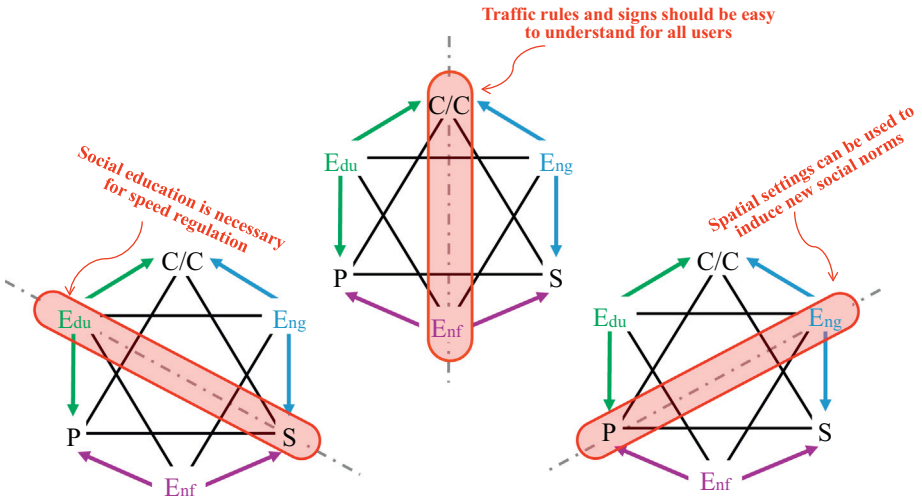

Fig. 19. Areas where cross-sector cooperation is still required.

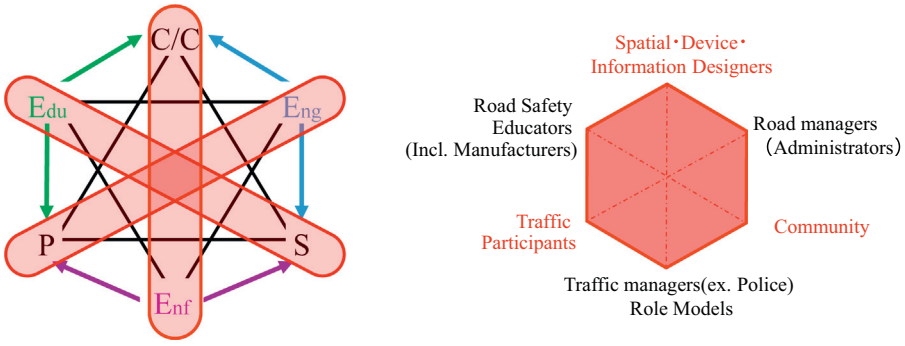

Fig. 20. Desired cross-sector cooperation in road safety.

same for Engineering measures targeting the attainment of either Compactness or Speed, as well as the Enforcement measures aiming at either Priority or Speed. Our objective in doing so was to determine:

- If the representative countries were already incorporating road safety measures that merged PSC and the 3Es concept; and
- If so, the extent to which the countries have merged the two concepts into a unit.

Our investigation revealed that, indeed, the representative countries had incorporated road safety measures that were both PSC and 3Es in nature (see Table 5). We also found considerable fragmentation, as some measures seemed to fall on only one side of the "merger spectrum." Based on the definition for the safety hexagon (see Fig. 2),

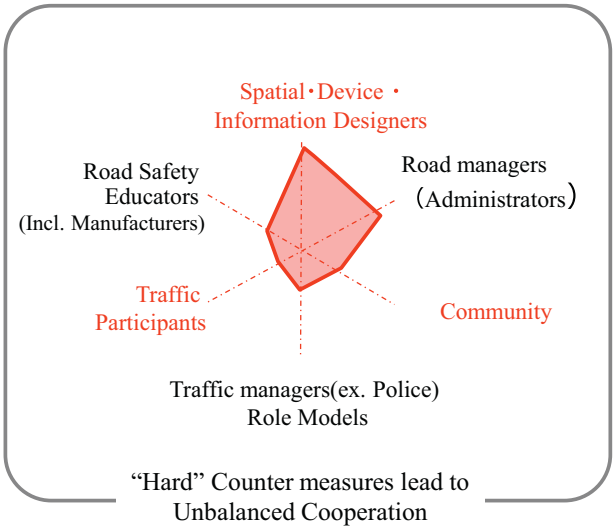

Fig. 21. Irregularities caused by unbalanced cross -sector cooperation.

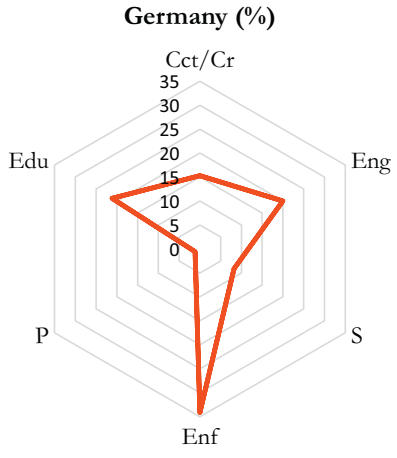

Fig. 22. The situation in Germany.

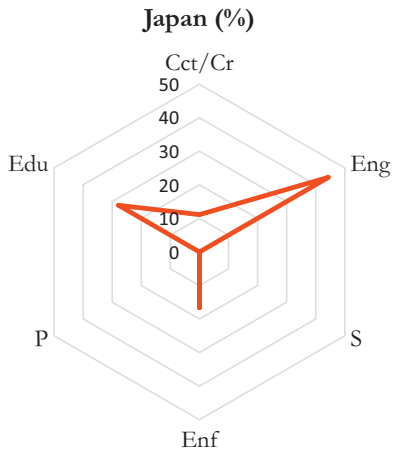

Fig. 23. The situation in Japan.

Education measures should aim to achieve Priority and Comprehension; Engineering measures should aim at achieving Compactness and Speed; and finally, Enforcement measures should aim to achieve Priority and Speed management.

As the results in Table 5 indicate, however, all the countries used Education to achieve Comprehension but did not use it for the Priority component. Similar results are evident in Engineering efforts, which went toward Speed management goals but not road Compactness goals. Enforcement, likewise, served as a tool to enhance Speed management but not Priority goals. The Netherlands and Germany tried to come up with measures that fell on both sides of the "PSC and 3Es merger spectrum," while Japan only did so for one out of six aspects.

Due to this fragmentation, we introduced a third dimension (see Fig. 19) in addition to the traditional perspectives to close any loopholes in the safety hexagon and thereby make it all-inclusive.

We arrived at the results in Table 6 in the same way as we found those in Table 5. Despite the fact that the third dimension is a non-traditional one, two of the representative countries seem to have already incorporated it in their road safety policies. This shows that the concept informing the safety hexagon is not only applicable but also achievable.

The extent of the fragmentation evident in Tables 5 and 6 further emphasizes the importance of understanding and exploring the latent relationship between the PSC and 3Es approaches.

Therefore, we created Fig. 20 to highlight all the dimensions that road safety policies need to incorporate as well as the parties that are

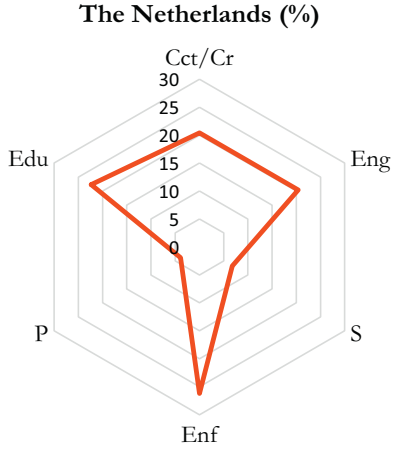

Fig. 24. The situation in Netherlands.

Table 5
Measures from both the PSC principle and the 3Es approach.

Country	Edu/Cr (%)	Edu/P (%)	Eng/Cct (%)	Eng/S (%)	Enf/P (%)	Enf/S (%)
Germany	61	0	0	29	0	10
Japan	40	0	0	0	0	0
Netherlands	61	0	5	10	4	19

vital in policymaking. Cross-sector cooperation seeks to involve all relevant parties because the traditional norm has left some parties out of the policymaking process. For instance, the parties in black text in Fig. 20 are usually involved in these proceedings, while the ones in red text are most times excluded. This may stem from the fact that the 3Es concept is better understood than the PSC concept is. From Fig. 20, one can see the direct link between the 3Es and the parties in black text and the link between PSC and the parties in red text.

As the world is moving toward holistic road safety, co-creation is of paramount importance and attainable only if the roles of each party are recognized. Failing to take these roles into account invariably leads to irregularities in the system, as Fig. 21.

This kind of situation has been observed by researchers such as Rahman et al. [5] during their research into the public acceptance of evaluations of the traffic-calming process. The researchers found that the community rejected some traffic-calming measures after implementation simply because it had not been involved in decision making.

Figs. 22–24 further demonstrate the aforementioned irregularities within the representative road safety policies.

The figures above show that policies in the different countries are directly or indirectly based on the 3Es. Other approaches such as PSC have not yet taken root in policymaking but still play key roles in road safety. As expected, the Netherlands and Germany have a somewhat more inclusive approach compared to the Japan because they involve various parties in decision making.

Such irregularities in policy may account for the stagnation in the rates at which traffic accidents should be decreasing. This lack of balance among approaches might also explain why fatalities among some vulnerable road users (elders, cyclists, etc.) have increased over the years despite several government interventions.

5. Conclusions

A road safety policy, defined as a course of action adopted or proposed by a government, gives an idea of what the implementation and possible results of road safety might be. Many road safety policies refer to past achievements and outline future achievements that could be possible if the policy takes root as intended. This is the sole basis for using different countries' road safety policies to expound on the new cross-sector cooperation approach to road safety. This study set out not to show which policy is performing better or which policy constitutes a model policy but rather to demonstrate how different road safety guiding principles affect the makeup of a road safety policy. In so doing, we aimed to elucidate why the inclusion of the PSC principle in the formation of road safety policy is so vital.

One should note that our study only evaluated current national policy statements, not the actual level of deployment or cumulative past policies, in a bid to give us an idea of the future direction of road safety in these countries. This also explains why the analysis did not fully

Table 6
The third dimension in the safety hexagon.

Country	Edu/S (%)	Eng/P (%)	Enf/C (%)
Germany	0	9	7
Japan	0	0	0
Netherlands	0	19	19

reflect the impact of speed measures such as zone 30 in countries like Germany and the Netherlands despite the fact that such measures came into effect as early as the 1980s.

Our analysis did not identify a balance within each traditional approach (3Es, soft vs. hard, etc.). This may have resulted from the differences in road transportation situations in the countries, which dictate different combinations of countermeasures. When we compared the 3Es and PSC components (Table 5) together, we found many measures to be biased toward a particular component. The fragmentation may also be due to the fact that these countries already tackled the "lacking components" in their previous endeavors and therefore see no need to emphasize them in the future. But it could also suggest that this degree of fragmentation in the policies, is a point that requires attention if the set road safety goals are to be met.

The results also indicated the need for change in the Education category: although education measures have a significant weight in most countries, education-related measures require revisions because they rarely tackle Priority. Compactness-related measures did not figure into the analysis because their percentage value was negligible, exposing another point to address.

This study not only showed the relationship between the 3Es and PSC but also used that connection as the foundation for introducing a new, more inclusive cross-sector cooperation approach. Through our research, we identified the extent to which the existing road safety policies are embracing the new cross-sector cooperation directly or indirectly. Our investigation revealed fragmentation that prompted the introduction of the third dimension to form the framework in Fig. 19, which aims at plugging all possible loopholes in road safety and hence bring about inclusive road safety. Furthermore, we identified the general key players based on their PSC-3Es relationships. Their roles in co-creation for road safety are instrumental in preventing irregularities in the system, as Figs. 22–24. We intend to further evaluate cross-sector cooperation basing on the actual implementation in each country.

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