Shifting audience and the visual language of avalanche risk communication

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ABSTRACT: As more people venture out into avalanche terrain we must also deal with a shift in avalanche bulletin audience. They are the core product of avalanche warning services yet many still operate with an outdated idea of their user group. How do we capture the attention of novices and people venturing into potentially dangerous terrain on the spur of the moment without even the basic understanding of what they are getting into?

We explored current state of bulletins, highlighted the essential elements and presented various practices in their implementation. We chose 4 representative concepts from European and North American warning services and modified them to present the situation in Slovenia. The resulting bulletins were presented to expert and advanced users for evaluation then compared to findings gathered in a concurrent usability study with lay people.

Bulletins with well implemented use of graphics performed best in presenting critical information however they must be accompanied by extended information in textual form preferred by experts and older users.

KEYWORDS: avalanche bulletins, risk communication, visual language, avalanche awareness

1 INTRODUCTION

In the past decade, if not more, anyone paying attention to ski resort marketing could witness the paradoxical situation of skiers/snowboarders carving nice arcs in virgin powder snow. It leads one to wonder why then, do we even need resorts with their perfectly groomed runs? Yet in many of those same places it is contrary to the rules, in some countries or states even illegal (McArdle, 2013; ZVSmuč, 2006), to venture out of resort boundaries or simply outside marked groomed runs. Out-of-bounds and backcountry skiing have been growing rapidly compared to alpine skiing. (Jamieson and Stethem, 2002; Tase, 2004; George, 2005; Harvey and Zweifel, 2008; SIASnowTrak, 2010)

Hägeli, in 2005 research involving industry professionals, shows rising trends over all non-commercial backcountry use which, in addition to skiing, also includes snowmobiles.

Driven largely by media, advertising, and commercialisation as well as advances in technology (Puchan, 2004; George 2008), skiing in the backcountry is seen as an adventure sport with calculated risk as one of top motivating factors. (Puchan, 2004) As it becomes more mainstream it is opening up to less “extreme” persons, inspired by risk is fun culture, followed by large outdoor equipment manufacturers.

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The main issue resulting from all this is increasing number of backcountry and ski resort visitors being exposed to avalanche terrain and making under informed decisions. Many of whom have little or no avalanche training or don't even bother to check the relevant avalanche bulletin (Tremper and Conway, 2006; Eckerstorfer, 2008; George, 2008; McCammon et al., 2008)

Lack of knowledge too often ends in injury or death. Yearly analysis of avalanche accidents in France shows how the sport evolved over the years and where the out-of-bounds skiers and snowboarders now account for more than 50% of avalanche victims compared to backcountry ski tourers (George, 2008). The same yearly summary also suggests the reason is that ski tourers habitually wear avalanche beacons and have better general knowledge of avalanche dynamics whereas sidecountry skiers don't. Sidecountry terrain is potentially more dangerous because users tend to be less educated and equipped, access is easier, users do not get the stability clues that backcountry users get on a skin track, and there is more potential for large group social dynamics and incidents (Diegel, 2013). The term itself provides a false sense of security, as there are no avalanche mitigation actions or rescue personnel on hand, and is as such being widely rejected by avalanche professionals in favour of unified term backcountry or out-of-bounds terrain (Kray, 2013; Kircher, 2012).

Sometimes even educated professionals have trouble with information recall and then find themselves in avalanche terrain with no clear memory of the exact, crucial, wording in the bul-

letin (Tremper, 2006). Therefore we are dealing with two sides of the same problem.

To begin with, there is the absence of avalanche awareness in the general skiing population. The issue facing avalanche professionals being how to disseminate the current avalanche conditions to a very heterogeneous crowd with little or no interest in what, in essence, should be of great importance to them once they go out-of-bounds. The second is improving the effectiveness of information recall for those that do look for and find it.

2 THE AVALANCHE BULLETIN

An avalanche bulletin or advisory, specifically the forecast of avalanche release potential, is the basic product of avalanche warning services (AWS) around the world. In its essence, it combines meteorological and topographical data to present the current avalanche danger and how it will develop over a period of time. (Eckerstorfer, 2008)

European and North American approaches diverge, but there are some signs of cooperation in developing effective tools and forms of risk communication.

How a bulletin should look and what information it should contain has been and still is a mix of opinions, mostly determined by the individual AWS or other similar body producing them. Our review of AWS around the world revealed at least 67 bulletins with only three designs being shared to some degree. One of these designs is currently shared among 15 services, with a varying amount of common graphic/layout elements.

According to EAWS (European Avalanche Warning Services) the hazard map should follow the standard journalistic inverted pyramid approach (for explanation see Scanlan, 2002), with the most important information presented at the top and followed by increasingly less crucial information. As such, the bulletin should start with the current general hazard level followed by current hazard level split into region, elevation, daily temperature curve and slope orientation, information on snow profile condition, other meteorological parameters, and expected development in the following days (Eckerstorfer and Nairz, 2007).

While not yet standardized, the North American avalanche bulletins are converging in concept and going beyond the European four point avalanche hazard differentiation (Tremper and Conway, 2006; Lazar et al., 2012) by including:

1. Avalanche problem (loose snow, deep slab, persistent slab etc)
2. probability, likely release size and trend of a certain type of problem
3. elevation divided into three distinct zones rather than two variable (below, around and above tree line)
4. linking each problem to an avalanche encyclopaedia

Producing detailed, spatially accurate and up-to-date avalanche forecasts is meaningless if we fail to present them to the end users where they can see them and in a way they can understand. The times when the only target groups were experienced winter alpinists and road clearing crews are gone. Risk possibility can quickly become probability due to wrong impressions given by poorly presented data. While we may explain the concepts in great detail by employing text or present the same information using only graphics, doing both at the same time is better. (Miller, 2010; Semmel et al, 2009)

3 METHODOLOGY

Previous studies only evaluated individual bulletins (Tremper and Conway, 2006; Statham and Jones, 2006; Semmel et al., 2009) or compared them across countries (Eckerstorfer, 2008) and the latter inevitably came up against language as well as cultural barriers. Users unfamiliar with a specific language are unlikely to understand much beyond the common elements such as danger rating. Their opinion is much less relevant when it comes to spatial awareness (no or limited knowledge of local geography). But most importantly, they cannot be expected to understand the text (regardless of help from Google Translate), so how can they extract information or judge the quality of a bulletin?

To overcome this issue we decided to evaluate bulletins in a levelled playing field. To enable this we selected four representative bulletins and localized them to a common area and language (Slovenian) to improve understanding and spatial awareness.

3.1 Analysis and selection

To manage the number of bulletins requiring localization we first performed a comparative analysis of various bulletins around the world, but mostly we focused on European and North American avalanche warning services. The eliminating criteria were adopted from EAWS recommendations to which considerations on graphical interface, web design, and technology were added.

After eliminating clearly outdated bulletins and ones with very similar concepts from the first round of selection, we moved on to localization with four avalanche bulletins. We selected bulletins designed by Lawinenwarndienst Tirol (rated best in 2008 study by Eckerstorfer), Utah Ava-

lanche Center (used to some degree by 14 other AWS), Institut Geològic de Catalunya, and Canadian Avalanche Centre.

3.2 Communication efficiency

Individual bulletins can present identical information in many different ways that are not necessarily efficient. Identifying and combining best practices is essential for possible future improvements in bulletin design.

Evaluating communication concepts is by design a subjective task. Efficiency of information transfer is in many ways dependent on the subject but there are nevertheless certain criteria that we can apply to obtain a deeper insight (Plenković et al., 2008). We applied these criteria in designing a questionnaire aimed at our target user group of people who know what avalanche bulletins are and use them at least occasionally.

The questionnaire, together with links to a website containing modified bulletins, was sent to out-of-bounds, backcountry and heli skiers (snowboarders included), ski tourers, mountaineers, mountain guides and mountain rescue teams. This way we included a population that, more or less regularly, follows and uses avalanche bulletins as well as people who sometimes do not know enough about potential dangers associated with their chosen activities.

Special emphasis was on evaluating clarity and quality of presenting critical information and consequently on information recall and communicative efficiency of graphic and cartographic elements.

3.3 Usability study

Concurrently we assembled a group of test subjects that contained mostly laypersons with limited participation in mountain winter sports, practically no snow avalanche awareness beyond knowledge of their existence, and no prior contact with avalanche bulletins. Some subjects, however, were involved in occasional ski touring or out-of-bounds skiing in the past, but only two of those had ever seen a bulletin before.

Each subject was presented with all four bulletins and then went through a supervised simulated trip planning. The order of bulletins was changed for each person to cancel out familiarity bias as the subjects became accustomed to a certain common logic found in all products. For further information regarding our usability study see The Avalanche Review 31/4, p.28-30.

4 RESULTS

Comparing general first impressions in Fig.1 we see TIR and CAT are rated best *(note TIR was also voted best in 2008 study be Eckerstorfer)* with the mean just above and below 4 (good). With the possible exception of UT bulletin (mean: 2,94) we cannot claim any of them evoked strong negative feelings on the 5 point scale.

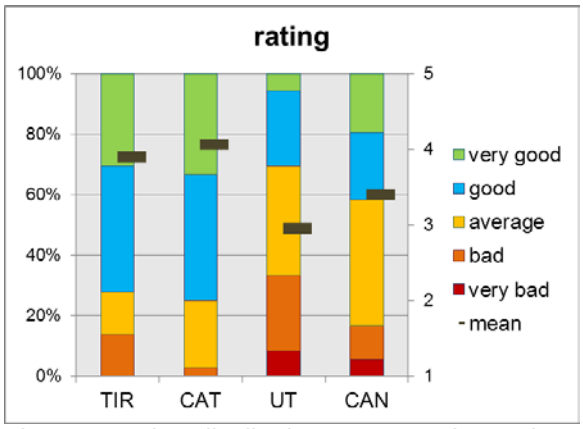

Figure 1. rating distribution on a 5 point scale & mean rating (right axis)

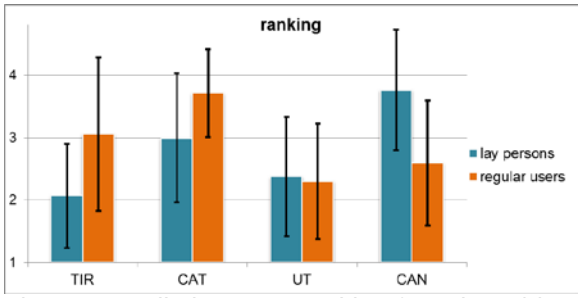

Figure 2. Bulletin mean ranking from best (4) to worst (1) with standard deviation

We asked subjects from both studies to sort bulletins from best (4) to worst (1) so Fig.2 shows opinions of both regular users and lay persons. As bulletins should serve both experts and novices it is interesting to compare views and we see a very different picture from Fig.1. Lay persons clearly prefer CAN, followed by CAT, UT and text heavy TIR well below them. Regular users sorted bulletins in the same order as in the previous question. What you can also see is higher agreement (st.dev: 0,7) in CAT compared to TIR (st.dev: 1,2).

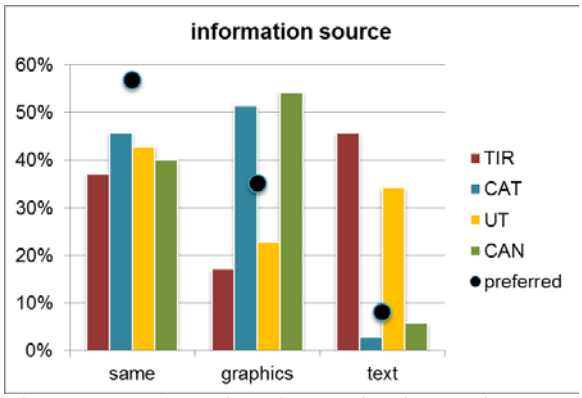

Figure 3: Preferred and perceived actual source of information

Following questions served to determine why some bulletins might be better than others. Fig.3 shows a comparison between the preferred source of information (black spots) and the perceived one. What we can see immediately is that nearly 60% consider text and graphics equally important while 35% prefer graphics. CAT seems to be closest to the correct balance between the two while CAN may be hiding the text and exposing graphics too much and TIR does not provide enough graphic information.

informative value				
	mean	st.dev	mode	median
TIR	3,92	0,94	4	4
CAT	**4,03**	**0,91**	5	4
UT	*3,08*	*1,27*	4	3
CAN	3,37	1,24	3	3
thoughtful use of infographics				
	mean	st.dev	mode	median
TIR	3,44	1,16	2	3
CAT	**4,11**	**1,01**	4	4
UT	*2,74*	*1,22*	3	3
CAN	3,56	1,18	4	4
understandability of infographics				
	mean	st.dev	mode	median
TIR	3,60	*1,33*	5	4
CAT	**4,11**	**0,90**	4	4
UT	*2,83*	1,15	3	3
CAN	3,63	1,09	4	4
aesthetic appeal				
	mean	st.dev	mode	median
TIR	3,47	1,11	4	4
CAT	**4,08**	**0,87**	4	4
UT	*2,42*	*1,16*	2	2
CAN	3,61	1,15	4	4

Table 1: four parameters evaluated on a 5 point likert scale

Analysing further, looking at data in table 1, as expected all bulletins are adequately informative with both North American ones rated slightly lower. As CAN hides the text version of the bulletin on a subpage it is possible it was simply overlooked. UT received the worst ratings for understandability and thoughtful use of graphics while CAT and CAN are at the top. We were also interested in purely aesthetic appeal of the designs and the results fit the overall ratings. The only one which did not evoke many positive responses was UT.

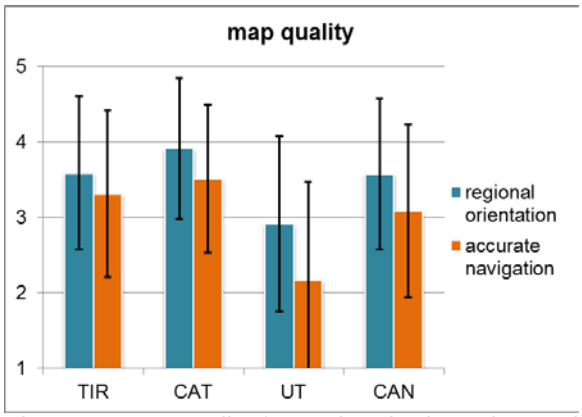

Figure 4: Map quality for regional orientation and accurate navigation, mean ratings with standard deviation.

What we wanted to see is how people rate included maps for general orientation on a regional level and for accurate navigation on a detailed level (fig.4). Rated worst was UT with a very general overview map and few visual clues. It's fine for regional level orientation but severely deficient for determining specific locations. The other three are very similar on a regional scale while CAT and TIR mapping styles work best for finding specific locations by offering some place names. However, all of them have much room for improvement.

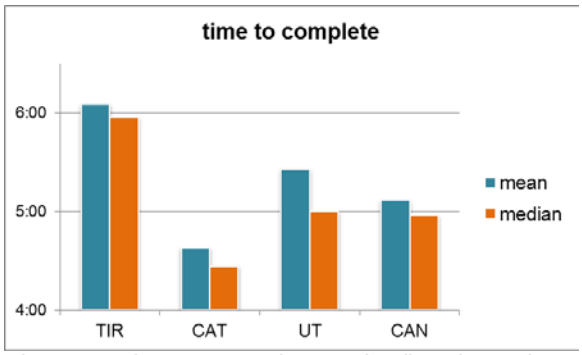

Figure 5: Time to complete tasks (in minutes)

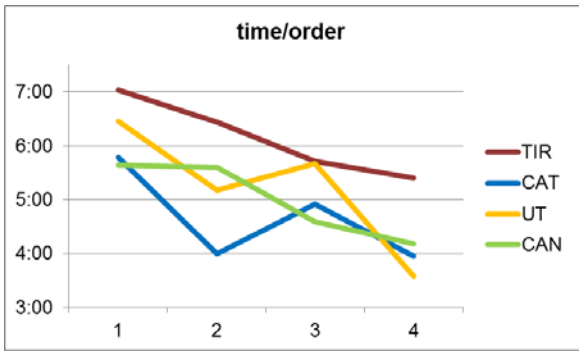

Figure 6: Time to complete vs. order position

In the usability study we measured the time it took to complete the assigned tasks (fig.5), and there was a quantifiable difference between bulletins, suggesting ease of finding required information independently from the subjective rating for the bulletin. Since we rotated the order to avoid the bias introduced by familiarity, we can compare the time it took to complete the tasks relative to the position in the order (1–4). We can see there is a noticeable increase in average speed the further along the order a bulletin was (fig.6). But what we can also see is how intuitive CAN and CAT were at first exposure. A difference of nearly 25% compared to TIR in first exposure or nearly identical time to when TIR was shown last.

Such difference clearly indicates how much easier well-designed and properly used graphics can be compared to text when looking for information. While our study didn't measure information recall it has to be said that both CAN and CAT offer the bulletin in text form as well, but it is found on a sub-page. UT mixes both in the same layout. While time spent searching for information might not be of great importance in normal use, it is vital in “stumble upon” scenarios such as waiting in line for the ski lift.

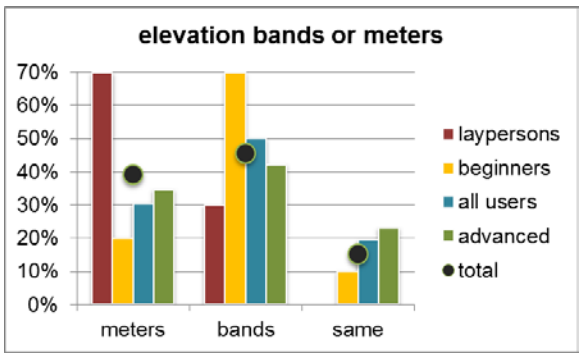

Figure 7: preferrence for elevation bands or meters

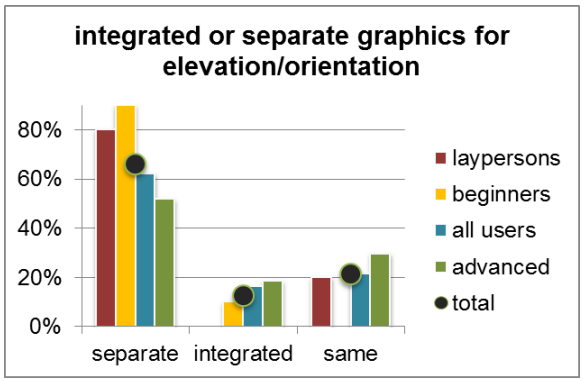

Figure 8: preferrence for integrated or separate graphics for elevation/orientation

To finish both surveys we asked our subjects what they think about certain design and content issues. One approach commonly used in Europe is specifying meters above sea level where specific threats are present (such as: above 2200m). The (predominantly) North American practice uses three distinct elevation bands (usually specified as under, at, and above tree line). Opinions about one or the other style were quite equally distributed (fig.7). What stood out was a strong preference for meters by several subjects in the usability study, which could be explained by their background in engineering and their desire for precision. In follow-up discussions this bias was clearly evident. The other standout opinion was from users with less avalanche training or experience who clearly preferred descriptive elevation bands. With expert users the opinions were more equally spread, so the question of style could come down to the target group and customization.

The next question was about graphics for elevation and slope orientation. It was aimed at the practice of using the avalanche danger rose which combines both parameters into one graphic. The usability study and expert opinion clearly support the idea of abandoning the avalanche rose, as it nearly always required additional explanation, while the separate graphics were completely intuitive. To further emphasise this point: even subject who couldn’t understand the rose on their own, either didn’t see or didn’t bother to search for the explanation. It might as well have been a blank space. The explanation had to be given by the supervisor. Overall 66% said they prefer separate graphics, 21% didn’t care either way (fig.8). While it is less of an issue with experienced users and can be learned we obviously do not wish to confuse people when presenting critical information, and the danger rose is such a case.

Question reflected in Fig.9 had double purpose. In a way it was a control for general ratings, but it should also serve as an encouragement for AWS. We asked subjects about useful-

ness (fig.9, 1=not useful to 5=very useful) of extra audio-visual content showing the situation in the field (snow profiles, analysis of recent avalanche events, etc.). Most agree it is a very useful addition to a bulletin, which contradicts the low ratings given to UT – the only one that contained such materials (photos and descriptions of recent avalanches). So the result really should serve as encouragement for AWS to supplement the abstract forecast with current real-life situations but think carefully how to present them.

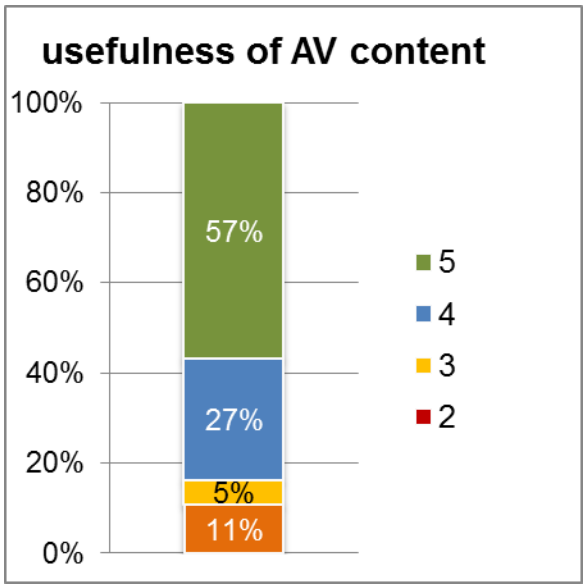

Figure 9: usefulness of extra audiovisual content rated on 5 point scale

5 DISCUSSION

Results suggest a certain duality. It cannot be disputed CAT got the best ratings in nearly all categories. Further solidifying its position as the best compromise, CAT has consistently smallest disagreement in responses. But on the other hand we have TIR that received good ratings from experts yet did not perform as well in usability study and was disliked by laypersons and novices. One explanation could be a certain familiarity with that specific bulletin, or ones similar, to which our subjects were likely exposed before as it is used in a neighbouring country. The other three bulletins, with their heavy use of graphics, are very unlike most past and current European products. This style seems to better suit less experienced users. A balanced mix of graphics and text is actually the preferred source of information across the sample. CAN and CAT have even gone so far as to place the text bulletin in a secondary role by moving it to a subpage, which is not very obvious in either case and should perhaps be rethought.

The usability study showed both CAN and CAT bulletins suffer from some misunderstanding problems with graphics and visibility of certain information. However, they both effectively present a compromise of graphics, relatively helpful maps and text which satisfy the greatest spectrum of subjects.

The worst performer in our studies was UT. *(Note: their bulletin started undergoing updates just as our survey started, and most serious deficiencies found seem to have been corrected.)* Our results suggest various reasons for worse performance. The problems begin with poor maps only useful for basic regional-level orientation. The bulletin could undoubtedly be improved through better structuring as well as by eliminating the avalanche danger rose and replacing it with two separate elevation/orientation graphics. The updated version now uses a much improved map and an advanced/basic switch that puts the avalanche rose in a secondary role. It is vitally important to remember that it does not perform badly when it comes to either the amount or quality of information contained. What we can conclude though, is that the other three simply do a better job presenting it.

The final part of the study was the most important when thinking about further work. Integrated elevation/orientation information in the avalanche danger rose is obviously an anomaly in this culture, and as such, hard to understand without explanation. The need to offer additional information or even training just to understand a critically important infographic is inexcusable and further use should be reconsidered, at least when dealing with general audience.

Different practices in separating elevation zones are less controversial. The advantage of one or the other depends on the target audience and specifics of the geographic area. People with little or no experience are better served with descriptive elevation bands, as it is easier for them to determine their relative elevation by whatever they see around them. On the other hand, precise elevation ranges can be better for advanced users especially in cases where a threat is not present in the entire vegetation band (such as above tree line, yet still well below the danger band).

The extra audio-visual content is a welcome addition to the bulletin and likely serves dual purpose. Users are more aware of what is waiting for them in the field and they also provide an educational/preventive service by presenting potential scenarios and their dangers through real-world cases.

6 CONCLUSION

Our study is a small advance towards developing unified requirements in infographic and cartographic standards in avalanche bulletins.

Spatial awareness, familiarity with the terrain and navigation are crucial in backcountry travel. One must consider the visitors from outside the region who need more visual clues to determine where exactly they are in unfamiliar terrain and what avalanche information pertains to their situation. Various bulletins use a wide range of cartographic styles that are often very poor and all could be greatly improved.

Further development also needs to consider and adapt to specifics of the target groups as well as media and locations where the information can be presented (paper, web site, mobile device, TV, animation, public interactive station, etc.).

With a more unified approach we could also solve stylistic and content irregularities and misunderstandings in our own or a foreign language, which is a common problem especially in Europe. A standardized icon set and descriptions could make translations a trivial intervention. Since information recall can be a problem in one's own language, we should strive to eliminate further problems stemming from misunderstanding due to poor written or visual language. Analysing different bulletins and user expectations can lead to development of common building blocks thus reducing the development and deployment costs for individual avalanche warning services.

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