

Risk modelling for remote communities: An Inuit-driven Bayesian network approach to enhance search and rescue operations in Arctic Canada

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ABSTRACT

The Canadian Arctic's vast and unforgiving landscape presents unique challenges for Search and Rescue (SAR) operations, particularly in supporting the SAR volunteers in remote Inuit communities who face extreme conditions with limited resources. This study addresses the need for a culturally informed, probabilistic model that can enhance SAR effectiveness in Nunavut and Nunavik by enabling data-driven strategic planning and resource allocation. The paper introduces a novel Bayesian Network (BN) risk model that aims to capture the complexities involved in the Arctic ground SAR system. The model, developed through extensive community engagement, highlights the interdependencies between environmental conditions, resource availability, and SAR outcomes. By incorporating local knowledge and addressing systemic risks, the BN model offers a quantitative framework for SAR decision-making and policy development, aiming to improve the safety and resilience of Northern communities in the face of climate change and evolving geopolitical challenges. This work contributes to the wider SAR literature by offering a replicable approach for risk assessment and decision-making rooted in community expertise.

Keywords

Risk modelling, Bayesian network, search and rescue, Arctic.

INTRODUCTION

The Canadian Arctic's vast and unforgiving landscape presents unique challenges for Search and Rescue (SAR) operations, especially in supporting remote communities in Inuit Nunangat¹ as they sustain their traditional way of life. SAR responders, primarily community members, face extreme conditions across vast, shifting terrain, which require not only technical skills but also deep, locally rooted knowledge of the environment and community needs (Clark, Ford, Berrang-Ford, et al., 2016; Kikkert et al., 2024; Kikkert & Belton, 2024; Kikkert & Lackenbauer, 2023). Despite the critical role of SAR services in the safety and resilience of Northern residents, the system is strained by severe limitations in resources, infrastructure, and coordination across Federal,

¹ Inuit Nunangat, the Inuit homeland in Canada, comprises the Inuvialuit Settlement Region in Northwest Territories, the Territory of Nunavut, the Nunavik region of Quebec, and Nunatsiavut in Newfoundland and Labrador.

Territorial/Provincial, and local levels (Clark & Ford, 2017; Kikkert et al., 2024). Furthermore, the Inuit SAR volunteers' lived experiences – grounded in traditional knowledge (Inuit Qaujimagatjuqangit, IQ) – often go under-recognised in formal SAR planning and response protocols (Kikkert & Belton, 2024).

Addressing these challenges effectively requires a modelling approach that can incorporate the unique, community-based insights of Inuit responders while accounting for the uncertainties and systemic risks specific to Arctic SAR. Existing approaches to strategic planning may struggle to capture the full complexity of the Arctic environment and community-driven SAR, particularly as the region faces rising pressures from climate change, evolving infrastructure, and shifting resource availability (Kikkert et al., 2023). To address this issue, we developed a Bayesian Network (BN) model that integrates the experiences of Inuit SAR volunteers, captured through roundtable discussions and interviews, to enhance SAR responsiveness and effectiveness. This approach uses a co-production methodology that adapts Bayesian modelling to incorporate IQ- and community-driven insights.

Our study contributes to SAR literature and policy by presenting a culturally informed, probabilistic model that supports SAR operations, resource allocation, and best practices in Nunavut and Nunavik. This model offers a replicable framework for risk assessment and decision-making rooted in community expertise, addressing critical gaps in Arctic Canada's SAR system.

THE CONTEXT – SAR CHALLENGES IN ARCTIC CANADA

Our research in Inuit Nunangat has, to date, been focused on the Territory of Nunavut and the region of Nunavik in Quebec. Together, these areas contain 39 communities with a population of around 55,000 people (87% of the population of Inuit Nunangat), and a land area of just under 2.5 million km² (93% of Inuit Nunangat and 37% of Canada). This section provides a brief overview of the current state of SAR operations in Nunavut and Nunavik, Canada, highlighting the challenges and strengths of community-driven efforts in the regions. This context is essential to understand both the operational realities and the pressing need for improved systems in such an extreme environment.

An effective SAR system is a vital adaptation tool for Northern communities. The security it provides can help communities cope with Arctic climate change; constitutes critical infrastructure required to support Inuit health and well-being; and is a necessary foundation for safe harvesting activities to address food insecurity in the region. Strong SAR capabilities facilitate on-the-land activities, fostering the connection with land, water, and ice that is a requirement for Inuit physical, mental, social, and cultural health, and support not only travel between communities but also economic activities including local subsistence economies, commercial fisheries, and tourism (Clark, Ford, Berrang-Ford, et al., 2016; Cunsolo Willox et al., 2013; Kikkert & Lackenbauer, 2023).

Northern Canada's geography – characterised by its vast, remote, and cold landscape – presents formidable challenges to SAR operations. In addition, support for local responders from federal assets provided by the Canadian Coast Guard and Royal Canadian Air Force can be substantially delayed due to the distance of those assets from Northern communities. Community SAR teams contend with a range of other issues including underfunding, recruitment challenges, lack of standardized policies, and insufficient access to necessary equipment and training, limiting the effectiveness of their operations (Ford & Clark, 2019; Inuit Circumpolar Council Canada, 2019; Kikkert et al., 2024; Kikkert & Lackenbauer, 2023).

SAR operations in both Nunavut and Nunavik are deeply rooted in the commitment of local volunteers, who rely on personal knowledge and community ties to carry out rescue efforts. This approach effectively leverages the cultural knowledge and understanding of Inuit communities, enabling responders to navigate large areas, often in harsh weather conditions, quickly and safely. However, the personal commitment involved in SAR also brings significant emotional strain, as responders frequently search for friends and family members. "We have to go out. Those who know the land, know what they're doing. We have to go out. People depend on us" (Jimmy Haniliak, quoted in Kikkert et al., 2024).

Northern SAR also requires a large number of disparate groups to work together efficiently, including community responders, local, territorial and federal authorities and the armed forces. In the past, communication and coordination between local, territorial, and federal responders has often proved challenging. Misunderstandings and miscommunications have hindered search efforts and contributed to negative outcomes (Kikkert & Belton, 2024; Kikkert & Lackenbauer, 2023). Another significant issue is the lack of consistent, formalised training for community responders. Although organizations like Nunavut Emergency Management (NEM)², Kativik Civil

² NEM is the designated Emergency Management Organisation for the Territory of Nunavut.

Security (KCS)³, the Canadian Coast Guard and the Canadian Rangers do offer some training, gaps remain in establishing a coherent programme that is appropriate for the Northern environment. In addition, there is a need to better integrate IQ into formal SAR training and protocols, which could greatly improve operations and foster culturally sensitive, sustainable SAR practices.

Efforts have been made to introduce new technology such as satellite communication devices (e.g., Garmin InReach and SPOT) to improve SAR operations in Nunavut and Nunavik. These tools allow individuals in remote locations to signal for help, potentially removing the need for a search and reducing rescue times dramatically. The introduction of aerial drones to support Arctic SAR also holds much promise ((Nilsen, n.d.)). However, greater investment in prevention initiatives, including on-the-land safety education and preparedness training for community members, is needed to reduce the frequency of SAR incidents (Clark, Ford, Pearce, et al., 2016). This, in turn, requires a deeper understanding of the causes of SAR events and the factors that determine whether a search is successful or not.

It is important to note that the two regions studied here, Nunavut and Nunavik, are similar but different. For example, official control of SAR in Nunavik is shared between the Nunavik and Quebec police forces but neither force has historically had significant involvement in local searches in practice, leading to a variety of local approaches to SAR across the region. Nunavut has a more streamlined process, with NEM having authority over all ground SAR in the territory. Conversely, the Nunavik villages benefit from significant financial and logistical support from KCS, including for training, safety programs, and equipment. Communities in Nunavut have more difficulty accessing funds for these purposes (Kikkert et al., 2024). Nevertheless, the fundamental features outlined above are common across the Canadian Arctic and, as such, apply to both Nunavut and Nunavik.

To conclude, in order to tackle its many challenges, the SAR system in Arctic Canada requires strategically targeted investment, which involves being able to assess which points within the system can have the greatest positive impact on SAR outcomes. Current policies appear focused on addressing specific individual issues rather than improving the SAR system in a holistic manner; this perspective makes it difficult for policy makers to compare the value of one intervention against another or to account for the inter-relationships between factors in the system.

METHODOLOGY

This section outlines the methodology used to develop a BN model aimed at supporting strategic decision-making under uncertainty for SAR operations in Nunavut and Nunavik.

SAR in Nunavut and Nunavik is a multi-faceted socio-technical system comprising many varied and highly interconnected factors. A complex network of people, physical assets and administrative processes must be coordinated at a distance and respond flexibly to a dynamic search situation. And yet, while past research has highlighted individual issues faced in Northern SAR (e.g., Clark et al., 2016; Kikkert & Lackenbauer, 2021) or identified specific changes that could enhance SAR operations, such as improvements to the legal framework (Christodoulou et al., 2022), use of drones (Clark et al., 2018; Nilsen, n.d.) or the introduction of paid public safety officers ((Kikkert & Lackenbauer, 2021), there has been little-to-no focus on the interdependencies between factors. When considering risks, this has been referred to as “risk systemicity” (Ackermann et al., 2007) or systemic risk, which is the risk of having not just statistically independent failures, but interdependent, ‘cascading’ failures in a network of interconnected components (Helbing, 2013). The present research therefore adopted a systems-based approach to understanding and supporting SAR activities.

BNs have proved to be effective tools for evaluating systemic risk (e.g., Goerlandt & Islam, 2021; Lu et al., 2019). Previous research has successfully used a BN to model a SAR system (UK marine SAR: Norrington et al., 2008), but there are no comparable models for Ground SAR (GSAR) and none that take account of the unique features of the Canadian Arctic. The present modelling process included extensive community engagement through roundtables and workshops, thematic analysis, and iterative feedback to ensure that the model accurately reflects the lived experiences of Inuit SAR responders and the unique challenges of SAR in the Arctic environment. The overall aim of this approach to data collection was to embrace the principles of co-creation as it applies to research involving cross-disciplinary and cross-cultural groups with very different experiences and perspectives. Co-creation involves reconciling competing values and worldviews to produce outputs that reflect the ‘greater good’ (Cairns & Wright, 2019), ensuring that the process leaves participants feeling empowered to effect positive change (Bourgeois et al., 2017; Freeth & Drimie, 2016), and recognising the sensitivities involved in aggregating highly contextualised local knowledge with data from other sources (Klenk et al., 2017; Latulippe & Klenk, 2020).

³ Kativik Civil Security is the department of the Kativik Regional Government (created in 1978 to deliver public services to Nunavimmiut in the North of Quebec) that is responsible for supporting SAR services.

Identification of Key Factors to be Used in the SAR Model

Ethical approval for the research was obtained from the authors’ university ethics committees. In addition, the authors have ensured that the work is aligned with the principles established in the National Inuit Strategy on Research (Inuit Tapiriit Kanatami, 2018) and obtained a scientific research licence from the Nunavut Research Institute. All Inuit project participants have been and will continue to be involved in the data life cycle, including having both access to and ownership of data generated, which has been stored securely throughout the project and will be shared – subject to community approvals – on the project websites <https://nunavutsar.ca/> and <https://nunaviksar.ca/https://nunaviksar.ca/>.

Five SAR roundtables were conducted to gather insights from local and governmental stakeholders and rightsholders about the key factors influencing SAR operations in the North. The first roundtable took place in February 2020 in Cambridge Bay for the Kitikmeot region of Nunavut. Three additional two-day roundtables were held in November 2022, one for each of the Qikiqtani, Kivalliq, and Kitikmeot regions of Nunavut, and a roundtable for Nunavik was held in Montreal in December 2022⁴. These roundtables included over 100 Inuit community responders and over 100 representatives from various territorial, federal, non-profit, and Inuit organizations. The discussions were guided by Inuit principles of piliriqatigiingniq (working together for a common purpose) and aajiiqatigiinni (decision-making through discussion and consensus), which shaped the model structure by prioritizing community insights and values.

Contemporaneous notes from the roundtable sessions were coded and analysed using thematic analysis to identify key issues affecting SAR operations in Nunavut. This process followed the approach outlined by Braun & Clarke (2006), where researchers located initial codes in the data and then grouped them into higher-level themes. The thematic analysis helped surface common challenges across regions as well as location-specific issues, providing a comprehensive view of the SAR landscape in Nunavut. Following the thematic analysis, causal maps were developed using the Decision Explorer tool (<https://banxia.com/dexplore/>) to visually represent the interdependencies among the key themes identified (Ackermann et al., 2014; Bryson et al., 2004). The initial causal maps created after the 2020 session were further refined after the 2022 roundtables to incorporate new insights. These maps highlighted complex interactions between people, equipment, vehicles, vessels, and administrative processes, all of which require coordination over vast distances and flexible responses to dynamic environmental conditions. Each concept in the causal map was categorized as an uncertainty, decision, outcome, or constraint, using colour coding for visual distinction.

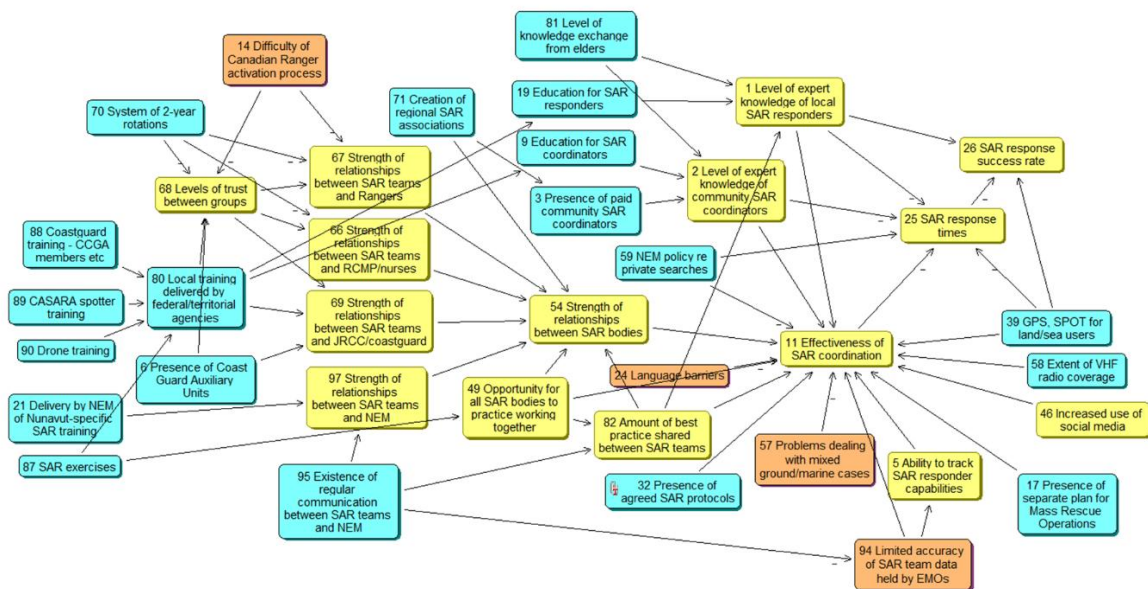


Figure 1. Extract from a causal map representing the 2020 and 2022 roundtable data. Yellow nodes are uncertainties, blue nodes are decisions, and orange nodes are constraints. There are no outcomes shown in the selected extract.

Construction of the Bayesian Network

⁴ For reports on these roundtables, see (Kikkert et al., 2021, 2024; Kikkert & Lackenbauer, 2023).

The BN was constructed using the GeNIe Modeler software (<https://www.bayesfusion.com/genie/>), based on the qualitative structure identified in the causal mapping and, in parallel, the output of the thematic analysis. As a probabilistic graphical model, the BN uses a directed acyclic graph to represent variables and their conditional dependencies. The first draft of the BN was constructed to focus on the qualitative relationships between factors identified by SAR responders as impacting SAR outcomes, specifically from the perspective of the probability of successfully rescuing an individual in need. This initial BN was reviewed by the researchers who organized and led the 2022 roundtables to ensure consistency with the findings and was further refined to confirm its alignment with stakeholder and rightsholder viewpoints.

The draft BN was then presented at the Arctic SAR exchange 2023 in Trenton, Ontario (Kikkert & Belton, 2024), a workshop for community SAR volunteers and Federal and Territorial responders, which allowed researchers to gather feedback from participants and reflect on the validity of the BN as a representation of the personal narratives shared by responders at that event. Further validation of the BN structure was obtained through a face-to-face, in-depth interview with two Inuit SAR coordinators from Nunavut who were not present at the 2023 Arctic SAR Exchange. The result of this work is that every node in the BN can be related back, directly or indirectly, to particular stories or comments shared. Additional reviews were conducted by two experienced volunteer SAR coordinators, who provided in-depth insights that further refined the BN structure. This iterative process ensured that the model remained grounded in the practical experiences of SAR responders across Nunavut and Nunavik.

Quantification of the Bayesian Network

Quantifying the BN allowed us to better understand SAR operations in Nunavut and Nunavik, giving an estimate of the likelihood of successful SAR outcomes, and allowing further investigation as to which factors may increase the likelihood of this outcome. Nodes and interactions were quantified through a structured approach that incorporated both elicited expert knowledge and mathematical modelling techniques. This involved defining probabilistic values and distributions for key nodes in the BN (such as SAR response time, search area, availability of resources, and survival probabilities) based on a combination of empirical data and expert knowledge elicited from SAR responders in both regions. GeNIe Modeler and the programming platform MATLAB (<https://www.mathworks.com/products/matlab.html>) were used to support the quantification of the BN.

The BN can be broadly categorised into five main sections: GSAR response time, marine SAR (MSAR) response time, aerial SAR (ASAR) response time, search subject survival time, and environmental conditions. It is worth noting that our definition of response time is the time taken from the initial alert that SAR is required until the search subject is located and has been collected by SAR responders. While other studies may consider SAR to be complete when the search subject is in a safe location (e.g., back in the Hamlet or in a hospital), the additional modelling that this would require is beyond the scope of our study.

Both MSAR and ASAR are relatively well studied areas, the International Maritime Organisation have even published guidance on these topics (International Maritime Organization & International Civil Aviation Organization, 2019). However, GSAR is a far less studied segment of the overarching SAR framework and limited previous GSAR modelling efforts (e.g., Koester et al., 2014) are not applicable to the unique conditions within Nunavut and Nunavik. The limited access to resources and huge land areas within Nunavut and Nunavik makes the role of GSAR vital in attaining a successful outcome from any SAR operation. Therefore, the modelling of GSAR, as part of the BN quantification, was identified as both a novelty and a priority within this project.

The outcome of SAR can be determined through a comparison between the estimated response time of SAR responders, and the likely survival time of the search subject. If response time is shorter than survival time there will be a successful outcome, if it is longer there will likely be a fatality.

The following sections briefly summarise the modelling processes undertaken to quantify an earlier version of the BN that was presented at the Arctic SAR exchange 2023 (Kikkert & Belton, 2024). The following sub-sections define the formulation of the GSAR model, outline the creation of a search subject survival model and describe how environmental conditions were incorporated into the BN. The modelling of both MSAR and ASAR is yet to be completed and so is not presented within this paper.

Ground Search and Rescue Response Time

GSAR can be categorised into three types of searches based on the quality of the alert provided by the search subject: (1) the exact location is provided by the search subject, e.g., via a GPS device (type 1 search), (2) some information is provided on the whereabouts of the search subject, for example, we may know that the search subject was travelling between two Hamlets but they are reported overdue, so SAR responders have a good idea where the search subject will be (type 2 search), and (3) little-to-no information is provided on the location of the search subject (type 3 search).

Both type 1 and type 2 searches are modelled as two-dimensional processes. Type 1 searches assume direct travel to the search subject, and so response time is simply based on the distance to the search subject (modelling described in section 4.3) and the average travel speed of SAR responders – elicited to be 60km/h in ideal conditions. Type 2 searches are similar to type 1 searches, however, SAR responders travel along a sinusoidal pattern (to represent how responders may check either side of a track for the search subject); this is accounted for by reducing the average travel speed to 26 km/h.

Type 3 searches are three-dimensional, demonstrating the broader search of an area that is needed to locate the search subject when limited information is provided. We represent type 3 searches as a “decay problem” where SAR responders cover 20km²/h, but more responders join the search as time goes on, thus increasing the coverage of the area over time. The capability of drones can be demonstrated within type 3 searches, where the three-dimensional process can be partially converted into a two-dimensional search, significantly improving response time.

Other factors that can affect GSAR response time include the availability of local equipment and SAR responders, which can affect the commencement of the search, as well as the arrival time of responders during the search – factors that are modelled using probability distributions with distribution types and parameters derived through elicitation. The time taken to locate the search subject’s whereabouts is also modelled depending on the type of search that has been triggered. This “investigation” node is also affected by the level of experience that SAR responders have, with well-connected local responders likely being able to deduce a missing person’s whereabouts more efficiently than an inexperienced, new, police officer on rotation. Environmental factors, such as wind speed and visibility, can act to reduce the speed of the search process, and can even halt the search completely if weather conditions are severe enough.

Search Subject Survival Time

Survival time is modelled with a normal distribution, following Tikuisis & Keefe (2012), and is a function of factors that influence how long the search subject can survive in the cold environment: clothing suitability, shelter availability, survival equipment, and environmental conditions. Several cold weather survival models exist to model these processes at a physiological level, such as the cold exposure survival model (Tikuisis, 1995) and the Cold Weather Ensemble Decision Aid (Xu et al., 2021), however no such model is freely available at present. Work is still underway to obtain a licence for a published survival model and thus improve the insight available from this branch of the BN. Currently, model features and relationships are drawn from freely available, published, studies on cold exposure survival within the harsh arctic climate.

Wind speed and air temperature can have dramatic effects on the estimated survival time of a search subject, as stronger winds and colder temperatures can increase the speed with which the effects of hypothermia can take hold. Survival time can be modelled as a function of both these factors, with relationships derived from Tikuisis (1995). If the search subject had access to, or the knowledge to create, shelter, this would help mitigate the exposure to wind chill and increase survival times.

Two types of clothing ensembles are accounted for within the survival model: poorly dressed (a clo rating of 1.65) and well dressed (clo rating of 3.0: Power et al., 2016), with the well dressed search subject surviving longer in the cold environment. The relationship between clo rating and survival time was derived from Tikuisis & Keefe (2012).

Finally, survival equipment adds directly to the estimated mean survival time, representing how long a subject can endure based on their preparation. For example, someone with adequate provisions (e.g., food, drink, equipment to make a fire) can last longer than someone without them.

Environmental Conditions

The BN accounts for environmental factors to help represent the unique challenges presented by SAR in Nunavut and Nunavik. Weather conditions (currently wind speed, visibility, and air temperature) are categorised into three states: favourable, unfavourable, and no-go (Fernandes, 2024). Favourable conditions represent ideal conditions for SAR, whilst unfavourable conditions impede the rate that searches can be carried out - halving the search speed. No-go conditions completely halt the search and trigger an additional delay until the search can be commenced which is related to the length of the no-go condition. Historical weather data for Canada was obtained from the Environment Canada climate data extraction tool (Government of Canada, n.d.), with available observations from all stations in Nunavut and Nunavik analysed from as far back as 1953 up until the start of 2025. The thresholds for unfavourable and no-go conditions for each weather type are derived from the criteria that Environment Canada use to issue public alerts (Government of Canada, 2024).

Continuous distributions are fitted for both wind speed and air temperature, allowing for easy implementation into the search subject survival model. Due to the paucity of visibility data in Nunavut and Nunavik, the visibility node is defined by the likelihood of occurrence of favourable, unfavourable, and no-go conditions i.e., a continuous distribution is not fitted for visibility data.

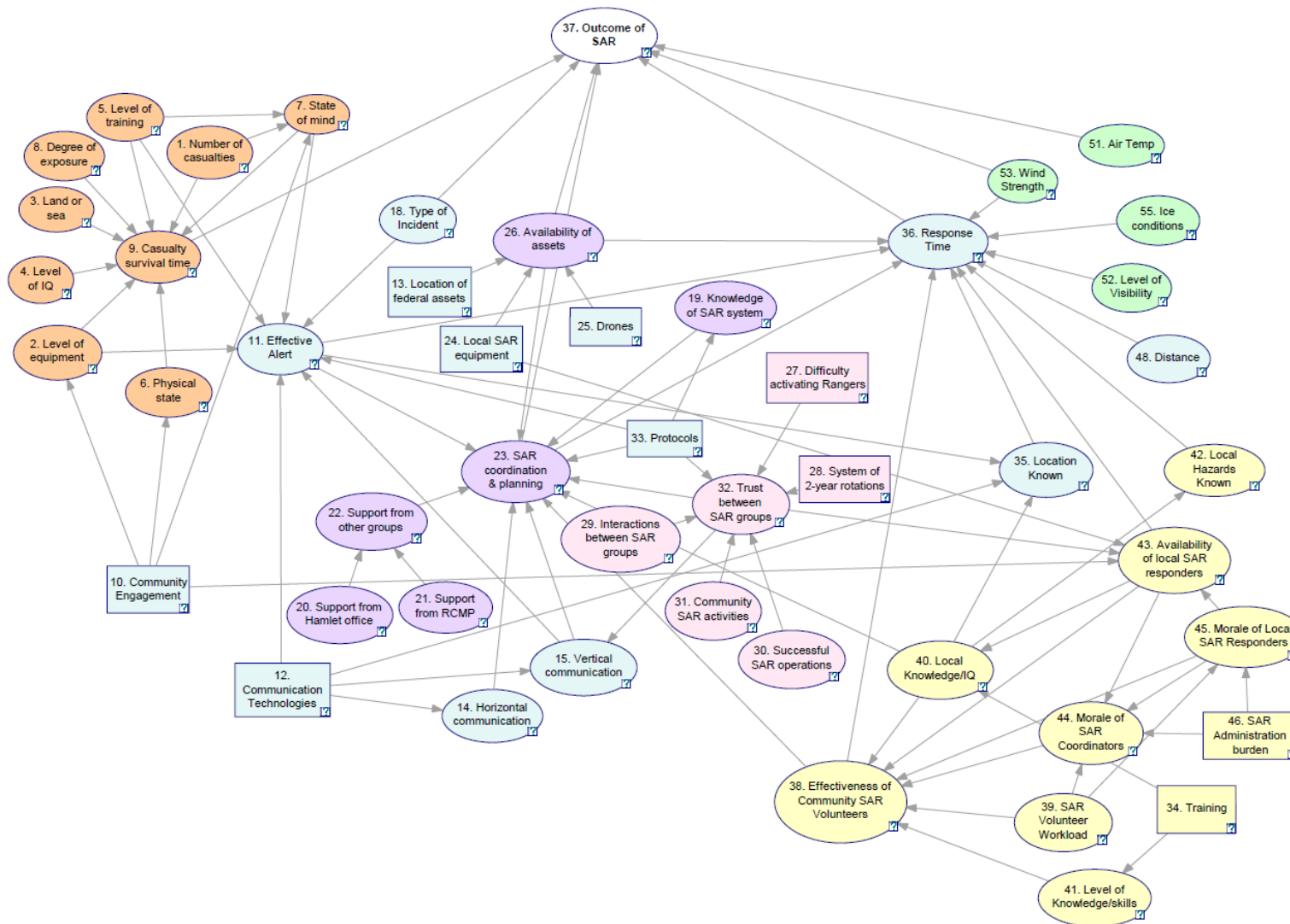
Geographical factors can also influence the outcome of SAR, with certain “hotspot” areas, such as those where harvesting may occur regularly, having a higher likelihood of locating a search subject, and “danger” areas, such as floe edges, making it harder for SAR responders to search - but also increasing the risk of an incident occurring within them. An ongoing, novel, mapping exercise aims to incorporate expert estimations of the size of each Hamlet’s search area jurisdiction, as well as the size and location of “hotspot” and “danger” areas, thus providing greater insight into the role that geography has to play in SAR activities in Nunavut and Nunavik. The future introduction of seasonality (in weather conditions, availability of assets, and use of different travel paths) and regionality (intra-Hamlet differences in size, access to resources, and environmental challenges faced) to the BN will further help to model SAR activities for each Hamlet taking part in the study.

The Current Model

Bayesian Network Structure

The full BN model structure is shown in Figure 2, color-coded to group key issues concerning the search subject, communication technology, planning and execution, inter-agency relationships, volunteer contributions, and environmental factors. The color-coded nodes help to visualize critical risk mitigation opportunities, represented as square nodes. This structure not only supports understanding for SAR experts but also aids community responders in understanding the direct and indirect relationships within the SAR system. The overall purpose of the BN is to represent the relationships between the key issues affecting SAR in Nunavut and Nunavik and the target variable, “Outcome of SAR”, which captures whether any given search and rescue case results in the safe return of a search subject, or a fatality.

Figure 2. Bayesian network structure reflecting factors identified as having a key impact on search and rescue outcomes in Nunavut and Nunavik.



Quantified Bayesian Network

For quantification, we used a simplified version of the BN, which focuses on a sub-set of key nodes in the BN structure that could reasonably be quantified using currently available data. This reduced model allows for focused analysis of the critical impact factors. Table 1 illustrates the effect on outcomes as individual factors change, allowing SAR teams to understand the specific conditions most likely to impact mission success. For example, location information quality (GPS vs. poor location) directly affects SAR success rates, highlighting the importance of technological and environmental conditions for effective SAR responses individually. Initial validation of the quantified BN was carried out by using the model to generate a set of plausible scenarios ranging from low to high risk, which attendees at an Arctic SAR Exchange held in Halifax, NS, in March 2025, then ranked to test the alignment between model outputs and community judgment. The results suggest a strong correlation between the two sets of risk estimates.

Table 1. Estimated impact of single-state changes to the Bayesian network on the percentage likelihood of the target variable “Outcome of SAR” being in the states “Safe” or “Mortality”.

Variable	State	Safe (%)	Mortality (%)
Base Case (No changes)	-	98	2
Location information provided	GPS	100	0
	Good information	99	1
	Poor information	84	16
Distance from base	50 km	99	1
	200 km	95	5
Clothing suitability	Suitable	99	1
	Unsuitable	97	3
Shelter availability	Available	98	2
	Unavailable	97	3
Training level	High	98	2
	Low	97	3
Equipment availability	Available	98	2
	Unavailable	98	2
Local knowledge of SAR responders	High	98	2
	Low	98	2
Maximum possible number of responders	6 persons	98	2
	20 persons	98	2

DISCUSSION

This study presents a pioneering Bayesian Network model that captures the complex interdependencies influencing the outcomes of SAR operations in the Arctic. By incorporating key factors such as weather conditions, the state of the person at risk, search team organization, asset availability, and intergovernmental communication, our model provides a probabilistic framework for understanding SAR success rates. Importantly, this is the first model to integrate lived experiences, drawing upon Inuit narratives to inform its structure and relationships. This approach ensures that the model is grounded in the realities of Arctic SAR operations, enhancing its relevance and applicability.

Looking ahead, we plan to complete our quantification of the BN as far as is possible using currently available SAR data. We will then be in a position to prepare a full description of the quantified model for future publication. We also aim to refine the BN model by directing data collection efforts to improve the accuracy of its inference. This continued development will strengthen its predictive capabilities, ultimately supporting more effective decision-making in Arctic SAR missions as well as informing investment to improve operations. By bridging probabilistic modelling with experiential knowledge, our work offers a novel contribution to both SAR strategy

and BN applications in extreme environments.

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