Research Needs:
Phase I of the project summarizes the SD EMS data from the geographic (e.g. counties in SD) and temporal (e.g. time of day, day of week, and month of year) perspectives and concentrates on several time- and distance-dependent variables such as response time, en-route time, on-scene time, and transporting time as well as the distance to and from the incident scene. The macroscopic-level of analysis did not find apparent outstanding issues with the service. The 911 call volume does not display a strong pattern of spatial clusters. Each of the three EMS regions (East, Center, and West) seems to have a mixture of counties with high, intermediate, and low demand. After accounting for the county population, the demand per capita by county changes moderately, as East region which includes Minnehaha County and Lincoln County has a relatively low EMS demand per capita. It is noteworthy that the average distance between the EMS station and incident scene is only 5.51 miles and the median distance is less than 2 miles. On the other hand, the average distance between the incident scene and receiving agency is 13.74 mile and the median distance is 6 miles. The comparison suggests an excellent EMS coverage and confirms a relatively low density of receiving hospitals. Considering SD is a predominant rural state and many EMS tasks rely on volunteer community members, the network of first responders, paramedic personnel, or volunteers, appears to be well connected.

However, In phase I we were not able to distinguish between the demand in urban and rural areas as well as travel distance and time. It has been well recognized that wide disparity exists in the delivery of EMS in rural areas compared with urban areas due to many causes, including geographic barriers, lack of professional and paraprofessional, inadequate financial resources, aging or inadequate equipment, absence of specialized EMS care and local medical facilities (1). These discrepancies have been reflected at the average EMS response time. 2011
National average EMS response time for fatal crashes is 37.22 minutes in urban areas compared with 54.49 minutes in rural areas (2), which is almost the end of the ‘golden hour’ — the critical first hour from incident to hospital treatment. Therefore, it is important to define and establish the criteria for classifying EMS into rural and urban according to the area setting and compare the two. Among all type of EMS dispatch complaints, traffic incidents are of particular interest because they are random in location, not restricted to homes or work places, and present a great challenge for accessing and transporting the victims from the accident scene to the emergency room. In this phase, we will intensively investigate the EMS services responding to traffic incidents under the rural and urban setting, respectively.

**Research Objectives:**
Two objectives will be achieved in this phase 1) perform survival and route of choice analysis to identify key variables contributing to the time intervals during an EMS process; 2) address potential issues and concerns; and recommend appropriate countermeasures. Moreover, given location information, we are able to predict service delivery more accurately and establish more specific, data-driven, and performance-based measures.

**Research Methods:**
In this phase, we will intensively investigate the EMS services responding to traffic incidents under the rural and urban setting, respectively. SD EMS data are available in the National EMS Information System (NEMSIS) which records EMS information in detail. This database has a unique post-accident perspective; crash data from SDDPS, on the other hand, provides specific prior-, and during-accident views such as the contributing factors to the traffic accident (e.g. human, highway, vehicle, and environment). Piecing together the crash and EMS information, a complete sequence of elements involving a traffic accident can be recovered from the beginning of a crash to the emergency room. A survival analysis is proposed to study each traffic incident in depth to identify critical factors attributing to the chance of survival of a traffic accident victim. Survival analysis is a statistical method that models time to events data and explores certain circumstances and characteristics increasing or decreasing the probability of survival. The event can be a death, a severe injury or something else. It is an ordinary regression model in which the response variable is time and a hazard function or survival function is developed to correlate the time to events with explanatory variables.

Another important aspect of the phase is to understand the route choice decision of ambulance drivers and identify potential bottlenecks and sites of improvements in the highway and street network. With location-specific information, each traffic incident EMS trip can be retrieved and compared to the expected travel time using the GIS roadway network provided by the SDDOT. The trip level of analysis will unravel information in relative to specific routes, segments, and intersections that may be improved or modified to accommodate the need of EMS. Two objectives will be achieved in this phase 1) perform survival and route of choice analysis to identify key variables contributing to the time intervals during an EMS process; 2) address potential issues and concerns; and recommend appropriate countermeasures. Moreover, given location information, we are able to predict service delivery more accurately and establish more specific, data-driven, and performance-based measures.
**Expected Outcomes:**
It is expected that the study will produce the following outcomes:
1. Understanding of variables contributing to time intervals during EMS process
2. Accurate prediction of service delivery
3. Identification of specific, data-driven, and performance-based measures

**Relevance to Strategic Goals:**
The research will directly benefit the health care, social welfare and safety for rural residents and road users. Road safety is vital for sustaining safe and livable communities and has implications for health promotion because it results in preventable death and injury and has economic and psychosocial burdens. Livable communities and safety are among the AHWA strategic outcomes (United States Department of Transportation, 2010). Ensuring that Federal, State, Tribal, and local health agencies have the necessary infrastructure to effectively provide essential public health services is one of the Healthy People 2020 National Goals (Department of Health and Human Services 2011).

**Educational Benefits:**
This research project will involve graduate students and undergraduate students, data collection and analysis. It will provide first-hand research experience for students to master analytical techniques and practice their communication skills.

**Work Plan:**

The work plan is composed by the following tasks:

1) Continue to review and update the literature as it relates to EMS process (2 months)
2) Acquire and filter available state EMS and trauma data
3) Perform data analysis
4) Write report and make recommendations

Project schedule is as follows:

| Task 1: Update Literature Review | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Task 2: Obtain and filter EMS and trauma data | | | | | | | | | | | | | | | | |
| Task 3: Analyze Data | | | | | | | | | | | | | | | | |
| Task 4: Write the Final Report and disseminate Findings | | | | | | | | | | | | | | | | |
**Project Cost:**
Total Project Costs: $58,185
MPC Funds Requested: $43,647
Matching Funds: $14,538  
Source of Matching Funds: SDSU

**TRB Keywords:** EMS, Rural Transportation, Rural Safety, Ambulance Crashes

**References**