

**Highway Work Zone Safety Grant:
Highway Work Zone Safety Audit Guidelines Development and Training
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**A REPORT ON
QUESTIONNAIRE SURVEY ON
HIGHWAY WORK ZONE SAFETY AUDITS**

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EXECUTIVE SUMMARY

This report documents the findings of a questionnaire survey conducted in mid-July 2007 to collect pertinent information to help the research team prepare and refine strategies and methodologies for developing the national highway work zone safety audit guidelines. Specific questions asked in the questionnaire include leading causes of work zone safety problems and effective countermeasures; types of projects suitable for auditing and audit frequencies; suitable project delivery stage, lead party and composition of auditing team, and funding sources for performing work zone safety audit; expected audit tasks, approach, and useful tools; whether or not to cover worker safety and safety training. Empty spaces were also provided for respondents to supply with additional comments.

The expert database maintained by the National Work Zone Information Clearinghouse was used to solicit potential respondents. In total, 604 experts on highway work zone safety and mobility from the FHWA, state transportation agencies, local government agencies, private consultants, equipment vendors, general contractors, universities/research institutions, unions, and professional associations in the United States were selected for participation. The survey period lasted for 4 weeks and 85 respondents returned their completed surveys through the Website, by email, or by fax.

The key findings of the survey are summarized as follows:

- The leading causes of work zone safety problems are due to inadequate work zone setup, inadequate pre-construction planning, and improper enforcement.
- Effective measures for improving highway work zone safety include periodic work zone safety review and public outreach and education on work zone safety issues.
- Major projects shall be given the highest priority for work zone safety audits. Regardless major, minor, or minimal projects, it was generally recommended to perform safety audit on an as needed basis.
- The work zone safety audit at the construction stage is identified as the most needed. Safety audits at the project design and pre-construction stages are also highly recommended.
- State transportation agencies are recommended to lead highway work zone safety audits. In addition, a partnership with the project owner, project owner's consultant, and contractor is also regarded as essential to carry out roadway work zone safety audits.
- A work zone safety audit team shall consist of representatives of Federal agencies, state transportation agencies, highway contractors, and local law enforcement.
- The recommended funding sources for work zone safety audits shall come from the following sources: the FHWA, state transportation agencies, and the project budget.
- The primary audit tasks shall include checking the work zone activity area configuration, examining the implementation of temporary traffic control devices, and assessing driver behavior; and reviewing project design, construction, and transportation management plans.
- An interactive computer tool and computer-based prompt lists are mentioned as useful tools for assisting work zone safety audits.
- A majority of respondents believe that a safety audit shall review the contractor's worker safety training and safety inspection records. They also support that the contractor submit its workers' injury data to the project owner on a regular basis was.
- The contractor's project manager and project owner's representative are identified as most needed for safety training.

In addition, the survey respondents provided additional comments on enhancing work zone safety from engineering, enforcement, and education perspectives, as well as on issues related to the execution of

work zone safety audits. Many of these comments are consistent with the findings from the review of existing literature on highway work zone safety.

ACKNOWLEDGEMENTS

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LIST OF ABBREVIATIONS

ATSSA	American Traffic Safety Services Association
DOT	Department of Transportation
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GIS	Geographical Information System
IOP	Independent Oversight Process
ITS	Intelligent Transportation Systems
MUTCD	Manual on Uniform Traffic Control Devices
NHTSA	National Highway Traffic Safety Administration
OSHA	Occupational Safety and Health Administration
RE	Resident Engineer
RFID	Radio Frequency Identification
RSA	Road Safety Audit
TCD	Traffic Control Devices
TMP	Transportation Management Plan
TTC	Temporary Traffic Control

1 INTRODUCTION

A questionnaire survey was administered in mid-July 2007 to collect pertinent information to help the research team prepare and refine strategies and methodologies for developing the national highway work zone safety audit guidelines.

The survey questionnaire is attached to this report in Appendix A , which consists of thirteen questions. Question one seeks expert opinion on the leading causes of highway work zone safety problems. Question two solicits inputs on effective measures for improving highway work zone safety. Question three inquires types of highway projects suitable for conducting work zone safety audits and desirable audit frequencies. Question four asks the appropriate project delivery stages for performing work zone safety audits. Question five asks for the lead entity of a highway work zone safety audit. Question six relates to the appropriate composition of a highway work zone safety audit team. Question seven inquires how to fund work zone safety audits. Question eight is concerned with the expected tasks for an audit team. Questions nine and ten investigate appropriate approaches to summarize audit findings, and useful tools for assisting work zone safety audits. Question eleven deals with construction worker safety in work zone safety audits. Question twelve specifically seeks opinion on whether the contractor should submit worker injury data to the project owner. Question thirteen pertains to safety training requirement for major parties involving in the project. The questionnaire also provides spaces for respondents to supply with additional comments.

The expert database maintained by the National Work Zone Information Clearing House was used to solicit potential respondents. A total of 604 experts on highway work zone safety and mobility from the Federal Highway Administration (FHWA), state transportation agencies, local government agencies, private consultants, equipment vendors, general contractors, universities/research institutions, and professional associations in the United States were selected and contacted via a mass email. The email contained a link to the online survey Website. An electronic copy of the questionnaire in fillable PDF format was also attached to the email to allow more options to participate in the survey. A respondent may choose to submit the completed survey online, via email, or by fax.

The survey period lasted for 4 weeks. A total of 85 respondents returned their questionnaire. Of which, 57 completed the survey through the Website, 9 responded by email, and 19 responded their responses by fax. The following sections discuss the survey results. Appendix B summarizes the responses in graphs.

2 SURVEY RESULTS

2.1 Employment Distribution

Providing employer information is optional in the survey. Table 2-1 presents a breakdown of the employment information on the eighty five respondents in numbers and percentage respectively. Among the responded, 16 percent did not provide employment information. A majority of the respondents (44 percent) are employed by state transportation agencies. The other respondents work for a wide range of employers with 24 percent from local agencies, 15 percent from Federal agencies, 7 percent from university/research institution, 5 percent from private consultants, and 1 percent from the construction industry. The 4 percent respondents in the “others” employment category include one from an association, a labor union, and a roadway safety hardware manufacture, respectively.

TABLE 2-1 Employment Breakdown of the Respondents

Employment	Responses	
	No.	%
State transportation agencies	37	44%
Local government agencies	20	24%
Federal agencies	13	15%
Universities/ research institutions	6	7%
Private consultants	4	5%
General contractors	1	1%
Others	3	4%

2.2 Leading Causes of Highway Work Zone Safety Problems

Table 2-2 summarizes the responses to the leading primary causes of highway work zone safety problems. The top leading causes of work zone safety problems are found to include: inadequate work zone setup (40 percent), Inadequate pre-construction planning (36 percent), deficient work zone speed enforcement (35 percent), inadequate or inefficient temporary traffic controls (34 percent), and inadequate implementation of traffic and construction rules and regulations (31 percent).

For the 29 percent of the responses in the “others” category, the causes include too many signs at the work zone, lack of coordination with other projects in the vicinity and miscommunications among different parties, work zone induced congestion and vehicle delays, lack of knowledge on highway work zones among permit officers in state and local agencies, unattended drive behavior, and insufficient highway capacity.

TABLE 2-2 Leading Causes of Highway Work Zone Safety Problems

Primary Causes leading to work zone crashes	Responses	
	No.	%
Inadequate work zone setup	34	40%
Inadequate pre-construction planning	31	36%
Deficient work zone speed enforcement, such as police patrol, photo enforcement, etc.	30	35%
Inadequate/inefficient temporary traffic controls	29	34%
Inadequate implementation of/compliance with traffic and const. safety rules and regulations	26	31%
Lack of work zone safety outreach and education to road users	25	29%
Lack of work zone information disseminated to the traveling public	24	28%
Malfunctioning and lack of maintenance of traffic control devices	23	27%
Lack of positive separation between work activity areas and the traveled way	19	22%
Insufficient work zone safety training to work zone participants	19	22%
Long project construction duration	13	15%
Others	25	29%

2.3 Effective Measures for Improving Highway Work Zone Safety

As shown in Table 2-3, the most effective measures for improving work zone safety include periodic work zone safety review or inspection (74 percent), public outreach and education (64 percent), innovative contracting methods to reduce construction duration (56 percent), innovative construction methods to minimize traffic disruption during construction (53 percent), corridor- or network-level project planning to minimize the impact of road work (46 percent), and dissemination of accurate lane closure and delay information to road users (46 percent).

Among the 29 percent “others” effective measures, three respondents recommend proper enforcement; One respondent suggests the need for quality Transportation Management Plans (TMPs); some respondents mentioned the need for adequate use and maintenance of traffic control devices. Other

measures referred by the respondents include: higher speeds limits in absence of workers in operation areas; sufficient funding to plan, design, and construct durable and adequate roadways; use of full-time freeway closures when available; conduction of vehicle crash analysis during project development and construction; regular training; implementation of staged closures and development of alternative routes; better lane channelization; use of positive barriers; development of internal traffic control plans; adoption of best-value contracting (instead of low bid); partnership with law enforcement; clear terms of responsibility between project owner and contractor; and deployment of work zone Intelligent Transportation Systems (ITS).

TABLE 2-3 Effective Measures for Improving Highway Work Zone Safety

Effective Measures	Responses	
	No.	%
Periodic work zone safety review/inspection	63	74%
Public outreach and education on work zone safety issues	54	64%
Innovative contracting methods to reduce construction duration	48	56%
Innovative construction methods to minimize traffic disruption during construction	45	53%
Corridor/network level project planning to minimize the impact of road work	39	46%
Disseminate accurate lane closure and delay info. to road users, both pre-trip and en-route	39	46%
Innovative materials and design to extend facility service lives	24	28%
Increase the use of nighttime construction	20	24%
Others	25	29%

2.4 Types of Highway Projects Suitable for Work Zone Safety Audits and Audit Frequencies

According to the FHWA’s Rule on Work Zone Safety and Mobility (FHWA 2004), a project can be classified into three categories: major, minor, and minimal based on its significance. As shown in Table 2-4, an overwhelm 95 percent of the respondents recommend safety audits for major reconstruction projects. In terms of audit frequency, 56 percent believe that a safety audit be performed as needed.

Eight-two percent respondents support the need for work zone safety audits for minor highway preservation projects. Of which, 32 percent suggest that highway work zone safety audits be performed as needed, 25 percent suggest one time only, and 14 percent recommend once a year as the desirable frequency.

Seventy-one percent recommend safety audits for minimal maintenance projects with 35 percent respondents supporting auditing as needed, thirteen percent for one time auditing, and 8 percent for once a year.

TABLE 2-4 Highway Projects Suitable for Work Zone Safety Auditing and Audit Frequencies

Project Significance	Audit Suitability and Frequencies		Responses	
			No.	%
Major project	Suitable for work zone safety auditing	Yes	81	95%
	Auditing frequencies	Perform as needed	48	56%
		Once a year	19	22%
		One time only	2	2%
		Other frequency	13	15%
Minor project	Suitable for work zone safety auditing	Yes	70	82%
	Auditing frequencies	Perform as needed	27	32%
		One time only	21	25%
		Once a year	12	14%
		Other frequency	11	13%
Minimal project	Suitable for work zone safety auditing	Yes	60	71%
	Auditing frequencies	Perform as needed	30	35%
		One time only	11	13%
		Once a year	7	8%
		Other frequency	15	18%

2.5 Appropriate Project Delivery Stages to Perform Highway Work Zone Safety Audits

Regarding the appropriate stage to perform highway work zone safety audits, a large number of respondents (78 percent) recommend the construction stage, 56 percent suggest the design and contracting stage, 20 percent support the planning stage, and 11 percent recommend the programming stage as shown in Table 2-5. In addition, 41 percent recommend safety audits at the post-construction stage.

TABLE 2-5 Appropriate Project Delivery Stages to Perform Highway Work Zone Safety Auditing

Project Delivery Stages	Responses	
	No.	%
Construction stage	66	78%
Design and contracting stage	48	56%
Post-construction stage (to examine the effectiveness of implemented measures)	35	41%
Planning stage	17	20%
Programming stage	9	11%

2.6 Lead Entity of Highway Work Zone Safety Audits

As shown in Table 2-6, state transportation agencies are recommended by 48 percent of the respondents as the responsible party to lead the effort for highway work zone safety audits. Forty percent recognize the importance of a partnership between the project owner, project owner's consultant, and contractor in performing highway work zone safety audits.

TABLE 2-6 Leading Entity for the Conduction of Highway Work Zone Safety Auditing

Lead Entities	Responses	
	No.	%
State transportation agencies	41	48%
Partnership of the project owner, project owner's consultant, and contractor	34	40%
Federal Highway Administration	13	15%
Independent entities	8	9%
Others	11	13%

2.7 Composition of A Highway Work Zone Safety Audit Team

Table 2-7 summarizes the responses on the composition of a highway work zone safety audit team which shall be consisted of representatives from state transportation agencies (89 percent), FHWA (76 percent), highway contractors (75 percent), law enforcement personnel (62 percent), local government agencies (55 percent), road users (33 percent), independent consultants (27 percent), and project-affected communities (25 percent).

The “others” representatives in the survey include local emergency services such as fire, rescue, and emergency management services, traffic control suppliers, road owners, and roadway safety hardware manufacturers.

TABLE 2-7 Composition of Highway Work Zone Audit Team Members

Audit Team Members	Responses	
	No.	%
State transportation agencies	76	89%
Federal agencies (FHWA, NHTSA, FMCSA, OSHA, etc.)	65	76%
Highway contractors	64	75%
Law enforcement	53	62%
Local governments	47	55%
Road users (commuters and truckers)	28	33%
Independent consultants	23	27%
Representatives of project affected communities	21	25%
Representatives of construction industry insurance agencies	7	8%
Representatives of auto insurance agencies	5	6%
Others	11	13%

2.8 Funding Sources for Highway Work Zone Safety Audits

As seen in Table 2-8, the recommended fund sources for highway work zone safety audits are: FHWA (44 percent), state transportation agencies (26 percent) and the project budget (14 percent).

Among the thirty-two percent in the “others” funding category, seventeen respondents suggest independent entities. Other responded funding sources include national audit fund, a separate item in the project budget, project funding sources, And each participant’s agency.

TABLE 2-8 Funding Sources of Highway Work Zone Safety Audits

Auditing Funding Sources	Responses	
	No.	%
Federal Highway Administration	37	44%
State transportation agencies	22	26%
The project budget	12	14%
Others	27	32%

2.9 Key Tasks of Highway Work Zone Safety Audits

The responses to key audit tasks are summarized in Table 2-9. Respondents assign high priorities on the following tasks: inspecting work zone sites to check the work zone setup and implementation of traffic control devices (91 percent), checking the road user’s driving behavior at work zones (78 percent), examining the configuration of activity area (75 percent), meeting managers of the project owner and contractor to discuss audit findings and reviewing project geometric design, construction plans, and transportation management plans (74 percent), observing construction workers working behavior (66 percent), reviewing crash data and reports (61 percent), familiarizing project basic information (59 percent), reviewing contractor’s work zone safety programs (53 percent), and checking training profiles of work zone participants and interviewing contractor’s project safety supervisors, inspectors, and workers (49 percent), reviewing project owner’s work zone safety programs (48 percent), interviewing project owner’s project safety managers and inspectors (44 percent).

The “others” tasks based on the responses include: nighttime reviews for effectiveness and reflectivity of traffic control devices, a two-stage audit process with one for design audit and the other for construction audit, checking the coordination of the project sequence with TMPs, and checking devices for compliance.

TABLE 2-9 Key Tasks of Highway Work Zone Safety Audits

Auditing Tasks	Responses	
	No.	%
Drive through the work zone to check temporary traffic devices and work zone setup	77	91%
Drive through the work zone to experience road users' driving behavior	66	78%
Drive through the construction site to check the configuration of activity area	64	75%
Review project geometric design, construction plans, and transportation management plans	63	74%
Meet with managers of the project owner and contractor to discuss audit findings	63	74%
Drive through the construction site to observe construction workers' working behavior	56	66%
Review crash data/reports	52	61%
Familiarize project basic information	50	59%
Review contractor's work zone safety programs	45	53%
Check the training profile of work zone participants	42	49%
Interview contractor's project safety supervisor, inspectors, and workers	42	49%
Review project owner's work zone safety programs	41	48%
Interview project owner's project safety manager and inspectors	37	44%
Others	9	11%

2.10 Approach to Summarize Audit Findings

As shown in Table 2-10, regarding how to present the audit finding, fifty-one percent respondents recommend a combination of written summary and scoring methods; forty-eight percent suggest a written summary to document good practices and identify areas for safety improvements;. Only 7 percent support the use of an overall score to qualitatively rate the work zone safety level of the project.

TABLE 2-10 Appropriate Approaches to Summarize Highway Work Zone Safety Audit Findings

Approach to Summarize Auditing Findings	Responses	
	No.	%
A written summary to document good practices and identify areas for safety improvements	41	48%
An overall score to qualitatively rate the work zone safety level for each project	6	7%
Combination of written summary and scoring methods	43	51%

2.11 Tools Useful For Assisting Highway Work Zone Safety Audits

The responses on useful tools for assisting safety audits are almost evenly distributed as shown in Table 2-11. Fifty-five percent of the respondents welcome the use of a computer-based prompt list, 54 percent support the use of an interactive computer tool, and 51 percent like the use of a hardcopy checklist.

Among the “others” possible tools, the responses include: Geographic Information Systems (GIS)-based auditing tool, and videotaping the work zone to document actual conditions.

TABLE 2-11 Tools Helpful for Accomplishing Highway Work Zone Safety Audits

Useful Tools	Responses	
	No.	%
A computer-based prompt list that can be customized to specific work zone conditions	47	55%
An interactive computer tool that allows entering audit findings	46	54%
A hardcopy audit item checklist	43	51%
Others	10	12%

2.12 Construction Worker Safety in Work Zone Safety Audits

Table 2-12 summarizes the opinion on whether or not to consider construction worker safety in work zone safety audits. A majority of eighty percent believe that work zone safety audits shall cover worker safety inside the construction area. As a part of this effort, it is recommended to review construction workers’ safety training records and safety inspection records. Out of the eighty percent of respondents in favor of considering worker safety, 59 percent recommend reviewing construction workers’ safety training records but 21 percent object to reviewing construction worker’s safety training records.

Among the eighty percent of respondents in favor of considering worker safety audits, 64 percent suggest reviewing contractor’s safety inspection records during the construction-stage worker safety audit but 16 percent object to it.

TABLE 2-12 Worker Safety in the Highway Work Zone Safety Audits

Construction Worker Safety		Responses	
		No.	%
a) Should work zone safety audits consider construction worker safety inside the construction area?	Yes	68	80%
	No	17	20%
b) If answered “Yes” in part a), should construction worker safety audit review contractor's worker safety training records?	Yes	50	59%
	No	18	21%
c) If answered “Yes” in part a), should construction worker safety audit review contractor's safety inspection records?	Yes	54	64%
	No	14	16%

2.13 Construction Worker Injury Data

As shown Table 2-13, ninety-three percent out of the eighty five respondents provided feedback to this question. Of which, 60 percent recommend that the contractor should submit their worker injury data to the project owner on regular basis, but thirty-three percent object to it.

TABLE 2-13 Reporting Worker Injury Data to the Project Owner

Submission of Worker Injury Data		Responses	
		No.	%
Should the contractor submit its worker injury data to the project owner on regular basis (e.g., weekly)?	Yes	51	60%
	No	28	33%

2.14 Requirements of Project Personnel for Safety Training

There is a general consensus in the need for project personnel to receive adequate safety training. As shown in Table 2-14, 95 percent of the respondents believe that the contractor’s project managers need to receive safety training; eighty-five percent suggest the need for project owner’s representatives and construction workers to receive safety training, respectively. Seventy-six percent recommend project owner’s consultants to receive safety training.

TABLE 2-14 Project Personnel in Need of Work Zone Safety Training

Project Personnel Classification	Response	
	No.	%
Contractor's project managers	81	95%
Project owner's representatives	72	85%
Construction workers	72	85%
Project owner's consultants	65	76%
Others	19	22%

2.15 Additional Comments

The survey respondents provided more insights by supplying their returned surveys with specific comments. Thirty out of the 85 respondents (35 percent) provided additional comments on issues related to the conduction of work zone safety audits, as listed in Table 2-15. The comments addressed by the respondents can generally be classified into four categories: engineering, enforcement, education, and execution of work zone safety audits. Many of these comments are consistent with the findings from the review of existing literature on highway work zone safety.

The comments on engineering issues mainly emphasized multi-entity partnerships, transportation management plans (transportation operations management, temporary traffic control, and public information), and work zone safety impact assessment. Forming a strong partnership among the project owner, FHWA, contractor, and law enforcement was mentioned to be critical to improve the overall work zone safety. Establishing an agency-level work zone safety management program could provide a direct venue to foster an effective partnership. In addition, maintaining close communication between the road users and construction crew was mentioned to be important in securing the optimal balance between the road user and construction worker safety. The respondents also proposed to clearly stipulate the legal responsibilities of all entities involving a specific highway project. When a highway project involves a high percentage of Hispanic workers, the project safety related documents shall be prepared in both English and Spanish.

The preparation of transportation management plans was recommended to begin at the project early planning stage. Considering over build the project by acquiring excessive right-of-way, the network impacts of the project, and adequate detours and work zone accesses are crucial to produce effective transportation management plans. However, the respondents stressed the importance of the project owner’s role in ensuring the meticulous implementation of the plans by the contractor, monitoring and assessing the effectiveness of the implemented plans, and enhancing the plans as needed.

In the aspect of work zone safety impact assessment, there was a call for developing guidelines for collecting data to estimate the impacts of an isolated project on network-level safety and mobility. For any work zone safety impact assessment, alternative lane closure and incident management strategies must be given due considerations. Furthermore, it was recommended to include the assessment of contractor’s productivity versus worker safety within the general framework of work zone safety impact assessment. It was proposed to carry out cross comparisons of safety impacts of similar projects as a means to mitigate such impacts to be caused by similar projects in the future.

The MRUTC stipulates the minimum acceptable standards for deploying various types of roadway safety hardware, including signs (warning and regulatory-related and information-related), signals, lighting, detection devices, pavement markings and stripping, and guardrails, barriers, and crash cushions. Keeping the balance of sufficient, but not overloaded amount of hardware is a key concern in the process of developing a temporary traffic control plan. Equally important to this is to maintain an agency-level policy or process that promotes consistent traffic controls for all projects within the same agency.

Providing accurate, sufficient, and real time information to the traveling public, pre-trip and en route, is a key ITS function to effectively handle travel demand according to the adjusted highway capacity (i.e., the supply). This will avoid many work zone safety and mobility consequences caused by capacity reduction.

Enforcement has typically involved a law enforcement agent parked in a vehicle alone the project work zone observing for violations. It has been widely proven to be an effective means to improve work zone safety. However, this method is unsafe for the officer, expensive, and requires a lot of staff resources for the law enforcement agency. The use of ITS-oriented automated enforcement systems for speeding is a potentially effective way to deter high-risk driving behaviors, thus creating a change in behavior that will translate into a crash reduction. It was recommended to consider variable speed limits with and without workers' presence in the work zone and during peak and off-peak period within a day to maximize mobility while maintaining high level of safety.

Education is one of the 3E principles (i.e., engineering, enforcement, and education) for safety enhancement. The process targets the education of general public and road users, and training of project owner's and contractor's staff. The materials for general education or training are recommended to be specifically prepared according to the individuals' background. To ensure the effective delivery of education and training sessions, the trainers must receive adequate training before hand.

Some respondents urged to implement works zone safety audits to effectively comply with the requirements of the FHWA Final Rule on Work Zone Safety and Mobility. When conducting audits of road segment and intersection work zones, nighttime audits are highly recommended. Audits of projects in tourism areas need to be given specific considerations. Pedestrian issues were mentioned to be critical in urban intersection work zone safety auditing. The audit team members must be carefully assembled to ensure the efficiency of audit effort and fairness of audit findings. It was recommended to use a checklist to assist in auditing, but it was not recommended to use a scoring system for work zone safety audits to qualitative assess work zone safety level. It was highly recommended to reach a resolution between the project owner and audit team at the audit close-up meeting. For any concerns raised by the audit team, the acceptance of remedying measures proposed by the audit team and reason for declining the recommendations must be well documented and the audit report must be regarded as a part of project documents.

TABLE 2-15 Additional Comments Provided by Respondents

Topic	Comments from	Details
Organizational Strategy	Colorado	Work in close partnership with the FHWA to continually improve work zone safety evaluation processes
	Michigan	<ul style="list-style-type: none"> - The safety issues for each project should reflect the legal responsibilities as defined by current case histories - Form strong partnerships with construction industry and enforcement - Engage specialized teams to provide support when safety issues occur - Perform weekly project site review - Conduct post construction review
	Texas	Create a specific public awareness program for each major project
	West Virginia	Maintain close communication between highway users and construction crews to optimize the balance of road user and worker safety
Transportation Management	Illinois	Maintain adequate work zone accessibility during all stages of construction
	North Carolina	Pre-planning for network considerations and use alternative routes
	Texas	Project agency taking responsibility for TMP development, partnering with contractors for TMP implementation, and performing inspection
	Virginia	Begin developing TMPs at the project planning stage
Work Zone Safety Impacts Assessment	Colorado	<ul style="list-style-type: none"> - Use statistical modeling to help direct resources to work zone areas with the most potential for safety improvements - Need guidance for collecting and analyzing traffic delay data, systematically conducting this type of analysis on a regular basis, and implementing changes as necessary while the road work is ongoing - Address productivity versus safety for construction workers on site
	Michigan	Review crash patterns on similar projects to reduce or eliminate crashes on the next project before they occur
Incident Management	Illinois	Consider incident management in work zone safety strategies
Lane Closure	Pennsylvania	Congestion management and mitigation is key to work zone safety
	Florida	Need for the FHWA to develop requirements for sidewalk closures
Traffic Control	Illinois	Practice ramp and road closures in the vicinity of work zones
	District of Columbia	Lack of personal knowledge of Manual on Uniform Traffic Control Devices (MUTCD) in small towns reflects in poor work zone operations
	Michigan	Promote consistency in traffic control signing throughout agencies and conformation of proper signing. The Michigan DOT requires placing 8 signs before mobilizing a worker to the work zone area
Public Information	West Virginia	Innovative use of portable barriers, movable barriers, and work staging to provide barrier protected work areas or allow more lateral buffer space
	Michigan	Providing current information to road users to reduce work zone crashes
	Pennsylvania	Use ITS technologies to disseminate information to en-route travelers

TABLE 2-15 Additional Comments Provided by Respondents (Continued)

Topic	Comments from	Details
Enforcement	District of Columbia	Criticize the very poor operation by just placing a policeman at the work zone to direct traffic
	Florida	Emphasize the role of a national audit system in promoting work zone safety and the necessity of fining, if necessary, project shutdown in case of violation of rules by audit agencies
	Michigan	- More police presence to enforce the traveling public slow down when workers are in the operation area - Have enforcement in the merge area of multilane reductions - Use 45 mph speed limit when workers are present at the work zone site and raise speed limit when workers are not present
	North Carolina	Partner with law enforcement to provide visible speed reduction when lane closures happened
	Utah	Recommend videotaping of safety and traffic monitoring both within the worksites all major construction projects and their impacts on adjacent traffic corridors and other modes of transportation
	Virginia	- Law enforcement presence in work zones - Driving behaviors are expected to change along with effective work zone speed limits
Education	Arkansas	Continue to educate the public and strive to get the monitoring public to adhere to work zone safety
	Colorado	Educate the public on hazards in work zones
	Michigan	Educate new drivers on work zone safety during drivers education
	Nebraska	Educate drivers to drive more safely in work zones
Training	Colorado	Have an executive level safety council set safety training courses
	Michigan	- Arrange contractor and staff training annually to keep staff up on current practices or correction issues - Provide training to road users to reduce work zone crashes
	Texas	- Emphasize government agency review/inspection of on-job work activities by qualified employees - Need specific training for consultants which may result in highest pay back of time and money - Need better qualified work zone training instructors and better compensation to attract quality instructors - Need specific training courses geared to trainees' background, such as contractors, government agencies, and consultants
	Virginia	Better trained workers resulting in fewer mistakes made, and more consistent work zone traffic control applications

TABLE 2-15 Summary of Additional Comments on Work Zone Safety Audits (Continued)

Topic	Comments from	Details
Execution of Work Zone Safety Audits	Colorado/ Virginia	Implement work zone safety audits to meet the requirements of the FHWA Final Rule on Work Zone Safety and Mobility
	Michigan	<ul style="list-style-type: none"> - When performing safety audits, the project items should be evaluated and either accepted, or accepted with corrections - Perform nighttime inspections as part of work zone safety auditing - No audit team should leave a project site that has identified safety concerns on a project without correcting those issues, which place the agency in a position of liability - Develop plan to go with the work zone safety audits
	Pennsylvania	Integrate work zone safety audits with the FHWA's Independent Oversight Process (IOP) reviews
	Puerto Rico	<ul style="list-style-type: none"> - Perform an initial audit on the roadside, a second audit in the mainline pavement, and the third audit in the median - For auditing intersection projects, the audit should incorporate all access and interviews from owners of the business in the perimeter of intersections - For auditing projects in tourist's areas, specifically seasonal areas like winter, summer, or weekends, special attention should be given to unfamiliar drivers - Pedestrian issues in work zones in urban areas are extremely critical, particularly in areas with a high percentage of elderly people and children - Perform nighttime inspections as part of work zone safety auditing - Include prompt list/checklist both in Spanish and English particularly in construction projects that include a high percentage of Hispanic or Spanish speaking workers
	Texas	Perform monthly inspection on major projects by non-project personnel
Composition of Audit Team Members	Michigan	<ul style="list-style-type: none"> - Safety audits are important, but do not have values if they are used to criticize the project - Bringing a "team of experts" into projects has shown to create more problems than help, unless the team consists of the right number of individuals who perform safety audits to provide support to the project owner and contractor
Summary of Audit Findings	Michigan	No safety audit should provide a low score on a project. This indicates that the audit team is there to criticize, but not correct. Scoring systems should be abandoned

3 SUMMARY AND CONCLUDING REMARKS

The key findings of the survey are as follows:

- The respondents identified the following leading causes that may result in highway work zone safety problems: inadequate work zone setup, inadequate pre-construction planning, deficient work zone speed enforcement, deficient temporary traffic controls including positive separation between work activity areas and the traveled way and overloaded signage, and malfunctioning and lack of maintenance of traffic control devices. In addition, they also recognize the following important causes: inadequate implementation of traffic and construction rules and regulation, lack of work zone safety outreach, information dissemination, and education and training to road users and other work zone participants.
- A majority of the respondents believe that periodic work zone safety review or inspection can significantly improve work zone safety. Other effective measures for enhancing work zone safety performance include: corridor- or network-level project planning to minimize the impact of road work, innovative materials and designs that reduce construction frequency, innovative contracting methods and adoption of best value contracting (instead of low bid) that reduce construction duration, and innovative construction methods to minimize traffic disruption during construction. Other effective measures also include quality TMPs; effective work zone impact assessment addressing mobility, safety, and productivity; analyzing vehicle crash patterns before/during construction, use of full or staged lane closures when available, provision of better lane channelization, greater use of positive barriers, appropriate use and maintenance of traffic control devices, deployment of work zone ITS installations, variable speed controls, police and photo enforcement, and partnership among state transportation agencies, FHWA, and enforcement. Creation of specific public awareness programs for outreaching and dissemination of accurate lane closure and delay information to road users pre-trip and en-route are also identified by respondents as useful for improving work zone safety.
- A overwhelm majority of respondents recommend safety audits for all major, minor, and minimal projects at an as-needed basis.
- A large number of respondents suggest the construction stage is appropriate to perform highway work zone safety audits. In addition, one-half of the respondents support safety audits at the design and contracting stage.
- State transportation agencies are mentioned by one-half of the respondents as the entity to lead the effort of highway work zone safety audits. In addition, a partnership between the project owner, project owner's consultant, and contractor is highly recommended.
- The survey respondents recommend a work zone safety audit team to be consisted of members mainly from state transportation agencies, FHWA, highway contractors, and law enforcement although suggested memberships also include emergency services, local government agencies, road users, and project-affected communities.
- The commended funding sources mainly include: FHWA, state transportation agencies, or the project budget. Some suggest having a "national audit fund".
- The respondents consider the following important audit tasks: reviewing project geometric design, construction plans, and transportation management plans; reviewing transportation management plans ranging from examine work zone accessibility, lane closure, incident and emergency management during all stages of construction, coordination of the project sequence with transportation management plans, and measures to ensure the implementation and inspection of approved transportation management plans. Furthermore, respondents suggest reviewing crash data and reports, reviewing work zone safety programs of the project owner and contractor, checking training profiles of work zone participants, inspecting work zone sites to check the work zone setup,

examining the adequacy and consistency of traffic control devices and safety hardware, checking the road users' driving behavior and construction workers' working behavior at work zones, examining the configuration of activity area, interviewing contractor's project safety supervisors, inspectors, and workers, and meeting managers of the project owner and contractor to discuss audit findings. Respondents agree that audits must be performed both at daytime and at night.

- A majority of respondents recommend reviewing of construction workers' safety training profiles and contractor's safety inspection records during the construction-stage worker safety audits. In addition, respondents support that the contractor should submit their worker injury data to the project owner on regular basis.
- Respondents indicate that using one or more combination of hardcopy checklist, computer-based prompt list, interactive computer tool, GIS-based auditing tool, and videotaping would be helpful. Moreover, ease of use is very important for the tools. Check lists and prompt lists are desirable to be prepared in both English and Spanish languages.
- Respondents are generally in favor of using a written summary to document good practices and identify areas for safety improvements, but they are against the use of an overall score to rate the work zone safety level of the project.

APPENDICES

APPENDIX A: FHWA Grant DTFH61-06-G-00005: Highway Work Zone Safety Audit Guidelines Development and Training
Questionnaire Survey on Highway Work Zone Safety Audits

PURPOSE OF THIS QUESTIONNAIRE

The Federal Highway Administration (FHWA) awarded a grant (Award No. DTFH61-06-G-00005) to a joint research team comprised of Illinois Institute of Technology, Illinois Department of Transportation, and Utah LTAP Center to develop the national highway work zone safety audit guidelines, prepare guidelines training materials, and conduct training across the country. This questionnaire survey is intended to help the research team recommend strategies and methodologies for developing the audit guidelines and conducting work zone safety audits.

Please email, fax, or mail the completed survey form by July 31, 2007 to:

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Please spend your valuable time to complete this questionnaire. Your input is very important to make our WORK ZONES safer for all of us.

YOUR GENERAL INFORMATION (OPTIONAL)

Name: _____

Title: _____

Address: _____

Phone: _____

Fax: _____

E-mail: _____

YOUR EMPLOYER

- Federal agency
- State transportation agency
- Local government agency
- Private consultant
- General contractor
- University/research institution
- Other (please specify) _____

1. Please check the leading causes of highway work zone safety problems from your experience.

- Inadequate pre-construction planning
- Long project construction duration
- Inadequate work zone setup
- Lack of positive separation between work activity areas and the traveled way
- Inadequate/inefficient temporary traffic controls
- Malfunctioning and lack of maintenance of traffic control devices
- Lack of work zone information disseminated to the traveling public
- Deficient work zone speed enforcement (such as lacking police patrol, photo enforcement, etc.)
- Lack of work zone safety outreach and education to road users
- Insufficient work zone safety training to work zone participants
- Inadequate implementation of/compliance with traffic and construction safety rules and regulations
- Other (please specify) _____

2. Please check the effective measures for improving work zone safety from your opinion.

- Public outreach and education on work zone safety issues
- Corridor/network level project planning to minimize the impact of road work
- Innovative materials and design to extend facility service lives
- Innovative contracting methods to reduce construction duration
- Innovative construction methods to minimize traffic disruption during construction
- Increase the use of nighttime construction
- Periodic work zone safety review/inspection
- Disseminate accurate lane closure and delay information to road users, both pre-trip and en-route
- Other (please specify) _____

3. Please check the types of projects suitable for highway work zone safety audits and desirable audit frequencies.

Project Scale	Check if Suitable	Audit Frequency if Suitable for Auditing			
		Once a Year	One Time only	Perform as Needed	Other (please specify)
Major reconstruction project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Minor preservation project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Minimal maintenance project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

4. Please check the appropriate project delivery stage(s) to perform highway work zone safety audits.

- Planning stage
- Programming stage
- Design and contracting stage
- Construction stage
- Post-construction stage (to examine the effectiveness of implemented measures)

5. Please check the entity that should lead highway work zone safety audits.

- Federal Highway Administration
- State transportation agencies
- Independent entities
- Partnership of the project owner, project owner's consultant, and contractor
- Other (please specify) _____

6. Please check appropriate composition of a highway work zone safety audit team members:

- Federal agencies (FHWA, NHTSA, FMCSA, OSHA, etc.)
- State transportation agencies
- Local governments
- Law enforcement
- Independent consultants
- Highway contractors
- Road users (commuters and truckers)
- Representatives of project affected communities
- Representatives of auto insurance agencies
- Representatives of construction industry insurance agencies
- Other (please specify) _____

NHTSA- National Highway Traffic Safety Administration;
FMCSA- Federal Motor Carrier Safety Administration;
OSHA- Occupational Safety and Health Administration.

7. How should highway work zone safety audits be funded?

- Federal Highway Administration
- State transportation agencies
- The budget for each project
- Other _____

8. Please check expected key tasks of highway work zone safety audits.

- Familiarize project basic information
- Review project geometric design, construction plans, and transportation management plans
- Review crash data/reports
- Review project owner's work zone safety programs
- Review contractor's work zone safety programs
- Check the training profile of work zone participants
- Drive through the work zone to check the implementation of temporary traffic devices and work zone setup
- Drive through the construction site to check the configuration of activity area
- Drive through the construction site to observe construction workers' working behavior
- Drive through the work zone to experience road users' driving behavior
- Interview project owner's project safety manager and inspectors
- Interview contractor's project safety supervisor, inspectors, and workers
- Meet with managers of the project owner and contractor to discuss audit findings
- Other (please specify) _____

9. Please check the most appropriate approach to summarize audit findings.

- A written summary to document good practices and identify areas for safety improvements
- An overall score to qualitatively rate the work zone safety level for each project
- Combination of written summary and scoring methods

10. Please check tools that could help accomplish highway work zone safety audits.

- A hardcopy audit item checklist
- A computer-based prompt list that can be customized to specific work zone conditions
- An interactive computer tool that allows entering audit findings
- Other (please specify) _____

11. Should work zone safety audits consider construction worker safety inside the construction area?

- Yes
- No

If “Yes”, please continue on the following:

Should construction worker safety audit review contractor’s worker safety training records?

- Yes
- No

Should construction worker safety audit review contractor’s safety inspection records?

- Yes
- No

12. Should the contractor submit its worker injury data to the project owner on regular basis (e.g., weekly)?

- Yes
- No

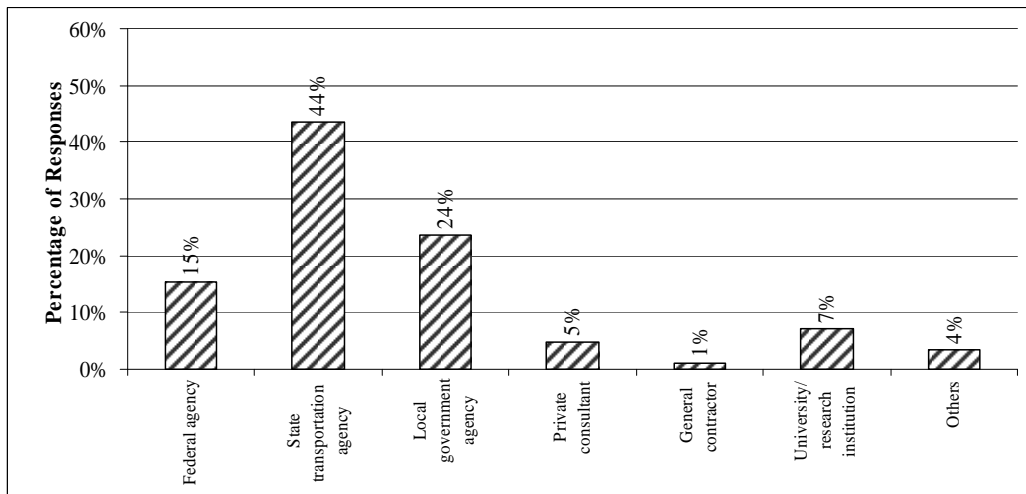
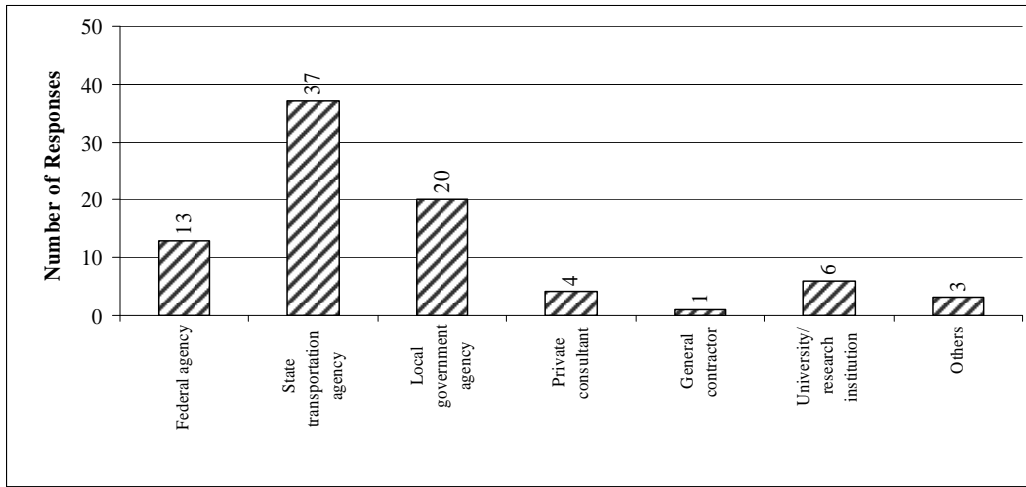
13. Please check following project personnel who need to receive safety training.

- Project owner’s representatives
- Project owner’s consultants
- Contractor’s project managers
- Construction workers
- Other (please specify) _____

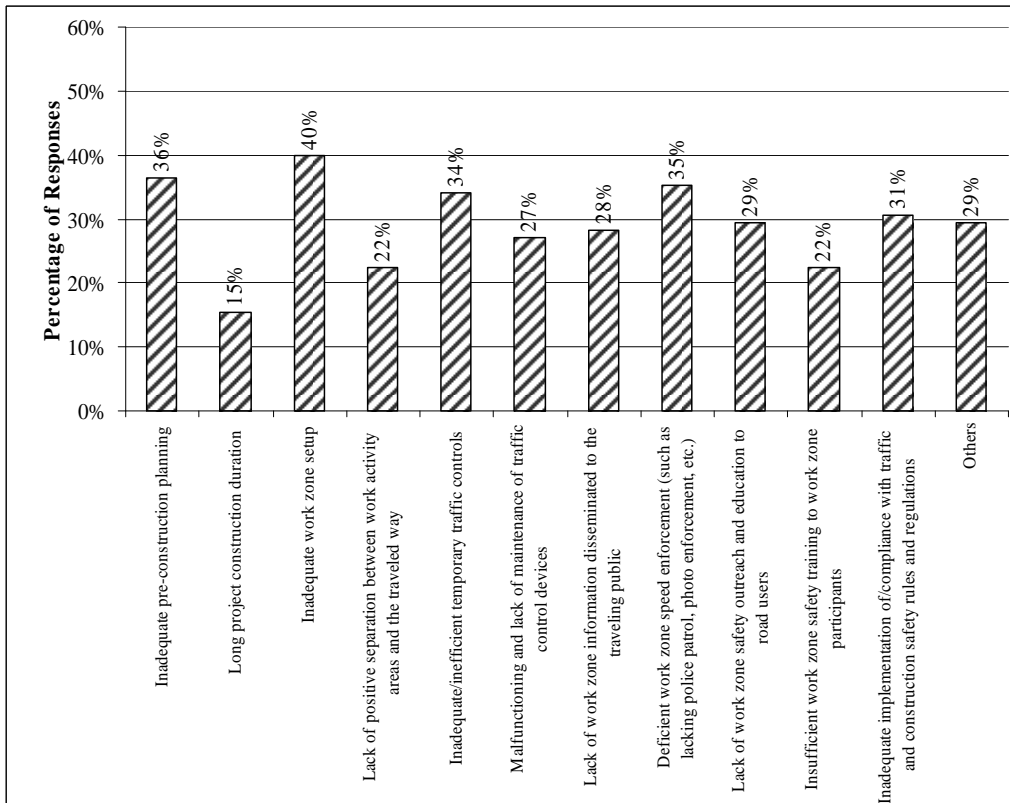
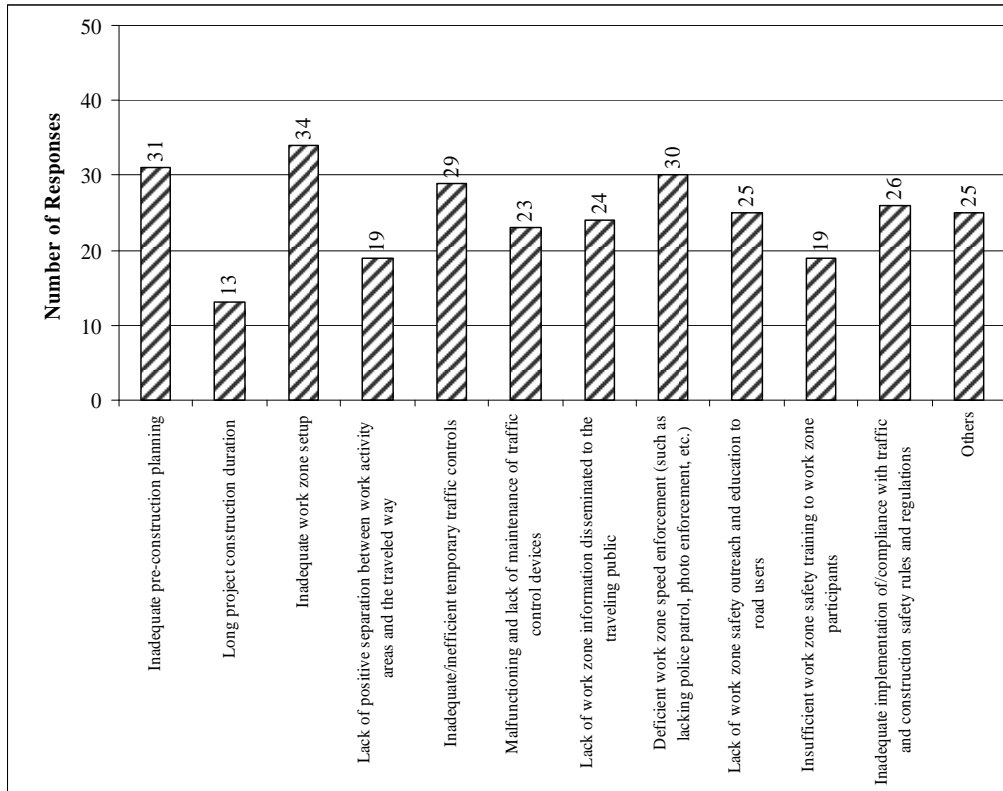
14. Additional comments for improving work zone safety:

APPENDIX B: Graphic Presentations of Survey Results

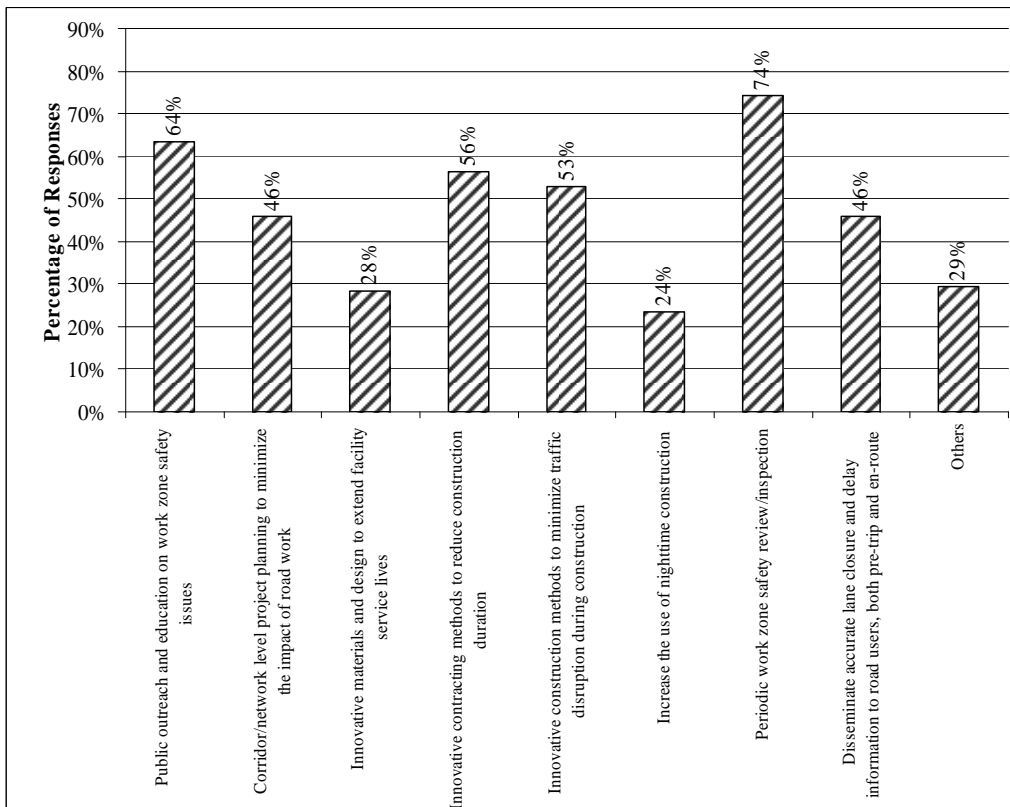
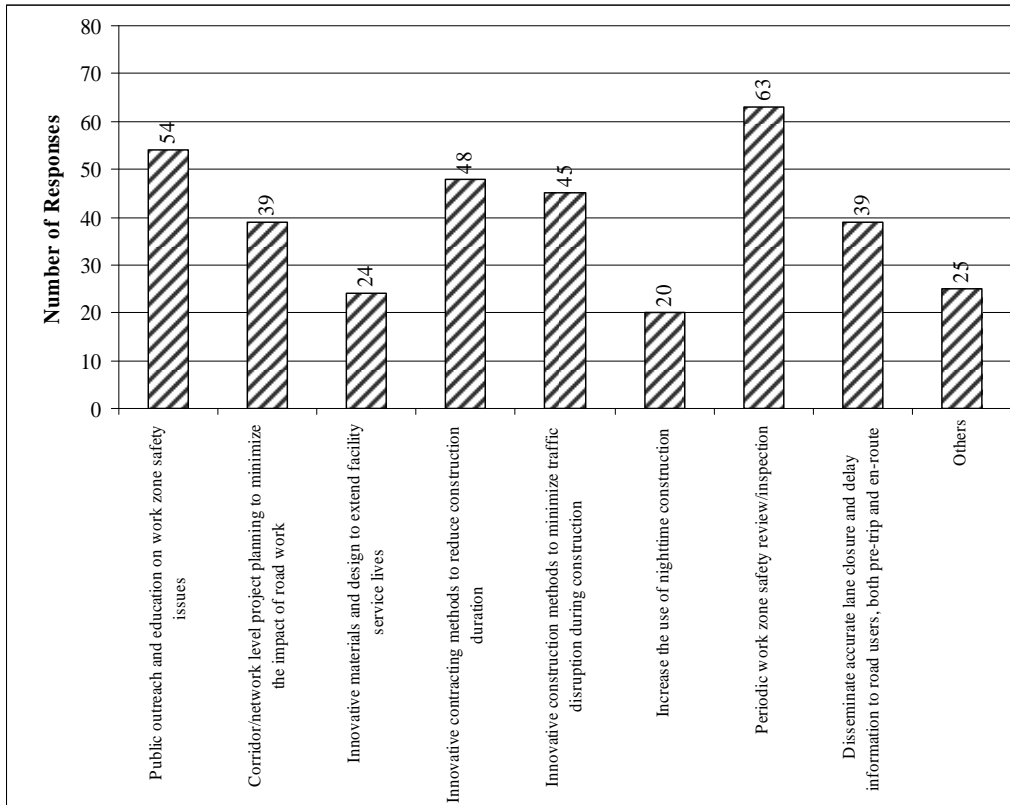
Distribution of Survey Respondents



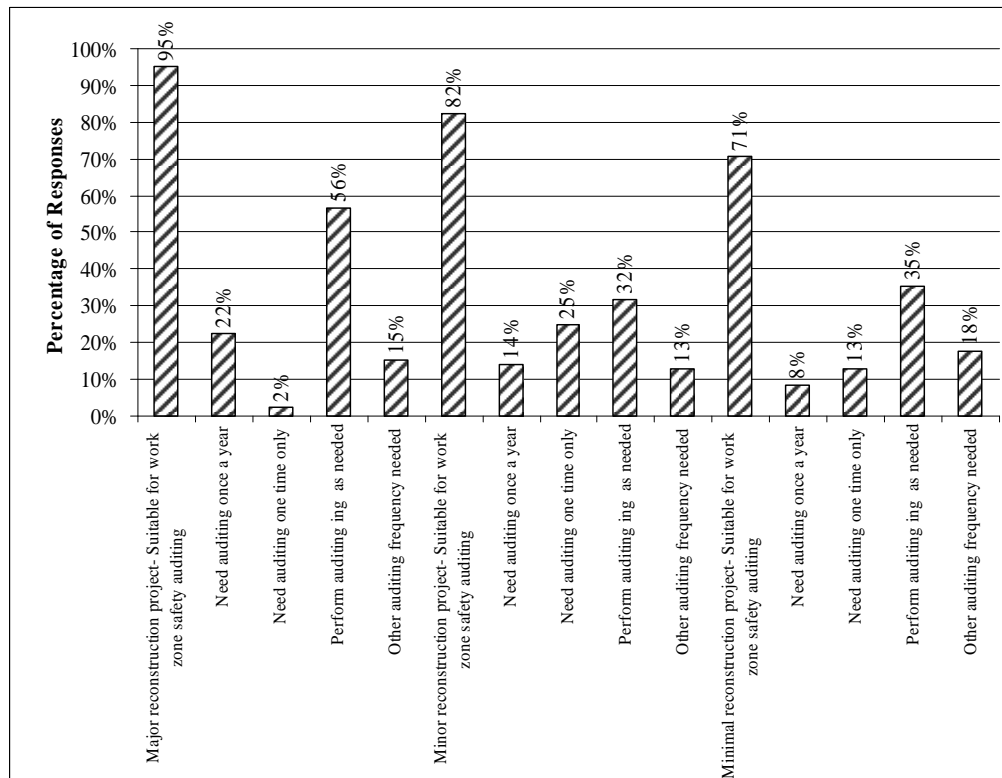
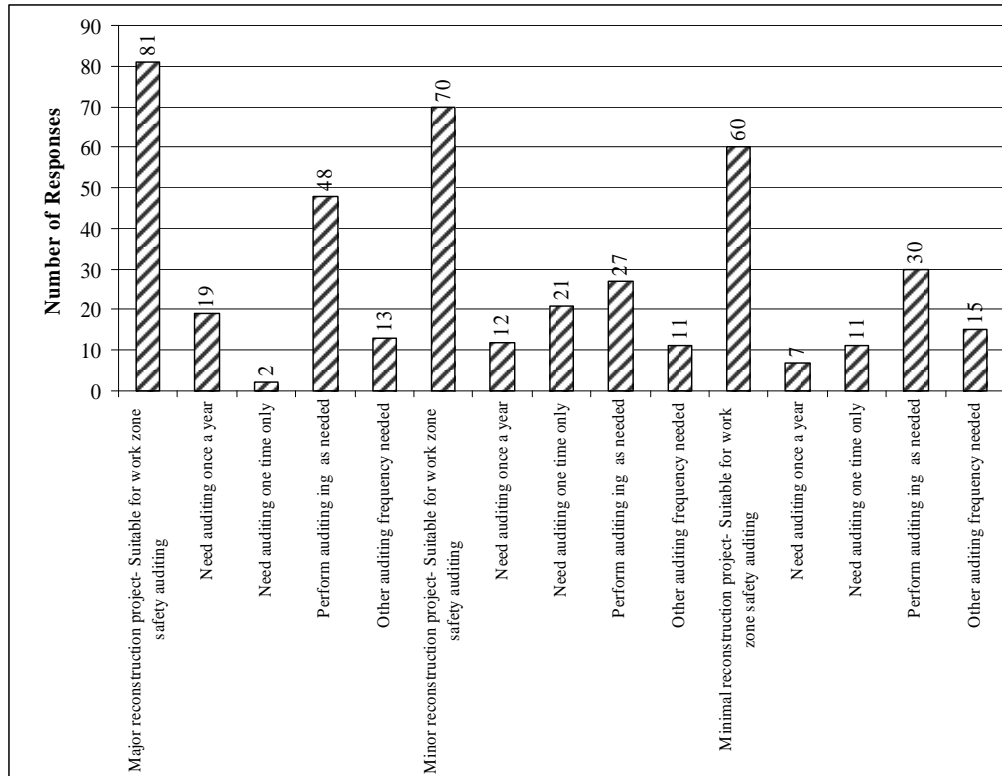
1. Leading causes of highway work zone safety problems



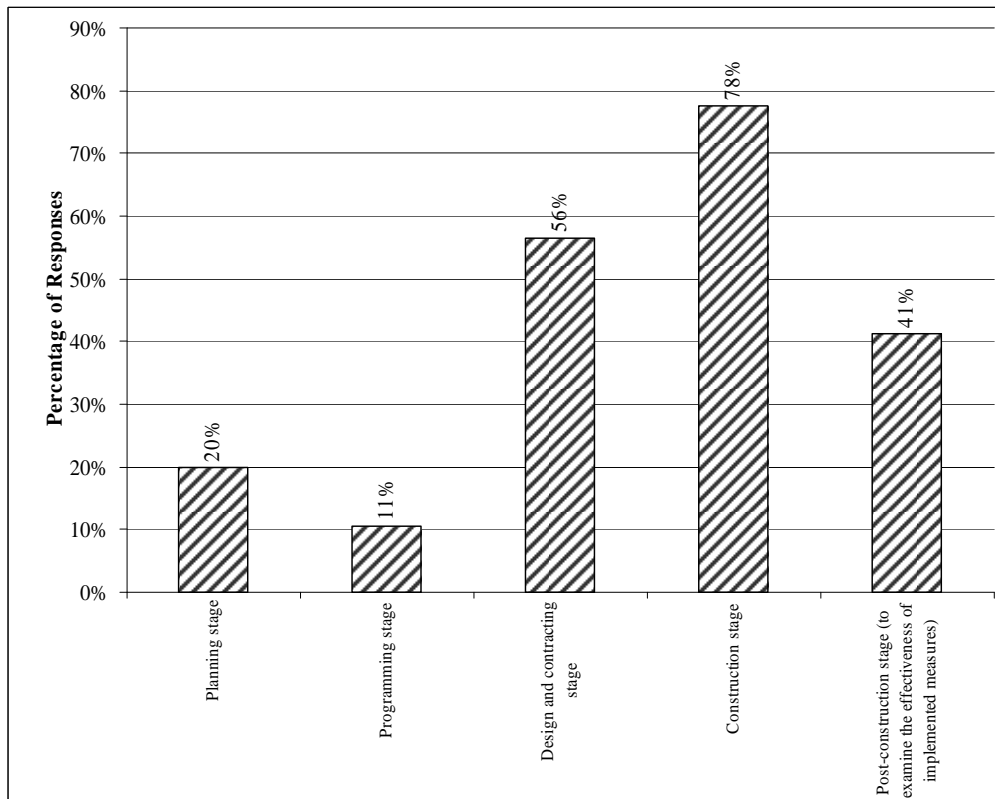
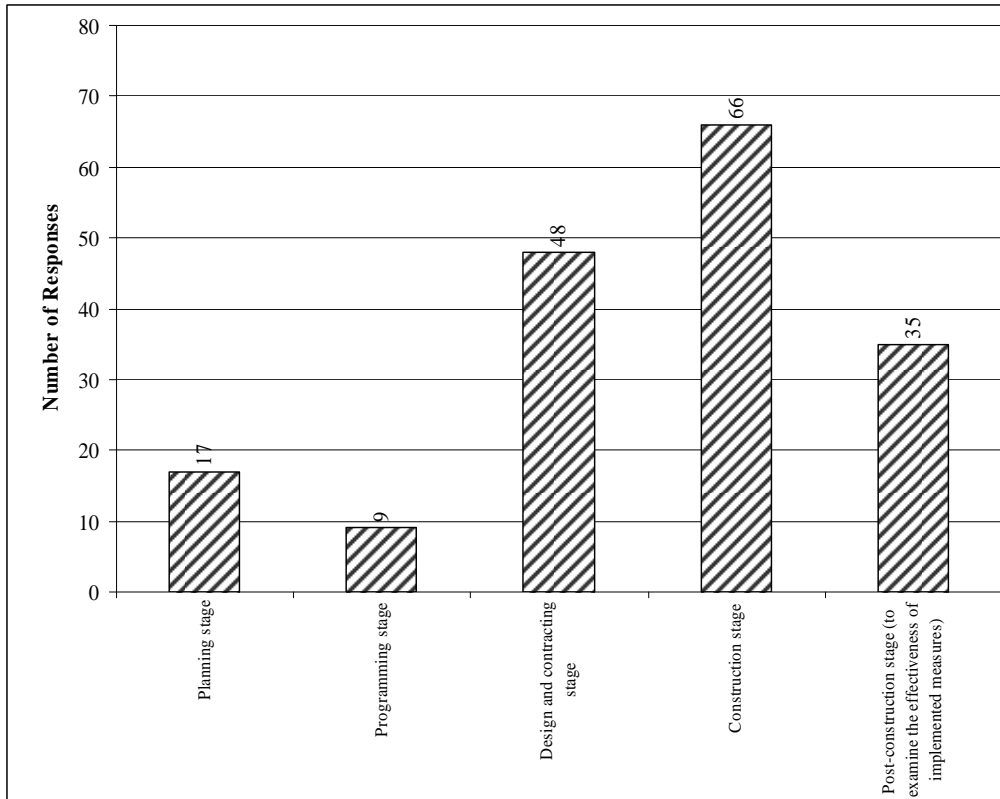
2. Effective measures for improving work zone safety



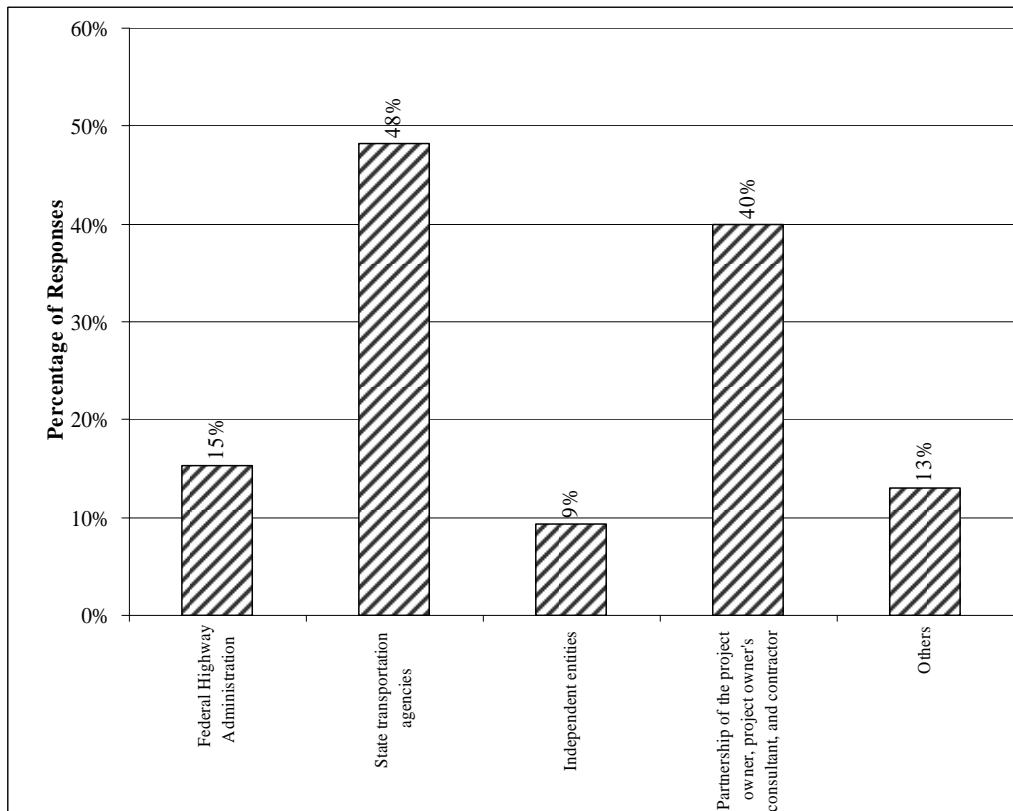
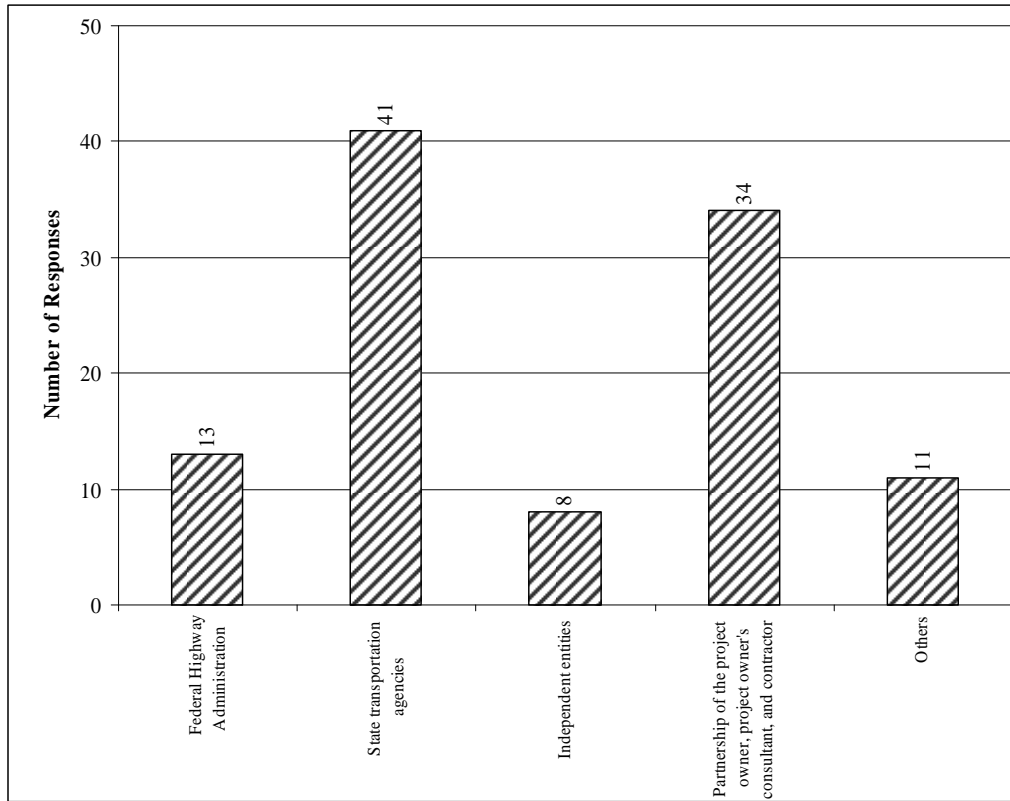
3. Types of projects suitable for highway work zone safety audits and audit frequencies



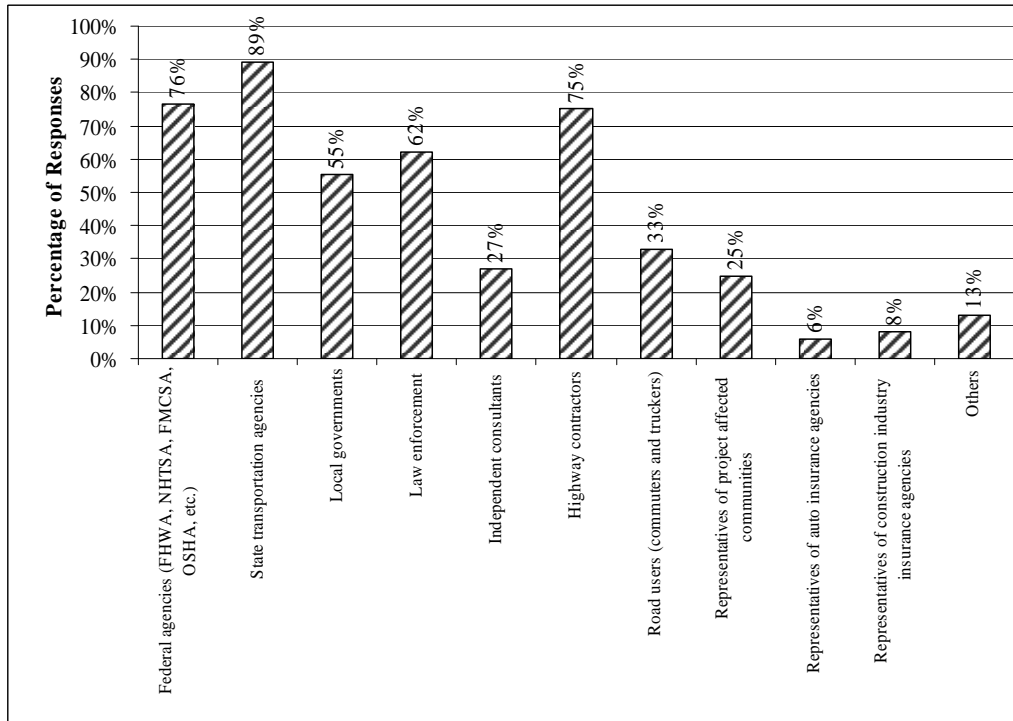
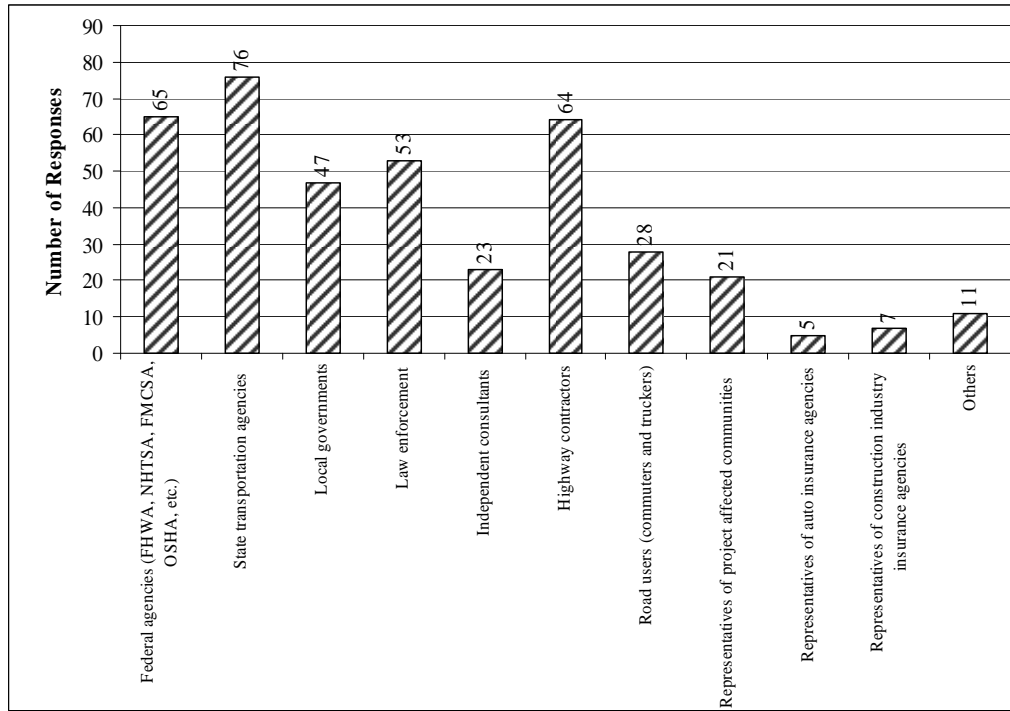
4. Appropriate project delivery stages to perform highway work zone safety audits



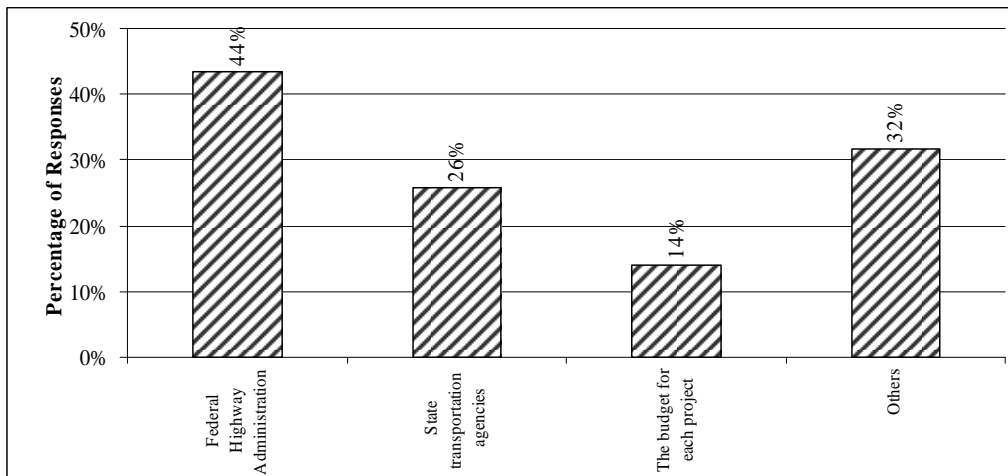
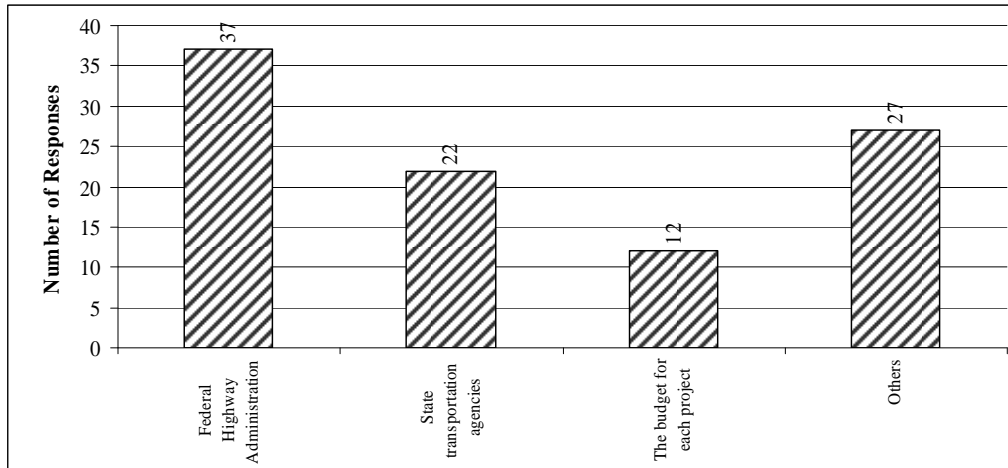
5. Entity leading highway work zone safety audits



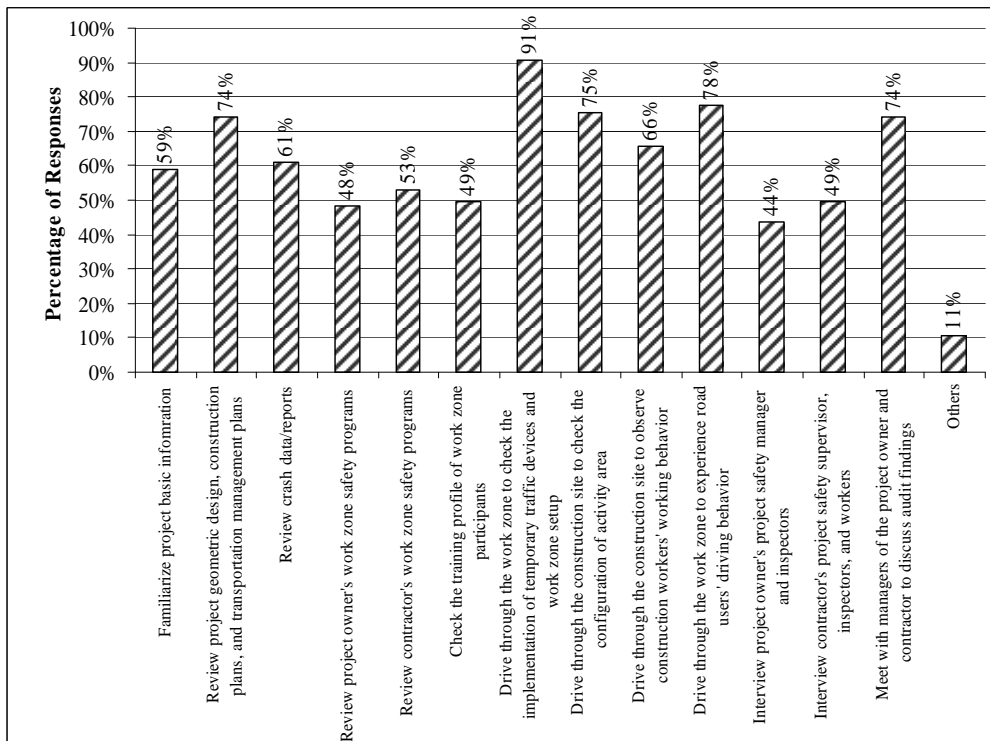
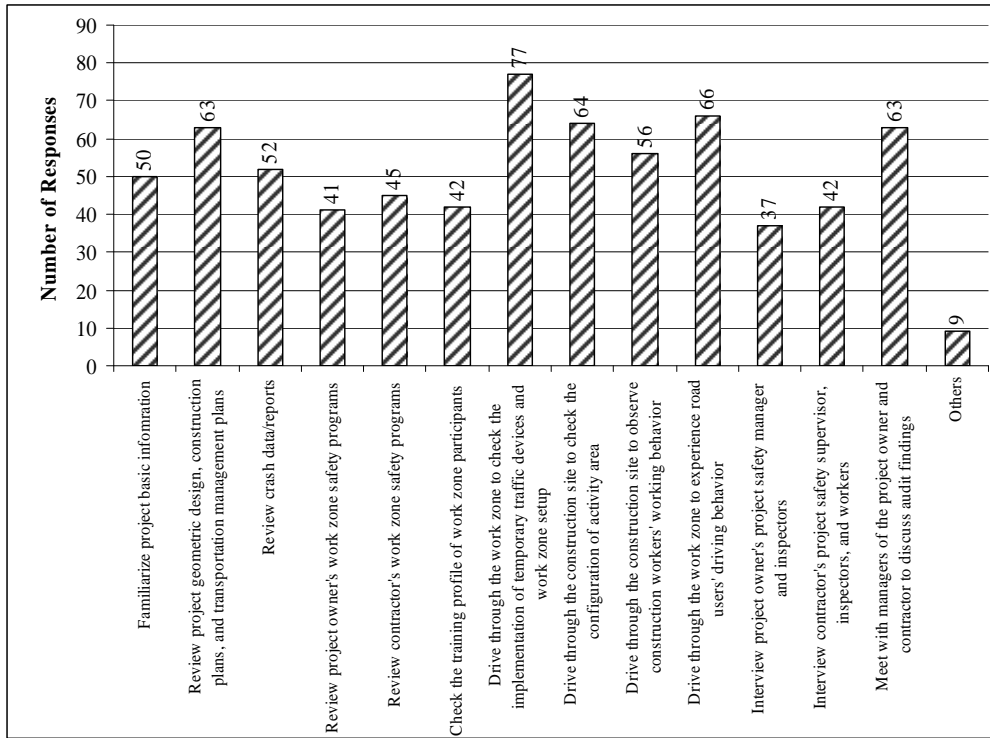
6. Composition of a highway work zone safety audit team members



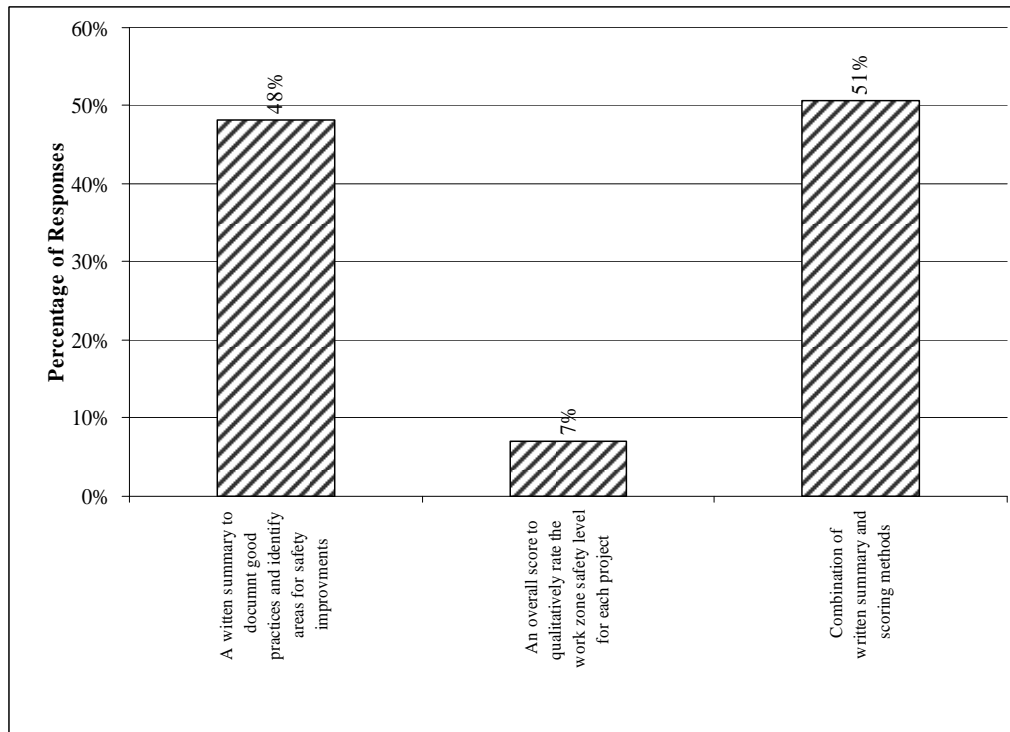
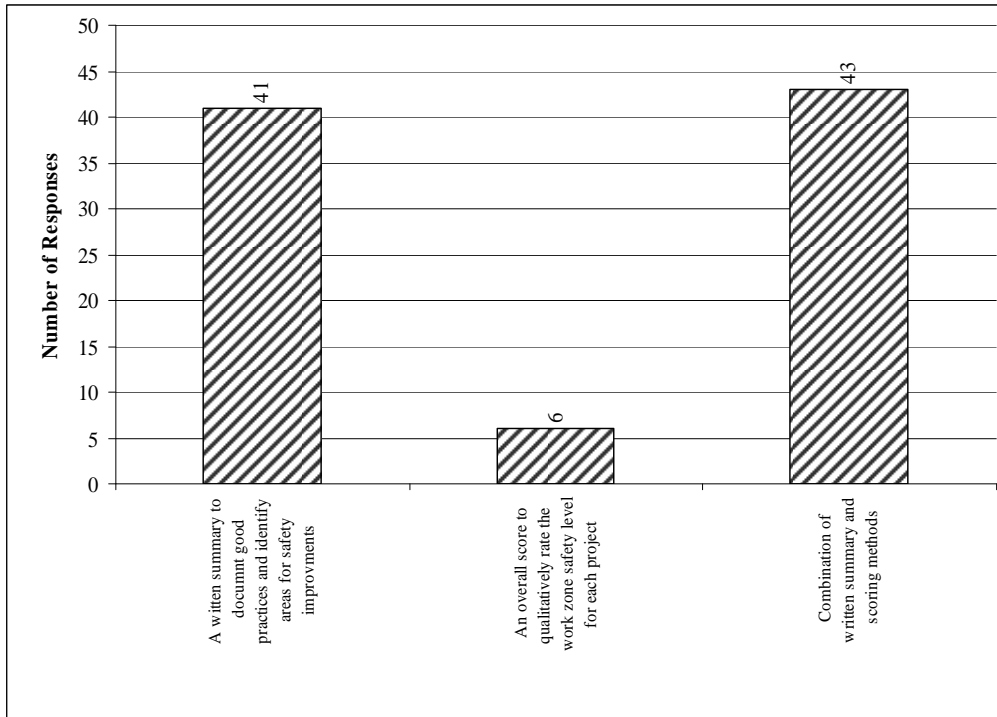
7. Funding sources for highway work zone safety audits



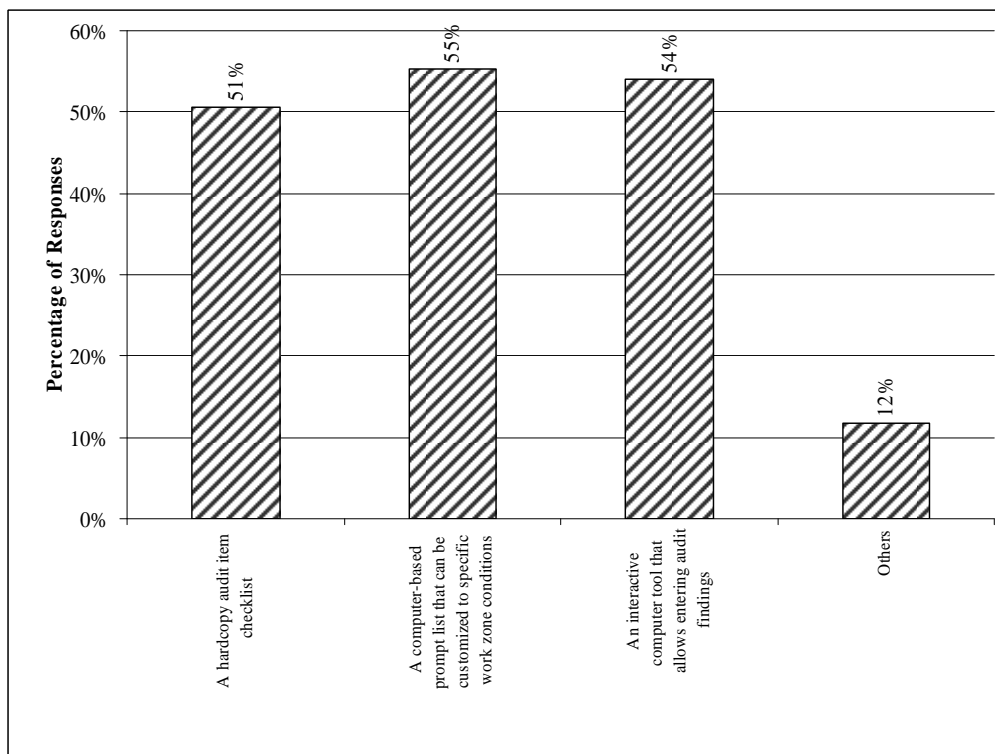
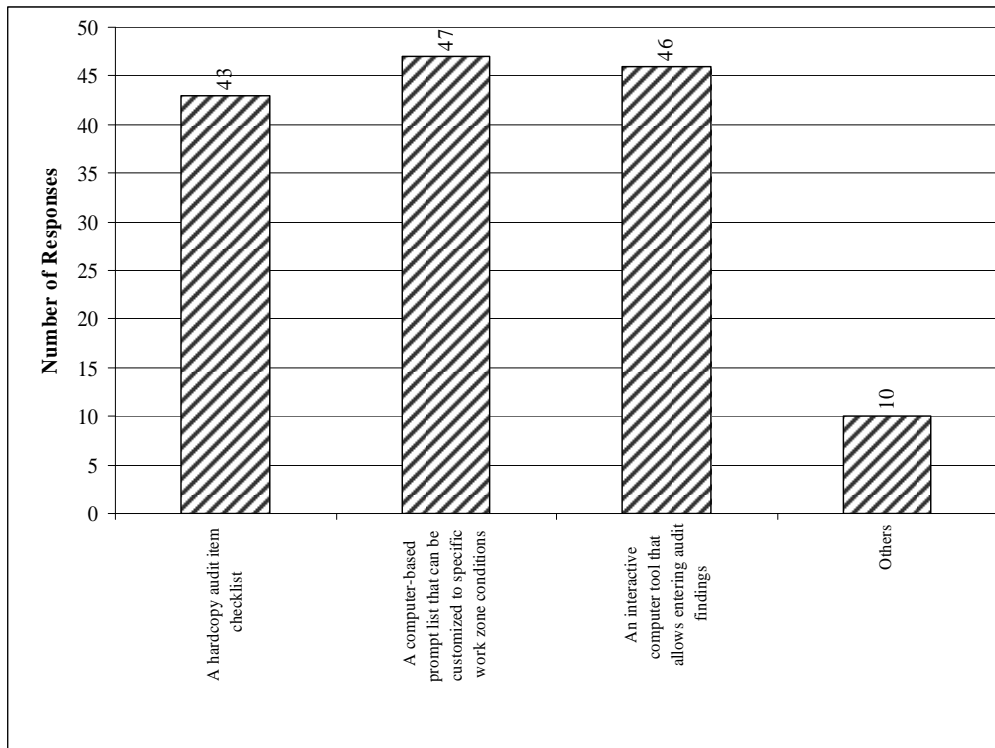
8. Key tasks of highway work zone safety audits



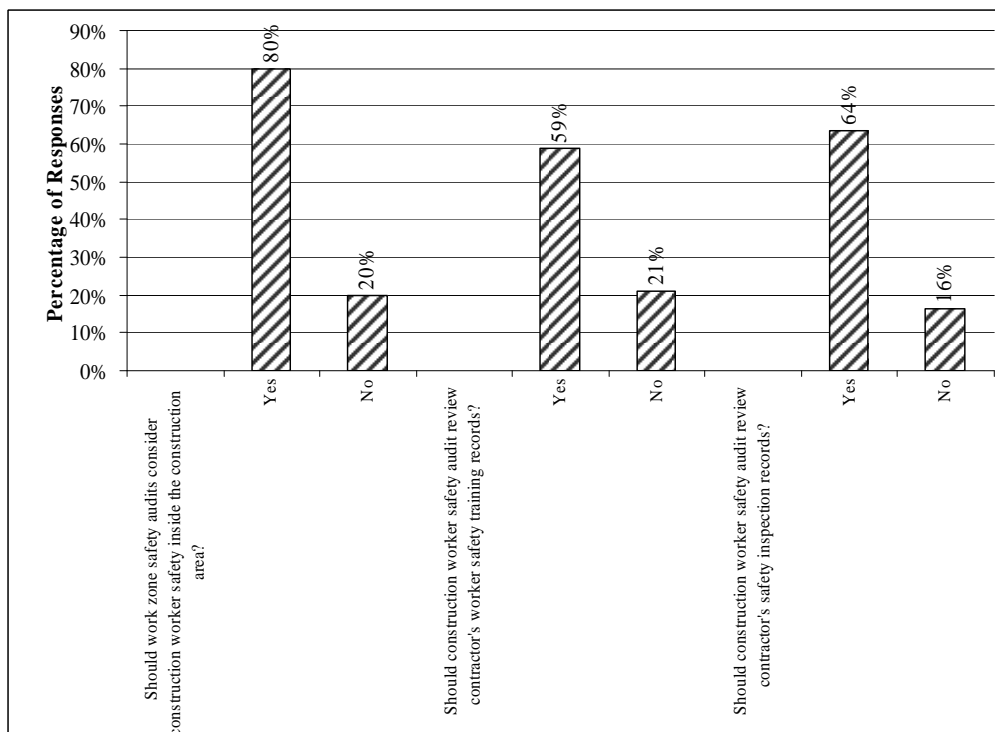
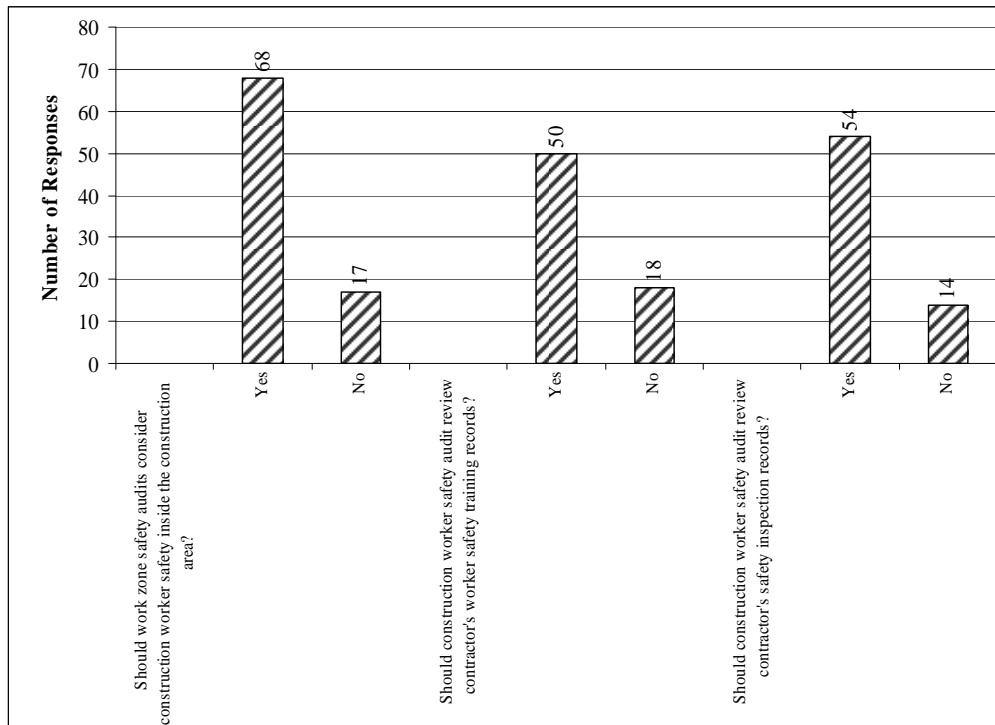
9. Approach to summarize audit findings



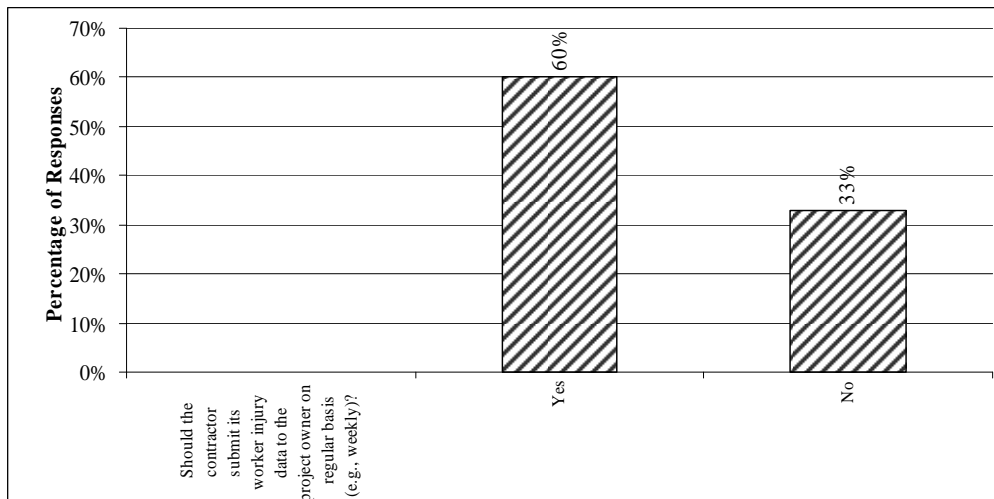
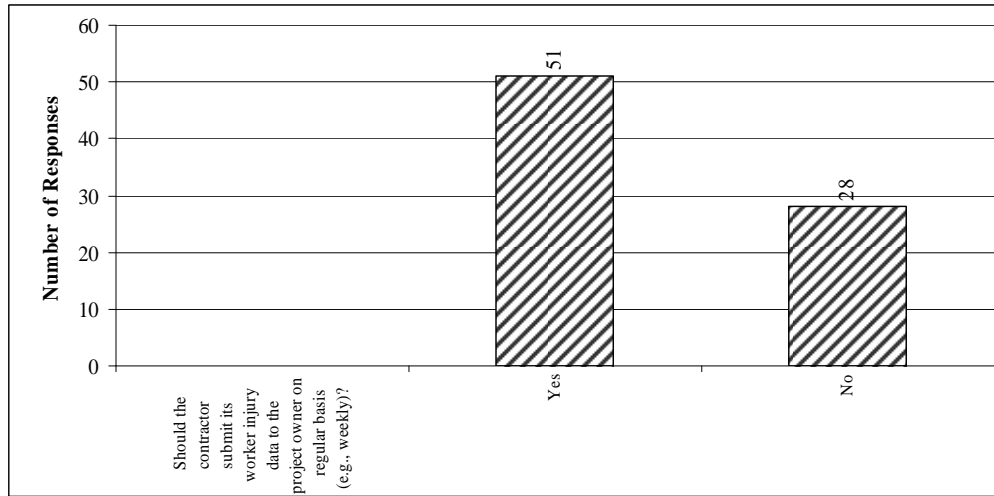
10. Tools helpful for accomplishing highway work zone safety audits



11. Consideration of construction worker safety in work zone safety audits



12. Contractor regularly submitting worker injury data to the project owner



13. Project personnel needed for safety training

