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# Expert System to Manage the Safety Requirements for Concrete Works Related to Jordanian Construction Projects

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**Abstract**
Numerous investigations that had been conducted in Jordan to evaluate the safety management in carrying out construction projects revealed that the implementation of this item is relatively below the desired level. In this research, a specialized software (Expert System) was proposed to improve the current situation regarding the application of the right rules in safety management for concrete works related to Jordanian construction projects. The proposed system contains a lot of ideal terms, specifications, and standards for conducting an acceptable safety management and for getting rid of (or reducing) accidents and other types of risks inside the project site. As a conclusion derived from this research, Expert System is aimed at enhancing the existing situation regarding the safety management for construction projects, and therefore to keep the workers and other staff to be away from all kinds of public risks inside the construction project, and accordingly the proposed software is recommended to be adopted in following up the application of safety management procedures in construction sites.
**Keywords**: Safety Management, Concrete Works, Expert System, Construction Projects, Safety Requirements

## 1. Introduction

In general, safety management is a term that concern with the improvement of work's environment and its conditions, supervising the employees and worker's safety, and studying the causes and effects of work's injuries and work-related diseases, and then organizing these parameters with the goal of verifying the minimum lower limit of work's accidents (Merhij M. 2002).

A lot of construction projects in Arab countries are suffering from poor application and monitoring of the safety requirements for these projects in a correct manner. In Jordan, researches that focused in their studies on specific areas regarding the safety management (say for concrete works) concluded that the implementation of safety management for this activity was classified to be of medium to low level (Al Rawi O. and Al Fahdawi M.).

Accordingly, in this research, an Expert System was suggested and designed for the purpose of managing the safety at these projects and finding of the ideal solutions concerning the above item.

The Expert system is an excel sheet that consists of several windows in which the activities related to concrete works for the intended project were previously downloaded, so that the ideal management of safety for each required activity could be easily obtained through clicking for this activity on the same system, then continue through the designed windows until reaching the instructions (safety management requirements) that shall be implemented for the intended activity.

In addition, the system was designed to be able for planning the work progress concerning all activities of the project. Furthermore, in case of any emergency has been occurred inside the project site, this system will submit the suitable solutions to address those emergency situations.

## 2. Literature Review

The most important researches specific to safety management and related to the construction execution sector had been reviewed during this research. It is to be stated that most of the reviewed investigations were free of designing a software system similar to that suggested in this research. The following is a brief explanation for some of these literature.

Dorji K. and Bonaventura H. (2006) showed that there were many work-related safety problems in the construction projects in Bhutan, including safety training shortage, shortage of documented and organized management safety systems, low safety priority, lack of information and data on safety at sites of construction projects, and shortage of safety inspections. The study concluded the main reasons for the poor application of safety management systems and why it was not sufficient. However, the contractors identified the major five reasons were, the lack of safety training services and facilities, shortage of safety awareness and understanding benefits of safety, shortage of safety professionals, lack of knowledge and education about safety management, and weak enforcement of safety regulation.

Fang, et al. (2006) studied fifteen factors that were extracted and formed the safety climate dimensions. Significant statistical relationships were found between some personal characteristics, the safety climate, and the individual safety behavior. The study revealed that employees and workers (who are older) had further positive perception of the safety climate, also the level of safety knowledge and education is also important for the safety

climate, employees who reported better safety climate had better knowledge of safety than those with poor safety knowledge. Furthermore, employees at joint ventures or subcontractors (in general) had less positive safety climate than the direct company employees.

Razuri, et al. (2007) identified the significant factors that influence the performance of safety in construction project sites in Chile. The top fourteen factors (variables) that closely correlated with the performance of safety in construction sites were provided in this investigation. The authors concluded that construction project sites with a formal program for safety incentive (76.7%) had better records for construction safety than those that did not have formal safety incentive programs. Most of the construction projects (79.6%) evaluated the performance of safety for the field supervisors and showed a positive impact for their opinions on safety performance. In less than half of the construction projects (34.9%), the contracting company sponsored safety dinners for workers to encourage them to maintain their commitment to safety.

Ibrahim M., Al Hallaq M. and Enshassi A. (2012) investigated the relationship between safety climate/safety behavior and personal characteristics, as well as the relationship between safe work behavior and safety climate. The study revealed that there is a positive perspective for the safety climate. The results were promising and coherent, in terms of safe behavior at work place, construction staff followed procedures of safety to a percentage of 62.9%, and their colleagues on job site up to 59%. The authors concluded that the workers who received safety training and with more building experience, had further positive perception for safety climate. In addition, the results of the study indicated that workers who were older in age, had more experience and more education, would have better safe behavior at work site. However, the remaining characteristics such as direct employer, skill levels, and the quantity of training safety received had no effect on safe behavior at the work site.

## 3. Methodology

The methodology of this research were divided into two major parts. The first part was concentrated on the collection of the data and any information regarding the safety management and its applications in the local and global areas, then analyzing these data in order to estimate what is required for the next step of this study. Whereas, the second part was focused on adopting a software (Expert System) that has the ability of providing the necessary procedures to manage the safety for concrete works inside the construction projects.

## 4. The Simulation Software

Based on the evaluations concerning the safety management for the concrete works in Jordan (as stated before), the authors point of view was the necessity to adopt a suitable program to deal with the requirements needed to conduct the suitable safety management in performing concrete works for all scales of construction projects in Jordan (small, medium, and large). Therefore, Expert System was designed to present Excel sheets that containing detailed safety measures, works, and durations to implement safety management procedures for concrete works in projects. Therefore, the software was designed in the form of six windows, as discussed and illustrated below.

The first window is the "Welcome Window", as shown in Figure 1. After clicking the "Click Here to Start" on this window, therefore four options will appear to the user, namely: Browse, Display Data Sheet, Display Time Line Graph, and Display Concrete Related Activities. In general, those four options represent the 2nd, 3rd, 4th, and 5th windows of this software. The "Browse" option is used to download the project that required to present its safety measures in executing concrete works.

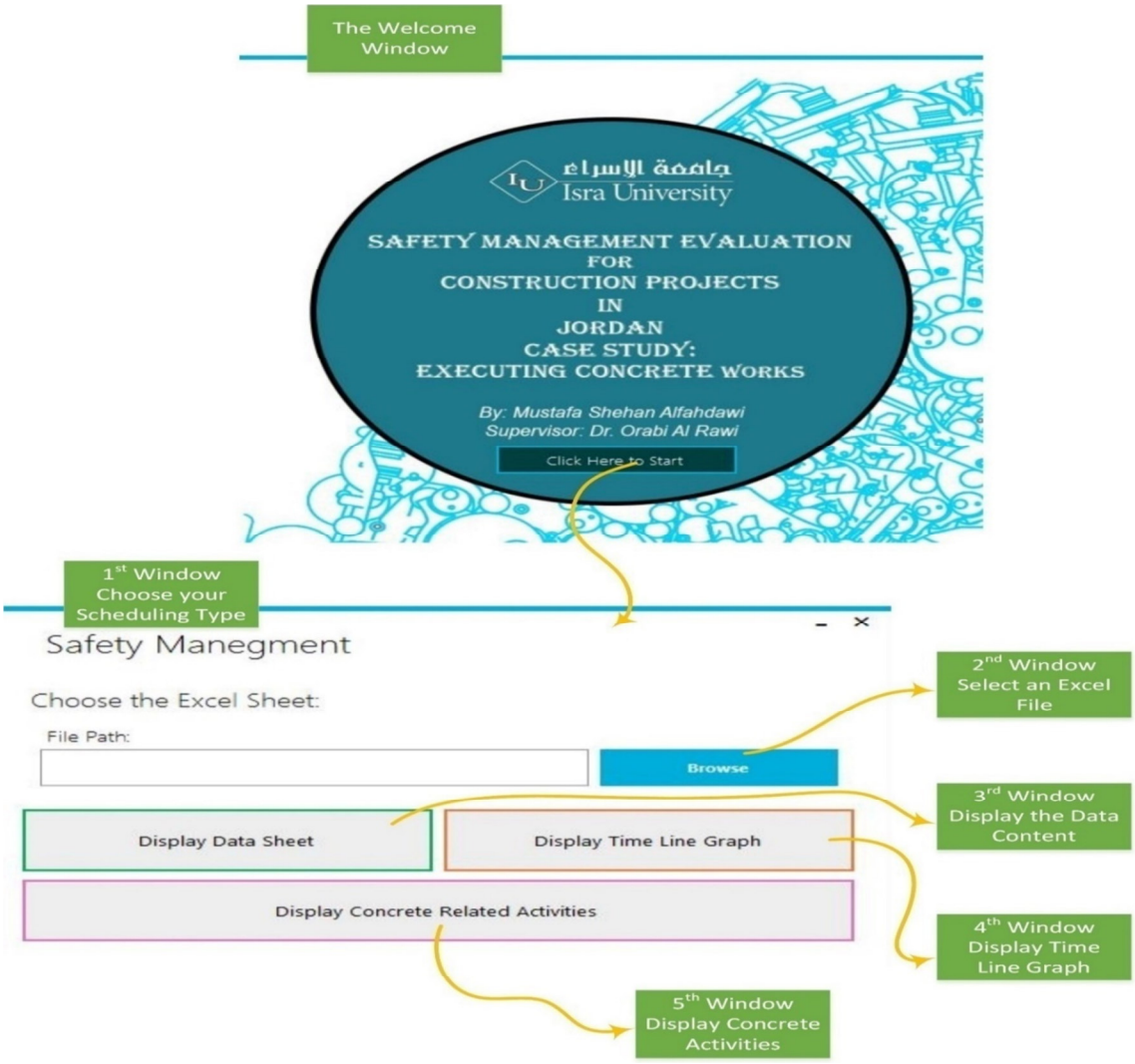



Figure 1. The Welcome Window (Including Four Options)

After downloading the intended project, the Excel spreadsheet for the overall project's activities will also be downloaded, as shown in Figure 2.

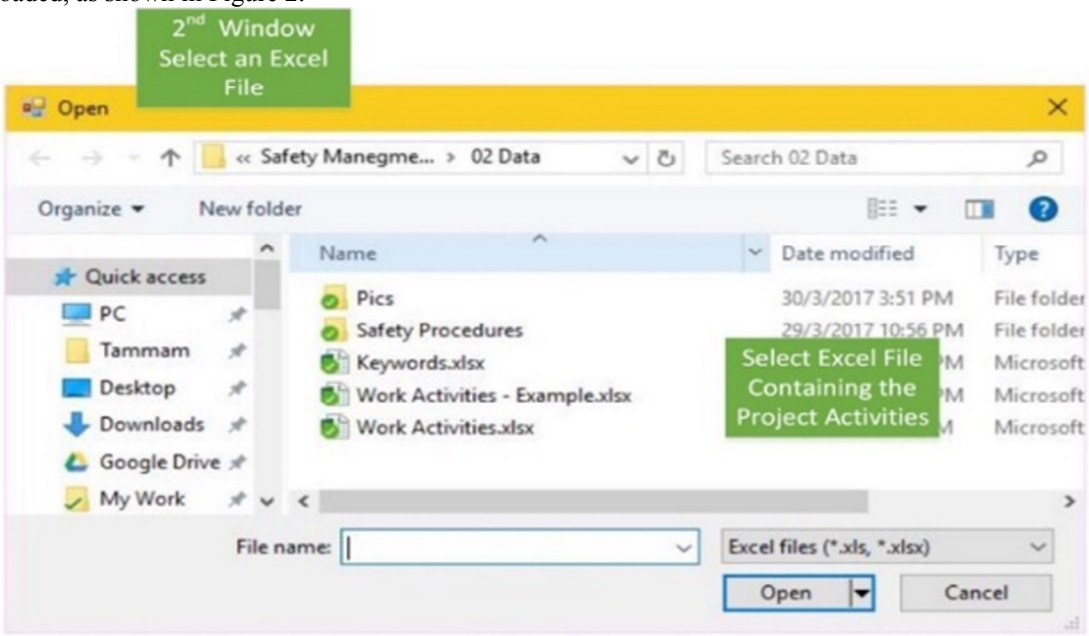
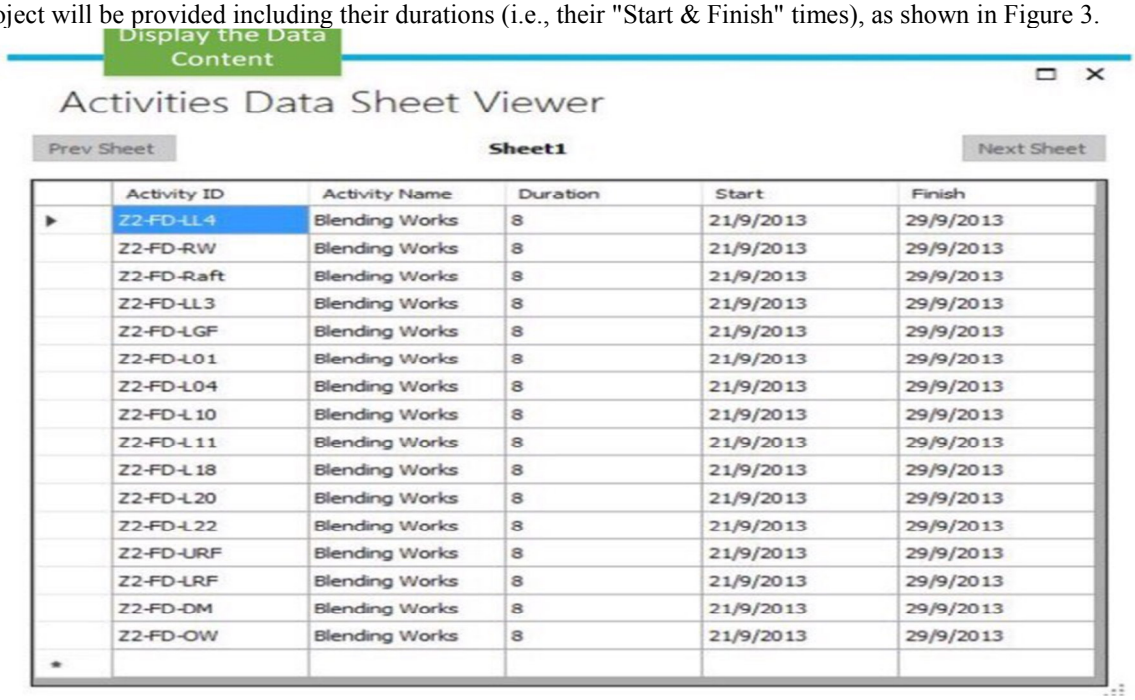



Figure 2. The Second Window of the Software

After that, the user should move to the option "Display Data Sheet" by which all activities related to the project will be provided including their durations (i.e., their "Start & Finish" times), as shown in Figure 3.




| | Activity ID | Activity Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| ▶ | Z2-FD-LL4 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-RW | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-Raft | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-LL3 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-LGF | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-L01 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-L04 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-L10 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-L11 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-L18 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-L20 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-L22 | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-URF | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-LRF | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-DM | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| | Z2-FD-OW | Blending Works | 8 | 21/9/2013 | 29/9/2013 |
| * | | | | | |

Figure 3. The Third Window of the Software

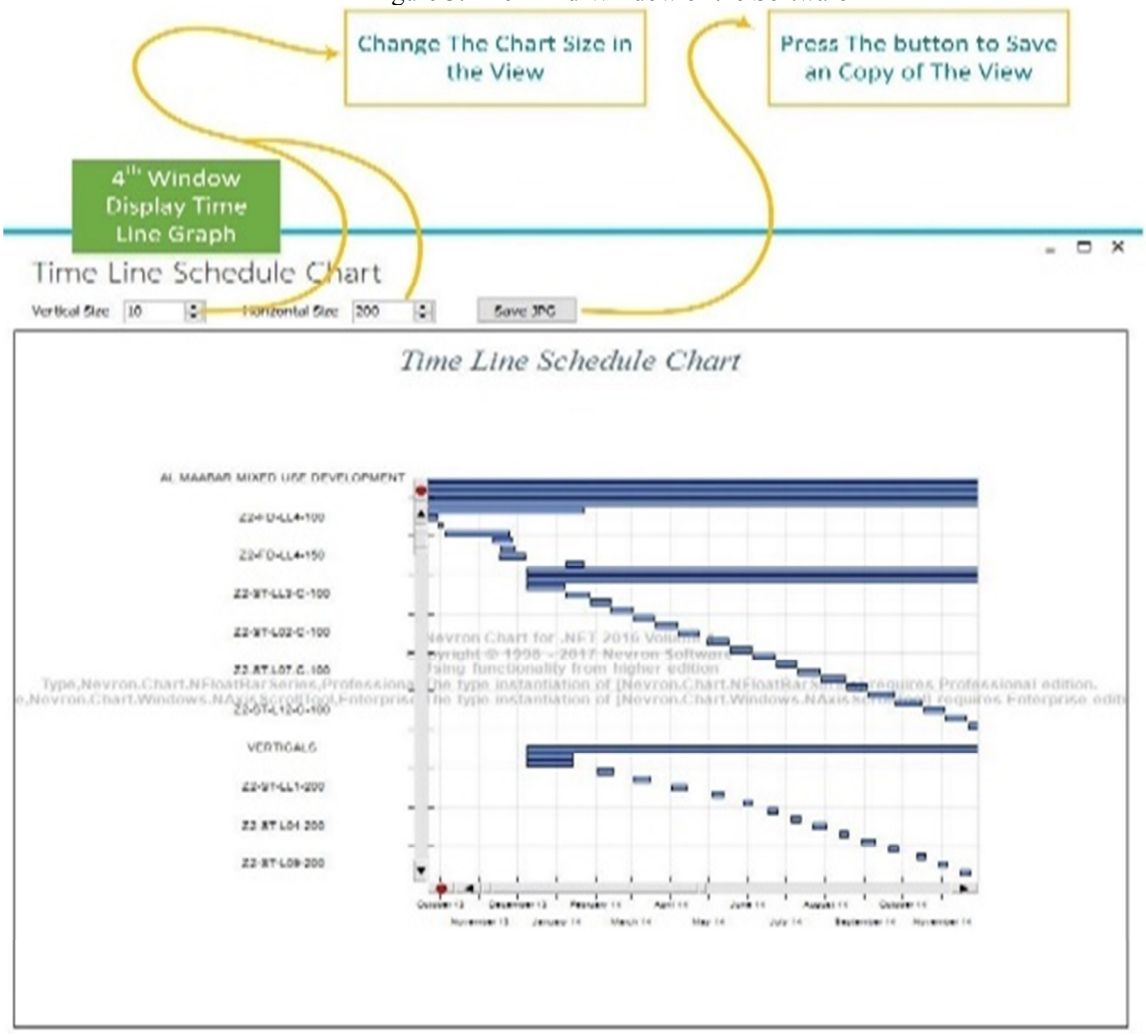
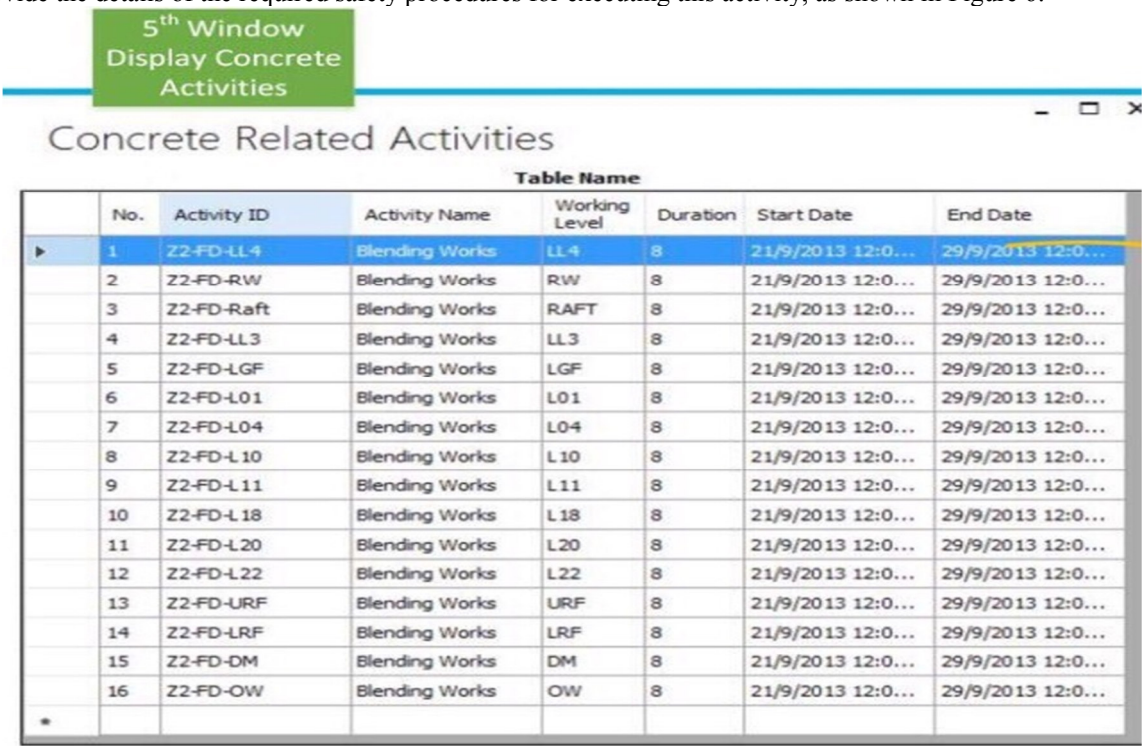



Figure 4. The Fourth Window of the Software

Referring to the fourth window "Display Time Line Graph", shown in Figure 4, a work progress table (including the time schedule) will be drawn up for all activities related to the intended project.

Figure 5 shows the fifth window of the software. This window takes into consideration the concrete works and separate them from all other works of the project. Therefore, a click on any activity on this window will provide the details of the required safety procedures for executing this activity, as shown in Figure 6.




| | No. | Activity ID | Activity Name | Working Level | Duration | Start Date | End Date |
|---|---|---|---|---|---|---|---|
| ▶ | 1 | Z2-FD-LL4 | Blending Works | LL4 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 2 | Z2-FD-RW | Blending Works | RW | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 3 | Z2-FD-Raft | Blending Works | RAFT | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 4 | Z2-FD-LL3 | Blending Works | LL3 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 5 | Z2-FD-LGF | Blending Works | LGF | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 6 | Z2-FD-L01 | Blending Works | L01 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 7 | Z2-FD-L04 | Blending Works | L04 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 8 | Z2-FD-L10 | Blending Works | L10 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 9 | Z2-FD-L11 | Blending Works | L11 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 10 | Z2-FD-L18 | Blending Works | L18 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 11 | Z2-FD-L20 | Blending Works | L20 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 12 | Z2-FD-L22 | Blending Works | L22 | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 13 | Z2-FD-URF | Blending Works | URF | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 14 | Z2-FD-LRF | Blending Works | LRF | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 15 | Z2-FD-DM | Blending Works | DM | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| | 16 | Z2-FD-OW | Blending Works | OW | 8 | 21/9/2013 12:0... | 29/9/2013 12:0... |
| * | | | | | | | |

Figure 5. The Fifth Window of the Software

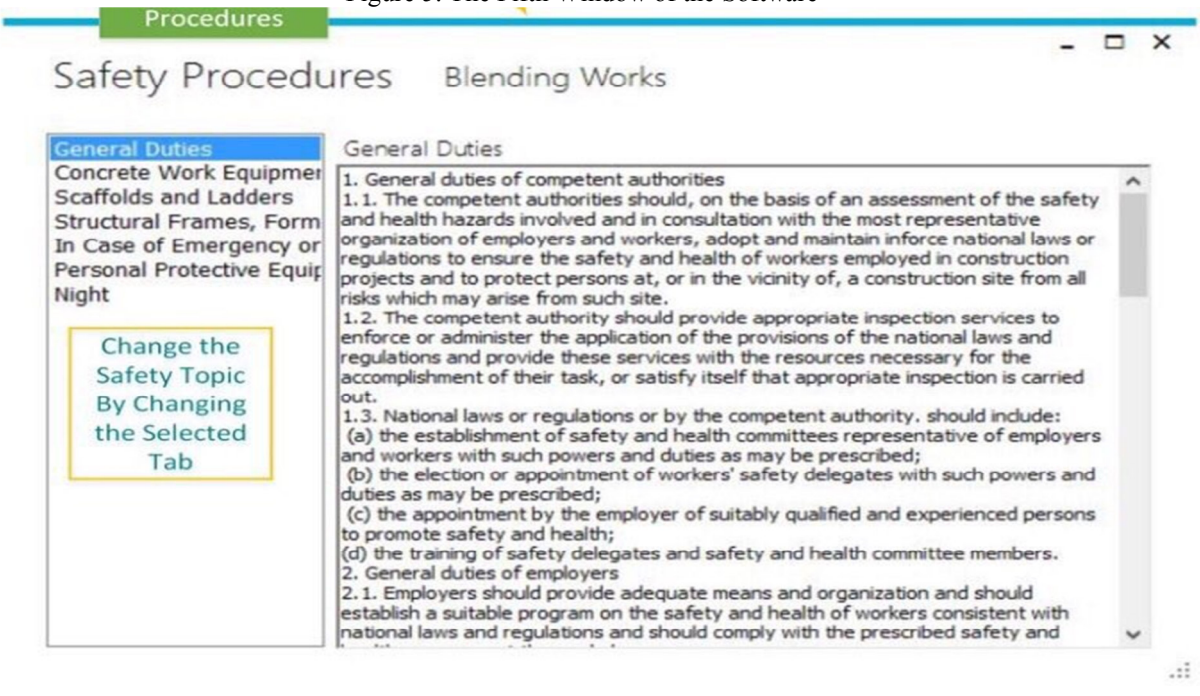



Figure 6. The Sixth Window of the Software

## 5. Conclusions

The major conclusions that derived from this research are briefly mentioned in the following points:

1. Most investigations that previously performed in Jordan revealed an existence of defects concerning the application of the safety management for concrete works at construction projects. Therefore, proposing a

suitable software (such as Expert System) to deal with these defects may be one of the solutions that should be implemented at the Jordanian projects.

2. Expert System enables the project manager to obtain an ideal safety management (i.e., free of defects and unexpected incidents).
3. The proposed system provides the accuracy and speed in obtaining the right standards for the application of the general safety requirements for each kind of concrete works at the construction project.
4. Expert System was designed so that the work progress for each activity related to the project is submitted through a time schedule, and that is to assure obtaining of the fixed time for carrying out each activity.
5. The designed system has the ability to deal with the emergency accidents inside the construction project (if any), and that is through providing the immediate and convenient solutions for them.
6. The proposed software could be applied for all project categories (large, medium, and small), and that is due to its easily in implementation and getting the required information.

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