AN ABSTRACT OF THE DISSERTATION OF

Neeta Singh for the degree of Doctor of Philosophy in Family Resource Management presented on September 10, 1999. Title: Expert Systems Prototype for Food Aid Distribution

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Jean Chambers

Numerous investigative reports have cited the problems of inefficient food aid distribution by various international disaster relief agencies. These problems not only deprive the disaster victims of life giving support, but can also discourage potential sources of contributions. Lack of a feedback process has been attributed as a cause of organizational inefficiencies in these agencies. Existing old-fashioned distribution processes failed to incorporate present day tools for advanced process control. Investigations of food distribution organizations revealed a need for a state-of-the-art monitoring system. Typically, these systems incorporate an expert knowledge base which aids an adaptive decision making process.

This research identified data related to food aid monitoring and evaluation processes of various international organizations. It then applied an artificial intelligence based expert system to develop a prototype for those processes. Existing data related to monitoring and evaluation program cycles were obtained from two international food relief organizations. An expert system shell called CLIPS (©NASA) was utilized to develop a prototype system named FAM (Food Aid Monitor) for monitoring and evaluating food aid distribution. FAM, a rule based expert system, uses facts and heuristic rules to provide advice regarding food aid monitoring and evaluation processes at various stages of an operation.

The FAM was evaluated and validated by three expert panels checking the prototype system for: (1) completeness and relevancy, by a faculty expert panel; (2) consistency, (3) correctness, (4) and precision, by a software engineering expert panel; and (5) usability, by a field expert panel.

The faculty panel identified some modifications to the original set of rules. Their review indicated a relatively complete set of rules and high rule relevancy to the knowledge base. Upon revision of the rule source code by the researcher, the software experts validated the prototype in two iterations. The panel determined a system accuracy of approximately 95% and 100% in the two iterations. This exceeded the initial objective of the research. Finally, usability experts commented upon the generic nature of the prototype and indicated a belief that the system might have an overall positive impact on the stages of monitoring and evaluating food aid distribution.

Doctor of Philosophy dissertation of Neeta Singh presented on September 10, 1999

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by

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1. INTRODUCTION

1.1. BACKGROUND

Natural disasters have been in existence from well before the dawn of the human race. Floods, famine, fires and other calamities triggered by natural forces fill the chronicles of recorded history. Along with wars, they were, for centuries, the principle events by which people marked the transition from one epoch to another.

A disaster refers to an event that threatens peoples' lives and may have ruinous consequences such as floods, hurricanes, or fires. Man-made and natural disasters create famines and, therefore, the scarcity of food that could affect many people. In 1991, there were 10 million people around the world for whom emergency food aid was the only lifeline (1).

Organizational inefficiency, politics and corruption are among some of the problems that can impede the progress of relief operations in terms of food aid distribution or medical services. They not only deprive the victims of life giving support, but also discourage potential sources of contributions. The role of politics in disaster areas is by no means limited to the government of the affected countries alone. Donor government organizations have also been known to delay operations

or overlook irregularities in food aid distribution. It should be a major concern for any relief-providing organization to preclude disaster victims from the above-described suffering (2).

Some by-products of modernization have led to an explosive population growth and have put drastic stress on the fragile balance of the ecosystem. Hence, natural disasters could easily increase the toll of fatalities. The improvement of long-distance communication, transportation, and computer technology permits international relief agencies to reach remote disaster areas without much delay (3). These technologies provide the means that alleviate much of the distress caused by a natural disaster. They should be readily available to all victims. Only rarely has it been unfeasible, with the available present day technology, to bring aid directly to the place where it was needed. Hence, the obstacles to effective relief in the 1990's were primarily organizational and political. Measures should have been aimed at improving organizational deficiencies that allow disasters to become far more tragic then they need be (4).

Although there have always been politics in food distribution, it has now emerged as a focused issue. Food has become a controversy and a contest in which the argument revolves around how it should be distributed and how the efficiency of aid distribution may be improved. It has been suggested that monitoring and evaluation can provide a range of quantitative answers with respect to the efficiency of food aid operations, particularly the question of end use. Monitoring

and evaluation reports have been shown to help administrators and the decision-makers of food aid distribution programs make improvements to increase their effectiveness (4).

A method identified as being particularly effective in improving decision-making strategies is an expert system based method. An expert system (ES) is, typically, a computer program that simulates the performance of human experts in a specific field or domain (5). Expert systems inherently include the features of monitoring, evaluation, and decision-making processes typically required for successful implementation of a decision-based system. Monitoring and evaluation data and reports can act as feedback processes thereby helping administrators and decision-makers make improvements to further increase the effectiveness of their programs (6).

1.2. JUSTIFICATION

The presence of technology in all aspects of life has enabled solutions to real-life problems that were either difficult or unfeasible. The availability of computer based database management, monitoring and maintenance systems and its world-wide web based accessibility have revolutionized information processing for organizations that operate over a vast region and are spread all over the world with active units in various countries. The basic fabric of food aid distribution, monitoring and evaluation, requires efficient information disseminating systems

similar to the ones which are the backbone of all large-scale inventory, marketing and sales infrastructure for multinational organizations.

Intelligent inference machines based upon available data are being implemented throughout the industry. Typically expert system based decision-making software is employed to review hundreds of megabytes, at times even gigabytes of data, from a database, and assist human managers to interpret and implement their decisions. It has been shown that, in association with their computer colleagues, human managers have been able to improve efficiencies of their operation significantly (1,2,7).

Due to the multinational presence, the mammoth amount of data and the distributed nature of the operation of a typical food aid provider, such a database and expert system could potentially revolutionize the food aid distribution process the way it has impacted the commercial and industrial sectors. Thus, an expert system based method of decision-making and data gathering was proposed for this research study. Accordingly, a prototype expert system for the monitoring and evaluation processes of food aid was developed. The prototype system has the obvious potential to be useful for food relief organizations seeking ways to improve their monitoring and evaluation processes. Furthermore, the ultimate beneficiaries of the research would be the disaster victims. Such an expert system can help to get a higher percentage of aid to their intended beneficiaries (disaster victims). The outcome of this research was a prototype expert system, which is intended to

facilitate monitoring and evaluation processes at various food relief organizational levels.

Potential users of the prototype system:

- International relief organization headquarters: the decision-makers at the organizations may use the system to establish operational guidelines as well as for getting feedback from the operation sites. The prototype can be used by donor organizations as a potential tool to facilitate decision-making activities at various stages of planning, implementing, controlling and evaluating the food aid monitoring and evaluation processes.

- Food relief emergency operation sites: the food relief operation staff can use the system at several stages (pre-operation, operation, and post operation) in order to follow operational guidelines as well as to send performance feedback to the headquarters.

- Further, the knowledge base of the prototype system can be altered and adapted for similar purposes by various food relief organizations at national and local levels.

- The prototype system could also be useful in academia as a teaching aid as well as for research purposes.

1.3. GOAL AND OBJECTIVES OF THE STUDY

The goal of this research was to improve disaster food aid monitoring and evaluation processes by utilizing artificial intelligence technology to build and validate a prototype expert system. To accomplish the above stated goal, the following objectives were laid down for this research.

1. Gather data (policy/procedure manuals/program cycles) on monitoring and evaluation processes of food aid from international relief organizations to develop a database.
2. Classify and structure the database into domains, facts and rules according to the CLIPS expert system syntax.
3. Convert the database into a knowledge base.
4. Develop a prototype expert system using the CLIPS expert system shell.
5. Verify and validate the prototype for consistency, correctness, precision (with the goal of software operational accuracy of 95% or more), completeness and usability.

1.4. GLOSSARY OF TERMS

The following terms were utilized in this study:

1. *ADA*: Automatic data acquisition (high level of computer programming language) (7).

2. *ANSI*: American National Standard Institute (7).

3. *ART*: A commercial knowledge based system, which can maintain a number of internally consistent, hypothetical words that are allowed to contradict each other (8).

4. *Artificial Intelligence*: Branch of computer science that investigates computer systems that exhibit human like intelligence (8).

5. *Circular Rules*: Rules are circular when their result directly or indirectly establishes the set of conditions, which fire the rule (9).

6. *CLIPS*: *CLIPS*: C Language Integrated Production System (7).

7. *Conflicting Rules*: Rules conflict when their results do not agree when repeatedly presented with the same set of condition (9).

8. *C language*: A popular high level programming language, widely used in system and applications programming (7).

9. *Conventional Language*: High-level computer programming languages such as C, C++, Fortran, Pascal, typically used for software application development, mathematical modeling and simulations (6).

10. *Domain*: A subject matter area or a set of problem solving tasks (10).

11. *Decision Chart*: A graphic representation of the knowledge segments and reasoning contained in the rule-set triangles of a dependency diagram (11).

12. *Deep Knowledge*: Refers to the underlying knowledge or basic principles, of a domain. It is generally used in the context of expert systems in contrast to the "shallow" heuristic rules, which constitute the knowledge base of the first generation expert system. The term is relative to the context (8).

13. *Dummy Data*: Artificial argument, instruction, and record of data inserted solely to fulfill the prescribed condition (12).

14. *Evaluation*: Assesses the overall project effects, both intentional and unintentional and their impact (2).

15. *Expert Shell*: Computer software that facilitates the development of an expert systems (13).

16. *Expert System*: Refers to a computer system that could perform at, or near, the level of human experts (13).

17. *Fact*: A statement whose validity is accepted. In most expert systems, a fact consists of an attribute and one or more values that are associated with the attribute (13).

18. *Fact Validation*: for a fact to be valid it has to appear in at least one premise (Right Hand Side) of a rule (14).

19. *FORTRAN*: Formula Translator (8).

20. *Heuristic*: In an Artificial Intelligence context, heuristic knowledge is knowledge that is generally true and is applicable and helpful in many situations, but is not guaranteed to be universally valid (12).

21. *High Level Programming Language* (HLL): Computer programming language which is easy to learn and allows the user to write a program using words and commands that are easy to understand and look like English words. The program is then translated into machine code, with one HLL command often representing a number of machine code instructions (15).

22. *Inference*: The process by which new facts are derived from established facts (10).

23. *Inference Engine*: "Algorithms used to derive inferences and to control the reasoning process" (16).

24. *Isolated Rules*: Rules are isolated if the set of conditions through which they may be fired can never be achieved or if the results they achieve do not affect any other knowledge element or cannot be otherwise used (16).

25. *Knowledge*: An integrated collection of facts and relationships that, when exercised, produce competent performance (16).

26. *Knowledge Base*: A reservoir of domain facts and rules that symbolize expert knowledge (10).

27. *Multiple Methods*: expressions that appear more than one time in questions and facts, questions and conclusions, or facts and conclusions (8)

28. *Monitoring*: Assesses whether project inputs are being delivered, are being used as intended, and are having the initial effect as planned (17).

29. *Natural Disaster*: An event that threatens people's lives and may have ruinous results such as floods, hurricanes, fires, or famine (1).

30. *Object Oriented Programming*: From the object-oriented viewpoint, an object is an entity responsible for performing a particular set of tasks. It generally contains both data and some method of manipulating the data. Objects may communicate with each other by message passing. Each object has distinct properties associated with it and it is situated in a network, which allows inheritance of properties from other high-level objects. Any system, that uses objects as described above, is known as 'object-oriented' (18).

31. *Pascal*: High-level structured programming language used both on microcomputers and for teaching programming (19).

32. *Procedural Programming*: High level programming language in which the programmer enters the actions required achieving the desired results. (19).

33. *Production Rules*: A representation of a rule as a condition-action pair. It is interpreted by checking to see if the condition is true and, if so, allowing the

action to be carried out. If action is carried out, the rule is said to "fire". Production rules are also known as "productions" (20).

34. *Protocols*: Pre-agreed signals, codes and rules to be used for data exchange between systems (8).

35. *Prototype*: An initial version of an expert system that is developed to test the effectiveness of the overall knowledge representation and inference strategies being employed to solve a particular problem (10).

36. *Pseudocode*: English sentence structures are used to describe program instructions that are translated at a later date into machine code (18).

37. *Redundant Rules*: Rules are redundant if they can be fired using the same sets of conditions and provide the same set of results as other rules (8).

38. *Rule*: A statement of the form IF THEN or IF..THEN.ELSE (18).

39. *Rule Firing*: Means the program has selected a certain rule from the agenda for execution (8).

40. *Rule Matrix*: A tabulated listing of the components of a “rule” as defined in the expert system (8).

41. *Runtime Error:* Error that occurs after compilation, during the execution of the translated source program (8).

42. *Shallow Knowledge*: Refers to the heuristic rules that constitute the knowledge base of a first generation expert system. The term relates to the context: knowledge that may appear as shallow and heuristic in a detailed domain, may be regarded as shallow and heuristic in a detailed domain, or may be regarded as constituting basic principles in another, more general, context (21).

43. *Source Code*: Set of codes, written by a programmer, that cannot be directly executed by the computer, but has to be translated into an object code program by a compiler or interpreter (16).

44. *Subroutine*: Section of program that performs a required function and can be called upon any time from inside the main program (16).

45. *Subsumed Rules*: Rules are subsumed within other rules when the premise contains a larger set of conditions but yields the same results as other rules (8).

46. *Tools*: Computer software packages that simplify the efforts involved in building an expert system. Most tools contain an inference engine, various user interfaces, and a knowledge acquisition aid and lack the knowledge base (e.g., expert system shell) (22).

47. *Unused Facts:* Facts, that are in the knowledge base of an expert system but are not used during execution of the program (8).

48. *Unused Rules:* Rules that are in the knowledge base of an expert system, but are not used during the execution of a program (8).

49. *User Interface*: Provision for the user to interact with the system (22).

50. *Validation:* The process of validation of an expert system is the process of ascertaining whether its behavior is correct. This is not to ask whether it succeeds in the general sense of solving problems as an expert might (e.g., that a monitoring expert system actually monitors the operation), but rather to ask whether the judgments it makes are sound and reasonable in the circumstances in which it made them, and whether or not they are comparable to those made by human experts (14).

51. *VAX11/780:* 32 bit mini computer (8).

52. *Verification:* Process of assuring completeness, consistency and correctness of the syntax of a knowledge base (14).

53. *X Windows*: User-friendly, menu driven, windows based multiprocessing, multi-user operating systems (23).

2. REVIEW OF LITERATURE

The purpose of this chapter is to outline the process of monitoring and evaluating emergency food aid, and to describe how the application of expert systems technology to this process can improve it. This chapter is organized into three main sections. The first section reviews current literature related to emergency food aid distribution efforts by various international organizations. The second section presents information on specific issues related to monitoring and evaluation cycles. Finally, the third section discusses the background of expert systems technology and the design of expert systems. The final section also reviews the application of expert systems in foodservice and other organizations.

2.1. FOOD AID DISTRIBUTION

Disaster relief aid is a type of humanitarian assistance that has, primarily, short-term goals. It has usually been directed not just at relieving immediate distress, but also towards rebuilding infrastructure. While donors were often motivated by a desire to help the unfortunate people affected by a disaster, an operation's purpose was to benefit aid recipients by alleviating their immediate hardship. Thus, the objectives are transparently the same for both donor and recipients. Donors want to help and gain goodwill; recipients want help and in most cases, remember the goodwill (4).

The World Food Program (WFP) of the United Nations has been the world's largest multilateral food organization. It has become the manager of the largest food assistance program in the world, supplying over 5.2 million tons of food worth over $1.7 billion in 1994. The undertaking of any project typically begins with a consultation between the WFP and a country in need of food assistance. Donor countries provide food and money to the WFP through voluntary pledges for emergency and development purposes. These donations take the form of commodities, shipping, overland transport and cash for operating expenses. Donor countries also respond to emergency operations on a case-by-case basis (24).

The WFP has been responsible for implementing and assessing food aid emergency projects and informing donor countries about how their contributions are used. The WFP has the ability to obtain, store, transport, and distribute large quantities of food throughout the world (mainly the developing world), and it can respond quickly to emergencies because of its access to enormous quantities of food positioned throughout the world (24).

Distribution of food aid to beneficiaries has been the last link in the food aid delivery chain. Being the most visible part of the process, it naturally attracts the most attention. Since it generally determines the image of an operation, little attention is paid to the earlier stages of the process. The distribution stage is the one over which donors have least control, since all action and mobilization involved in this step takes place within the territory of the recipient country.

Consequently, it is this stage of the operation that is of greatest concern to donors. This concern is frequently expressed through requests to undertake evaluation and participate in monitoring activities. Donors at all levels are concerned about this final stage of the distribution process, for it is at this point that they discover whether food is getting where it is intended to go. This is the period at which relief organizations are held accountable to provide the outcome that donors expect. Thus, this is when monitoring and evaluation processes play their most critical role (2).

2.2. MONITORING AND EVALUATION

Monitoring may be defined as a continuous overview of an activity. The primary goal of monitoring is to establish to what extent the various inputs into the project are able to satisfy its objectives. It also provides for corrective actions due to deviation from or non-fulfillment of these objectives. Consequently, monitoring enables quantitative control to be accomplished and can indicate whether the food aid is getting to its intended destination (17).

Fundamentally, monitoring systems are a consequence of the 150-year history of formal organizations struggling to use technology for better observation of their environment and for decision-making. Monitoring is, thus, a continuous assessment of both the function of the project activities in the context of implementation schedules and the use of project inputs by the targeted population in the context of designed expectations. It is an internal project activity, an

essential part of good management practice and therefore an integral part of day-to-day management (24)

Monitoring is regarded as an internal function, which is performed by project management. It is designed to determine whether the inputs are being delivered in the intended quantities and at the correct time, to see whether they are being converted into the output envisaged on the project documents and to take remedial actions when an actual performance diverges from the plan. As such, it has been an essential device for assessing what is generally described as "effectiveness" (3).

Evaluation is complementary to monitoring. Monitoring indicates if the food aid is getting to its designated target, it does not answer the question as to whether this is actually the best place for the aid to go. Evaluation provides quantitative considerations and a measure of value judgment, which may lead to changing or modifying the objectives themselves. Evaluation relies heavily on data provided by monitoring operations. Evaluation of food aid should be encouraged in order to make recommendations to donors and recipients for improvement of the operation, changes in objectives or purpose, method of distribution, and control of food aid (25).

Elaborate evaluation systems are continuously being developed to ensure that the performance of aid is not only recorded but also fed back into the organization. Almost all donor agencies have produced lengthy and detailed

appraisal and evaluation manuals, which clearly show that there was nothing wrong with the intentions in this respect. There seems to be a serious interest to know the effect and efficiency of food aid. However, the knowledge available on the efficiency of food aid is, at best, ambiguous or, more commonly, non-existent (3).

Studies have confirmed that the impact of aid continues to be a controversial issue, which is made abundantly clear when comparing several of the more important works such as Cassen's "Does Aid Work" (3) and Mosley, et al's "Aid and Power" (26). The first supported that food aid distribution worked, while the others were more critical. In general the quality of evidence available has been insufficient to substantiate the claims of both proponents and critics of aid. There was a tendency to be too hasty in drawing far-reaching conclusions on the basis of scanty data. These studies suggested that we actually do not know much about the effectiveness of aid; it is something that food aid agencies need to know in order to maximize the impact of aid. For years, aid agencies have devoted much time and effort to designing systems for acquiring knowledge and improving feedback and organizational learning. As a result every agency has its own unique and elaborate manual for monitoring and evaluation (3,26). These manuals have however not been instrumental in ensuring that the aid agencies make the best decisions or provide data in a manner that would allow comparisons among agencies.

In other words, the aid agencies were not really equipped for ensuring that the right things were done at the right time and the right place. An agency's

evaluation function was the primary tool by which the agency acquired knowledge about its activities and fed it back into its operational decisions. Ideally, it also learned from the evaluation. The general problem that has faced the evaluation function has been the inability to evaluate comprehensively (17).

Evaluation deals with planning and monitoring. Mid-term and ex-post evaluations, which focus on final or intermediate outcomes are most prevalent. An analysis of efficacy and impacts has been rare indeed. Rather than focusing on broader development issues, the evaluation function has had, and to a large extent still has, the character of a management tool. Its major purpose had been to improve the policies and procedures for delivering and receiving aid. Furthermore, it seemed that ex-post evaluation was less frequent than ex-ante appraisals, which obviously limited the knowledge available and the opportunities to learn from experience. Thus there has been a discrepancy between what the evaluation function was supposed to do and what it actually did (3, 26).

From international aid system's discussions and analyses of the problem during the last 30 years, it was not difficult to find a number of factors having an influence on the effectiveness of aid distribution. Staff training, inappropriate methods, and formulation of improper objectives were some factors. The aid agencies were of course highly aware of the problem of learning and feedback, but the approach to improving the situation reflected a rationalist approach to organizational development. Food relief organizations spent a substantial amount

of time and effort on trying to perfect their delivery systems by new project preparation methods, and improved systems of disseminating information, but the problem of knowledge, feedback and learning could not be reduced to a problem of administrative systems, planning techniques and evaluation manuals alone (17).

A Committee on Government Operations (CGO), which investigated delivery of food aid by the United States Agency for International Development (USAID) and the World Food Program (WFP), submitted a report in 1994. The report stated that thousands of tons of commodities donated as emergency food aid had been stolen or mishandled. Food aid distributed to beneficiaries was not monitored on a regular basis due to ineffective monitoring practices, and follow-up on losses and evaluations were incomplete. Additionally the committee found that the United States delegates were generally unaware of this commodity mismanagement, and when they were knowledgeable, they did not voice any concern during project renewal. Some of the suggestions made by CGO were to implement a system to monitor, report, and evaluate emergency food aid distribution, strengthen capacity for monitoring emergency food aid programs, and train personnel to implement efficient delivery systems for food relief operations (27).

However, there is relatively little literature on emergency food aid monitoring and evaluation methods. The United Nations Children's Fund (UNICEF) developed one of the useful methodologies for food aid evaluation using

regression analysis. The method involves assessing (a) the percentage of target population for which food aid was available, and accessible, (b) who made use of it and (c) who was given the quality of service that brought about positive change. For instance, if a given commodity was made available to 80 percent of the target population but only 40 percent of them were actually making use of it, then there must have been a problem of acceptability of that commodity. In another case a commodity may have been intended for 90 percent of the target population, but only 60 percent had access to it, then there was a doubtless problem of distribution (3).

Both monitoring and evaluation are management tools. In the case of monitoring, information is routinely gathered for tracking progress according to previously agreed upon plans and schedules are routinely gathered. Discrepancies between actual and planned implementation are identified and corrective actions taken. When findings are used to monitor the development results (effects, impacts) it is sometimes referred to as ongoing evaluation (3).

Evaluation is more episodic than monitoring. It is facilitated by monitoring but utilizes additional sources of information. Many such sources are identified during project reviews when there is a need to understand why inputs did not lead to plan outputs. Evaluation focuses on specific questions related to effectiveness and impact in order to influence future programs or services. For the purposes of this research it was important to review the monitoring and evaluation cycles of

international food aid organizations. The next part of the discussion gives an overview of the conduct of these at the organizational level. Knowledge of these monitoring and evaluation cycles will help in understanding the Methods section of this research (3).

Monitoring and Evaluation Cycles: The discussion of monitoring and evaluation program cycles covers (a) monitoring and evaluation responsibilities of government officials, food aid organizations and other donors, (b) how evaluation and monitoring are organized, and (c) how monitoring and evaluation fit into food aid organizations programming cycle.

The approach taken by the United Nations and its organizations included monitoring and evaluation processes (28). While these processes may not be suitable for some countries, they contain the features of a general model. Hence, users could derive or customize the general monitoring and evaluating procedures to suit particular needs. Both government officials and food aid organizations staffs are responsible for monitoring and evaluation of food aid programs. The United Nations monitoring and evaluating processes described below, however, may not always be attainable in practice.

Monitoring progress and evaluating results are key management functions used to improve program performance by government officials, from the local to the national level, who are responsible for implementing various programs. Government officials who supervise program managers or allocate public resources

use evaluations to ensure accountability, strengthen programs, decide the activities to fund, and provide information for policy-making (28).

At the same time, donor agencies are responsible to contributors for evaluating the effectiveness of the use of their resources, consistent with their mandates. Donors also use evaluations for accountability, improving performance, and decisions-making. Food aid organizations' staffs often oversee how donor resources are used and present reports to the donor agencies. Since these evaluations may not be a responsibility shared with the recipient country, they may not be adequately reported. In order for them to be accepted, by donors they must be made by the recipient country itself, or at least with its cooperation. Close communication and careful negotiation are necessary while planning and carrying out monitoring and evaluation processes. Deciding who will carry out each of the many tasks involved in monitoring and evaluation is an important component of program and project planning (28).

Roles and Responsibilities of Donor Organization: In general, the responsibility for monitoring and evaluation lies with the appropriate donor offices of the recipient country. Regional offices of the donor organization have an important responsibility in monitoring country evaluation plans and providing support for monitoring. They are also required to provide training and technical assistance to the recipient country representatives (28).

The representatives of the recipient countries are expected to ensure that sufficient food aid, staff resources and time are dedicated to the tasks involved in monitoring and evaluation at the different stages of the programming cycle. Also, the representatives are required to check their communication with government officials as well as the involvement of the donor organization officials in the decision-making process. Recipient government participation is vital in the program preparation stage of food aid distribution, since the recipient country is partially responsible for implementing services and activities supported by food aid organizations. The recipient country office may provide training and technical assistance to increase local planning, monitoring and evaluation capabilities. According to the monitoring and evaluating procedures/model used by United Nations, some of the routine tasks and responsibilities of designated staff in administering the monitoring and evaluation program cycle are given below (28).

A. Tasks during the situation analysis stage:

- Identification of baseline data and means to collect the data
- Aggregation and desegregation of data
- Analysis of trends and prospects
- Analysis of needs and identification of constraints and possibilities for action.

B. Tasks during the program preparation stage: The plan for the activity or service in which food aid organizations will co-operate should include:

- Objectives that are specific
- Indicators and criteria to measure success or progress
- Monitoring and evaluation activities
- Budgetary provisions for monitoring and evaluation
- Examination of the national capacity for monitoring and evaluating programs
- Measures to strengthen the country's capacity to monitor and evaluate the programs, e.g., training, technical back-up and institutional strengthening
- Opportunity to share reviews and results.

C. Tasks during the program implementation stage:

- Ensuring that data collection is proceeding according to the monitoring plan
- Reviewing regular progress reports with managers and comparing progress to what was planned
- Making field visits to project sites
- Monitoring food aid organization inputs
- Identifying additional training, technical assistance and other resources that may be needed
- Obtaining agreement for making annual and mid-course corrections, if needed

- Changing monitoring procedures, if necessary
- Identifying additional studies and evaluations needed as the result of program review
- Providing feedback to concerned parties.

D. Tasks during the program evaluation stage

- Proposing evaluations, when necessary
- Seeking technical help from the regional or headquarters office, when needed
- Discussing the evaluation with appropriate ministries, departments, sections and other partners
- Reaching agreement on the audience and purposes of the evaluation
- Obtaining agreement on the Terms of Reference
- Agreeing on the selection of a team
- Briefing the evaluation team jointly with country officials
- Following the progress of the evaluation and giving support to the team
- Participating in discussions of the recommendations
- Promoting the implementation of the recommendations and use of evaluation results in present and future programming.

Generally food aid organization field offices designate a staff member as an "evaluation focal point". The chief functions of the focal points are:

- Helping to design, update, implement and monitor the office's plans to promote and support evaluations and share evaluation results
- Helping to link evaluation with planning, that is, incorporating lessons learned from evaluations into the country's program-level and project-level planning
- Proposing topics for training in evaluation methods to meet needs of government officials and food aid organization staff
- Advocating improved monitoring and evaluation, especially with regard to activities in which food aid organizations are co-operating
- Keeping informed of technical issues in evaluation
- Consulting with other program officers to identify topics for special research and
- Maintaining a regular dialogue with the Evaluation Office in relation to these issues (28).

The food aid organizations regional offices have planning and evaluation officers, where responsibility is to provide technical support to the field offices, to plan training activities, co-operate with the Evaluation Office and the Program Division, monitor evaluation plans in the region, and ensure that the field offices monitor the projects and programs (28).

The donor county initiates the majority of evaluations. When donors request an evaluation, food aid organizations undertake the evaluation if the

recipient government gives permission, the request is made in a timely fashion and the donor bears the cost. The functions of the Headquarters Evaluation Office are:

- Assisting in setting policies and guidelines for evaluation
- Building organizational capacity to address evaluation needs
- Providing technical support and staff training to field offices to improve field capacity in planning and supporting evaluations
- Establishing an institutional memory of field evaluation reports
- Conducting "thematic" evaluations to assess selected sectors or activities in several country programs
- Responding to donor requests for evaluations
- Initiating research on selected topics
- Providing technical information on evaluations, monitoring, research and studies to country office (28).

The Evaluation Office supports various information exchanges. The office reviews recipient country evaluation plans, assesses evaluations done in the field, participates in reviews and evaluations in the field, and provides training to field staff. Training activities include meetings, seminars and workshops at the global, regional and national level (28). A copy of evaluations of all activities in which the food aid organization co-operates should be sent to its Evaluation Office. This enables the office to disseminate evaluations that may be helpful to others and provide feedback to recipient and donor country offices (28).

The number of evaluations in which food aid organizations are involved has increased due to the higher priority given to the evaluation process. In 1989, 379 evaluations were completed, compared to 129 in 1987 and 218 in 1988. However, countries generally fail to complete the number of evaluations planned for the year. Nearly 40 per cent of the evaluations scheduled for 1989 were postponed or cancelled; over half of those completed had not been anticipated in the previous year's annual report (28).

2.3. EXPERT SYSTEMS

Expert Systems (ES) is a branch of Artificial Intelligence (AI). Artificial Intelligence is a way of making a computer think intelligently. This is accomplished by studying how people think when they are trying to make decisions and solve problems, breaking those thought processes down into basic steps, and designing computer programs which solve problems using those same steps. Artificial Intelligence thereby provides a simple structured approach to designing complex decision-making program (29).

An expert system is software that is designed to mimic the human expert to make managerial decisions. The basic idea behind an expert system is simple; the expertise associated with human knowledge is transformed into an advanced database on a computer. Based on this vast body of task- specific knowledge stored in the database, the system or program is able to make certain inferences and

help arrive at specific conclusions. Typically the ES also explains the logic behind its conclusion (30).

Wide ranges of knowledge-based expert systems have been built. Large systems contain thousands of rules. Many small systems for specialized tasks have also been constructed with several hundred rules. These small systems may not operate at the level of an expert but are designed to take advantage of expert system technology to perform knowledge intensive tasks. For the small systems, knowledge used to develop the database may be in books, journals, policy/procedure manuals, or other publicly available document (24).

Expert systems are generally designed very differently from conventional programs because the problems solved by ES usually have no algorithmic solution and rely on inferences to achieve reasonable solutions. Reasonable solutions are about the best one can expect if no algorithm is available to help the system achieve the optimum solution (13). Since the expert system relies on inferences, it must be able to explain its reasoning so that its reasoning can be checked. The main limitation of an expert system is its domain specific nature. In spite of the limitation, expert systems have been very successful in dealing with real world problems that conventional programming methodologies have been unable to solve, especially when dealing with uncertain, ambiguous, or incomplete information. It is important to be aware of the advantages and limitation of the new technology so it can be appropriately utilized (31,32).

2.3.1. Components of Expert Systems

Characteristics common to most Expert Systems include the knowledge base, inference engine and user interface. The following paragraphs explain these components briefly.

The Knowledge Base: The knowledge base component of an ES plays a similar role to that of a database in a database system. Essentially, it is the heart of the system. While a database holds only passive data, a knowledge base contains *facts*, the passive data, and *rules*, the active component, about how to manipulate those facts with regard to a particular domain. *Domain* is often described as the application area covered by the knowledge. Rules may also contain information regarding certain relationships among and between facts (31)

The Inference Engine: The inference engine contains the control strategy. It searches through the knowledge base and determines how the facts and the rules are to be managed and manipulated. It executes reasoning required to solve the problem (31).

The User Interface: The third major component of any expert system is the user interface. This is the code written to produce what the user of the system actually sees and interacts with during consultation (31).

Figure: Basic Concepts of Expert System Function (13).

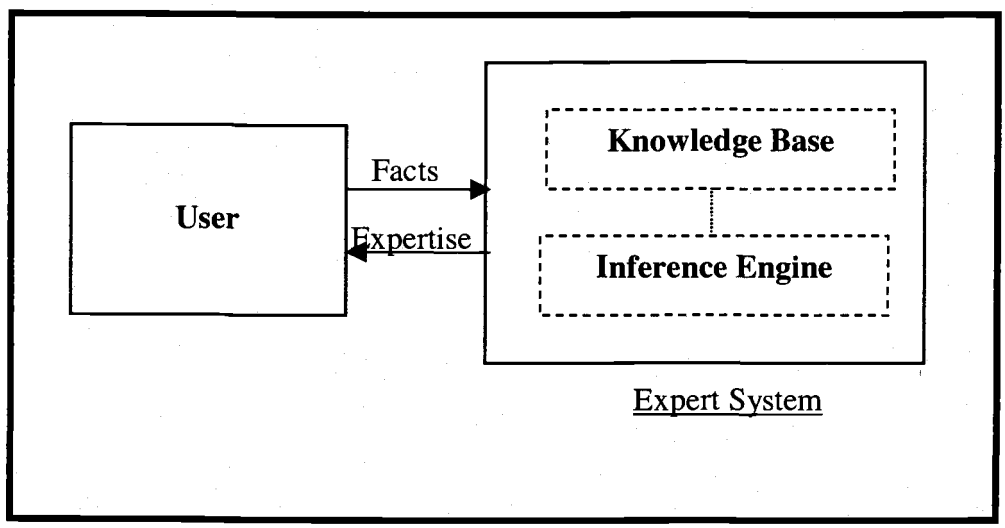

Figure 1 illustrates the basic concept of an expert system presented by Giarantano and Riley (1994). The authors' description of how an expert system functions was, "the user supplies the *facts* or other information to the expert system and receives *expert advice* or *expertise* in response. Internally, the expert system consists of two main components. The *knowledge base* contains the knowledge with which the *inference engine* draws conclusions. These conclusions are the expert system's responses to the users queries to the users expertise" (13).

2.3.2. Benefits of Expert Systems

Like many other traditional forms of software, an Expert System offers some benefits. Frenzel (16) identified the following benefits.

1. Permits a non-expert to do the work of an expert
2. Improves productivity by increasing work output and improving efficiency

3. Saves time in accomplishing specific objectives
4. Simplifies some operations
5. Automates repetitive, tedious, and overly complex processes

Frenzel (16) further contended an Expert System offers these additional benefits over conventional software:

1. Permits new kind of problems to be solved thereby making computers more useful
2. Captures and stores valuable knowledge that might be lost due to absence of an expert
3. Makes expert knowledge available to a wider audience, thus increasing the problem solving ability of more people

Expert Systems, like any other software, have the potential to save money. They cost money to develop and use, but the benefits derived usually justify the cost.

2.3.3. Limitations of Expert Systems

Frenzel (16) also identified problems and limitations of Expert Systems. Included were:

1. Developing an Expert System is extremely difficult, more difficult than creating conventional software. Extracting knowledge from experts, books,

and manuals is a long tedious job and coding that knowledge into software in a major chore.

2. Expert Systems are expensive. It is expensive to develop one, test it and deliver it to the end users.

3. Expert Systems are not 100% reliable. Even with the best expert contributing to the design, expert systems are not perfect or infallible. For that reason their output must be weighed, tested and otherwise scrutinized before it is used. Human beings should always provide the final judgement.

These limitations are significant, but certainly not impossible to overcome. Some of these limitations will gradually disappear or lessen as further technological improvements in hardware and software occur (16).

2.3.4. Appropriateness of Expert Systems

Before starting to build an expert system, it is essential to decide if an expert system is the appropriate paradigm. Girratano and Riley (13) identified some factors to consider in determining if a problem is appropriate for ES development. First, can conventional programming solve the problem effectively, if yes then an ES is not the best choice. An expert system is best suited for situations in which there is no efficient algorithmic solution. Such cases are called ill-structured problems and reasoning may offer the only hope for a good solution. Second, the authors suggest that a determination should be made as to whether the

domain is well bounded. It is very important to have well defined limits on what the Expert System is expected to know and what its capabilities should be. The authors further concluded that there should be a need for an Expert System. If there are already many human experts, it is difficult to justify an Expert System based on the reason of scarce human expertise (13).

2.4. DEVELOPMENT OF EXPERT SYSTEMS

Frenzel (16) and Turban (32) have identified defined steps in the development of ES. The steps discussed are generic or standard, regardless of the type and nature of the ES that is built.

2.4.1. Selection of the Problem

The development of an expert system must start with the problem identification process. To justify creation of an expert system, there must be a real problem to be solved or need to be met (16). This step may include a feasibility study, assessing justification and benefits, evaluating the limitations of expert system technology, and determining the appropriateness of the problem for an expert system. The general rule suggests that if the problem is knowledge related it would most likely be suitable for an expert system solution (16,32).

According to Bahill (14), expert systems have all the problems of traditional software, and in addition they also have problems caused by human knowledge being imprecise, incomplete, and perhaps incorrect. Furthermore, the problems

attacked by experts system are usually ill structured, requirements are vague, and solutions are heuristic rather then algorithmic (14).

2.4.2. Selecting the Expert(s)

Classical expert systems embodied unwritten knowledge that was extracted from experts by extensive interviews with knowledge engineers over a long period of time (32). Use of recent/updated published materials for building a knowledge base is becoming common practice as it saves time and efforts of knowledge engineers.

2.4.3. Selecting the Hardware and Software

The next step is to decide upon a development tool, software that will help to create the system. The two basic types of expert system development tools are languages and shell. Language refers to programming languages used with the computer to create new software. An expert system shell is a special software package created specifically to build an expert system. A shell provides the basic framework in which data or knowledge can be entered and manipulated in predefined ways (8). The hardware utilized depends upon the size of the system. Smaller systems can be developed and installed on personal computers whereas a large system may require a special workstation (33).

2.4.4. Knowledge Acquisition

Development of an expert system begins with knowledge engineering; that is acquiring the knowledge. Knowledge comes in many forms. It can be standard textbook knowledge that one can obtain from books, articles, journals and procedure manuals. The other way of acquiring knowledge is from individuals who are experts in the subject. The format of knowledge will guide the selection of a particular knowledge representation scheme. Most knowledge can be represented in production rule form (13).

2.4.5. Rapid Prototyping

The prototype is conceptualized as a fairly complete small version of a portion of what will become a larger system. A prototype is developed to prove that full-scale development efforts are justified. Developing a prototype system includes the following tasks: learning about the domain and the task; specifying performance criteria; developing an initial implementation; and testing the implementation (34). Advantages of prototyping a system include aiding the knowledge acquisition process, assisting in selling the system to users, obtaining support from upper management, and helping to keep the expert's interest in the project (32).

2.4.6. Verification, Validation and Improvement of System

Evaluation of the prototype system is done initially in a simulation environment. A test situation can be used to refine and update the system. New rules can be added or modified. The comparison is based on its performance with human expert decisions. This is called a modified Turning Test approach (35). Validation applies to the expert system product itself (9). All components of the ES are subjected to validation. Validation involves five basic areas: consistency, completeness, correctness, precision, and usability (14). In domains where there is no clear agreement among experts on the correctness of any one particular solution, an alternative approach is to achieve consensus among the experts that a decision is good, reasonable or acceptable (e.g., medical diagnosis, forecasting, decision making) (32).

Bahill (14) has further described verification as a process of assuring completeness, consistency and correctness of the syntax of a knowledge base. There are many sub-tasks in verification that must be performed in perfect order. First proofread the knowledge base. Next run a spell check on it. Then look for low-level syntactic mistakes (most shells do a part of this function). Then look for more subtle mistakes and finally run a debugger. Validation according to Bahill (14) is the process of assuring the compliance of system performance with the specified system requirements and needs (14).

Artificial intelligence literature cites various tools for verification and validation such as; "CHECK ", a program that verifies the consistency and completeness of an expert system, "ESC" a decision table-based processor for checking completeness and consistency in a rule-based expert system and "Validator" that checks the validity and usage of each fact (14). These tools help the knowledge engineer debug and check the syntax and semantics of a knowledge base to ensure its correctness and completeness of the system.

2.4.7. Installation Approach

Field-testing is feasible for the expert system when it reaches an acceptable level of quality and stability. This level is determined by a desired percentage error rate. Some tasks identified for installation include adapting hardware and software at the site of implementation, conducting user tests and modifying the system as needed, providing a user's manual, and setting up maintenance procedures (36).

2.4.8. Documentation, Maintenance and Security

Communicating, updating and protecting the software is crucial and often a problem. The updates and security must be done without restricting the user application of the system (37). A user manual containing information to use as reference that defines the uses of the system and step-by-step application of the prototype system should be written. Maintenance is made easier with an expert system development tool. Usually there will be a need to add new rules, delete old

rules, or modify rules as required. Using the editing process built into the system, such changes can be made quickly and easily (37).

2.4.9. System Release

The final step is the release of the full-scale expert system. This is accomplished only after each step is completed. The larger systems may consist of over 2000 rules and take three or more years to develop (32). System release requires the developer to copyright the system and provide required documentation for users.

2.5. GENERAL APPLICATIONS OF EXPERT SYSTEMS

Expert systems have been applied to various fields of knowledge. Some have been designed as research tools while others fulfill important business, organizational and industrial functions. Hundreds of expert systems have been built and reported in computer journals, books and conferences. This only represents the tip of the iceberg since many companies and military organizations will not report their system because of the proprietary or secret knowledge contained in the systems (38).

The types of tasks performed by expert systems tend to cluster according to the problem solving approach (39). Several categories of the expert system application have been identified according to the task paradigm. Expert systems

can perform diagnosis, configuration, instruction, interpretation, monitoring, planning, prognosis, remedy and control related applications (10,30,37).

2.6. EXPERT SYSTEMS IN ORGANIZATIONAL SETTINGS

Computers have been utilized as a tool in managerial decision making for over 40 years. Electronic Data Processing (EDP) systems appeared in the 1950s and Management Information Systems (MIS) followed in the 60s. While the Office Automation System (OAS) and the Decision Support System were developed and introduced in the 70s they are being utilized even today. However, a computerized decision-making tool developed since the 80s is the Expert Management System (EMS); it is gaining popularity gradually. To help managers make better decisions, many organizations, public and private, have been developing and using the EMS. Emerging computer technologies for managers based on the principle of the EMS could change the manner in which organizations are being managed. Furthermore this, with other technologies, may create a synergy, potentially with an even greater impact on the effectiveness of managerial decision-making (19,36,40).

Cited in the literature are frequent uses of Expert Systems in organizations (profit and non-profit) to serve various purposes such as managing, planning, evaluating, feedback and decision-making (22,33,35,38, 41). Organizational processes are important vehicles for the operation of organizations, yet most of the processes are repetitive, routine, and time consuming for members who are

engaged in their execution. The step-by-step solution guidelines for the process generally exist in managerial policy/procedure manuals. Automation of these high volume routine processes can improve efficiency. Organizational processes can be modeled as intelligent computerized agents that emulate the behavior of human agents (42). Some researchers have shown that decision-makers utilizing an expert system as a tool provided higher quality decisions than those who worked without the ES tool (28, 32, 38,43).

Some examples of functional expert systems are LDS (assists legal experts in settling cases), BRAINS (a stock portfolio management system), ERASMUS (for decision making in road maintenance) and STUDENT (for solving high school algebra problems) (19). Expert systems are increasingly being used as an alternative to written manuals. The provision of standard information about organizational procedures can be extremely valuable in situations where information is practically non-existent and can be useful in the feedback process (35).

The ES technology has the potential to help solve problems that affect developing countries and have global significance for outcomes of elements related to environment, disasters, famine, water supply, and waste management for example. Previously computer technology in these areas primarily targeted data collection; but management, human expertise, and knowledge are still necessary to retrieve relevant data and find solutions to the problems. Being an integrated

information system that provides inference capabilities makes expert systems a comprehensive evaluation and decision aid (16,40). Some expert systems have been developed with additional features, such as a statistical analysis tool kit that produces statistical reports (e.g., statistical significance), evaluation tools etc.(44).

2.7. EXPERT SYSTEM APPLICATIONS IN THE FOOD SERVICE INDUSTRY

Automatic data processing in the foodservice industry can be traced back to 1964. Balintfy and Vetter (45) introduced the first Computer Assisted Menu Planning (CAMP) system. CAMP was based on linear programming algorithms, which tried to find the optimal value of a linear function of a certain number of variables. Some variables included in CAMP were taste, cost, nutrients and acceptance rating of a menu item. The authors concluded that from the cost point of view the computer assisted menu planning was desirable as it could reduce cost by twenty five percent.

In 1985 Woodman implemented an expert system for foodservice menu planning. Several variables were utilized such as food color, texture, flavor mixes, seasonal availability and local customer taste (46).

Most recently Sterling, et al., (47) have used an artificial intelligence system for menu planning. The expert system, CAMPER, is a tool for planning menus in accordance with the nutritional needs and personal preferences of individuals. The present version of the system plans menus only for healthy adults, but the authors

discussed how the framework and methodology could also apply to planning special purpose menus for use in many different settings (47).

Davis (48) has studied the use of an expert system for service-ware selection in school foodservice. As a result of this study an expert system, "SWXpert", was developed. The author reported that the SWXpert system demonstrated a 76.5% accuracy rate between the decisions made by the ES prototype and the school foodservice processionals. The study concluded that by using SWXpert, the service-ware selection could be delegated to a non-expert (48).

Parker and O'Brien (49) described the use of an expert system as an instructional tool in a university setting. The system was used to train student managers of foodservice at Florida International University. The system allowed the students to make choices and recognize success or failure depending upon the decisions that were made. The authors stated that this kind of expert system experience for new managers could make the difference between the success and failure of a restaurant in a very competitive market (49).

Graham, et al. (33) reported successful use of a model expert system to forecast production in a foodservice organization for an educational application. Factors considered in this scenario were day of the week, weather, temperature, customer counts in previous years and the previous week, season of the year, holidays and specials (33).

2.8. OTHER EXPERT SYSTEM APPLICATIONS

A room control expert system developed by Balsam Grand Resort was reported to be successful in the hospitality industry (29). The purpose of the system was to better utilize room occupancy during slow and peak periods. The organization experienced, immediate payback, both financially and in customer goodwill with a reduction of 50% in unoccupied rooms. McCool (29) also reported that routine and repetitive activities, which utilize preexisting judgments and experience, are the best problems for the use of an expert system (29).

Hott, et al. (39) reported another expert system for the lodging industry. This system was used to analyze the occupancy rate and room charges in a yield management program. The expert system allowed the lodging industry to forecast future demand months and even years in advance, similar to the airline industry (39).

Abecker, et al. (50) identified an expert system as a framework for processing knowledge. Their knowledge-processing model supported enterprise wide knowledge management through the collection and organization of information from several sources. The authors further described that the framework featured intelligent assistant capabilities that allowed executing tasks and providing information enabling workers to handle their job more effectively (50).

Gervais (51) has developed and applied two rule-based expert systems to logistics problems. The first expert system pertained to the selection of an appropriate type of warehousing by applying heuristics selection of rules from human experts and published materials on warehousing decisions. The second expert system was applied to the selection of material handling equipment. The knowledge base for this system was developed by applying heuristic rules and published work on the subject. The authors concluded that these expert systems would help in decision making regarding demand projection, company cash flow, logistics management and for handling customer requirements (51).

Lee Hunsoo (52) also looked into the potential of an expert system to facilitate decision-making in logistics. The author hypothesized that available expert system software packages are not widely applied due to difficulties in finding expert assistance, collecting and aggregating necessary data, interpreting the results, and converting them into implemental strategies. However, his analysis of the problems led one to believe that expert system technology could be a valuable aid in expanding applications, as well as in overcoming most of the hypothesized difficulties (52).

2.9. SUMMARY

The review of literature included background information on emergency food aid, monitoring, evaluation and expert systems. The first part of the review discussed problems related to food aid distribution among food aid organizations.

Also reviewed were data on monitoring and evaluation program cycles, indicating an existence of only partially developed processes of monitoring and evaluation among food aid organizations.

The field of artificial intelligence is not in wide use, but there was ample literature on the use of expert systems covering a wide range of topics such as components, benefits, limitations and development of systems. Further, the literature identified the usefulness of expert system to improve various organizational processes such as managing, planning, evaluating, feedback and decision-making. It was obvious from the literature that more and more organizations are considering automation of their high volume routine processes to improve efficiency. Some researchers also indicated that decision-makers utilizing an expert system as a tool provided higher quality decisions than those who worked without the expert system tool, suggesting a need for such systems in organizational processes.

Finally, the review on expert systems in foodservice illustrated that the use of such systems was relatively new but catching up slowly. Even though reviews in this area were few they did cover a range of foodservice applications as in menu planning, service-ware selection and forecasting, as well as in training and in the lodging industry. Most of the research related to foodservice and expert systems was limited to prototype development and simulation at a university level.

However, the literature review revealed that research directly related to use of an expert system for food aid distribution was rare or non-existent.

3. METHODOLOGY

This chapter describes the methods and procedures used in this study, divided into three broad sections. The first section discusses the research problem, the second identifies the sources of data and knowledge acquisition, while the third section describes the method of data analysis, system development and validation process for the prototype expert system. The methodology used for this research was prototype development, which was case specific. Upon modification, the prototype may be used by food relief agencies as well as for academic purposes, thereby creating a dual audience for the final product.

3.1 PROBLEM STATEMENT

The main objective of this research was to develop a prototype system for monitoring and evaluating emergency food aid. The system utilizes artificial intelligence technology, an expert system based structure ideally suited for complex knowledge transfers. The monitoring and evaluation processes among international food relief agencies are extremely complicated and intensive. Ideally the processes require abiding by extensive guidelines, continuous feedback and decision-making. This can be further complicated when the operations are conducted far away from the donor organizations. Several independent and dependent variables such as number of distribution sites, available staff, food spoilage and location of food storage need to be considered before decisions are made.

The problem to be solved in this research was a control problem that required determination of control decisions based upon real-life feedback data. Control problems include processes that require interpretation, monitoring, planning and prognosis. The expert system requires determination of the inference engine based upon the type of problem. An inference engine of an expert system is a component that draws conclusions to execute the highest probable rule, based upon the facts in the available database. For example, diagnostic problems are better solved with backward chaining while prognosis, monitoring and control are better done with forward chaining.

Control problems tend to be well suited for forward chaining rule-based language because of their data driven nature. Forward chaining is reasoning from facts to a conclusion. For example, *If* the *fact* database infers that there is a shortage of food supply in an inventory, one of the *conclusions* drawn by the inference engine may be to order more food supplies to continue the food distribution process. Typically, sets of input values are read during each program execution cycle. Inferencing occurs until all possible conclusions that can be derived from the input data are reached. This is consistent with a data driven approach in which reasoning occurs from the data and to the conclusions that can be derived from the data.

The design of this research was prototype development. Prototype development is an initial version of an expert system that is developed to test the

effectiveness of the overall knowledge representation and inference strategies being employed to solve a particular problem (10). Prototype development includes defining a problem, identifying an authentic source of data or knowledge, verification of an approach for building a knowledge base, and selection of hardware and software to construct a trial version of a system. The main goal of this research was to develop a prototype expert system for monitoring and evaluating food aid distribution processes and thereby validating the conceptual feasibility of such a system.

3.2 DATA SOURCE/ KNOWLEDGE ACQUISITION

The data sources for this research were the operational information and database maintained by international food relief organizations. Initially three international food relief organizations were selected for obtaining information regarding each organization's monitoring and evaluation processes program cycle. The International Council of Red Cross (ICRC), United States Agency for International Development (USAID) and World Food Program (WFP) were the organizations that were contacted.

The primary reason for selecting three organizations was to comparatively verify the completeness of the documentation of their monitoring and evaluation program cycles. Data from the ICRC lacked the required information and hence was not considered for further evaluation in this research. Data sets obtained from the USAID and WFP were sufficiently complete to allowed further investigation.

It was observed from the USAID and WFP relief operation reports that they worked together for food aid relief operations in cases for which the operational data were obtained.

Additionally, published reports indicated that USAID funds the WFP for various emergency operations (27). However, it was observed that the WFP was equipped with more infrastructure than the USAID for international emergency operations (27). The USAID and WFP evaluation offices were contacted mainly through electronic mail regarding the requests for operational data. These requests were re-routed to their internal libraries for a data search by the evaluation offices. The libraries conducted the required data search and provided electronic files with the relevant information. The electronic documents obtained from these libraries consisted primarily of extensive keyword searches and available documents on the requested topics.

The available data on the monitoring and evaluation program cycles were adequate to conduct further research though missing in parts. Hence, the missing parts were reconstructed utilizing a partial "dummy" database that also emulated real-life operational conditions. This resulted in a more complete data set for the monitoring and evaluation program cycles solely for the research purposes. This information was then structured to analyze the appropriateness of the CLIPS syntax. Finally, the structured information was converted into pseudocode, which

is a notation resembling a programming language but not intended for actual compilation.

3.3 SYSTEM DEVELOPMENT

The CLIPS software program was used to develop a prototype expert system intended to serve as an aid to monitor and evaluate food aid distribution processes. The development steps included (1) identifying developmental tools and system requirements for building the prototype, (2) determining the method of data analysis, (3) incremental buildup of rules to solve the problem, and finally (4) validation and verification of the prototype.

3.3.1 Developmental Tools

Some of the most commonly available tools for expert system development are shells for expert systems. A shell is a user interface that simplifies the process of developing an expert system. In simple terms, expert system "shells" are expert systems stripped of their knowledge component. Only inference and explanation mechanisms are attached to the shell. A typical shell consists of some form of knowledge representation scheme and a ready-made inference mechanism. Expert shells can be differentiated according to the knowledge representation techniques. They include inductive tools, simple rule based tools, structured rule based tools, and hybrid tools (22).

An expert system shell was utilized to develop the knowledge base for the prototype system. This research employed the C Language Integrated Production System (CLIPS) knowledge based expert system shell (53, 54, 55) originally developed at the National Aeronautics and Space Administration (NASA). Though CLIPS lacks a friendly Graphical User Interface (GUI), it is acknowledged as one of the prominent ES shells available today [Appendix A].

Background of CLIPS: The origins of CLIPS date back to 1984 at NASA's Johnson Space Center. During this time, the Artificial Intelligence Section (now the Software Technology Branch) had developed over a dozen prototype expert system applications using state-of-the-art hardware and software. However, despite extensive demonstrations of the potential of expert systems, few of these applications were put into regular use.

The first prototype version of CLIPS was developed in 1985. Particular attention was given to making the tool compatible with expert systems under development. Thus, the syntax of CLIPS was made to very closely resemble the syntax of a subset of the ART expert system tool developed by Inference Corporation. This research utilized CLIPS 6.05, which was the most recent addition (53).

CLIPS is used throughout the public and private community including all NASA sites and branches of the military, numerous federal bureaus, government contractors, universities, and many companies. The reasons for selecting CLIPS

for this research were because of the features of the system. The key features of CLIPS are:

Knowledge Representation: CLIPS provides a cohesive tool for handling a wide variety of knowledge with support for three different programming paradigms: rule-based, object-oriented, and procedural. Rule-based programming allows knowledge to be represented as heuristics, or "rules of thumb," which specify a set of actions to be performed for a given situation. Object-oriented programming allows complex systems to be modeled as modular components (which can be easily reused to model other systems or to create new components). The procedural programming capabilities provided by CLIPS are similar to capabilities found in languages such as C, Pascal, ADA, and LISP (53).

Portability: CLIPS is written in the C language for portability and speed and has been installed on many different computers without code changes. Computers on which CLIPS has been tested include IBM PC compatibles, Macintosh, VAX 11/780, and Sun 3/260. CLIPS can be ported to any system that has an ANSI compliant C compiler. CLIPS provide all source codes, which can be modified or tailored to meet a user's specific need (53).

Integration/Extensibility: CLIPS can be embedded within a procedural code, called as a subroutine, and integrated with languages such as C, FORTRAN and ADA. A user, through the use of several well-defined protocols, can easily extend CLIPS (53).

Interactive Development: The standard version of CLIPS provides a simple, text oriented development environment, including debugging aids, basic on-line help, and an integrated editor. Interfaces providing features such as pull-down menus, integrated editors, and multiple windows have been developed for the Macintosh®, Windows 3.1, 95, 98, and Windows® NT workstation operating systems (53).

Verification: CLIPS includes a number of features to support the verification of expert systems. The main features include support for modular design and partitioning of a knowledge base, static and dynamic constraint checking of slot values and function arguments, and semantic analysis. These inconsistencies of rule patterns could prevent a rule from firing or generate an error (53).

Additionally, copies of CLIPS executables, documentation, and source code can be downloaded from the World Wide Web and can be freely used, modified, and redistributed without any restrictions. The freedom of development, along with its extensive features as an ES shell compared to the other available shells, made CLIPS the obvious choice for this research (53).

Limitations of the CLIPS Expert System Shell:

Graphical User Interface (GUI): While CLIPS lacks an extensive GUI, a Windows® based interface with pull-down menus may be developed using standard software development tools such as Visual C++® and Visual Basic®. CLIPS's compatibility with other object-oriented programming tools would allow easy integration with any custom developed GUI.

Certainty Factor (CF): CLIPS has no built in capabilities for handling uncertainty. However it is possible to incorporate uncertainty into CLIPS by placing information dealing with uncertainty directly into facts and rules.

IF

The perishable food aid is in storage for more then 30 days

There have been two incidents of power outage in last 30 days.

THEN

There is fair possibility (0.6) that food will be spoiled.

Check the food for spoilage.

The certainty factor ranges from -1 to 1, where -1 means a given fact is known to be false, and 1 means the fact is known to be true, and 0 means no information is known about the fact (completely uncertain). The Certainty Factors were not added to the facts in the prototype due to the nature of information the facts contained. The system contained facts that are of a more generic nature and may require modification according to different organizational guidelines/settings.

3.3.2 CLIPS 6.05 System Requirements

- Intel 486, 100 MHz processor or higher
- Windows® 3.1, 95 / 98 or Windows® NT workstation operating system
- Minimum 16 MB RAM
- 10 MB available hard drive space
- SVGA color monitor

3.3.3 Method of Data Base Development

In CLIPS, knowledge can be encapsulated in rules and objects. Furthermore, rules can match patterns or objects as well as facts and objects can operate independent of rules. A rule-based system was developed during the course of this research. The reasons for using a rule-based approach were due to its ease of encapsulation of knowledge and future expandability (54, 55).

Testing: While developing the rules they were formatted in various ways utilizing template features of the system shell. Initially, testing was done on a small section of data. The section used for testing was about one fifth of the data set. The data were structured in various formats to find out the best way to encapsulate knowledge and create a knowledge base for the system. A pseudocode was developed from the same portion of data. The code was utilized to determine the validity of the syntax and verify the structure of the data. Simultaneously, a tentative knowledge base was generated based on the template creation feature of CLIPS. This method was inadequate to handle such a varied data type, and it lost much information. It was later realized that the template based knowledge encapsulation was appropriate for shallow knowledge, whereas the available data characterized a knowledge type, categorized by CLIPS, as deep knowledge.

Due to the complexity of the available data, the information was re-formatted into "if" and "then" rules. This rule syntax was able to accommodate more detailed information. This turned out to be the desired method of creating the

knowledge base for the system. Trial runs on the same section of data helped to determine any syntax error and programming problems. Finally, upon determination of the validity of the syntax and program execution for the same portion of data, all of the information was converted into "if" and "then" rules. Before programming, the rules were further divided into three files according to various food aid operation stages: pre-operation, operation, and post operation. The pre-operation batch file contained information regarding monitoring and evaluation processes before relief operations start. Operation batch files were further divided into three sections that contained data regarding the operation stage. The last batch file contained data regarding the post-operation stage of monitoring and evaluation processes of food aid distribution.

3.3.4 Prototyping

An expert system prototype refers to a scaled down version of a larger system. It typically includes representation of knowledge captured in a manner that will enable quick inference and the major components of the expert system on a rudimentary basis. Prototype development includes definition of a problem, verification of an approach, identifying an authentic source of data or knowledge, and selection of hardware and software. After the prototype is developed, the system developer and expert panels verify and validate the results, and make improvements to the basic system in order to include the required enhancements. The system typically requires addition of complete information about a process to

the knowledge base and goes through several iterations with required refinements before the final expert system becomes available for general use.

An expert system prototype for monitoring and evaluation of food aid was developed and named FAM (Food Aid Monitor). The FAM is a rule-based prototype and was developed using both *facts* and *heuristic rules*. The FAM was developed for use as an aid for decision-making regarding food aid monitoring and evaluation processes at various stages of food relief operations (pre-operation, operation, and post-operation). This allowed for forward chaining or the data driven approach, which starts with available information and draws conclusions from that information. Rules within the knowledge base were written in "IF" (antecedent), and "THEN " (consequent) statements. While the information was derived from international food aid organizations, the literature review determined the facts and rules that were utilized as the knowledge base of the prototype expert system.

The FAM was designed for use by international food relief organizations for decision-making regarding monitoring and evaluating processes. When installed on organizations computing system, the general capability of the system was to provide advice and recommendations regarding food aid monitoring and evaluation procedures at various stages of the relief operation, thereby improving the process. FAM creates advice and recommendations for the food aid organizations which when used internally (with in the organization) provide critical

need-to-know information to employees. The prototype could be considered a useful tool for decision-makers at the headquarters level as well as for the operation staff of food relief organizations [Appendix B].

3.3.5 System Verification and Validation

The final stage in developing an expert system involves validation and verification of the system. The process of confirming accuracy and effectiveness of the methodology, as applied to the product, is known as verification (14). Verification means building the system right, that is, ensuring that the system correctly implements the specification. It determines if the knowledge base conforms to its design requirements and the software syntax from which it is built (14). In order to test the accuracy of the prototype system, it must be subjected to the food distribution process during a disaster.

For this research the programmer performed verification of the system. The verification phase of the prototype development included using built-in CLIPS verification features. While programming, the rules were checked for inconsistencies, syntax error and duplication. The knowledge base and the inference engine system were subjected to verification by checking their rule syntax. Typical checks included rules with same name, rules with incorrect syntax, redundant rules, isolated rules, subsumed rules, conflicting rules and circular rules. These programming errors would have prevented rule production by the system.

Validation is the process of ensuring that the methodology, as applied, produces the desired results for the prototype expert system for monitoring and evaluation of food aid. In expert system terminology, determining that a chain of correct inferences lead to the correct answer is called validation (14). Real-life emulation for the validation and verification of the methodology would require the development of a food aid distribution, monitoring, and evaluation plan (validation) and also subjecting the plan to a disaster scenario to observe the outcome (verification). Unfortunately, employing the prototype for a food aid distribution scenario is well beyond the scope of the present research.

Validation, therefore, was limited to expert reviews. This process allowed experts and potential users of the methodology to determine the desirability and the applicability of inputs and outputs of the prototype system for practical purposes. While this method was primarily a subjective approach, it still had the capability to address practical situations and generate successful results by incorporating specific requirements based upon the experience of experts in real-life disaster situations.

Based upon review of literature (9,13,22) questionnaires and checklists were developed to facilitate the validation process. The validation process consisted of checking the prototype system for *completeness*, by a faculty expert panel; *consistency*, *correctness* and *precision* by a software-engineering expert panel; and *usability*, by a field expert panel.

The prototype validation for *completeness* included checking the knowledge base for satisfactory antecedent and consequent parts of the rules [Appendix C]. It also required checking for relevancy of each rule to the subject matter. This was achieved by having the faculty expert panel check the rule combination matrix of the prototype knowledge base.

The software validation process for checking *consistency*, *correctness* and *precision* included running the prototype system and using a rule combination matrix to detect system errors and complete the checklist [Appendix D]. A panel of software engineers checked the prototype for fact validation, unused facts, unused rules, multiple methods, run-time errors and unfired rules. The objective of this stage was to achieve an accuracy of 95 percent or more. Finally, a panel of field experts checked the *usability* of the prototype by reviewing the knowledge base for the applicability of the facts and rules to real-life situations and completed a questionnaire [Appendix E].

Three expert panels were selected for the validation process. The first panel was responsible for evaluating relevancy (*completeness*) of the prototype knowledge base. Faculty members from Oregon State University were chosen as expert panelists for this purpose. Individuals with software engineering expertise were the panelists who reviewed the prototype source code for accuracy (*consistency, correctness and precision*). Applicability (*usability*) of the prototype was evaluated by an expert panel consisting of individuals with knowledge and

experience in the field of international development (diverse background in food aid relief operations such as working for international development projects / field experience with food aid).

The expert panelists were selected based on information obtained from various international food relief organizations, software associations, educational institutions and personal knowledge. Ten panelists (three faculty members, three software engineers, and four from food relief organizations) agreed to participate in the research and completed the validation activities.

The validation activities consisted of checking the rule combination matrix of the knowledge base and/or testing the prototype system. Expert panelists were asked to run the prototype system on a PC and/or check the rule combination matrix and finally, complete questionnaires/checklists. Cover letters along with the checklists/questionnaires/FAM prototype floppy diskette were mailed to all the expert panelists [Appendices F, G and H]. The process of running the prototype system was facilitated by instructions on how to start the program as well as a CLIPS programming guide [Appendices I and J]. The last part of the validation activities included completing checklists/questionnaire. Changes in the system were made based on the panel's comments and are presented in the results and discussion section.

4. RESULTS AND DISCUSSION

The aim of this research was to develop and validate a prototype expert system called Food Aid Monitor (FAM). The purpose of the expert system was to provide instruction/advice regarding food aid monitoring and evaluation processes at various stages of food relief operations. The data related to monitoring and evaluation of food aid distribution were identified and utilized to develop the prototype system. Operational data were obtained from two international food relief agencies to provide real-life information for the knowledge base of the FAM. Ten expert panelists, according to the process described in the methodology section, validated the prototype. The results of the prototype system development and validation are presented in this chapter.

4.1. PARTICIPATION OF FOOD RELIEF ORGANIZATIONS

A total of six international food relief agencies involved in international disaster relief were contacted through telephone calls as well as electronic mail and were requested to provide operational data regarding their monitoring and evaluation program cycles. Out of six contacted, only three (50% response rate) responded favorably with the assurance of providing data. The remaining three cited lack of practical documents, unstructured available data and complex organizational structure as causes for being unable to participate in the research. They also indicated that prior commitments and time constraints further prevented them from participating.

Out of three food relief organizations, which responded favorably, only two had sufficient data to develop the prototype system and thus one organization was eliminated from this phase of the research. It was also noted that most of the contacted organizations had only recently started converting data into electronic documents. This organizational transition stage added both complexity as well as delays to the data gathering process. Finally, lack of financial resources for the research was also a major constraint in the data collection process. For instance, numerous international telephone calls were required to effectively communicate the need and the type of data required for the research. Additionally, all of the contacted organizations charged a high premium for the hard copies of their documents.

4.2. STRUCTURING DATA FOR CLIPS

Monitoring data provided by two international food relief organizations were mainly the operational information and database maintained by the organizations. The raw data were unstructured and hence, required proper structuring to fit them within the syntax rules of CLIPS. The structured information was then converted into pseudocode (Table 1) and rule matrixes as required by CLIPS to develop the expert system.

Table 1. An Example of Pseudocode for a Rule

```
defrule Waste-accounting-of-food-aid-distribution-operation

The food aid is given out without any record)
(Food is distributed to non-beneficiaries)
(Food is sold in the local markets of the host country)
(Food is reported stolen from the site)
=>
(assert (It is considered food aid waste )
(Discuss the food aid waste problem in the weekly staff meeting)
(Proper measures should be taken to decrease or stop the waste)
Keep the records of the food aid waste as operation data)))

(assert  (The food aid is given out without any record)
(Food is distributed to non-beneficiaries)
(Food is sold in the local markets of the host country)
(Food is reported stolen from the site))
(run)
```

In order to facilitate programming it was essential to divide the data into different files. After the initial review of pseudocode and the rule matrixes the most obvious choice was to divide it according to different stages of a food relief operation as pre-operation, operation and post operation. The final program contained five source code files named according to different stages of food relief operations. They were pre-operation (PO.CLP.BATCH), operation (OP1, OP2 and OP3.CLP.BATCH), and post-operation (POST.CLP.BATCH) and included 18, 14, 37, 17, and 6 rules respectively in the five stages. This process not only facilitated programming and execution of the overall system but also enabled it to be user-friendlier.

4.3. DUMMY DATA

For conventional programming languages such as C, the programmer may write executable commands for generating numerical or alphabetical dummy data/variables to represent original data/variables. A dummy variable is an artificial argument inserted in any program solely for the purposes of prescribed condition and execution. Creating dummy data is necessary when data are partially missing or incomplete. Unfortunately, the CLIPS shell did not include this automatic feature.

The review facilitated detection of missing parts of each rule. The dummy data for the missing parts were created by going back to the source of knowledge/information and creating the closest possible antecedent and consequent of a rule. For instance, the creation of such a set of dummy data is exemplified in Table 2 and Table 3. Table 2 shows structured incomplete data with a missing consequent of a rule. For proper rule execution in CLIPS, complete antecedent and consequent portions are required. Thus, the consequent of Table 2 was written with partial dummy data as shown in Table 3 to complete the rule according to the CLIPS syntax.

Table 2. An Example of an Incomplete Rule

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)
Food-storage-Investigation	1. Food storage inventory shows difference between records and actual count 2. Food is reported stolen from storage 3. Audit shows excessive spoilage /mishandling	1. Discuss, investigate

Table 3. An Example of the Use of Dummy Data to Create a Complete Rule

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)
Food-storage-investigation	1. Food storage inventory shows difference between records and actual count 2. Food is reported stolen from storage 3. Audit shows excessive spoilage due to food mishandling	1. Investigate into the matter and discuss the audit report with staff 2. Take required action to stop the problem 3. Follow-up after making changes 4. Keep the audit reports of the storage of storage investigation as operation data

4.4. SYSTEM DEVELOPMENT

The last two steps of system development as identified in the review of literature [16] involve rapid prototyping and system evaluation and validation. Rapid prototyping for this research included developing rules from the data and designing the FAM. Finally, three expert panels evaluated and validated the FAM.

4.4.1 Rapid Prototyping

Upon initial structuring of the operational data as mentioned in Section 4.2, pseudocode was generated for the prototype system. After several iterations of the pseudocode review, the rule matrix was tabulated. The rule matrix was a tabulated listing of the components of a "rule" as defined in the expert system, shown as an example in Table 2 and Table 3. While the rule matrix facilitated the process of program coding, it also provided a convenient means of reviewing the systems internal coding by the experts without them having to learn the CLIPS syntax. The existing data were used to form a total of ninety-two rules, which were divided into five files [Appendix C].

The criterion for developing source code for the knowledge-base was to represent monitoring and evaluation programming cycles in terms of production rules with multiple antecedents. Then, the data were divided into three stages of a food aid relief operation: pre-operation, operation and post operation. A total of 92 rules were developed based on the available data that followed the CLIPS syntax of the *If* and *Then* format. Due to the substantially large number of rules within the operation stage, it was further divided into three stages in order to improve program execution. Accordingly, the rules for the operation stage appear in three different batch files, which contained the overall data of the operation stage [Appendix C].

4.4.2 FAM Design

The design of the FAM essentially consisted of developing the rule matrix, generating the pseudocode and finally, writing the source code in CLIPS syntax. As mentioned before, the FAM is an expert system prototype designed to be used as an aid for decision making regarding monitoring and evaluation of food aid at various stages of food relief operations. Hence, it is a rule-based prototype and was developed using both *facts* and *heuristic rules*. This allowed for forward chaining or the data driven approach, which starts with available information and draws conclusions from that information. Rules within the knowledge base were written in "IF" (antecedent), and "THEN " (consequent) statements [Appendix C]. A copy of the FAM program is enclosed in a diskette [Appendix B].

4.4.3 Validation

Ten expert panelists validated the FAM. The validation process consisted of checking the prototype system for; (1) *completeness* and *rule relevancy* by the faculty expert panel; (2) *consistency,* (3) *correctness,* and (4) *precision* by the software engineers expert panel; and (5) *usability* by the field expert panel. Expert panelists were asked to run the prototype system on a PC and/or check the rule combination matrix followed by completing a questionnaire or checklist. Further details on the validation and verification process may be found in Section 0.

4.4.3.1 Review by Faculty Experts

The prototype validation for *completeness* and *rule relevancy* included checking the knowledge base for satisfactory rules. Faculty panelists were asked to validate the prototype knowledge base of the system by checking the rule matrix. They checked for "completeness" by reviewing the rule matrix for accuracy of the "if" and "then" portions of the rules and determined the "relevancy" of the rules to the subject matter of the knowledge base. Results of completeness as well as rule relevancy evaluated by the panelists were tabulated and are presented in Table 4. Further, remarks made by the panelists are discussed in section 4.5.

Table 4. Completeness and Rule Relevancy of FAM Knowledge-base (n = 3)

CLIPS BATCH File Name	**Number of Rules**	**Rule Completeness (%)**	**Rule Relevancy (%)**
PO. Batch.CLP	17	90.19	100
OP1. Batch.CLP	18	90.74	98.14
OP2. Batch.CLP	14	90.47	97.61
OP3. Batch.CLP	37	90.99	98.19
POST. Batch.CLP	6	83.33	94.44
Total/Aggregate	**92**	**89.12**	**97.67**

Table 4 represents the responses of the three faculty panelists expressed in terms of percentage of completeness and rule relevancy of the prototype knowledge base. The different columns of the table contain file names followed by the number

of rules in each file, percentage of completeness and percentage of rule relevancy. Initially, mean scores of the three experts' responses were calculated. Percentage of rule completeness and rule relevancy was derived from the mean scores for each source code file (PO.Batch.CLP, OP1,2 and 3.Batch.CLP and POST.Batch.CLP) and finally the aggregate was calculated and is presented in the table above.

Results of Table 4 depicted a relatively high percentage of rule completeness indicating that the antecedent and consequent of the rules in the knowledge base were satisfactory. The results of rule relevancy were 98 percent, indicating that nearly all of the rules in the knowledge base were relevant to the subject matter.

Most of the remarks and suggestions were in the area of organizational levels and related processes, which could not be improvised completely. Only partial correction of such remarks was made in an effort to maintain the original data set. Making all suggested changes could have created misleading organizational structure and processes. Approximately four percent of the rules were pointed out to include deficient antecedents or consequents. All missing antecedents and consequents suggested by the faculty panel were added to the program.

Other important remarks made by the panelist were regarding the lack of precision in some rules as well as pre-assumptions made by certain rules. For example, one of the panelists suggested that some rules in the knowledge base

assumed certain conditions, such as, the rule "adding requested resources to the operation site" assumed available resources by the relief organization. An important comment made by a panel member was that some of the terms used in the rules were vague such as "follow-up"

A possible cause for "pre-assumption" and usage of "vague terminology" may be attributed to the incomplete condition of the original data from the source. For example, some data provided by the relief organizations were relatively obscure. Additionally, programming restrictions imposed by the CLIPS language syntax may have complicated the comprehension of rules. According to the CLIPS syntax, if the knowledge base contains similar terms, sentences, punctuation marks, antecedents or consequents in a rule, while executing that rule the inference engine will search for all possible combinations. It is very likely to occur when the data are knowledge intensive as opposed to numerical. This can further result in unfired rules, syntax errors or wrong matches between rules, antecedents or consequents.

There were many organization process related questions raised by the expert panel such as "how do you know if weekly check points are the best?" and "food may be wasted due to many reasons such as beneficiaries can't use it, don't like it or don't want it". Most of the organizational processes were not addressed in the modifications in order to maintain original process related data. There were many valuable recommendations made by the panel, such as "reducing frequency of

activities to reduce operational cost". Approximately 50 percent of such suggestions were used in the source code modification.

Since the basic framework of the FAM was to verify the conceptual feasibility of the system, only necessary data modifications were made. Approximately 20 percent of the rules (antecedent or consequent) were modified for minor grammatical changes. Only a few rules (approximately 5 percent) were modified for completeness by addition of an antecedent or a consequent. Possible recommended modifications were made to the original source code of the program. It would be important that the organization specific modifications be made if this system were put into actual use or explicit organizations were the subject of research.

After making changes in the source code of the FAM, the prototype along with the rule matrix, CLIPS program, programming guide and checklist were mailed to software engineering expert panelists for evaluation and validation. Overall, the results of the faculty validation process indicated the expert system rule matrix was feasible for organizational monitoring and evaluating processes.

4.4.3.2 Review by Software Engineering Experts

The software validation process of checking *consistency, correctness* and *precision* was performed by executing the prototype system within CLIPS and using the rule combination matrix to detect system errors. The prototype was

checked by the software engineering experts for fact validation, unused facts, unused rules, multiple methods, run-time errors and unfired rules. Results of the panel review are tabulated in Table 5.

Table 5. Consistency, Correctness and Precision of FAM Knowledge-base (n = 3)

System file name	Rules #	File Size (KB)	Fact Validation Errors	Unused Facts Errors	Unused Rules Errors	Multiple Method Errors	Runtime Errors Errors	Fired Rules	Round one Accuracy %	Round two Accuracy %
PO Batch. CLP	18	15	None	None	None	None	1	17	94.11	100
OP1. Batch. CLP	14	15	None	None	None	None	1	13	94.44	100
OP2. Batch. CLP	37	10	None	None	None	None	1	37	92.85	100
OP3. Batch. CLP	17	28	None	None	None	None	2	17	94.59	100
POST. Batch. CLP	6	4	None	None	None	None	None	6	100	100
Total	92	72	0	0	0	0	5	92	95.19	100

Table 5 represents source code or structural completeness of the FAM prototype. Different columns of the table represent system file name, file size, number of rules in each file, fact validation, unused facts, unused rules, multiple methods, runtime errors and fired rules. The last two columns represent mean scores (percentage) of validation for each round of reviews performed by software engineering expert panelist.

Results of this validation process indicated no inaccuracy of fact validation, unused facts, unused rules or multiple methods. Panelists did find a few rules were

not being fired and also some run time errors in round one. The first round showed a total of 95 percent accuracy, which is generally, accepted for prototype software (14). The source code was updated and modified for error correction by the researcher/developer. Upon the completion of modifications in the source code, it was mailed back to the software engineering panel for a second round of validation. Results of round two showed 100 percent accuracy, suggesting the FAM prototype had no structural errors to preclude obtaining satisfactory performance.

4.4.3.3 Review by Field Experts

The check on *usability* of the prototype was accomplished by having four food relief agency experts review the knowledge base for the applicability of the facts and rules to real-life situations. A questionnaire was developed for the purpose of determining the *"usability"* of the FAM. Prior to sending the questionnaire for review, a brief presentation of the FAM prototype was organized to exhibit the capabilities of the system. This presentation was designed to help the field experts better understand the program prior to determining the *usability* of the system in an organization like theirs. Field expert panelists with varied backgrounds from a food relief organization were asked to review the rule combination matrix and express their views towards *usability* of the system by completing a questionnaire [Appendix H]. The experts were also provided with copies of the CLIPS shell and the FAM program in order to facilitate their

knowledge of the prototype system. The responses to the questions on the questionnaire are tabulated and presented in tables 6 through12.

Table 6. Usefulness of FAM for Decision Making (n = 4)

Question to the experts: Would the proposed expert system be useful in the decision making process for the monitoring and evaluating process listed?			
Stages of monitoring and evaluation processes	**Agree (Frequency)**	**Disagree (Frequency)**	**No Response**
1. In planning, monitoring and evaluation processes	4	-	-
2. For organizing, monitoring and evaluation activities	3	1	-
3. For implementing the monitoring and evaluation plans	2	2	-
4. For decision making regarding monitoring and evaluation activities	4	-	-
5. For controlling the monitoring and evaluation activities	3	1	-
6. For feedback process	4	-	-

Table 6 represents responses from the panelists in terms of usefulness of the prototype for decision-making at various stages of monitoring and evaluation. All panelists agreed with the usefulness of the system for planning, decision-making and feedback of the food aid monitoring and evaluation functions. Furthermore, 75% of the panelists suggested that the system would be useful in the functions of organizing and controlling activities of food aid monitoring and evaluation. Fifty percent of the panelists agreed on the usefulness of the prototype for implementing activities. The main remarks made by the panelists regarding the implementation

of the monitoring and evaluation processes were that it was very generic and lacked the practical details typically required for a real-life implementation. These comments were not unexpected since the FAM prototype was an attempt to verify the feasibility of a generic expert system for the food aid distribution process. It was not designed to accommodate details of organization specific processes. If adapted by a food relief organization, the FAM program has the provision for modification to fit specific organizational needs.

Table 7. Usefulness of FAM at Pre-Operation Stage (n = 4)

Question to the experts: Listed below are the stages of an emergency food aid activity where monitoring and evaluation may occur. There are also some examples of activities that would be occurring in these stages. Would the proposed expert system be a useful decision-making aid in the activities listed below?

Stage and Examples	**Agree (frequency)**	Disagree **(frequency)**	**No Response**
Pre-operation			
1. In trend analysis of food aid distribution.	4	-	-
2. For risk analysis of the distribution process.	3	-	1
3. For deciding operational guidelines.	2	1	1
4. For data collection for food aid operation.	4	-	-

Table 7 represents responses of the panelists towards the FAM in three stages of an emergency food aid activity where monitoring and evaluation can be used for the decision-making process. The aggregate percentage of the responses for each stage (pre-operation, operation and post operation) was calculated. 81% of

the panelists responded that the FAM could be a useful system in the pre-operation stages given as examples on the usability questionnaire. Six percent of responses showed disagreement towards the same questions and 13% were missing responses. All of the panelists agreed that the system could be useful during pre-operation stages like trend analysis and data collection.

Table 8. Usefulness of FAM at Operation Stage (n = 4)

Question to the experts: Listed below are the stages of an emergency food aid activity where monitoring and evaluation may occur. There are also some examples of activities that would be occurring in these stages. Would the proposed expert system be a useful decision-making aid in the activities listed below?			
Stages and Examples	**Agree (frequency)**	**Disagree (frequency)**	**No Response**
Operation Stage			
1. For merging food aid distribution sites.	3	1	-
2. For following progress of the plan.	4	-	-
3. For investigating excess food aid waste.	3	-	1
4. For auditing food inventory	4	-	-
5. For midcourse monitoring correction plan.	2	1	1
6. For reviewing collected data.	4	-	-
7. For collecting beneficiaries' feedback.	2	1	1
8. For feedback discussion process.	3	1	-

Table 8 represents responses of the panelists towards usefulness of the FAM during the operation stage. The responses depict 78% agreement that the FAM

could be useful in the examples given for the operation stage of food aid distribution. The entire panel agreed upon the usefulness of the prototype for activities like food inventory audit, data collection and following the progress of plans. Thirteen percent of the panel responses were not in agreement that the FAM could be useful for the four examples of the operation stage of food aid distribution as listed in Table 8. For certain examples given for feasibility of the FAM at the operation stage, 9% of the panel gave no response.

Table 9. Usefulness of FAM at Post-Operation Stage (n = 4)

Question to the experts: Listed below are the stages of an emergency food aid activity where monitoring and evaluation may occur. There are also some examples of activities that would be occurring in these stages. Would the proposed expert system be a useful decision-making aid in the activities listed below?

Stages and Examples	**Agree (frequency)**	**Disagree (frequency)**	**No Response**
Post-operation Stage			
1. For conducting final inventory.	3	1	-
2. For conducting closing meeting for the operation.	3	1	-
3. For data classification and analysis.	4	-	-
4. For concerned party feedback process.	2	1	1

In response to the examples provided for the post operation stage in table 9, 75% percent of the panel members agreed that the FAM could be useful. The entire panel agreed that it could be a useful system for data collection and analysis.

After reviewing examples for the post-operation stage, 19% of responses disagreed upon the usefulness of the prototype for three of the examples, while 6% showed no response towards one of the examples.

Table 10. Expected Outcomes of FAM (n = 4)

Question to the experts: Based on your review of the prototype, would it accomplish these outcomes?			
Expected outcomes	**Agree (frequency)**	**Disagree (frequency)**	**No Response**
1. Easy to follow monitoring and evaluation process guidelines.	4	-	-
2. Easy access to the decision-making information related to monitoring & evaluation.	3	-	1
3. Save time by speeding the process.	3	-	1
4. May improve efficiency of the process.	3	1	-
5. May increase the efficiency of monitoring activities.	3	1	-
6. May increase the efficiency of evaluation activities.	3	1	-
7. Can be further web deployed for increasing functionality.	4	-	-

Table 10 represents responses of the panelists towards expected outcome of the FAM prototype. All respondents expressed the usefulness of the prototype for following monitoring and evaluation process guidelines. Some panelists commented that this kind of a system could be an advanced substitute for reference manuals used by organizations. Seventy five percent of the responses agreed that the FAM could be useful in accessing information required for the decision making

process. The same percentage of the responses agreed that the FAM, if used by a food aid relief organization, could increase efficiency of monitoring and evaluation processes. The entire panel agreed with the possibility of web deployment of the prototype for increasing functionality of the system.

Table 11. Potential Users of FAM (n = 4)

Question to the experts: Would the proposed expert system be useful for the type of agencies and purposes listed?			
Potential users and examples of tasks	**Agree (frequency)**	**Disagree (frequency)**	**No Response**
1. International food relief organization headquarters	4	-	-
2. Decision making with regards to food relief operation.	3	1	-
3. Following operational guidelines of monitoring & evaluation.	3	-	1
4. As a feedback system.	4	-	-
5. Collecting food aid relief operation related data.	4	-	-
6. Adding recent information to expand/update the system.	3	1	-
Food relief operation sites			
1. Decision making with regards to food relief operation.	2	1	1
2. Following operational guidelines by various field staff.	4	-	-
3. Feed back processes from headquarters to operation sites.	3	-	1
Others			
1. Modified & adapted by similar international organizations.	3	1	-
2. Modified & adapted by national food relief organizations.	4	-	-

Table 11 represents responses of the panelists towards various uses of the prototype by organizations at different levels. The entire panel agreed upon the usefulness of the prototype by international food relief organizations, as a feedback system and for data collection processes. Seventy-five of the responses agreed upon the usefulness of the system for decision making, following monitoring and evaluation guidelines and for storing the food aid relief information. Twenty five percent of responses by the panelists disagreed that the FAM would be useful for the above listed tasks. The main reason for disagreement given by the panelists was that the organization should build software according to their own needs.

In the response to the question of usefulness of the prototype at food relief operation sites, all panelists agreed that the system could be a useful tool for following operational guidelines. They further commented that the traditional method of following manuals, which are often not updated regularly, is a time consuming process. They believed that a system like the FAM might enhance the process. Seventy five percent of the panelist agreed that the system could be useful as a feedback system to communicate between sites and the headquarters. One panelist gave a negative response towards the same question.

Half of the panel agreed that the FAM could be a useful aid for decision making, while the other half thought decision making at the relief sites is a more complicated process and it is difficult to encompass that in a computer program.

Most of the respondents agreed that the system could be adapted for similar international (75%) and national (100%) organizations

Table 12. System Requirements of FAM (n = 4)

***Questions to the experts*:**	**Yes**	**No**	**No Response**
Do you think your organizations existing system can accommodate the FAM hardware requirements?	4	-	-
Does your organization currently use any software for monitoring and evaluation of food aid relief operations?	-	4	-
The complete and finalized FAM prototype from this research with users guide can be tried free of cost. Would you like to test the FAM prototype?	2	1	1
Is this a system you would want to use on a regular basis?	2	1	1

After reviewing the prototype's hardware requirement the entire panel agreed that their existing computer system could easily accommodate the FAM. This showed that the FAM had minimal hardware requirements, which could be adapted without upgrading existing systems. The responses of panelist showed that their organization currently is not using any software to facilitate the monitoring and evaluation processes. However, they indicated that they employ software in the areas of finance and presentations. Hence, there seemed to be a specific desire for such a system in their operational needs.

Two out of four panel members indicated that they would like to obtain a free copy of the software and would likely use such software on a regular basis. One of the panel members disagreed with the same question, commenting that the software would have to be modified for their organization. One of the panel members gave no response towards the last two questions of the usability questionnaire.

4.4.3.4 Performance of the Prototype

The FAM prototype had various checks for performance by the researchers/developer as well as the expert panels. The measures of performance were mainly verification and validation of the prototype as described in sections 0 and 4.4.3. Results of the validation processes indicated the system was practically feasible and its performance was highly encouraging. The requirements of food aid distribution can vary significantly based upon type of disaster, geographic location and number of people affected, to name a few variables. Thus, in order for the FAM to be used in an actual operation and obtain satisfactory performance it would be important that the rules in the database be updated, modified and validated by the user based upon intended applications.

4.5. DISCUSSION

An overall objective of this research was to develop a prototype expert system for monitoring and evaluating food aid as well as validating the system

source code for structural problems. The research was supported by a review of literature, which indicated lack of food aid monitoring and evaluations among food aid relief organizations. As mentioned in the review of literature section, there was no research directly related to the topic, which made the analysis and comparison of the prototype extremely difficult. The task of evaluation becomes difficult if there is no previously established yardstick to measure performance. Thus, the only justifiable way to evaluate the performance of the prototype was to use validation by various experts.

Validation of the FAM prototype by the faculty experts was presented in Table 4 along with its interpretation. The faculty experts panel was mainly responsible for identifying completeness of the source code, which is required for useful and meaningful rule production by the system. The main remarks made by this panel, and related explanations, were discussed in section 4.4.3.1. To improve the validation process by faculty experts, the researcher should have provided more materials such as organizational charts and a detailed explanation of monitoring and evaluation program cycles. This could have been a more detailed explanation in a cover letter. Some activities, like demonstration of the source code in a panel meeting prior to completing the validation checklist, would have helped the experts to have a better understanding of the program and its limitations. The reasons for omitting the meeting and keeping the validation process short and concise was due to time constraints expressed by the panel.

Validation of the FAM prototype, along with its interpretation by the software-engineering experts, was presented in Table 5 and section 4.4.3.2. The software validation process by the engineering experts went very smoothly due to the fact that they were only responsible for checking the program for structural errors and not data deficiencies. As mentioned in an earlier chapter, software development easily accommodates numerical data or shallow knowledge as opposed to knowledge intensive data or deep knowledge. The reported problems were corrected after round one of the source code validation process.

A review of tables 6 to 12 and the comments (section 4.4.3.3) presented by field experts indicate a need for such a system among food aid relief organizations. However, as expected, the panelists repeatedly commented upon the generic nature of the prototype and the need to incorporate detailed practical issues for real-life implementation. The experts believed that the system might have an overall positive impact on the stages of monitoring and evaluation. None-the-less they pointed out a few stages and examples of the process where the system needed to be updated according to their organizational needs and particular disaster scenario. The panel found that the system could be extremely helpful in planning, feedback process, conducting inventory audits, data collection/archive storage and in following operational guidelines. Overall, the FAM validation process by the three expert panels helped to detect structural errors, source code errors and to analyze the usability of the system.

It should be noted here that the FAM was an attempt to develop a proof-of-concept prototype system to verify the applicability of an expert system for the food aid distribution process. While the FAM demonstrated the efficacy of an expert system based monitoring and evaluation process for food aid distribution, the specific and detailed practical issues were beyond the scope of this research. Hence, as stated before, implementation would require the addition of various practical issue rules to the basic knowledge base developed in this work

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A prototype expert system Food Aid Monitor (FAM), for monitoring and evaluating food aid distribution was developed, evaluated and validated. The research obtained data related to food aid monitoring and evaluation processes of various international organizations and applied an artificial intelligence based expert system to develop a prototype for those processes. Three expert panels with varied backgrounds validated the FAM efficacy.

5.1. SUMMARY

Existing data related to monitoring and evaluation program cycles were obtained from two international food relief organizations. An expert system shell called CLIPS (©NASA) was utilized to develop a prototype system named FAM (Food Aid Monitor) for monitoring and evaluating food aid distribution. The FAM is a rule based expert system, which uses facts and heuristic rules to provide advice regarding food aid monitoring and evaluation processes at various stages of the relief operation.

The FAM was evaluated and validated by three expert panels by having the prototype system checked for *completeness* and *rule relevancy, consistency, correctness, precision* and *usability* by faculty, food relief agency and software engineering expert panels. In order to facilitate the validation process by the expert panels, separate questionnaires and checklists were developed for the purpose.

Modifications suggested by the three panels were made to the program. The final version of the system demonstrated total accuracy and panelists responses verified the conceptual feasibility of prototype

5.2. LIMITATIONS

The prototype developed during the course of this research concentrated on the development of an expert system for monitoring and evaluating food aid distribution processes. Development of a user interface and web deployment was not within the scope of this research. The latest version of CLIPS 6.05 used for this research did not feature advanced graphical user interface and web deployment. Adding and testing these features could be built upon the core expert system prototype for further enhancement.

The basic framework of an ES based program was verified to be conceptually feasible. The FAM prototype would not be applicable to all scenarios requiring food aid due to its limited case specific knowledge base. However, for practical implementation the knowledge base of the prototype can be built upon according to the specific requirements of organizations.

The limitations encountered in this research project were low participation rate from the food aid organizations and financial constraints. The reasons for low response rate expressed by contacted officials were conflicts with disclosure agreements, lack of financial incentives, time constraints and prior commitments.

Since the research was not funded it imposed financial constraints to smoothly conducting required activities (finding advanced tools for expert system, gathering data and experts for validation).

5.3. CONCLUSIONS

Numerous references in the literature cited the need for an effective method of monitoring food aid. The goal of this research was to utilize artificial intelligence technology to build and validate a prototype expert system as a tool for improvement of disaster food aid monitoring and evaluation processes. To accomplish the stated goal, data were gathered, structured according to required CLIPS syntax for developing a knowledge base, writing source code, and finally having the FAM verified and validated.

The validation process showed relatively high accuracy of completeness and rule relevancy (89 AND 97 %) and 100 percent operational accuracy, which exceeded the goal of 95%accuracy. Usability results were mixed, indicating the prototype could be more useful in monitoring and evaluation activities like trend analysis, data collection, inventory, audits, data analysis and accessing information required for decision making. Panelist found the prototype to be less useful in activities such as decision making at the operation sites and collecting beneficiaries' feedback. Overall, the experts believed that the system might have a positive impact on the stages of monitoring and evaluation. All above responses showed

the feasibility of the concept that an expert system can assist decision-makers in knowledge and process intensive tasks such as monitoring and evaluation.

4.5 RECOMMENDATIONS FOR FUTURE RESEARCH

Considerable enhancement to the original prototype as developed in this research may be required before the prototype could be employed in the field to assist in monitoring and evaluating processes of food aid distribution. The FAM does not have an extensive graphical user interface (GUI); neither does it have web deployment features. A GUI is likely to be preferred due to the user-friendliness provided by the interface for the user and expert system to communicate. Depending on the implementation of the system, the user interface may be a simple text-oriented display or a sophisticated high-resolution, bit-mapped display. The user interface could also provide for a report generator that would allow the conclusions of each program execution cycle to be formatted and presented in various ways.

Similarly, web deployment applications could be created, with user interface development software, which could run stand-alone in a testing environment and be deployed on the Web. With present-day software technology, developers have full flexibility to take advantage of the latest Web development techniques, including dynamic Hyper Text Mark-up Language (HTML), dynamic database calls, graphic design, and multimedia. Typically, a user interface could link to any major HTML editor and allow developers to establish pathways to

specific HTML pages for each question built. Once a knowledge base is complete, Web developers could collect all HTML pages for publishing on a Web server or for distribution to appropriate parties for further development or integration. When deployed on the Web, applications would run using software engines, which asks questions across the Web by food aid organization's staff working in different areas and report results using default or user-defined formats.

FAM can be modified and used for testing in food aid organizations. This type of work would help to determine the outcome and deficiencies of the prototype in real life situations. Other areas of food relief operations at national and international levels such as nutritional intervention, procurement, logistics, transportation and storage of food aid could also benefit from expert systems technology. Further studies could investigate the use of expert systems in other areas of nutrition and food services, such as creating expert systems for nutrition science laboratory experiments, patient diet plans, volume food production or management training for foodservice employees.

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APPENDICES

Appendix A. CLIPS (©NASA) Program Diskette

Appendix B. FAM Program Diskette

Appendix C Checklist for Faculty Experts

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
1 When-to-establish-multiple-sites-for-the-operation	1. Affected geographic area is more than the area preset by the donor organization 2. Affected population is more than preset number of people by the donor organization 3. The total cost of operation is more than preset dollar amount by the donor organization 4. The total length of operation is more than preset period of the time by the donor organization	1. Select multiple sites for food relief aid distribution 2. Inform the headquarter about the changes of the operation sites 3. Keep the records of multiple site selection process as operations data		
2 Assigning-or-reassigning-staff-duties	1. Duties are not pre assigned to the existing staff 2. Duties are not pre assigned to the newly selected staff or volunteers 3. Staff have different expertise than their assigned work 4. There are more than one distribution sites 5. The plan of food aid distribution has been changed to some extent	1. Program manager and management staff are responsible for assigning or reassigning the duties to the operation staff 2. Program manager is required to consult management staff for assigning or reassigning the duties 3. Maintain documents for the new changes as operations data		
3 Maintaining-daily-operation-records	1. All the operation staff is filing paper work as a requirement 2. All the operation volunteer staff is filing paper work as a requirement 3. All the operation non-governmental organizations staff is filing paper work as a requirement	1. Management staff will review all the paper work 2. Management staff will consolidate the data 3. Daily reports will be filed as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
4 When-to-merge-operation-sites	1. Some sites have slowed down the operation 2. Some sites are towards the end of operation 3. Some operation sites have low participation rate 4. Some operation sites need more staff and resources	1. Combine or merge the sites to reduce the number of sites and increase efficiency 2. Check on the operation of newly merged sites 3. Inform the main headquarters about the site merger 4. Keep the record of the site merger as operations data		
5 Suggestions-and-complaints-reporting-process	1. The food aid relief operation is defined long term by the donor organization 2. Various organization are involved in the food aid relief operation 3. Independent volunteers are part of food aid relief operation 4. Several non-governmental organizations are participating in food aid relief operation	1. Add complaint and suggestion box to all the operation sites 2. Program manager will be responsible to review reports periodically 3. Suggestions and complaints will be recorded and stored as operations data		
6 When-to-launch-special-food-aid-distribution-operations	1. The operation is progressing slow 2. There are frequent delays in the planned operation 3. The operation is subjected to significant changes	1. Plan special operations to recover from food aid distribution delays 2. Inform headquarters about the existing problem 3. Inform headquarters about special the operation plan and operations 4. Follow up during and after the special operation 5. Keep the special operation records as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
7 When-to-change-distribution-sites	1. Existing sites are not easily accessible by the beneficiaries 2. Established sites have shut down due to hazardous conditions of that area 3. Existing sites have shut down due to weather conditions of the area 4. There is shortage of operation staff	1. Use site change plan to increase efficiency of distribution 2. In staff meeting majority should agree on the site change plan 3. Use the planning document for details on the organizations site change plan 4. Follow up on the new distribution site 5. Maintain the records of changes as operation data		
8 Process-of-adding-sites	1. Sites are clustered at one area causing delays and confusion for the beneficiaries 2. Accessing site is problem by the beneficiaries 3. The number of beneficiaries are more then estimated 4. Transportation is a major concern and accessing other operations sites is a problem	1. Establish more distribution sites for better food aid flow 2. Inform the beneficiaries about the new food aid distribution site 3. Follow up on the newly added site 4. Keep the records of the new site as operations data		
9 Establishing-the-flow-checkpoints	1. Food aid distribution sites have been established) 2. Operation duties have been assigned to different staff) 3. The initial food aid distribution plan is designed for food aid flow check	1. Program manager is required to establish food aid flow checkpoints 2. Assign duties to staff for checking the food aid flow 3. Keep the records of the food aid flow checkpoints as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
10 Increasing-personnel-for-the-distribution-operation	1. Food aid distribution operation is slower then expected 2. There are frequent delays in the distribution 3. There is not enough staff to share the operation workload 4. Addition of new staff has been approved by headquarter	1. Non-governmental organization staff and volunteers can be appointed as temporary staff 2. The newly appointed staff should agree to the terms and conditions of the donor organization 3. Maintain the records of the appointed staff as operation data		
11 When-to-modify-existing-monitoring-procedures	1. A serious problem in the monitoring plan has been identified 2. The host country's situation is hindering the existing monitoring plan 3. There is no assistance from the host government 4. There are no signs of improvement in country's present condition 5. Changes in the monitoring process have been approved by the headquarter	1. Change identified to be necessary by the staff then modify the monitoring procedures 2. Refer to the new monitoring plan 3. Make the appropriate changes in the monitoring plan 4. Inform the headquarters about the changes in monitoring plan 5. Follow the improvements of the monitoring process 6. Maintain the records of the monitoring procedure changes as operations data		
12 Additional-staff-selection-process	1. The food aid distribution operation is bigger then the initial plan 2. The food aid distribution operation lacks the personnel or staff 3. There are interested candidates willing to serve as operation staff from the host country 4. Changes in the staff selection have been approved by the headquarter	1. Existing staff will go through team selection process 2. Select required number of candidates for the food aid distribution process 3. Keep the records of the newly selected staff as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
13 Briefing-evaluation-with-officials	1. The new team selection process has been completed 2. The newly selected team has gone through short training 3. The new staff has been allotted different operation sites 4. The newly selected staff has completed briefing of the monitoring and evaluation process with existing staff	1. Go through briefing of the evaluation team jointly with country officials 2. Maintain records of briefing process		
14 Following-progress-of-the-plan	1. The monitoring and evaluation process has been implemented 2. The operation has completed first week 3. The monitoring and evaluation is progressing according to plan	1. The staff is required to follow the progress on monitoring and evaluation plan 2. Maintain the records of the monitoring and evaluation progress		
15 Promoting-evaluation-activities-or-processes	1. Staff has discussed method of evaluation 2. The operation has been started 3. Evaluation duties and sites have been assigned to staff 4. Promotion of evaluation process has been discussed in the staff meeting	1. Program manager and field officer are required to ensure promotion of evaluation activities 2. Maintain the records of promotion of evaluation as operation data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
16 Provision-of-technical-support	1. There is a problem in the food distribution operation due to weather conditions 2. There is a problem in the retrieval of information required by the field officers 3. There is a problem with equipment that is crucial for the distribution operation 4. Addition of technical support has been approved	1. Provide personnel or technical support immediately to the requested site 2. Follow up on the technical problems of the operation site 3. Maintain the records of technical support as operations data		
17 Training-activities-for-the-operation-staff	1. The staff has been appointed in the host country of the relief operation 2. The newly appointed staff is not familiar with operation procedures 3. The plan of operation has been changed significantly 4. New procedures of operation are introduced	1. Training activities are required for the staff to understand the plan and changes 2. Follow up the operation after the training activities 3. Maintain the records of the training activities as operations data		
18 Ensuring-monitoring-processes-or-activities	1. The food aid distribution operation process has stated 2. The food aid distribution program has multiple phases 3. The monitoring activities have been instituted	1. Program manager is required to ensure that monitoring processes are progressing as planned 2. Keep the records of the progress of the activities as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
1 Collecting-beneficiaries-feedback	1. It is second week of the food aid distribution operation 2. Beneficiary's health is not in danger due to disaster 3. Beneficiaries are willing to participate in feedback process	1. Add beneficiaries interview as a feedback process 2. Record the beneficiaries concerns or complains 3. Maintain the record of the beneficiary's feedback as operations data		
2 When-to-establish-weekly-checkpoints	1. Operation sites have been launched 2. It is first week of the operation 3. If there is some problem in food aid flow 4. Staff has been assigned to check food aid flow	1. Follow up on the staff feedback of the food aid flow check 2. Keep the records of the food aid flow as operations data		
3 Waste-accounting-of-food-aid-distribution-operation	1. The food aid is given out without any record 2. Food is distributed to non-beneficiaries 3. Food is sold in the local markets of the host country 4. Food is reported stolen from the site	1. Discuss the food aid waste problem in the weekly staff meeting 2. Proper measures should be taken to decrease or stop the waste 3. Keep the records of the food aid waste as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
4 Investigating-excess-food-aid-waste	1. The food is given out repeatedly without any accounting 2. The food aid is intentionally distributed to non-beneficiaries 3. Relief food aid is reported to be selling in the local markets 4. Food aid loses are accruing frequently 5. There have been reports of food waste from accounting staff	1. The program manager and audit team should investigate the matter immediately 2. The matter should be resolved immediately 3. Follow up on the food aid waste problem 4. Keep records of the food aid waste documents as operations data		
5 Food-storage-investigation	1. Food storage inventory shows difference between records and actual count 2. Food is repeatedly reported stolen from storage 3. Audit shows excessive spoilage due to food mishandling	1. Investigate into the matter and discuss the audit report with staff 2. Take required actions to stop the problem 3. Follow-up after making changes 4. Keep the audit reports of storage investigation as operations data		
6 Food-inventory-audit	1. The operation has been started for more then a week 2. There is a separate facility for food storage 3. The operation has established inventory methods	1. There should be regular food inventory audit 2. Program manager should review records and reports of the audit 3. Maintain the audit records as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
7 When-to-close-inventory	1. There is still food in storage 2. The operation has been fully closed 3. There is an approval from program manager to donate the food commodities to local charities	1. Go according to the initial donor organization plan or donate remaining food commodities to local disaster relief agencies 2. Keep the records of the donations as operation data		
8 Transporting-food-aid-to-the-distribution-sites	1. There is separate logistic staff 2. The food aid is transported to the sites by logistic department 3. The logistic department has its own food storage facility	1. Food aid operation staff will have the responsibility for food aid transportation at the distribution site 2. Food aid distribution staff will maintain the inventory records		
9 When-to-add-informal-feedback	1. Operation is small with few sites 2. Operation is defined short term by the donor organization 3. The number of staff and non-governmental organizations involved is relatively small	1. Add informal feedback method for food aid operation 2. Informal feedback is mainly used when input of the staff serves as data 3. Maintain the records of the informal feedback as operation data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
10 Adding-formal-feedback	1. The operation has multiple sites 2. The operation is defined as extended or long-term by the donor organization 3. Numerous local and non-governmental organizations are involved in operation 4. Separate staff has been assigned for data collection	1. Add formal feedback method for food aid operation 2. Maintain the records of formal feedback and reviews as operations data		
11 When-to-add-formal-checks	1. The operation has multiple sites 2. The operation is defined extended or long-term operation by the donor organization 3. Various local and non-governmental-organizations are involved in the operation	1. Add formal checkpoints 2. Assign staff to report the distribution problems 3. Keep the record of the distribution problems as operations data		
12 When-to-add-informal-checks	1. The chances of food loss during operation are high 2. The food aid relief operation is defined large scale by the organization 3. There are multiple sites with large number of staff 4. Numerous local and non-governmental organizations are involved in the food aid operation 5. The operation is defined long term by the donor organization	1. Along with formal checks add informal checks and reporting procedures 2. Maintain the records of the informal checks as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
13 Field-visit-of-distribution-sites	1. The operations have been started 2. Various outside organizations are involved in the distribution operation 3. There are multiple operation sites	1. Program manager will make frequent field visits to operation sites 2. Program manager will check with field officers and beneficiaries 3. Maintain the records of the field visits as operations data		
14 Midcourse-monitoring-plan-correction-process	1. Monitoring activities are not progressing as planned 2. Program manager has identified serious weakness in the monitoring plan 3. Monitoring plan is not working due to host country's condition 4. Collected monitoring data depicts the need for correction in the plan	1. Conduct a staff meeting for midcourse correction 2. Get approval of mid-course correction from headquarters 3. Make the required changes in the monitoring plan 4. Follow up the monitoring plan 5. Maintain the records of the midcourse correction as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge-base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
1 Establishing-feedback-method-for-food-aid-operation	1. There are multiple operation sites for food aid distribution 2. Each site has an independent food aid distribution operation 3. All the sites have same food aid inventory 4. Each site has independent supervisor or field officer	1. Conduct bi-weekly staff meeting for feedback 2. Meeting will include staff feedback of ongoing operation 3. Send the records to headquarters 4. Keep records of feedback meeting as operations data		
2 When-to-get-headquarters-assistance	1. The operation is not progressing according to plan 2. Access to affected area is extremely difficult 3. Resources are not reaching the operation sites on time	1. Contact the headquarters for immediately assistance 2. Program manager and management staff is responsible to communicate with the headquarters 3. The suggested changes by headquarters should include program manager and management staffs consent 4. Implement suggested changes when appropriate 5. Follow up on the implemented changes 6. Keep the records of suggested and implemented changes as operations data		
3 Feedback-discussion-process	1. All the operations staff is required to file short daily report 2. All the operations volunteer are required to file short daily report 3. All the operation non-governmental-organizations staff is required to file short weekly report	1. Program manager will share the report feedback with all the staff on a regular basis 2. Issues which needs immediate attention should be resolved 3. Send to headquarters the weekly operation reports on periodic basis 4. Keep the records of daily operation reports and feedback as operations records		

Completeness: the antecedent and consequent of a rule are satisfied. **Rule Relevance:** relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
4 When-to-merge-or-close-sites	1. Some sites have slowed down the operation 2. Some sites are towards the end of operation 3. Some operation sites have low participation rate 4. Some operation sites need more staff and resources 5. There is headquarter approval for closing or merging operation sites	1. Combine or merge the sites to reduce the number of sites and increase efficiency 2. Check on the operation of newly merged sites 3. Inform the main headquarters about the site merger 4. Keep records of the site merger as operations data		
5 Suggestions-and-complaints-reporting-process	1. The food aid relief operation is defined long term by the donor organization 2. Various local organization are involved in the food aid relief operation 3. Independent volunteers are part of food aid relief operation 4. Several non-governmental organizations are participating in food aid relief operation	1. Add complaint and suggestion box to all the operation sites 2. Program manager will be responsible to review them periodically 3. Suggestions and complaints will be recorded and stored as operation data		
6 Process-of-recording-weekly-operation-expenditure	1. Expenditures have accrued in acquiring resources for the food aid distribution site 2. Expenditures are necessary to continue food aid distribution operation 3. Miscellaneous expenditures are within the established limit by the donor organization	1. Get weekly expenditure approved by management staff 2. Include expenditures as weekly operation expenditure 3. Maintain records of weekly expenditures as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
7 Decision-making-process-during-food-aid-relief-operation	1. Decision involves more then preset dollar amount 2. The decision involves changing sites or closing sites 3. Decision is related to long term change 4. Decision involves adding resources to different food aid operation sites 5. Decision is regarding conducting audits 6. Decisions is regarding handling complaints and making changes	1. Program manager along with input of other staff is authorized to make decisions 2. Volunteers are not authorized to make these decisions 3. Non-governmental organization can participate in the decision making process 4. Keep records of the decision making process as operations data		
8 Absent-manager-decision	1. Program manager is not present at the time of making decision 2. Normally the decision requires consent of the program manager 3. An issue requires immediate attention or decision 4. The field officer of the affected site is present	1. Field officer will have authority to make decision 2. Staff who makes the decision should inform the program manager 3. Maintain the records of absenteeism decisions as operation data		
9 Conflict-resolution-process-during-food-aid-distribution-operation	1. Some beneficiary or participating local agency is offended by the staff behavior 2. There is miscommunication between staff and beneficiaries due to language barrier 3. There is conflict between donor organization agency and participating local agency 4. There is conflict between donor organization and non-governmental organization	1. Matter should be resolved immediately by staff 2. Program manager should be informed about the incident 3. Maintain a incident record		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
10 Considering-special-cases	1. Beneficiary is an old person with health problems 2. Beneficiary is a pregnant woman 3. Beneficiary is person with serious health problems 4. Beneficiary can not access the site for assistance 5. Beneficiary has immediate special need like medicine	1. Case should be considered as special case by management staff 2. Special case should be assigned to staff 3. Keep records for information and referrals 4. Keep the record of special cases as operations data		
11 Reporting-method-during-operation	1. There are multiple food aid distribution operation sites 2. Each site has team leader or field officer 3. All the sites receive food from same storage facility 4. Program manager and management staff has allotted time for report reviewing	1. Bi-weekly reporting to program manager is a requirement 2. Program manager and management staff will go through each site report 3. Program manager gives feedback to all the field officer and team leaders 4. Site reports and feedback will stored as operations data		
12 When-to-inform-main-headquarters	1. There is discrepancy in planning and operation method 2. There are major barriers in food aid distribution 3. There is disagreement with the host country that is impeding speed of the operation 4. There have been major changes in the operation 5. According to initial operation plan requirement to inform the headquarters	1. Main headquarters should be informed immediately about discrepancies or changes 2. The program manager and management staff is responsible for informing headquarters 3. Keep the record of headquarters interaction as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
13 When-to-make-changes-in-the-operation-guidelines	1. The evaluation strategies have been decided at a headquarters prior to the operation 2. The headquarters staff has set the guidelines prior to the operation 3. The legal operation guidelines by the host county are available	1. Program manager can make minor changes in operation guidelines 2. The changes should be within legal guidelines given by the host country 3. Keep records of changes in operations guidelines		
14 Deciding-monitoring-strategies	1. The data of the host country are present 2. There are records of similar prior monitoring operations 3. There are records of similar monitoring plans 4. There are records of similar monitoring plans with analysis and report	1. The monitoring strategies will be decided by the relief operation staff at headquarters 2. Minor changes in the monitoring strategies can be made where required 3. Records of the monitoring strategies and changes should be maintained as operations data		
15 Referring-prior-records-for-planning	1. The host county had prior disaster condition 2. Some other organization had similar food aid distribution operation 3. There is a database or reports of prior distribution and evaluation procedures 4. There is a database or reports of prior distribution and monitoring procedures	1. Refer to those records in the initial meeting as aid for planning		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
16 Food-aid-donations-qualification-criteria	1. The person falls in the operational definition of disaster victims 2. The family or individual is negatively affected by the disaster 3. The host country has provided the list of victims	1. Person or family qualifies for the disaster food aid 2. Include them in the list of beneficiaries 3. Keep the record of the beneficiaries as operations data		
17 Reviewing-collected-data	1. Field staff is collecting monitoring and evaluating data 2. Data collection is proceeding according to the monitoring and evaluation plan 3. Data are complete with different phases of the food aid are distribution operation	1. Review collected information with program manager on regular basis 2. If data review indicates missing data follow rule for data revision		
18 Reviewing-regular-progress	1. The collected data are available for review 2. Field staff has allotted time for reviewing 3. There are regular update staff meetings	1. The operation progress will be reviewed regularly 2. Strategies if necessary for improvement will be implemented 3. Record the reviewed data as operations data		
19 Comparing -operation-progress	1. The complete progress report is available 2. Field staff and program manager are present in the meeting 3. Planning documents are available in the meeting 4. Collected operations data and reviews are available	1. Compare the progress with the initial operation plan 2. Write progress report of the food aid operation 3. Donor organization headquarters should receive the operation progress report 4. Maintain the progress report as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
20 Adding-resources-to-the-food-aid-distribution-operation	1. There is need for training existing staff 2. There is need for addition technical assistance for the food aid distribution operation 3. There is need for addition resources for continuing the food aid distribution operation 4. There is need for additional staff at existing sites 5. The site managers make an additional resource request	1. The program manager approves the resource request 2. Add identified additional available resources to the operation to increase overall efficiency 3. Follow up the food aid distribution operation after adding the resources 4. Maintain the records of the additional resources as operations data		
21 Referring-additional-studies-to-improve-efficiency	1. Monitoring and evaluation plan is not progressing as planned 2. Food aid distribution staff wants to change monitoring and evaluating procedure 3. The process of mid-course change has not started	1. Refer to other similar monitoring and evaluation plan before suggesting any changes 2. keep the records of mid-course changes as operations data		
22 Additional-team-selection-process	1. The food aid distribution operation is bigger then the initial plan 2. The food aid distribution operation needs personnel or staff 3. There are interested candidates willing to serve as operation staff from the host country	1. Existing staff will go through team selection process 2. Select required number of candidates for the food aid distribution process 3. Selected staff should be approved by program manager 4. Keep the records of the newly selected staff as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
23 Briefing-evaluation-with-officials	1. The new team selection process has been completed 2. The newly selected team has gone through short training 3. The new team has been allotted new operation sites 4. The newly selected team has completed briefing of the monitoring and evaluation process with existing staff	1. Go through briefing of the evaluation team jointly with country officials		
24 Following-progress-of-the-plan	1. The monitoring and evaluation process has been implemented 2. The operation has completed first week 3. The monitoring and evaluation is progressing according to plan	1. The staff is required to follow the progress on monitoring and evaluation plan 2. Maintain the records of the monitoring and evaluation progress		
25 Promoting-evaluation-activities-or-process	1. Operation staff has discussed method of evaluation 2. The operation has been started 3. Evaluation duties and sites have been assigned to staff 4. Promotion of evaluation process has been discussed in the staff meeting	1. Program manager and field officer are required to ensure promotion of evaluation activities 2. Maintain the records of promotion of evaluation as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
26 Provision-of-technical-support	1. There is a problem in the food distribution operation due to weather conditions 2. There is a problem in the retrieval of information required by the field officers 3. There is a problem with equipment that is crucial for the distribution operation	1. Provide personnel or technical support immediately to the requested site 2. Follow up on the technical problems of the operation site 3. Maintain the records of technical support as operations data		
27 Training-activities-for-the-operation-staff	1. The staff has been appointed in the host country of the relief operation 2. The newly appointed staff is not familiar with operation procedures 3. The plan of operation has been changed significantly 4. New procedures of operation are introduced	1. Training activities are required for the staff to understand the plan and changes 2. Follow up the operation after the training activities 3. Maintain the records of the training activities as operations data		
28 Ensuring-monitoring-processes-or-activities	1. The food aid distribution operation is in the progress 2. The food aid distribution program has multiple phases 3. The monitoring activities have been instituted	1. Program manager is required to ensure that monitoring processes are progressing as planned 2. Keep the records of the progress of the activities as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
29 Following-evaluation-guidelines	1. The evaluation plan has been instituted 2. Operation staff has been assigned to evaluate the operation 3. The evaluation plan is available at the time of operation 4. There is an evaluation manual for the staff to follow	1. The evaluation staff will go over the evaluation guidelines before beginning of the operation 2. The staff handling evaluation operations will a have copy of evaluation guidelines 3. Maintain the records of evaluation review by the staff as operations data		
30 Recording-monitoring-inputs	1. There are suggestions from the staff regarding monitoring procedures 2. There is staff input on the monitoring plan 3. There are suggestions about the improvement of the monitoring processes 4. During field visits program manager receives valuable input	1. Record the monitoring inputs for operation 2. Discuss the monitoring inputs in the staff meeting 3. Make necessary changes in monitoring procedures 4. Maintain the records of monitoring inputs as operation data		
31 Recording-evaluation-inputs	1. There are suggestions from the staff regarding evaluation procedures 2. There is staff input on the evaluation plan 3. There are suggestion about the improvement of evaluation process 4. During field visits program manager receives some valuable input staff	1. Record the evaluation inputs for the operation 2. Discuss the evaluation inputs in the staff meeting 3. Make necessary changes in evaluation procedures 4. Maintain the records of evaluation inputs as operation data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
32 What-is-considered-monitoring-data	1. Data are related to monitoring procedures 2. The staff makes suggestions and inputs regarding food aid distribution-monitoring operations 3. The part of the plan and policies which is related to monitoring of food aid distribution operation 4. There are reports and reviews of monitoring during food aid distribution operation	1. Consider them as monitoring data of the food aid operation 2. Maintain the records of the monitoring data		
33 What-is-considered-evaluation-data	1. Data are related to evaluation procedures 2. The staff makes suggestions and inputs regarding food aid distribution evaluation operation 3. The part of plan and policies which is related to evaluation of food aid operation exists 4. Reports and reviews of evaluation during food aid distribution operation	1. Consider then as evaluation data of the food aid operation 2. Maintain the record of evaluation data		
34 When-to-make-corrections-in-evaluation-data-collection-process	1. The collected data are not measuring food aid distribution 2. The procedure of data collection is not appropriate for the host country	1. Make correction in the procedure of data collection 2. Follow up on the changes of data collection procedures		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
35 When-to-make-corrections-in-monitoring-data-collection-process	1. The collected data are not measuring effectiveness of food aid distribution monitoring process 2. The procedure of data collection is not appropriate according to specific host country	1. Make correction in the procedure of data collection 2. Follow up on the changes of data collection procedures		
36 Implementing-monitoring-process	1. The process of monitoring is progressing according to the monitoring guidelines 2. The process of monitoring results in data to find if the food is reaching to its intended beneficiaries 3. The staff is following the guidelines of the monitoring plan	1. Program manager is responsible to check the implementation of monitoring process at various stages 2. Maintain the records of various stages of monitoring as operations data		
37 Implementing-evaluation-process	1. The process of evaluation is progressing according to the evaluation guidelines 2. The process of evaluation exists in data to find if the food is reaching to its intended beneficiaries 3. The staff is following the guidelines of the evaluation plan	1. Program manager is responsible to check the implementation of evaluation process at various stages 2. Maintain the records of various stages of evaluation as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
1 Pre-operation-meeting-criteria	1. All the staff and volunteer groups involved in the distribution process are present 2. The agenda has been prepared and approved for the meeting 3. Sites for the distribution have been decided upon	1. Conduct first pre-operation staff meeting 2. Meeting will mainly include operation plan and procedures 3. Keep the records of the pre-operation meeting as operations data		
2 Trend-analysis-of-the-food-aid-distribution	1. Reports of the similar prior operation are available 2. Reports from host country's situation are available 3. Reports from similar prior operations are present	1. These records should depict the general trend of food aid distribution 2. Conduct trend analysis to find out possible problems 3. Plan food distribution activities keeping the general trends in mind) 4. Maintain the records of trend analysis as operations data		
3 Risk-analysis-of-the-food-aid-distribution-process	1. Food aid relief operation has been planned 2. Food aid relief operation has not started 3. There are records for similar prior operations 4. Other relevant information of the host country is available	1. Perform risk analysis to find out safety aspects of the operation 2. Choose methods for the operation accordingly		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
4 Beneficiaries-record-from-host-country	1. There is a full beneficiaries record provided by the host government 2. The age of the beneficiaries is indicated on the record 3. The gender of the beneficiaries is indicated on the records 4. The special medical conditions if any are also indicated on record 5. There is enough staff to handle special cases	1. Prioritize the records according to special medical conditions 2. Prioritize the records according to gender 3. Prioritize the records according to age 4. Assign separate staff to handle special cases 5. Keep the records of the prioritized records as operations data		
5 Non-governmental-organization-involvement	1. Host country government recognizes the non-governmental organization 2. Non-governmental organization is from affected area 3. Staffs of these organizations has prior food aid distribution experience 4. The host country recommends the non-governmental organization	1. Include non-governmental organization in the food aid distribution operation 2. The non-governmental organization will review the conditions of donor organizations 3. Keep the records of the non-governmental organization participating in the operation as operations data		
6 Resource-access-for-non-governmental-organization	1. The non-governmental organization has good work record 2. The non-governmental organization has been involved in similar prior operation 3. The non-governmental organization has been certified by host country government 4. The non-governmental organization has been officially included in the food aid distribution operation	1. The non-governmental organization will have partial access to distribution operation resources 2. The donor organization will review the resource access with non-governmental organization 3. Keep the records of the non-governmental organization resource access as operations data		

Completeness: the antecedent and consequent of a rule are satisfied. **Rule Relevance:** relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
7 What-is-partial-access-for-non-governmental-organization	1. The non-governmental organization is partially involved in the official paper work of the donor organization 2. The non-governmental organization has no direct access to financial resources of the donor organization 3. The non-governmental organization has no direct access to headquarter reporting system of the donor organization	1. For present operation this will be considered partial resource access for non-governmental organization 2. The participating non-governmental organization will be informed about the partial access 3. Maintain the records for partial resource access as operations data		
8 How-to-select-volunteers-from-host-country	1. Volunteers are recommended by some recognized governmental institution of the host country 2. Candidates have food aid distribution or emergency operation experience that will be preferred but not required 3. Donor organization selection committee approves the selected candidates 4. The volunteers agree to terms and conditions of the donor organization	1. Include the volunteers in the list for the food relief aid operation 2. Provide volunteers with introductory training 3. Include volunteers in necessary distribution operation related meetings 4. Keep the records of selected volunteers as operations data		
9 Selecting-operation-site-for-food-aid-distribution	1. The site is located in the affected area 2. The site is fairly close to the affected area 3. The site is where beneficiaries are currently residing 4. The host government has recommended the site 5. The site is recommended by non-governmental organizations	1. Approve the site for establishing a food aid distribution center 2. Prepare the site for food aid distribution operation 3. Keep the records of selected sites as operations data		

Completeness: the antecedent and consequent of a rule are satisfied. **Rule Relevance**: relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (PO.CLP.BATCH)) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
10 Method-of-data-collection-for-food-aid-operation	1. Open-ended surveys can be easily distributed to the beneficiaries 2. The local language is not a barrier to conduct open-ended surveys 3. Surveys can be easily stored and converted into electronic database for organization records 4. There is enough staff or personnel for the data collection and processing 5. Open-ended surveys are preferably in local language 6. The survey results can be stored in the official language of the donor organization	1. Select open-ended survey as method of data collection for the entire operation 2. The surveys should be converted into official language of the organization before storing 3. Store all the surveys as operations data of the organization		
11 Evaluation-strategies	1. The data of the host country are present 2. There are records of similar prior operations 3. There are records of similar evaluation plans 4. There are records of similar prior evaluation plan accompanied by reports and analyses	1. The evaluation strategies will decided by the relief operation staff at headquarters 2. Minor changes in the evaluation strategies can be made if required 3. Records of the evaluation strategies and changes should be maintained as operations data		
12 Deciding-operation-guidelines	1. The food relief operation is an extended operation 2. The operating conditions and guidelines are made available from the host country 3. The legal guidelines are made available from the host country	1. The food aid relief operation guidelines will be decided at headquarters 2. The guidelines can be subjected to minor changes at operation stage 3. The records of the changes should be maintained as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
13 Monitoring -policies	1. The donor organization has monitoring policies and procedures manual for the operation 2. The policies for monitoring have been listed in manual 3. The manual has guidelines for the monitoring process 4. If there are any changes in the monitoring policies	1. The staff will proceed according to the monitoring policies 2. Minor changes can be made only with consent of the program manager 3. Notify concerned staff and keep the records as operations data		
14 Expected-monitoring-outcomes	1. There is prior planning of monitoring operation 2. There are set steps for the monitoring operation 3. There are guidelines for the monitoring operation	1. Plan should have clear and measurable expected outcome of monitoring 2. Staff responsible for monitoring should be aware of the expected outcomes of the monitoring activities 3. While conducting monitoring activities the staff should check the data for its measurability and accuracy		
15 Following-monitoring-guidelines	1. The monitoring plan has been instituted 2. Various operation staff have been assigned to monitor the operation 3. The monitoring plan is present at the beginning of operation 4. There is a monitoring manual for the staff to follow	1. The monitoring staff will go over the monitoring guidelines before beginning the operation 2. The staff handling monitoring operation will have a copy of monitoring guidelines 3. Maintain the records of monitoring guideline review by the staff as operations data		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
16 Donor-support-report-to-recipient	1. The donor organizations food aid operation has been completed 2. The recipient country government had partial involvement in the food aid operation 3. The recipient country government was involved in providing information to the donor organization	1. The donor organization staff or officials are required to submit report to the recipient country according to initial agreement		
17 Evaluation-policies	1. The donor organization has evaluation policies and procedures manual for the operation 2. The policies for evaluation have been listed in a manual 3. The manual has guidelines for the evaluation process	1. The staff will proceed according to the evaluation policies 2. Minor changes can be made only with consent of the program manager at the site 3. If there are any changes in the evaluation policies notify concerned staff and keep the records		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (POST.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
1 Conducting-the-closing-meeting-of-distribution-operation	1. The operation has been completed 2. About eighty percent or more of operation staff is present for the meeting 3. About fifty percent or more of the NGO staff is present for the meeting 4. About fifty percent or more of the volunteer staff is present for the meeting 5. Data for the operation are available	1. Conduct closing meeting to discus the outcomes of the operation 2. Get direct feedback from the staff 3. Keep the record of the closing meeting as operations data		
2 When-to-conduct-final-inventory	1. All the food aid distribution operations have been fully ended 2. Inventory records show there is still food in storage 3. The inventory is not closed	1. Conduct final inventory 2. Send the final inventory report to program manager of food aid operation 3. Keep the records of final inventory as operations data		
3 Data-classification-and-analysis	1. Food aid distribution operation has been fully completed 2. Complete data of operation are available 3. Data for different stages of operation are available 4. Complete sets of surveys are available	1. Operation data should be classified into different categories for analysis 2. Data should be converted into electronic data 3. Store the operation and analysis reports for future reference		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

RULE COMBINATION MATRIX (POST.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	Completeness	Rule Relevance
4 Post-evaluation-of-food-aid-distribution-organization	1. The operations have been fully ended 2. All the evaluation records are available 3. All the daily operation reports are available 4. The complete set of operation data is available	1. Send all the data to the headquarter for post evaluation 2. Post evaluation reports should be send to interested parties		
5 Recipient-support-report-to-donor	1. The recipient country operation has been completed 2. The recipient country government had partial involvement in the operation 3. The recipient country government was involved in providing information for planning	1. Recipient country officials are required to submit a report to donor organizations according to initial agreement		
6 Concerned-party-feedback-process	1. Monitoring and evaluation is proceeding as planned 2. There have been no major changes in the plan 3. The reports of the monitoring and evaluations are available	1. Write a separate report for concerned parties 2. Provide feedback to the concerned parties 3. Keep the record of the concerned parties feedback as operations data .		

Completeness: the antecedent and consequent of a rule are satisfied.
Rule Relevance: relevancy of the rule to the subject matter of the knowledge base.

Additional Comments:_____

Thank you for Your Assistance with This Research

Appendix D. Checklist for Software Engineering Experts

Prototype Validation Checklist

The following errors and inconsistencies in an expert system knowledge base can lead to false conclusions. These errors are used for checking correctness, consistency and precision (validation) in the knowledge base of an expert system. The checklist given below will help to modify, delete or add appropriate rules to correct the identified errors and validate the prototype system. Use the following definition for checking these errors in the rule combination matrix and FAM prototype expert system:

1. **Fact Validation**: for a fact to be valid it has to appear in at least one premise (Right Hand Side) of a rule.
2. **Unused Facts:** facts, which are in the knowledge base of an expert system but are not used during execution of the program.
3. **Unused Rules:** rules, which are in the knowledge base of an expert system but are not used during the execution of program.
4. **Multiple Methods**: expressions that appear more than one time in questions and facts, questions and conclusions or facts and conclusions.
5. **Runtime Error:** error, which occurs after compilation, during the execution of the translated source program.
6. **Rule Firing**: means program has selected a certain rule for execution from the agenda.

System file name	File Size (Kbytes)	Fact Validation	Unused Facts	Unused Rules	Multiple Method	Runtime Errors	Rules that never got fired	Comments
PO.CLP. BATCH								
OP1.CLP. BATCH								

System file name	File Size (Kbytes)	Fact Validation	Unused Facts	Unused Rules	Multiple Method	Runtime Errors	Rules that never got fired	Comments
OP2.CLP. BATCH								
OP3.CLP. BATCH								
POST.CL P.BATCH								

Additional Comments:_____

Thank you for Your Assistance with This Research

Appendix E. FAM Prototype Usability Questionnaire

This questionnaire is designed for the purposes of determining the "usability" of a Food Aid Monitor (FAM) prototype expert system. FAM is an expert system prototype designed to be used as an aid for decision making regarding monitoring and evaluation of food aid. After reviewing the rule combination matrix and/or FAM prototype please express your views towards "usability" of the system by completing the checklist and/or writing your opinion/comments in each section. This information will be used to determine "usability" of the prototype as well to make identified changes in the system.

To be completed by food aid relief expert:

Name: _____ Date: _____

Need of the Prototype Expert System: The literature frequently cites the problem of ineffective food aid distribution predominantly caused by organizational inefficiencies and lack of a feedback process. According to a report (Committee on Government Operations, 1994) "international food aid is not monitored on a regular basis due to ineffective monitoring practices, follow-up on losses and incomplete evaluations". These problems, not only deprive the disaster victims of life giving support, but can also discourage potential sources of contributions. Improving management requires better monitoring and evaluation throughout the programming cycle and prompt supply of information to the decision-maker. For this research, artificial intelligence technology was utilized to build and validate a FAM prototype expert system as a tool for improving the food aid monitoring and evaluation processes. Outcome of this research is a prototype system (FAM) that will facilitate the decision making process of food aid monitoring and evaluation.

PLEASE REVIEW THE ENCLOSED RULE MATRIX AND THEN ANSWER THE QUESTIONS ON THE FOLLOWING PAGES

Thank you for Your Assistance with This Research

1. Would the proposed expert system be useful in the decision making process for the monitoring and evaluating process listed?

Stages of monitoring and evaluation processes	**Agree**	**Disagree**
1. Planning, monitoring and evaluation processes		
2. Organizing, monitoring and evaluation activities		
3. Implementing the monitoring and evaluation plans		
4. Decision making regarding monitoring and evaluation activities		
5. Controlling the monitoring and evaluation activities		
6. Feedback process		

Additional Comments: _____

_____

2. Listed below are the stages of an emergency food aid activity where monitoring and evaluation may occur. There are also some examples of activities that would be occurring in these stages. Would the proposed expert system be a useful decision-making aid in the activities listed below?

Stages and Examples	**Agree**	**Disagree**
Pre-operation		
1. Trend analysis of food aid distribution.		
2. Risk analysis of the distribution process.		
3. Deciding operational guidelines.		
4. Data collection for food aid operation.		
Operation		
1. Merging food aid distribution sites.		
2. Following progress of the plan.		
3. Investigating excess food aid waste.		
4. Audits food inventory		
5. Midcourse monitoring correction plan.		
6. Reviewing collected data.		
7. Collecting beneficiaries' feedback.		
8. Feedback discussion process.		
Post-operation		
1. Conducting final inventory.		
2. Conducting closing meeting for the operation.		
3. Data classification and analysis.		
4. Concerned party feedback process.		

Additional Comments:

_____

3. Based on your review of the prototype, would it accomplish these outcomes?

Expected outcomes	**Agree**	**Disagree**
1. Easy to follow monitoring and evaluation process guidelines.		
2. Easy access to the decision-making information related to monitoring & evaluation.		
3. Save time by speeding the process.		
4. May improve efficiency of the process.		
5. May increase the efficiency of monitoring activities.		
6. May increase the efficiency of evaluation activities.		
7. Can be further web deployed for increasing functionality.		

Additional Comments:

_____

4. Would the proposed expert system be useful for the type of agencies and purposes listed?

Potential users and examples of tasks	**Agree**	**Disagree**
International food relief organization headquarters		
1. Decision making with regards to food relief operation.		
2. Following operational guidelines of monitoring & evaluation.		
3. As a feedback system.		
4. Collecting food aid relief operation related data.		
5. Adding recent information to expand/update the system.		
Food relief operation sites		
1. Decision making with regards to food relief operation.		
2. Following operational guidelines by various field staff.		
3. Feed back processes from headquarters to operation sites.		
Others		
1. Modified & adapted by similar international organizations.		
2. Modified & adapted by national food relief organizations.		

Additional Comments:

_____

_____

_____

5. Hardware requirements for the prototype is a PC that consists of at least an Intel 486, 100 MHz processor or higher, Windows 3.1 or higher, 16 MB RAM and 10 MB available hard drive space. Do you think your organizations existing system can accommodate these requirements?

   Yes / No

Additional Comments:

_____

_____

_____

6. Does your organization currently use any software for monitoring and evaluation of food aid relief operations?

   Yes/ No

If "yes" (and appropriate to release the information) please give a brief description of the software?

_____

_____

7. The complete and finalized FAM prototype from this research with users guide can be tried free of cost. Would you like to test the FAM prototype?

   Yes / No

Additional Comments:

_____

_____

If "yes" provide your mailing address

_____

_____

_____

8. Does the prototype have sufficient merits that you would recommend development of a full-scale expert system? Please use a five-point scale to respond.

Not Recommended Highly Recommended
1_____2_____3_____4_____5

If "not recommended " please give reason(s):

_____

_____

_____

9. Is this a system you would want to use on a regular basis?

Yes / No

10. Do you have any other comments about the FAM prototype expert system?

Comments:

_____

_____

_____

Appendix F. Sample Cover Letter to Faculty Experts

Date:

Name:
Title:
Address:

Dear Respondent:

I am developing a prototype expert system named Food Aid Monitor (FAM) as the research project for partial completion of my doctoral degree at Oregon State University. The reason for developing this prototype is based upon numerous references in the literature regarding the need for an effective method of monitoring food aid, especially for emergency food relief. Hence, FAM has been designed primarily to serve as an aid for monitoring and evaluating food aid distribution.

FAM utilizes a software tool that implements a knowledge-based expert system to help determine rules, or operations, based on facts, which are real-life data. An expert system utilizes techniques of artificial intelligence (AI) to help make managerial decisions based on an advanced database also known as a knowledge base.

I am at the final stage of the prototype development called validation. Validation for an expert system is the process of ascertaining the accuracy of the behavior of the system. In expert system terminology, determining that a chain of correct inferences lead to the correct answer is called validation. The process of validation usually requires checking for "consistency", "completeness", "correctness", "precision" and "usability" of the knowledge base of the prototype system. In order to facilitate the process of validation, the overall task has been distributed among three expert panels. The validation process will consist of checking the prototype system for: (1) completeness, by the faculty expert panel (2) consistency (3) correctness (4) precision, by the software engineers' expert panel and (5) usability, by the field expert panel.

As a member of the faculty expert panel you are requested to check the prototype system for "completeness" of the knowledge base by checking the rule matrix. The rule matrix is a tabulated listing of the components of the "rules" as defined in the expert system. The rule consists of an IF..and..THEN construction. The rule matrix of the FAM prototype consists of three columns. The first column lists the rule whereas the second and third column lists the "if" (antecedent) and "then" (consequent) part of the same rule. Validation of the prototype knowledge base for "completeness" requires the following:

(a) Checking for accuracy of the "if" and "then" portions of the rules;
(b) Checking for the relevancy of the rules to the subject matter of the knowledge-base.

There are five source code files in this prototype named according to different stages of food relief operations. They are pre-operation (PO.CLP.BATCH), operation (OP1, OP2 and OP3.CLP.BATCH), and post-operation (POST.CLP.BATCH). The rule matrix is divided according to these five stages and includes 18, 14, 37, 17, and 6 rules respectively in the five stages.

The rule matrix for the prototype has two columns on the right hand side where you are requested to indicate the completeness and relevancy of each rule by noting Y (for Yes) or N (for No) in the appropriate columns. For any "No" you indicate, please note in the comment area at the bottom of the page (or on a separate page) what you find incomplete or irrelevant about the rule, and if possible suggest your recommended correction.

Information received from you regarding this project will be maintained confidential. Changes may be made to the prototype system knowledge base upon reviewing your feedback. However, a summarized version of the results will be reported. I anticipate that it will take approximately 2 to 3 hours to validate the prototype system complete the checklist.

Please return the checklist in the postage paid envelope by June 4, 1999 to Neeta Singh
11511 Metric Blvd. #938, Austin, TX 78758. Your response is very essential to the success of this project and your assistance is highly appreciated. If you have any questions, please contact me at singhn@ucs.orst.edu or Ph# 512.977.9962.

Thank you for your contribution to this research validation process. I look forward to hearing from you.

Sincerely yours,

Neeta Singh
Ph.D. Candidate

Enclosures:
1. Rule Matrix
2. Return Envelope

M. Jean Chambers, PhD, RD, LD
Major Professor

Appendix G. Sample Cover Letter to Software Engineering Experts

Date:

Name:
Title:
Address:

Dear Respondent:

I am developing a prototype expert system named Food Aid Monitor (FAM) as the research project for partial completion of my doctoral degree at Oregon State University. The reason for developing this prototype is based upon numerous references in the literature regarding the need for an effective method of monitoring food aid, especially for emergency food relief. Hence, FAM has been designed primarily to serve as an aid for monitoring and evaluating food aid distribution.

FAM utilizes a software tool that implements a knowledge-based expert system to help determine rules, or operations, based on facts, which are real-life data. An expert system utilizes techniques of artificial intelligence (AI) to help make managerial decisions based on an advanced database also known as a knowledge base.

I am at the final stage of the prototype development called validation. Validation for an expert system is the process of ascertaining the accuracy of the behavior of the system. In expert system terminology, determining that a chain of correct inferences lead to the correct answer is called validation. The process of validation usually requires checking for "consistency", "completeness", "correctness", "precision" and "usability" of the knowledge base of the prototype system. In order to facilitate the process of validation, the overall task has been distributed among three expert panels. The validation process will consist of checking the prototype system for: (1) completeness, by the faculty expert panel (2) consistency (3) correctness (4) precision, by the software engineers expert panel and (5) usability, by the field expert panel.

As a member of the software engineering expert panel you are requested to check the prototype system for "correctness", "consistency" and "precision" of the knowledge base. This letter will accompany a copy of the CLIPS software program and FAM prototype. To start, install the CLIPS program on your PC and run the FAM prototype. Instructions on how to install CLIPS and execute FAM may be found in the document "Getting Started with CLIPS 6.05" provided along with this package. Upon execution of the program and determination of possible error conditions, complete the checklist provided to you. The checklist contains the file

names of the source code that constitute the prototype system and a possible list of error conditions. You are requested to execute each of the source code files (for example PO.CLP.BATCH, OP1.CLP.BATCH, etc.) and note down the errors that may occur upon execution.

There are five source code files in this prototype named according to different stages of food relief operations. They are pre-operation (PO.CLP.BATCH), operation (OP1, OP2 and OP3.CLP.BATCH), and post-operation (POST.CLP.BATCH). The rule matrix is divided according to these five stages and includes 18, 14, 37, 17, and 6 rules respectively in the five stages.

Information received from you regarding this project will be maintained confidential. Changes may be made to the prototype system knowledge base upon reviewing your feedback. However, a summarized version of the results will be reported. I anticipate that it will take approximately 4 to 8 hours to validate the prototype system complete the checklist.

Please return the checklist in the postage paid envelope by June 4, 1999 to Neeta Singh
11511 Metric Blvd. #938, Austin, TX 78758. Your response is very essential to the success of this project and your assistance is highly appreciated. If you have any questions, please contact me at singhn@ucs.orst.edu or Ph# 512.977.9962.

Thank you for your contribution to this research validation process. I look forward to hearing from you.

Sincerely yours,

Neeta Singh
Ph.D. Candidate

M. Jean Chambers, PhD, RD, LD
Major Professor

Enclosures:
1. Rule Matrix
2. CLIPS (©NASA) Program
3. FAM Expert System
4. Return Envelope

Appendix H. Sample Cover Letter to Field Experts

Date:

Name:
Title:
Address:

Dear Respondent:

I am developing a prototype expert system named Food Aid Monitor (FAM) as the research project for partial completion of my doctoral degree at Oregon State University. The reason for developing this prototype is based upon numerous references in the literature regarding the need for an effective method of monitoring food aid, especially for emergency food relief. Hence, FAM has been designed primarily to serve as an aid for monitoring and evaluating food aid distribution.

FAM utilizes a software tool that implements a knowledge-based expert system to help determine rules, or operations, based on facts, which are real-life data. An expert system utilizes techniques of artificial intelligence (AI) to help make managerial decisions based on an advanced database also known as a knowledge base.

I am at the final stage of the prototype development called validation. Validation for an expert system is the process of ascertaining the accuracy of the behavior of the system. In expert system terminology, determining that a chain of correct inferences lead to the correct answer is called validation. The process of validation usually requires checking for "consistency", "completeness", "correctness", "precision" and "usability" of the knowledge base of the prototype system. In order to facilitate the process of validation, the overall task has been distributed among three expert panels. The validation process will consist of checking the prototype system for: (1) completeness, by the faculty expert panel (2) consistency (3) correctness (4) precision, by the software engineers expert panel and (5) usability, by the field expert panel.

As a member of the field expert panel you are requested to check the prototype system for "usability". The questionnaire provided to you is designed for the purpose of determining the "usability" of the knowledge base of the prototype expert system. The rule matrix is a tabulated listing of the components of the "rules" as defined in the expert system. Each rule consists of an IF..and..THEN construction. The rule matrix of the FAM prototype consists of three columns. First column lists the rule whereas the second and third column lists the "if" (antecedent) and "then" (consequent) part of the same rule. After reviewing the rule combination matrix and/or FAM prototype, express your views towards

usability of the system by completing the checklist and/or writing comments in each section. The information provided by you will be utilized to determine the usability of the prototype as well as to make the identified changes in the system.

There are five source code files in this prototype named according to different stages of food relief operations. They are pre-operation (PO.CLP.BATCH), operation (OP1, OP2 and OP3.CLP.BATCH), and post-operation (POST.CLP.BATCH). The rule matrix is divided according to these five stages and includes 18, 14, 37, 17, and 6 rules respectively in the five stages.

Information received from you regarding this project will be maintained confidential. Changes may be made to the prototype system knowledge base upon reviewing your feedback. However, a summarized version of the results will be reported. I anticipate that it will take approximately 2 to 3 hours to validate the prototype system complete the checklist.

Please return the checklist in the postage paid envelope by June 4, 1999 to Neeta Singh 11511 Metric Blvd. #938, Austin, TX 78758. Your response is very essential to the success of this project and your assistance is highly appreciated. If you have any questions, please contact me at singhn@ucs.orst.edu or Ph# 512.977.9962.

Thank you for your contribution to this research validation process. I look forward to hearing from you.

Sincerely yours,

Neeta Singh
Ph.D. Candidate

Enclosures:
1. Rule Matrix
2. FAM Prototype
3. Return Envelope

M. Jean Chambers, PhD, RD, LD
Major Professor

Appendix I. Getting Started with CLIPS 6.05

GETTING STARTED WITH CLIPS 6.05

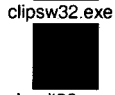
TO START: Load CLIPS on PC/MAC hard drive
Free software (CLIPS) and documentation can be downloaded via:http://www.ghgcorp.com/clips/download/
http://www.ghgcorp.com/clips/download/documentation/

CLIPS program will have two folders named PC and EXAMPLE

Double click on PC and drag **Shortcut to clipsw32.exe**

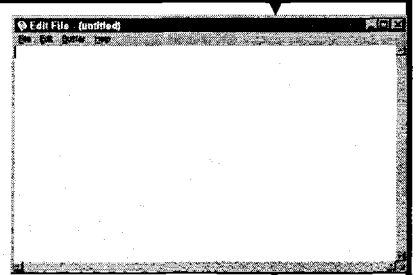
and **Shortcut to clpedt32.exe** icons on to the desktop


clipsw32.exe

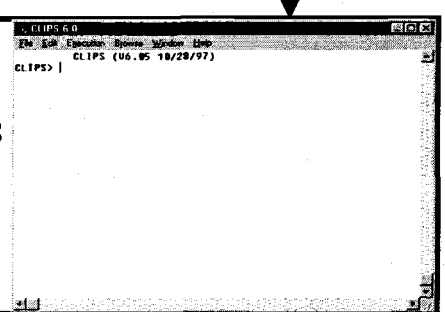

clpedt32.exe

Once these two icons are placed on the desktop, one can run the CLIPS and the editor directly from the desktop. There are two option for programming.

The first option is to use the CLIPS editor. The CLIPS editor is a text based application. To start writing a program double click on **Shortcut to clpedt32.exe** icon. Of course, it is necessary to follow the CLIPS syntax. Save your files as **batch** files after coding the program in the editor.



The other option is to program in CLIPS directly; double click on **Shortcut to clipsw32.exe** icon. This will open the CLIPS window. Once the CLIPS prompt appears on the window, you can start entering commands for execution. Alternatively, programs may be executed by loading the batch files, created by the editor, into CLIPS.



Save the CLIPS files as batch files before exiting from the program. CLIPS provides on-line help. For further details on CLIPS programming, refer to CLIPS Reference Manual (Volume I and II Basic Programming Guide) by Joseph C. Giarratano (1998).

Appendix J. Users Guide: CLIPS Version 6.05

A free copy of CLIPS software and documentation can be downloaded via:
http://www.ghgcorp.com/clips/download/
http://www.ghgcorp.com/clips/download/documentation/

BASIC PROGRAMMING ELEMENTS

CLIPS provide three elements for writing programs: primitive data types, functions for manipulating data, and constructs for adding to knowledge base.

Data Types:

CLIPS provide eight primitive data types for representing information. These types are **floats**, **integer**, **symbol**, **string**, **external-address**, **fact-address**, **instance-name** and **instance-address**.

a) A number is stored as **float** or an **integer**. Any number consisting of an optional sign followed by only digit is stored as an **integer** (12, 30, and 237). All other number are stored as **floats** (12.03, +30, and 237e3).

b) A **symbol** in CLIPS is any sequence of characters that start with a printable ASCII character and followed by zero or more printable ASCII characters. When a delimiter is found, the symbol is ended. The following characters act as delimiters: any non-printable ASCII character (including space, tabs, carriage returns and line feed), a double quote, opening and closing parentheses "(" and ")", ampersand "&", a vertical bar "|", a less then "<", and a tilde "~". CLIPS is case sensitive. Some simple examples of symbols are:

   Hello food B76-HI

c) A **string** is set of characters that starts with double quote and is followed by zero or more printable ASCII characters. A **string** ends with double quote. Some examples are

   "hello" "food" "a and b"

d) An **external-address** is the address of an external data structured returned by a function (written in a language such as C or Ada) that has been integrated with CLIPS.

   <Pointer-00CF61AB>

e) A **fact** is a list of atomic values that are either referenced positional or by name. Facts are referred by index or address. The printed format of **fact-address** is:

<fact-xyz>

where xyz is the **fact-index**.

f) An **instance-name** is formed by enclosing a symbol with left and right brackets.

[foo] [123-789] [stop-1]

The brackets are not part of name of the instance; they merely indicate that the enclosed symbol is an instance name.

g) **Instance-address** can only be obtained by binding the return values of function called **instance-address**. Within CLIPS, the printed representation of instance address is:

<instance-XXX>

where XXX is the address of the instance

Functions:

A **function** in CLIPS is a piece of executable code identified by a specific name that returns a useful value or perform a useful side effect (such as displaying information). There are several type of functions. **User defined functions** and **system defined functions** are the pieces of codes that have been written in languages (such as C, FORTRAN or Ada) and linked with the CLIPS environment. System defined functions are functions that have been defined internally by the CLIPS environment. A complete list of **system defined functions** can be found in CLIPS reference manual. The **deffunction** construct allows user to define new functions directly in the CLIPS environment using CLIPS syntax.

Constructs:

Several defining **constructs** appear in CLIPS: **defmodule**, **deffacts**, **deftemplate**, **defglobal**, **deffunction**, **defclass**, **definstance**, **defmessage-handler**, **defgeneric**, and **defmethod**. All constructs in CLIPS are surrounded with parentheses. The construct opens with left parentheses and closes with right parentheses.

DATA ABSTRACTION

There are three primary formats for representing information in CLIPS: facts, objects and global variables.

1. **Facts** are one of the basic high-level forms for representing information in the CLIPS system, Each fact represents a piece of information which has been placed in the current list of **facts**, called **fact-list.** Facts are fundamental units of data used by the rules. CLIPS recognize certain keywords. For example, if you want to put data into the fact-list, you can use the **assert** command. An example of an **assert** command is:

   CLIPS>(assert (Food relief operation has started))

   The assert command takes (Food relief operation has started) as its argument. Always press the **carriage return key** to send line to CLIPS. CLIPS will sort the fact and will assign the fact an **identifier.** When you press the carriage return key you will see the response:

   <Fact-0>

   All the commands in the CLIPS are surrounded by parentheses. CLIPS syntax uses parentheses as delimiters. Some of the commands in CLIPS (Window version) are menu driven while others you have to enter from the keyboard. For example the keyboard command to see facts is the facts command

   Entering commands from keyboard:

   CLIPS>(facts)
   f-0 (Food relief operation has started)
   For a total of 1 fact.
   CLIPS>

   The False message is returned by CLIPS to indicate that it was not possible to perform the **command**. For example when asserting a fact you have missed the parentheses:
   False Message:

   Missing Parentheses

   CLIPS>
   CLIPS> (assert Food relief operation has started)
   [PRINTUTIL2] Syntax Error: Check appropriate syntax for RHS pattern

Facts are added into CLIPS by the assert command. An alternative way to enter facts is by using the define facts keyword, **deffacts**. For example,
Adding facts by **defacts** command:

```
CLIPS>(deffacts food relief operation
(Food relief operation is of large scale)
(Food relief operation is long term))
CLIPS>
```

Checking fact list:

```
CLIPS>(facts)
f-0     (Food relief operation is of large scale)
f-1     (Food relief operation is long term)
For total of 2 facts.
CLIPS>
```

Facts may be added or retracted from the facts list:

Retracting facts:

```
CLIPS>(assert (Food relief operation involves NGO))
CLIPS>
CLIPS>(facts)
f-0     (Food relief operation has started)
f-1     (Food relief operation involves NGO)
For a total of 2 facts.
```

Asserting new facts to existing fact list:

```
CLIPS>(assert (Food relief operation involves local volunteers))
CLIPS>(facts)
f-0     (Food relief operation has started)
f-1     (Food relief operation involves NGO)
f-3     (Food relief operation involves local volunteers)
For a total of 3 facts.
```

Duplicating Facts: CLIPS respond with a FALSE if you try to duplicate the facts. The **set-fact-duplicate** command can be used to disable the CLIPS behavior, which prevents duplicate facts from being asserted.

Duplicating facts:

```
CLIPS>(set-fact-duplicate TRUE)
```

Will disable the behavior, similarly the command

CLIPS>(set-fact-duplication FALSE)

Will prevent duplicate facts from being asserted.

Retracting FACTS: Removing facts from the fact list is called retracting and is done with the **retract** command. To retract fact you must specify the fact index:

Retracting specific fact:

```
CLIPS>(retract 2)
```

Now check your fact list as follows:

Checking facts:

```
CLIPS>(facts)
f-0     (Food relief operation has started)
f-1     (Food relief operation involves NGO)
For a total of 2 facts
CLIPS>
```

CLIPS will issue an error message if you try to retract non-existent fact. You can also retract multiple facts at a same time or you can use "*" to retract all facts at the same time (retract *):

Retracting multiple facts:

```
CLPIS>(retract 0 1)
CLIPS>
CLIPS>(facts)
CLIPS>
```

The **undeffacts** command excises a (deffacts) from asserting facts by eliminating the deffacts from memory.

CLIPS provide several commands to help to debug the program. **watch facts** allows you to continuously watch facts being asserted and retracted. This is more convenient than having to type the (facts) command over and over again.

Debugging commands or watch commands:

```
CLIPS> (clear)
CLIPS> (watch facts)
CLIPS> (assert ( Food relief operation is long term))
==>f-0          (Food relief operation is long term)
<Fact-0>
CLIPS>
```

Right double arrow symbol ==> indicates that fact is entering memory while **left double arrow** <== indicates fact is leaving memory. To turn off **watch fact** enter (unwatch facts).

Watch commands are very useful in debugging. There are number of things you can watch while writing your program:

```
(watch facts)
(watch rules)
(watch generic-functions)
(watch globals)
(watch statistics)
(watch compilations)
(watch activations)
(watch all)
```

2. **Objects:** An **object** in CLIPS is defined to be a symbol, a string, a floating point or integer number, a multi-field value, an external-address or an instance of a user- defined class. Objects are described in two basic parts: properties and behavior. A **class** is a template for common properties and behavior of objects, which are **instances** of that class. Some example of object and their classes are

Object (Printed Representation)	**Class**
Rolls-Royce	SYMBOL
"Rolls-Royce"	STRING
8.0	FLOAT
8	INTEGER
(8.0 Rolls-Royce 8 [Rolls-Royce])	MULTIFIELD
<Pointer- 00XYZ10B>	EXTERNAL ADDRESS
[Rolls-Royce]	CAR (a user-defined class)

3. **Global Variables**: The **defglobal** construct allows variables to be defined which are global in scope throughout the CLIPS environment. That, is global variable can be accessed anywhere in the CLIPS environment and retains its value independent of other constructs.

KNOWLEDGE REPRESENTATION

CLIPS provide heuristic and procedural paradigms for representing knowledge.

Heuristic Knowledge -Rules: Rules are one of the primary methods of representing knowledge in CLIPS. Rules are used to represent heuristics, or "rules of thumb", which specify a set of actions to be performed for a given situation. The developer of an expert system defines a set of rules which collectively work together to solve a problem.

Adding Rules: A rule is similar to the IF THEN statement in a procedural language like Ada, C and Pascal. A fact is entered in the program by the **assert** or **deffacts** command, where as to add a rule to the program the **defrule** command is used. When a **rule** is added, CLIPS tries to match it with **pattern entity**. A pattern entity is a fact or instance of a user defined class.

In CLIPS the general syntax of rule is:

```
        (defrule rule-name "optional comment"
        (pattern_1)             ;Left-Hand Side (LHS)
        (pattern_2)             ;of the rule consisting of elements
                -               ;before the "=>"
                -
                -
        (pattern_N)             ;
=>
        (action_1)              ;Right-Hand Side (RHS) of the rule
        (action_2)              ;consisting of elements
                -               ;after "=>"
                -
                -               ;the last ")" balances the opening "(" to the left
                                of "defrule"
                -               ;Be sure all parentheses balance or three will
                                be an error
        (action_M)              ;message
```

The **rule** is composed of an **antecedent** and a **consequent**. The antecedent of rule is also referred as the **if portion** or the **left-hand side** (LHS) of the rule. The consequent of a rule is also referred to as **then portion** or the **right-hand side** (RHS) of the rule.

The antecedent of a rule is a set of **conditions** (or **conditioning elements**) which must be satisfied for the rule to be applicable. In CLIPS, the condition of rule are satisfied based on the existence or non-existence of specified fact in the fact-list or specified instance of a user-defined classes in the instance-list

The parentheses on the left side and right side of the **defrule** should be balanced otherwise there will be an error message. A rule usually has multiple patterns and actions. The numbers of patterns and actions are not necessarily to be equal for the activation of the rule. If all the pattern of rule matches the facts, the rule is **activated** and is put on the **agenda**. The symbol => represents the beginning of THEN part of IF-THEN rule. The term **fires** means that CLIPS has selected a certain rule for execution from the agenda.

CLIPS always execute the action on the RHS of the highest priority on the **agenda,** which is determined by the inference mechanism of the system. You can check what's on the agenda with the agenda command;

```
CLIPS>(agenda)
```

Just as with any other programming language, CLIPS have variables to store values. Unlike a **fact**, which is **static** and unchanging, the contents of variables are dynamic as the values assigned to it change. In contrast, once a fact is asserted, it's field can only be modified by retracting and asserting a new fact with the changed fields, even with the modify action acts by retracting and asserting a modified fact.

After adding facts and rules, to make the program run, just enter the **run** command. There is a rule and fact, which satisfies rule so rule, gets fired. If you try to run again you will see rule won't fire. Run is considered a useful debugging command as it takes an optional argument of the number of rule firings. For example (run 10) command will tell CLIPS to run program and then stop after 10 rule firings. The (step) command is equivalent to (run 1).

As an aid to debugging, CLIPS has a command called **matches** that will tell you which pattern in a rule matches the facts. This command is also menu driven. By clicking Browse on the CLIPS menu, click "Defrule Manager" and then you can use matches to find out which pattern in a rule match the fact.

The term **partial matches** refers to any set of matches of the N-1 patterns with facts. That is, the partial matches begin with the first pattern in a rule and end with

any pattern up to but not including the last (Nth) pattern. As soon as one partial match cannot be made, CLIPS does not check any further. For example, a rule with four patterns would have partial matches of the first and second patterns and also of the first, second and third patterns. If all N pattern matches, the rule will be activated.

Procedural Knowledge CLIPS also supports a paradigm for knowledge representation that of more conventional languages such as Pascal and C.

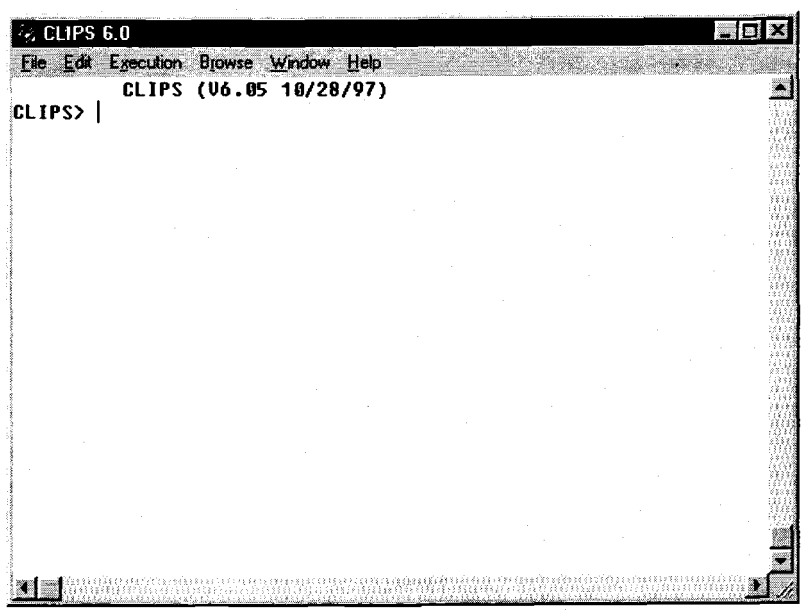
PROGRAMMING

CLIPS expert system may be executed in three ways: interactively using a simple, text oriented, command prompt interface; interactively using a window/menu/mouse interface on certain machines; or as an embedded expert system in which the user provides a main program and controls the execution of the expert system.

The generic CLIPS interface is a simple, interactive, text oriented, command prompt interface for high probability. The standard usage is to create or edit the knowledge base using any standard text editor, save the knowledge base as one or more batch or binary files, exit the editor and execute CLIPS, then load the knowledge base into CLIPS. The interface provides commands for viewing the current state of the system, tracing execution, adding and removing the information, and clearing CLIPS.

The primary method of interacting with CLIPS in an on-embedded environment is through the CLIPS **command prompt**. When "CLIPS>" prompt is printed, a command may be entered for evaluation.

CLIPS WINDOW



At this point, you can start entering **commands** directly into CLIPS. The mode in which you are entering a direct command is called top-level. In the Window version of CLIPS, you can just select the commands using mouse and arrow keys rather then typing in it.

The normal mode of leaving CLIPS is with the **exit** command.

```
CLIPS>(exit)
```

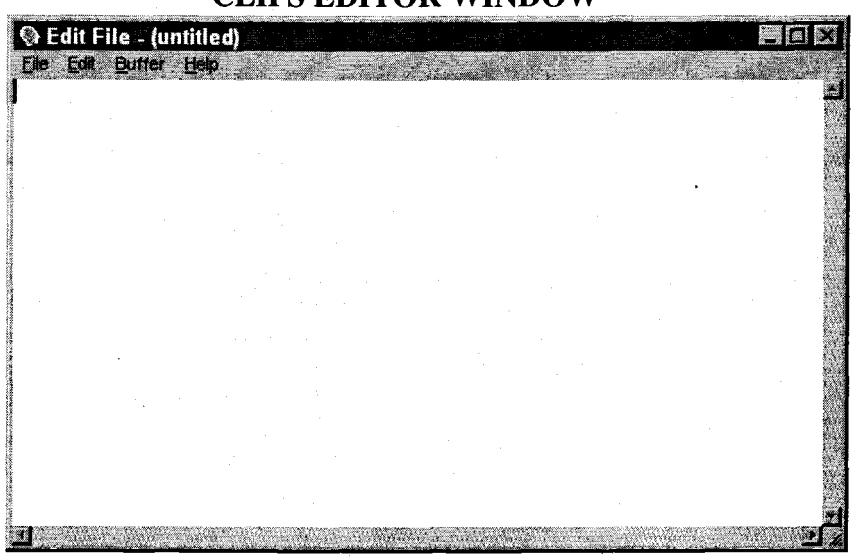
The **clear command** essentially restores CLIPS to original start-up state. It clears the memory of CLIPS and reset the fact identifier to zero.

```
CLIPS>(clear)
CLIPS>
```

CLIPS EDITOR:

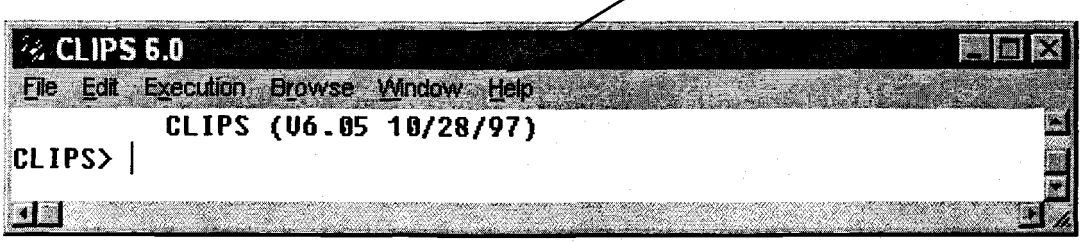
CLIPS editor is text-based application. To use CLIPS editor, double click on editor icon. Once the editor window appears on screen you one can start programming. To program in editor it is required to follow the CLIPS syntax. Save the editor files as batch files, which can be opened in the CLIPS for execution. Editor has menu bar for various commands as well as on-line help.

CLIPS EDITOR WINDOW

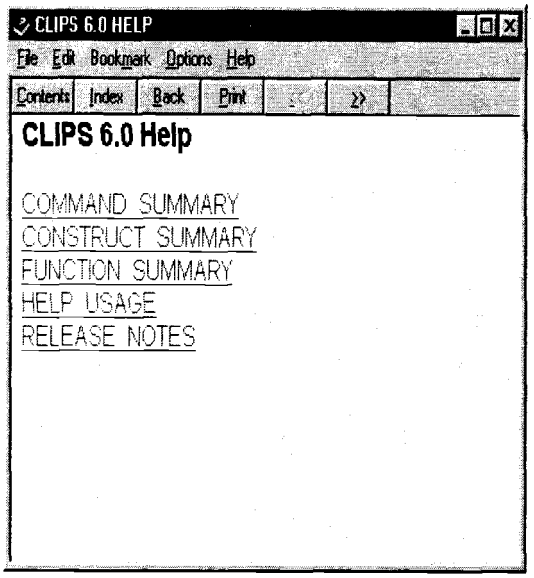


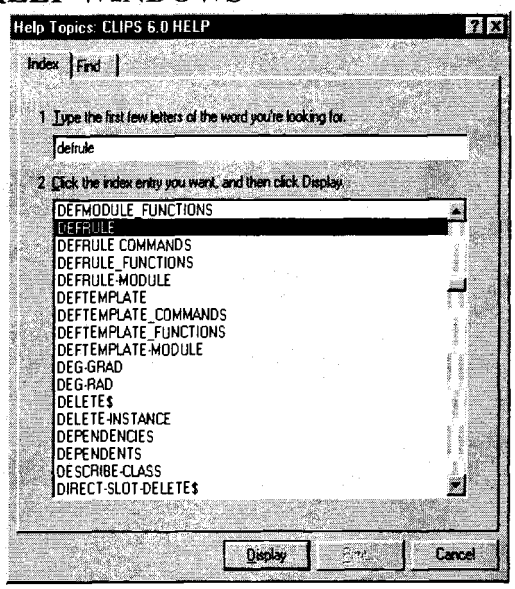
CLIPS has on-line help available. To access the help feature, go to CLIPS compiler menu bar press **Help** and go to **CLIPS help**. You can access index of topics, which include all the function commands.

HELP MENU



CLIPS ON-LINE HELP WINDOWS





Other frequently used commands include:
declare salience: Command provides explicit control over which rules will be put on the agenda.
load: Command loads the rules that have been previously saved on disk.
bsave: Command saves in binary format.
bload: Command loads binary command.
save-fact: Command will save all the fact form fact-list to file.
load-fact: Command will load in the facts from a file into fact list.
batch: Command will allow to execute commands form a file.
dribble-on: Will store everything entered in the Dialog Window to a disk file
dribble-off: Turns off the above command.

For further details on programming, refer CLIPS Reference Manual (volume I and II Basic Programming Guide) by Joseph C. Giarratano (1998).

Appendix K. Rule Matrix of FAM

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
1 When-to-establish-multiple-sites-for-the-operation	1. Affected geographic area is more than the area preset by the donor organization 2. Affected population is more than preset number of people by the donor organization 3. The total cost of operation is more than preset dollar amount by the donor organization 4. The total length of operation is more than preset period of the time by the donor organization	1. Select multiple sites for food relief aid distribution 2. Inform the headquarter about the changes of the operation sites 3. Keep the records of multiple site selection process as operations data	
2 Assigning-or-reassigning-staff-duties	1. Duties are not pre assigned to the existing staff 2. Duties are not pre assigned to the newly selected staff or volunteers 3. Staff have different expertise than their assigned work 4. There are more than one distribution sites 5. The plan of food aid distribution has been changed to some extent	1. Program manager and management staff are responsible for assigning or reassigning the duties to the operation staff 2. Program manager is required to consult management staff for assigning or reassigning the duties 3. Maintain documents for the new changes as operations data	
3 Maintaining-daily-operation-records	1. All the operation staff is filing paper work as a requirement 2. All the operation volunteer staff is filing paper work as a requirement 3. All the operation non-governmental organizations staff is filing paper work as a requirement	1. Management staff will review all the paper work 2. Management staff will consolidate the data 3. Daily reports will be filed as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
4 When-to-merge-operation-sites	1. Some sites have slowed down the operation 2. Some sites are towards the end of operation 3. Some operation sites have low participation rate 4. Some operation sites need more staff and resources	1. Combine or merge the sites to reduce the number of sites and increase efficiency 2. Check on the operation of newly merged sites 3. Inform the main headquarters about the site merger 4. Keep the record of the site merger as operations data	
5 Suggestions-and-complaints-reporting-process	1. The food aid relief operation is defined long term by the donor organization 2. Various organization are involved in the food aid relief operation 3. Independent volunteers are part of food aid relief operation 4. Several non-governmental organizations are participating in food aid relief operation	1. Add complaint and suggestion box to all the operation sites 2. Program manager will be responsible to review reports periodically 3. Suggestions and complaints will be recorded and stored as operations data	
6 When-to-launch-special-food-aid-distribution-operations	1. The operation is progressing slow 2. There are frequent delays in the planned operation 3. The operation is subjected to significant changes	1. Plan special operations to recover from food aid distribution delays 2. Inform headquarters about the existing problem 3. Inform headquarters about special the operation plan and operations 4. Follow up during and after the special operation 5. Keep the special operation records as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
7 When-to-change-distribution-sites	1. Existing sites are not easily accessible by the beneficiaries 2. Established sites have shut down due to hazardous conditions of that area 3. Existing sites have shut down due to weather conditions of the area 4. There is shortage of operation staff	1. Use site change plan to increase efficiency of distribution 2. In staff meeting majority should agree on the site change plan 3. Use the planning document for details on the organizations site change plan 4. Follow up on the new distribution site 5. Maintain the records of changes as operation data	
8 Process-of-adding-sites	1. Sites are clustered at one area causing delays and confusion for the beneficiaries 2. Accessing site is problem by the beneficiaries 3. The number of beneficiaries are more then estimated 4. Transportation is a major concern and accessing other operations sites is a problem	1. Establish more distribution sites for better food aid flow 2. Inform the beneficiaries about the new food aid distribution site 3. Follow up on the newly added site 4. Keep the records of the new site as operations data	
9 Establishing-the-flow-checkpoints	1. Food aid distribution sites have been established) 2. Operation duties have been assigned to different staff) 3. The initial food aid distribution plan is designed for food aid flow check	1. Program manager is required to establish food aid flow checkpoints 2. Assign duties to staff for checking the food aid flow 3. Keep the records of the food aid flow checkpoints as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
10 Increasing - personnel-for-the-distributio n-operation	1. Food aid distribution operation is slower then expected 2. There are frequent delays in the distribution 3. There is not enough staff to share the operation workload 4. Addition of new staff has been approved by headquarter	1. Non-governmental organization staff and volunteers can be appointed as temporary staff 2. The newly appointed staff should agree to the terms and conditions of the donor organization 3. Maintain the records of the appointed staff as operation data	
11 When-to-modify-existing-monitorin g-procedures	1. A serious problem in the monitoring plan has been identified 2. The host country's situation is hindering the existing monitoring plan 3. There is no assistance from the host government 4. There are no signs of improvement in country's present condition 5. Changes in the monitoring process have been approved by the headquarter	1. Change identified to be necessary by the staff then modify the monitoring procedures 2. Refer to the new monitoring plan 3. Make the appropriate changes in the monitoring plan 4. Inform the headquarters about the changes in monitoring plan 5. Follow the improvements of the monitoring process 6. Maintain the records of the monitoring procedure changes as operations data	
12 Additional -staff-selection-process	1. The food aid distribution operation is bigger then the initial plan 2. The food aid distribution operation lacks the personnel or staff 3. There are interested candidates willing to serve as operation staff from the host country 4. Changes in the staff selection have been approved by the headquarter	1. Existing staff will go through team selection process 2. Select required number of candidates for the food aid distribution process 3. Keep the records of the newly selected staff as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
13 Briefing-evaluation-with-officials	1. The new team selection process has been completed 2. The newly selected team has gone through short training 3. The new staff has been allotted different operation sites 4. The newly selected staff has completed briefing of the monitoring and evaluation process with existing staff	1. Go through briefing of the evaluation team jointly with country officials 2. Maintain records of briefing process	
14 Following-progress-of-the-plan	1. The monitoring and evaluation process has been implemented 2. The operation has completed first week 3. The monitoring and evaluation is progressing according to plan	1. The staff is required to follow the progress on monitoring and evaluation plan 2. Maintain the records of the monitoring and evaluation progress	
15 Promoting-evaluation-activities-or-processes	1. Staff has discussed method of evaluation 2. The operation has been started 3. Evaluation duties and sites have been assigned to staff 4. Promotion of evaluation process has been discussed in the staff meeting	1. Program manager and field officer are required to ensure promotion of evaluation activities 2. Maintain the records of promotion of evaluation as operation data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP1.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
16 Provision-of-technical-support	1. There is a problem in the food distribution operation due to weather conditions 2. There is a problem in the retrieval of information required by the field officers 3. There is a problem with equipment that is crucial for the distribution operation 4. Addition of technical support has been approved	1. Provide personnel or technical support immediately to the requested site 2. Follow up on the technical problems of the operation site 3. Maintain the records of technical support as operations data	
17 Training-activities-for-the-operation-staff	1. The staff has been appointed in the host country of the relief operation 2. The newly appointed staff is not familiar with operation procedures 3. The plan of operation has been changed significantly 4. New procedures of operation are introduced	1. Training activities are required for the staff to understand the plan and changes 2. Follow up the operation after the training activities 3. Maintain the records of the training activities as operations data	
18 Ensuring-monitoring-processes-or-activities	1. The food aid distribution operation process has stated 2. The food aid distribution program has multiple phases 3. The monitoring activities have been instituted	1. Program manager is required to ensure that monitoring processes are progressing as planned 2. Keep the records of the progress of the activities as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
1 Collecting - beneficiaries- feedback	1. It is second week of the food aid distribution operation 2. Beneficiary's health is not in danger due to disaster 3. Beneficiaries are willing to participate in feedback process	1. Add beneficiaries interview as a feedback process 2. Record the beneficiaries concerns or complains 3. Maintain the record of the beneficiary's feedback as operations data	
2 When-to-establish-weekly-checkpoints	1. Operation sites have been launched 2. It is first week of the operation 3. If there is some problem in food aid flow 4. Staff has been assigned to check food aid flow	1. Follow up on the staff feedback of the food aid flow check 2. Keep the records of the food aid flow as operations data	
3 Waste-accounting -of-food-aid-distribution-operation	1. The food aid is given out without any record 2. Food is distributed to non-beneficiaries 3. Food is sold in the local markets of the host country 4. Food is reported stolen from the site	1. Discuss the food aid waste problem in the weekly staff meeting 2. Proper measures should be taken to decrease or stop the waste 3. Keep the records of the food aid waste as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
4 Investigating-excess-food-aid-waste	1. The food is given out repeatedly without any accounting 2. The food aid is intentionally distributed to non-beneficiaries 3. Relief food aid is reported to be selling in the local markets 4. Food aid loses are accruing frequently 5. There have been reports of food waste from accounting staff	1. The program manager and audit team should investigate the matter immediately 2. The matter should be resolved immediately 3. Follow up on the food aid waste problem 4. Keep records of the food aid waste documents as operations data	
5 Food-storage-investigation	1. Food storage inventory shows difference between records and actual count 2. Food is repeatedly reported stolen from storage 3. Audit shows excessive spoilage due to food mishandling	1. Investigate into the matter and discuss the audit report with staff 2. Take required actions to stop the problem 3. Follow-up after making changes 4. Keep the audit reports of storage investigation as operations data	
6 Food-inventory-audit	1. The operation has been started for more then a week 2. There is a separate facility for food storage 3. The operation has established inventory methods	1. There should be regular food inventory audit 2. Program manager should review records and reports of the audit 3. Maintain the audit records as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	
7 When-to-close-inventory	1. There is still food in storage 2. The operation has been fully closed 3. There is an approval from program manager to donate the food commodities to local charities	1. Go according to the initial donor organization plan or donate remaining food commodities to local disaster relief agencies 2. Keep the records of the donations as operation data	
8 Transporting-food-aid-to-the-distribution-sites	1. There is separate logistic staff 2. The food aid is transported to the sites by logistic department 3. The logistic department has its own food storage facility	1. Food aid operation staff will have the responsibility for food aid transportation at the distribution site 2. Food aid distribution staff will maintain the inventory records	
9 When-to-add-informal-feedback	1. Operation is small with few sites 2. Operation is defined short term by the donor organization 3. The number of staff and non-governmental organizations involved is relatively small	1. Add informal feedback method for food aid operation 2. Informal feedback is mainly used when input of the staff serves as data 3. Maintain the records of the informal feedback as operation data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
10 Adding-formal-feedback	1. The operation has multiple sites 2. The operation is defined as extended or long-term by the donor organization 3. Numerous local and non-governmental organizations are involved in operation 4. Separate staff has been assigned for data collection	1. Add formal feedback method for food aid operation 2. Maintain the records of formal feedback and reviews as operations data	
11 When-to-add-formal-checks	1. The operation has multiple sites 2. The operation is defined extended or long-term operation by the donor organization 3. Various local and non-governmental-organizations are involved in the operation	1. Add formal checkpoints 2. Assign staff to report the distribution problems 3. Keep the record of the distribution problems as operations data	
12 When-to-add-informal-checks	1. The chances of food loss during operation are high 2. The food aid relief operation is defined large scale by the organization 3. There are multiple sites with large number of staff 4. Numerous local and non-governmental organizations are involved in the food aid operation 5. The operation is defined long term by the donor organization	1. Along with formal checks add informal checks and reporting procedures 2. Maintain the records of the informal checks as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP2.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
13 Field-visit-of-distribution-sites	1. The operations have been started 2. Various outside organizations are involved in the distribution operation 3. There are multiple operation sites	1. Program manager will make frequent field visits to operation sites 2. Program manager will check with field officers and beneficiaries 3. Maintain the records of the field visits as operations data	
14 Midcourse-monitoring-plan-correction-process	1. Monitoring activities are not progressing as planned 2. Program manager has identified serious weakness in the monitoring plan 3. Monitoring plan is not working due to host country's condition 4. Collected monitoring data depicts the need for correction in the plan	1. Conduct a staff meeting for midcourse correction 2. Get approval of mid-course correction from headquarters 3. Make the required changes in the monitoring plan 4. Follow up the monitoring plan 5. Maintain the records of the midcourse correction as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
1 Establishing-feedback-method-for-food-aid-operation	1. There are multiple operation sites for food aid distribution 2. Each site has an independent food aid distribution operation 3. All the sites have same food aid inventory 4. Each site has independent supervisor or field officer	1. Conduct bi-weekly staff meeting for feedback 2. Meeting will include staff feedback of ongoing operation 3. Send the records to headquarters 4. Keep records of feedback meeting as operations data	
2 When-to-get-headquarters-assistance	1. The operation is not progressing according to plan 2. Access to affected area is extremely difficult 3. Resources are not reaching the operation sites on time	1. Contact the headquarters for immediately assistance 2. Program manager and management staff is responsible to communicate with the headquarters 3. The suggested changes by headquarters should include program manager and management staffs consent 4. Implement suggested changes when appropriate 5. Follow up on the implemented changes 6. Keep the records of suggested and implemented changes as operations data	
3 Feedback-discussion-process	1. All the operations staff is required to file short daily report 2. All the operations volunteer are required to file short daily report 3. All the operation non-governmental-organizations staff is required to file short weekly report	1. Program manager will share the report feedback with all the staff on a regular basis 2. Issues which needs immediate attention should be resolved 3. Send to headquarters the weekly operation reports on periodic basis 4. Keep the records of daily operation reports and feedback as operations records	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
4 When-to-merge-or-close-sites	1. Some sites have slowed down the operation 2. Some sites are towards the end of operation 3. Some operation sites have low participation rate 4. Some operation sites need more staff and resources 5. There is headquarter approval for closing or merging operation sites	1. Combine or merge the sites to reduce the number of sites and increase efficiency 2. Check on the operation of newly merged sites 3. Inform the main headquarters about the site merger 4. Keep records of the site merger as operations data	
5 Suggestions-and-complaints-reporting-process	1. The food aid relief operation is defined long term by the donor organization 2. Various local organization are involved in the food aid relief operation 3. Independent volunteers are part of food aid relief operation 4. Several non-governmental organizations are participating in food aid relief operation	1. Add complaint and suggestion box to all the operation sites 2. Program manager will be responsible to review them periodically 3. Suggestions and complaints will be recorded and stored as operation data	
6 Process-of-recording-weekly-operation-expenditure	1. Expenditures have accrued in acquiring resources for the food aid distribution site 2. Expenditures are necessary to continue food aid distribution operation 3. Miscellaneous expenditures are within the established limit by the donor organization	1. Get weekly expenditure approved by management staff 2. Include expenditures as weekly operation expenditure 3. Maintain records of weekly expenditures as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
7 Decision-making-process-during-food-aid-relief-operation	1. Decision involves more then preset dollar amount 2. The decision involves changing sites or closing sites 3. Decision is related to long term change 4. Decision involves adding resources to different food aid operation sites 5. Decision is regarding conducting audits 6. Decisions is regarding handling complaints and making changes	1. Program manager along with input of other staff is authorized to make decisions 2. Volunteers are not authorized to make these decisions 3. Non-governmental organization can participate in the decision making process 4. Keep records of the decision making process as operations data	
8 Absent-manager-decision	1. Program manager is not present at the time of making decision 2. Normally the decision requires consent of the program manager 3. An issue requires immediate attention or decision 4. The field officer of the affected site is present	1. Field officer will have authority to make decision 2. Staff who makes the decision should inform the program manager 3. Maintain the records of absenteeism decisions as operation data	
9 Conflict-resolution-process-during-food-aid-distributio n-operation	1. Some beneficiary or participating local agency is offended by the staff behavior 2. There is miscommunication between staff and beneficiaries due to language barrier 3. There is conflict between donor organization agency and participating local agency 4. There is conflict between donor organization and non-governmental organization	1. Matter should be resolved immediately by staff 2. Program manager should be informed about the incident 3. Maintain a incident record	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
10 Considering-special-cases	1. Beneficiary is an old person with health problems 2. Beneficiary is a pregnant woman 3. Beneficiary is person with serious health problems 4. Beneficiary can not access the site for assistance 5. Beneficiary has immediate special need like medicine	1. Case should be considered as special case by management staff 2. Special case should be assigned to staff 3. Keep records for information and referrals 4. Keep the record of special cases as operations data	
11 Reporting-method-during-operation	1. There are multiple food aid distribution operation sites 2. Each site has team leader or field officer 3. All the sites receive food from same storage facility 4. Program manager and management staff has allotted time for report reviewing	1. Bi-weekly reporting to program manager is a requirement 2. Program manager and management staff will go through each site report 3. Program manager gives feedback to all the field officer and team leaders 4. Site reports and feedback will stored as operations data	
12 When-to-inform-main-headquarters	1. There is discrepancy in planning and operation method 2. There are major barriers in food aid distribution 3. There is disagreement with the host country that is impeding speed of the operation 4. There have been major changes in the operation 5. According to initial operation plan requirement to inform the headquarters	1. Main headquarters should be informed immediately about discrepancies or changes 2. The program manager and management staff is responsible for informing headquarters 3. Keep the record of headquarters interaction as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	
13 When-to-make-changes-in-the-operation-guidelines	1. The evaluation strategies have been decided at a headquarters prior to the operation 2. The headquarters staff has set the guidelines prior to the operation 3. The legal operation guidelines by the host county are available	1. Program manager can make minor changes in operation guidelines 2. The changes should be within legal guidelines given by the host country 3. Keep records of changes in operations guidelines	
14 Deciding-monitoring-strategies	1. The data of the host country are present 2. There are records of similar prior monitoring operations 3. There are records of similar monitoring plans 4. There are records of similar monitoring plans with analysis and report	1. The monitoring strategies will be decided by the relief operation staff at headquarters 2. Minor changes in the monitoring strategies can be made where required 3. Records of the monitoring strategies and changes should be maintained as operations data	
15 Referring-prior-records-for-planning	1. The host county had prior disaster condition 2. Some other organization had similar food aid distribution operation 3. There is a database or reports of prior distribution and evaluation procedures 4. There is a database or reports of prior distribution and monitoring procedures	1. Refer to those records in the initial meeting as aid for planning	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
16 Food-aid-donations-qualification-criteria	1. The person falls in the operational definition of disaster victims 2. The family or individual is negatively affected by the disaster 3. The host country has provided the list of victims	1. Person or family qualifies for the disaster food aid 2. Include them in the list of beneficiaries 3. Keep the record of the beneficiaries as operations data	
17 Reviewing -collected-data	1. Field staff is collecting monitoring and evaluating data 2. Data collection is proceeding according to the monitoring and evaluation plan 3. Data are complete with different phases of the food aid are distribution operation	1. Review collected information with program manager on regular basis 2. If data review indicates missing data follow rule for data revision	
18 Reviewing -regular-progress	1. The collected data are available for review 2. Field staff has allotted time for reviewing 3. There are regular update staff meetings	1. The operation progress will be reviewed regularly 2. Strategies if necessary for improvement will be implemented 3. Record the reviewed data as operations data	
19 Comparing-operation-progress	1. The complete progress report is available 2. Field staff and program manager are present in the meeting 3. Planning documents are available in the meeting 4. Collected operations data and reviews are available	1. Compare the progress with the initial operation plan 2. Write progress report of the food aid operation 3. Donor organization headquarters should receive the operation progress report 4. Maintain the progress report as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
20 Adding-resources-to-the-food-aid-distributio n-operation	1. There is need for training existing staff 2. There is need for addition technical assistance for the food aid distribution operation 3. There is need for addition resources for continuing the food aid distribution operation 4. There is need for additional staff at existing sites 5. The site managers make an additional resource request	1. The program manager approves the resource request 2. Add identified additional available resources to the operation to increase overall efficiency 3. Follow up the food aid distribution operation after adding the resources 4. Maintain the records of the additional resources as operations data	
21 Referring-additional-studies-to-improve-efficiency	1. Monitoring and evaluation plan is not progressing as planned 2. Food aid distribution staff wants to change monitoring and evaluating procedure 3. The process of mid-course change has not started	1. Refer to other similar monitoring and evaluation plan before suggesting any changes 2. keep the records of mid-course changes as operations data	
22 Additional -team-selection-process	1. The food aid distribution operation is bigger then the initial plan 2. The food aid distribution operation needs personnel or staff 3. There are interested candidates willing to serve as operation staff from the host country	1. Existing staff will go through team selection process 2. Select required number of candidates for the food aid distribution process 3. Selected staff should be approved by program manager 4. Keep the records of the newly selected staff as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
23 Briefing-evaluation-with-officials	1. The new team selection process has been completed 2. The newly selected team has gone through short training 3. The new team has been allotted new operation sites 4. The newly selected team has completed briefing of the monitoring and evaluation process with existing staff	1. Go through briefing of the evaluation team jointly with country officials	
24 Following-progress-of-the-plan	1. The monitoring and evaluation process has been implemented 2. The operation has completed first week 3. The monitoring and evaluation is progressing according to plan	1. The staff is required to follow the progress on monitoring and evaluation plan 2. Maintain the records of the monitoring and evaluation progress	
25 Promoting-evaluation-activities-or-process	1. Operation staff has discussed method of evaluation 2. The operation has been started 3. Evaluation duties and sites have been assigned to staff 4. Promotion of evaluation process has been discussed in the staff meeting	1. Program manager and field officer are required to ensure promotion of evaluation activities 2. Maintain the records of promotion of evaluation as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
26 Provision-of-technical-support	1. There is a problem in the food distribution operation due to weather conditions 2. There is a problem in the retrieval of information required by the field officers 3. There is a problem with equipment that is crucial for the distribution operation	1. Provide personnel or technical support immediately to the requested site 2. Follow up on the technical problems of the operation site 3. Maintain the records of technical support as operations data	
27 Training-activities-for-the-operation-staff	1. The staff has been appointed in the host country of the relief operation 2. The newly appointed staff is not familiar with operation procedures 3. The plan of operation has been changed significantly 4. New procedures of operation are introduced	1. Training activities are required for the staff to understand the plan and changes 2. Follow up the operation after the training activities 3. Maintain the records of the training activities as operations data	
28 Ensuring-monitoring-processes-or-activities	1. The food aid distribution operation is in the progress 2. The food aid distribution program has multiple phases 3. The monitoring activities have been instituted	1. Program manager is required to ensure that monitoring processes are progressing as planned 2. Keep the records of the progress of the activities as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
29 Following - evaluation - guidelines	1. The evaluation plan has been instituted 2. Operation staff has been assigned to evaluate the operation 3. The evaluation plan is available at the time of operation 4. There is an evaluation manual for the staff to follow	1. The evaluation staff will go over the evaluation guidelines before beginning of the operation 2. The staff handling evaluation operations will a have copy of evaluation guidelines 3. Maintain the records of evaluation review by the staff as operations data	
30 Recording - monitorin g-inputs	1. There are suggestions from the staff regarding monitoring procedures 2. There is staff input on the monitoring plan 3. There are suggestions about the improvement of the monitoring processes 4. During field visits program manager receives valuable input	1. Record the monitoring inputs for operation 2. Discuss the monitoring inputs in the staff meeting 3. Make necessary changes in monitoring procedures 4. Maintain the records of monitoring inputs as operation data	
31 Recording - evaluation -inputs	1. There are suggestions from the staff regarding evaluation procedures 2. There is staff input on the evaluation plan 3. There are suggestion about the improvement of evaluation process 4. During field visits program manager receives some valuable input staff	1. Record the evaluation inputs for the operation 2. Discuss the evaluation inputs in the staff meeting 3. Make necessary changes in evaluation procedures 4. Maintain the records of evaluation inputs as operation data	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	
32 What-is-considered-monitoring-data	1. Data are related to monitoring procedures 2. The staff makes suggestions and inputs regarding food aid distribution-monitoring operations 3. The part of the plan and policies which is related to monitoring of food aid distribution operation 4. There are reports and reviews of monitoring during food aid distribution operation	1. Consider them as monitoring data of the food aid operation 2. Maintain the records of the monitoring data	
33 What-is-considered-evaluation-data	1. Data are related to evaluation procedures 2. The staff makes suggestions and inputs regarding food aid distribution evaluation operation 3. The part of plan and policies which is related to evaluation of food aid operation exists 4. Reports and reviews of evaluation during food aid distribution operation	1. Consider then as evaluation data of the food aid operation 2. Maintain the record of evaluation data	
34 When-to-make-corrections-in-evaluation-data-collection-process	1. The collected data are not measuring food aid distribution 2. The procedure of data collection is not appropriate for the host country	1. Make correction in the procedure of data collection 2. Follow up on the changes of data collection procedures	

Additional Comments:_____

RULE COMBINATION MATRIX (OP3.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
35 When-to-make-correction s-in-monitorin g-data-collection-process	1. The collected data are not measuring effectiveness of food aid distribution monitoring process 2. The procedure of data collection is not appropriate according to specific host country	1. Make correction in the procedure of data collection 2. Follow up on the changes of data collection procedures	
36 Implement ing-monitorin g-process	1. The process of monitoring is progressing according to the monitoring guidelines 2. The process of monitoring results in data to find if the food is reaching to its intended beneficiaries 3. The staff is following the guidelines of the monitoring plan	1. Program manager is responsible to check the implementation of monitoring process at various stages 2. Maintain the records of various stages of monitoring as operations data	
37 Implement ing-evaluation -process	1. The process of evaluation is progressing according to the evaluation guidelines 2. The process of evaluation exists in data to find if the food is reaching to its intended beneficiaries 3. The staff is following the guidelines of the evaluation plan	1. Program manager is responsible to check the implementation of evaluation process at various stages 2. Maintain the records of various stages of evaluation as operations data .	

Additional Comments:_____

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
1 Pre-operation-meeting-criteria	1. All the staff and volunteer groups involved in the distribution process are present 2. The agenda has been prepared and approved for the meeting 3. Sites for the distribution have been decided upon	1. Conduct first pre-operation staff meeting 2. Meeting will mainly include operation plan and procedures 3. Keep the records of the pre-operation meeting as operations data	
2 Trend-analysis-of-the-food-aid-distributio n	1. Reports of the similar prior operation are available 2. Reports from host country's situation are available 3. Reports from similar prior operations are present	1. These records should depict the general trend of food aid distribution 2. Conduct trend analysis to find out possible problems 3. Plan food distribution activities keeping the general trends in mind) 4. Maintain the records of trend analysis as operations data	
3 Risk-analysis-of-the-food-aid-distributio n-process	1. Food aid relief operation has been planned 2. Food aid relief operation has not started 3. There are records for similar prior operations 4. Other relevant information of the host country is available	1. Perform risk analysis to find out safety aspects of the operation 2. Choose methods for the operation accordingly	

Additional Comments:_____

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
4 Beneficiaries-record-from-host-country	1. There is a full beneficiaries record provided by the host government 2. The age of the beneficiaries is indicated on the record 3. The gender of the beneficiaries is indicated on the records 4. The special medical conditions if any are also indicated on record 5. There is enough staff to handle special cases	1. Prioritize the records according to special medical conditions 2. Prioritize the records according to gender 3. Prioritize the records according to age 4. Assign separate staff to handle special cases 5. Keep the records of the prioritized records as operations data	
5 Non-governmental-organization-involvement	1. Host country government recognizes the non-governmental organization 2. Non-governmental organization is from affected area 3. Staffs of these organizations has prior food aid distribution experience 4. The host country recommends the non-governmental organization	1. Include non-governmental organization in the food aid distribution operation 2. The non-governmental organization will review the conditions of donor organizations 3. Keep the records of the non-governmental organization participating in the operation as operations data	
6 Resource-access-for-non-governmental-organization	1. The non-governmental organization has good work record 2. The non-governmental organization has been involved in similar prior operation 3. The non-governmental organization has been certified by host country government 4. The non-governmental organization has been officially included in the food aid distribution operation	1. The non-governmental organization will have partial access to distribution operation resources 2. The donor organization will review the resource access with non-governmental organization 3. Keep the records of the non-governmental organization resource access as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
7 What-is-partial-access-for-non-governmental-organization	1. The non-governmental organization is partially involved in the official paper work of the donor organization 2. The non-governmental organization has no direct access to financial resources of the donor organization 3. The non-governmental organization has no direct access to headquarter reporting system of the donor organization	1. For present operation this will be considered partial resource access for non-governmental organization 2. The participating non-governmental organization will be informed about the partial access 3. Maintain the records for partial resource access as operations data	
8 How-to-select-volunteers-from-host-country	1. Volunteers are recommended by some recognized governmental institution of the host country 2. Candidates have food aid distribution or emergency operation experience that will be preferred but not required 3. Donor organization selection committee approves the selected candidates 4. The volunteers agree to terms and conditions of the donor organization	1. Include the volunteers in the list for the food relief aid operation 2. Provide volunteers with introductory training 3. Include volunteers in necessary distribution operation related meetings 4. Keep the records of selected volunteers as operations data	
9 Selecting-operation-site-for-food-aid-distribution	1. The site is located in the affected area 2. The site is fairly close to the affected area 3. The site is where beneficiaries are currently residing 4. The host government has recommended the site 5. The site is recommended by non-governmental organizations	1. Approve the site for establishing a food aid distribution center 2. Prepare the site for food aid distribution operation 3. Keep the records of selected sites as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
10 Method-of-data-collection-for-food-aid-operation	1. Open-ended surveys can be easily distributed to the beneficiaries 2. The local language is not a barrier to conduct open-ended surveys 3. Surveys can be easily stored and converted into electronic database for organization records 4. There is enough staff or personnel for the data collection and processing 5. Open-ended surveys are preferably in local language 6. The survey results can be stored in the official language of the donor organization	1. Select open-ended survey as method of data collection for the entire operation 2. The surveys should be converted into official language of the organization before storing 3. Store all the surveys as operations data of the organization	
11 Evaluation -strategies	1. The data of the host country are present 2. There are records of similar prior operations 3. There are records of similar evaluation plans 4. There are records of similar prior evaluation plan accompanied by reports and analyses	1. The evaluation strategies will decided by the relief operation staff at headquarters 2. Minor changes in the evaluation strategies can be made if required 3. Records of the evaluation strategies and changes should be maintained as operations data	
12 Deciding-operation-guidelines	1. The food relief operation is an extended operation 2. The operating conditions and guidelines are made available from the host country 3. The legal guidelines are made available from the host country	1. The food aid relief operation guidelines will be decided at headquarters 2. The guidelines can be subjected to minor changes at operation stage 3. The records of the changes should be maintained as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
13 Monitoring-policies	1. The donor organization has monitoring policies and procedures manual for the operation 2. The policies for monitoring have been listed in manual 3. The manual has guidelines for the monitoring process 4. If there are any changes in the monitoring policies	1. The staff will proceed according to the monitoring policies 2. Minor changes can be made only with consent of the program manager 3. Notify concerned staff and keep the records as operations data	
14 Expected-monitoring-outcomes	1. There is prior planning of monitoring operation 2. There are set steps for the monitoring operation 3. There are guidelines for the monitoring operation	1. Plan should have clear and measurable expected outcome of monitoring 2. Staff responsible for monitoring should be aware of the expected outcomes of the monitoring activities 3. While conducting monitoring activities the staff should check the data for its measurability and accuracy	
15 Following-monitoring-guidelines	1. The monitoring plan has been instituted 2. Various operation staff have been assigned to monitor the operation 3. The monitoring plan is present at the beginning of operation 4. There is a monitoring manual for the staff to follow	1. The monitoring staff will go over the monitoring guidelines before beginning the operation 2. The staff handling monitoring operation will have a copy of monitoring guidelines 3.. Maintain the records of monitoring guideline review by the staff as operations data	

Additional Comments:_____

RULE COMBINATION MATRIX (PO.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
16 Donor-support-report-to-recipient	1. The donor organizations food aid operation has been completed 2. The recipient country government had partial involvement in the food aid operation 3. The recipient country government was involved in providing information to the donor organization	1. The donor organization staff or officials are required to submit report to the recipient country according to initial agreement	
17 Evaluation -policies	1. The donor organization has evaluation policies and procedures manual for the operation 2. The policies for evaluation have been listed in a manual 3. The manual has guidelines for the evaluation process	1. The staff will proceed according to the evaluation policies 2. Minor changes can be made only with consent of the program manager at the site 3. If there are any changes in the evaluation policies notify concerned staff and keep the records	

Additional Comments:_____

RULE COMBINATION MATRIX (POST.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
1 Conducting-the-closing-meeting-of-distribution-operation	1. The operation has been completed 2. About eighty percent or more of operation staff is present for the meeting 3. About fifty percent or more of the NGO staff is present for the meeting 4. About fifty percent or more of the volunteer staff is present for the meeting 5. Data for the operation are available	1. Conduct closing meeting to discus the outcomes of the operation 2. Get direct feedback from the staff 3. Keep the record of the closing meeting as operations data	
2 When-to-conduct-final-inventory	1. All the food aid distribution operations have been fully ended 2. Inventory records show there is still food in storage 3. The inventory is not closed	1. Conduct final inventory 2. Send the final inventory report to program manager of food aid operation 3. Keep the records of final inventory as operations data	
3 Data-classification-and-analysis	1. Food aid distribution operation has been fully completed 2. Complete data of operation are available 3. Data for different stages of operation are available 4. Complete sets of surveys are available	1. Operation data should be classified into different categories for analysis 2. Data should be converted into electronic data 3. Store the operation and analysis reports for future reference	

Additional Comments:_____

RULE COMBINATION MATRIX (POST.CLP.BATCH) FOR MONITORING AND EVALUATION OF FOOD AID

RULE	IF (ANTECEDENT)	THEN (CONSEQUENT)	REMARKS
4 Post-evaluation-of-food-aid-distribution-organization	1. The operations have been fully ended 2. All the evaluation records are available 3. All the daily operation reports are available 4. The complete set of operation data is available	1. Send all the data to the headquarter for post evaluation 2. Post evaluation reports should be send to interested parties	
5 Recipient-support-report-to-donor	1. The recipient country operation has been completed 2. The recipient country government had partial involvement in the operation 3. The recipient country government was involved in providing information for planning	1. Recipient country officials are required to submit a report to donor organizations according to initial agreement	
6 Concerned-party-feedback-process	1. Monitoring and evaluation is proceeding as planned 2. There have been no major changes in the plan 3. The reports of the monitoring and evaluations are available	1. Write a separate report for concerned parties 2. Provide feedback to the concerned parties 3. Keep the record of the concerned parties feedback as operations data	

Additional Comments:_____