Chapter – II

LITERATURE REVIEW

2.1 Introduction

The literature survey carried out during the course of this study has been systematically organized to afford a clearer picture of the topics covered. Figure 2.1 shows a taxonomical representation of the relevant literature. The review of literature highlights the informative inputs from scholarly documented books and articles carefully studied during the course of this work. They are basically concerned with the issues related with physical security or systems science or with both. The literature concerning security issues are in reference to either national security or transportation security in general and railway security in particular; while the literature on systems science covers the basic theory and practice of systems science tools methodology and applications.

2.2 Security Management: International Scenario

One of the most significant security-related events in the recent past has been the terrorist attacks on September 11, 2001 in the U.S. In response to these attacks, the U.S. government undertook unprecedented political, diplomatic, legal, law enforcement, financial, intelligence, and military actions to combat terrorism abroad.
Figure 2.1: Taxonomy of Relevant Literature Review
United States General Accounting Office (GAO 2003a) produced a report to assist congressional committees by providing an inter agency framework for planning, executing, and coordinating related federal efforts.

A number of issues of internal security and conflict management, and related areas of public policy have been addressed in the inter disciplinary publication series of *Faultlines*, which is the first series of its kind in South Asia. It addresses issues like Maoists insurgency in Nepal (Marks, 2008), women’s role in Jammu and Kashmir insurgency (Sobhrajani, 2008), linkages between the ethnic diaspora and the Sikh ethno-national movement in India (Kumar, 2008), and youth unrest and inter-group conflict in Sri Lanka (Peiris, 2008).

The Journal of International Security Affairs focused part of an issue on the subject of terrorism. It covered topics like Narco-terrorism (how drugs fund terrorism, Ehrenfeld, 2002), the revolution in military affairs and America’s New War against terrorism in the wake of September 2001 (9/11) attacks (Blank, 2002).

Arquilla and Ronfeldt (1993) have introduced the concept of *netwar*. They depict netwar as having two major facets—one dominated by terrorists and criminals that is quite violent and negative, and another pursued by social activists that can be militant but is often peaceable and may even be promising
for societies. The authors posit that the information revolution is favouring and strengthening network forms of organization for the militants, often giving them an advantage over hierarchical forms.

Weiner (2006) states that the international terrorism carried out by non-state actors and the use of weapons of mass destruction (WMD) by dangerous states have emerged as the most significant security threat to the international security.

### 2.3 Security Management: National Scenario

The United Nations, recognizing the critical nature of international counter terrorism cooperation, specifically directed its members to “work together urgently to prevent and suppress terrorist acts…through increased cooperation and full implementation of the relevant international conventions relating to terrorism.” *(United Nations Security Council Resolution 1373, 2001).* This acute need of international cooperation has prompted the United States to offer military, diplomatic, investigative and financial aid to over 170 countries participating in the global war on terrorism *(U.S. Dep. of State Report on Global War on Terrorism, 2001).*

Latimer (2004) avers that terrorism is the principal threat to global and national security in the post September, 11 world. The author posits that India, with an extensive history of counter terrorism efforts, can provide important
lessons to other countries. A comprehensive overview of various issues pertaining to national security, such as terrorism in Kashmir, separatist movement in Punjab, terrorism in North-East, naxalism, communal riots, etc., appears in Saksena, (2001).

2.4 Modeling Approaches

Systems engineering has been applied to the problems faced by Department of Homeland Security (DHS), USA, including defence of homeland against a complex threat. The authors use systems engineering techniques to perform analysis against a scenario prior to the field experiment.

A classic lesson in security is that a chain is only as strong as its weakest link. This is particularly appropriate to transportation security. Because transportation security is interdependent in nature, the transportation security strategy must be built on a systems perspective. Thus, the transportation system can be thought of as a Complex Adaptive System (Holland, 1998), a system of interacting elements which adapt to each other over time.

Tien (2006) reports that the urban infrastructures are the focus of terrorist acts because they produce the most visible impact. The author discusses many similarities to the way one should deal with the terrorist acts and those caused by natural and accidental incidents.
Extensive mathematical modeling applications have been discussed in a book edited by Banks and Castillo-Chavez (2003). Polillo (2003) discusses a system, which he calls "Secure Flow", a holistic, integrated methodology that addresses all security vectors (paths that a terrorist may take to enter a "threat object" into the transportation system), allowing people, baggage, and cargo to move through various transportation systems in a secure fashion.

Choucri et al. (2005) propose that better preparedness against security threats can be achieved by identifying, controlling and managing the hidden linkages and situational factors that propagate hostilities. They introduce a system dynamics-based model focusing on linking of pre- and post-conflict analysis. Donovan et al. (2003) also discuss a systems approach to John Wayne airport security management. This paper uses systems engineering tools to solve the problem of screening all passengers and luggage while maintaining smooth airport operations that satisfy the traveler.

Lei and Levinson (2008) posit that the desirability of a transportation network should be assessed not only by its economic efficiency but also by its reliability and security. Their research concerns how investment rules shape the hierarchical structure of roads and affect network fragility to natural disasters, congestion, and accidents and vulnerability to targeted attacks. A Monte Carlo simulation was carried out to evaluate the equilibrium road networks.
Chang and Hung (2005) propose that imprecise or vague importance as well as satisfaction levels of criteria may characterise the evaluation of alternative network security systems, include military security and communication network security. The authors treat this problem by the fuzzy set theory.

2.5 Security Management in Transport Sector

In the light of the September 11, 2001 attacks in the U.S., enhancing the security of transportation systems was given one of the highest priorities by transportation agencies. Transportation Research Board of The National Academies of the U.S. generated extensive discussion on this issue (http://gulliver.trb.org). Similarly, in Australia, the Government is working with state and territory governments and industry to improve the security of Australia’s transport system and reduce the likelihood of transport being a target for terrorism (Dep. of FTA, 2008). In the following sections, the relevant literature is specially covered from the perspectives of aviation, ground and maritime sectors.

2.5.1 Aviation Sector

The aviation sector security includes landside security, cabin baggage, policing at airports, air cargo security, contingency response, training, and compliance (TRANSEC Annual Report, 2007-08). In October 2002, the British
Government published an independent report on airport security review which was established with several terms of reference, such as, review of the arrangements for security, considerations of the seriousness of the security threat, and the relevant recommendations thereof (Airport Security Report, 2002).

The Department for Transport (DfT) in the United Kingdom is the "appropriate authority" under the guiding international legislation, responsible for setting, monitoring and enforcing the National Aviation Security Programme (NASP), with which airport operators and airlines in the United Kingdom are required to comply. Airport Security Report (2002) focused on the issues of serious and organised crime at airports, and recommended significant structural changes. The review recommended strategic direction and coordination between various relevant agencies like National Aviation Security Committee, supporting Airport Security Committees, Home Office, Cabinet Office, DfT, and Ministerial Committee on Protective and Preventative Security. A special reference was made to the use of CCTVs, Automatic Number Plate Recognition (ANPR) systems, and other emerging technologies.

A GAO (General Accountability Office) testimony in the U.S. (GAO 2003b) responded to the request of the National Commission on Terrorist Attacks upon the United States for information on transportation security. It addressed issues like: (1) transportation security before September 2001; (2)
what the federal government did since September 11, 2001 to strengthen transportation security, particularly aviation, mass transit, and port security; and (3) what long-term institutional challenges face the federal agencies responsible for transportation security. In another related report (GAO 2003c), GAO discusses actions and plans to build a results-oriented culture.

2.5.2 Ground Transportation Sector

Beyond aviation sector, the rapidly emerging ground transportation security industry has been divided into the following major categories (Greiper and Sauter, 2006): (i) mass transit: buses, trolley buses, ferries, rail, subway, and van pool, (ii) passenger railway, (iii) freight railway, (iv) inter city buses, and (v) freight trucking. Several experts (e.g., Committee Report on R&D Strategies to Improve Surface Transportation Security, 1999) have advocated for greater amount of R&D spends in the area of improving ground transportation security.

2.5.3 Maritime Transportation Sector

The aim of maritime security is to detect and deter security threats and take preventative measures against security incidents affecting ships or port facilities and to protect from harm the passengers, crews, ships and their cargoes, port facilities and the people who work and live in port areas (Dft Report, 2007). Among transportation modes, shipping appears to be one of the
highest risk options because of illegal transportation of goods, drugs and humans. Recent events like several hijackings of the Indian trade ships by Somalian pirates in October 2008 corroborate the above fact. Despite attempts to implement maritime security, shipping industry has been slow in implementing security measures. Tzannatos (2003) presents a decision support system (DSS) as a security management tool in the area of shipping.

2.6 Security Management in Railways

A nation’s enemies understand the vital role of transportation infrastructure and the human and economic damage that attacks upon it can wreak. Between the year 1995 and July 2005, over 250 terrorist attacks worldwide targeted rail systems, resulting in more than 900 deaths and over 6,000 injuries (Riley 2004). It has been recognized by the industry experts that the ground transportation sector (in particular, railways) represents far greater security challenges than aviation (Greiper and Sauter, 2006). Securing more than 400 airports and ordering security upgrades to the airlines, while a major endeavor, is a discrete and manageable task for various governments. However, the ground transportation industry involves thousands of organizations in multiple transportation modes spanning both the public and private sectors. Then there is the sheer size of the transportation infrastructure, including endless miles of track, large numbers of bridges and tunnels, countless passenger stops, and a vast horde of trucks traversing the country day and night.
Moreover, the system is designed to be open and accessible in nature. Various issues related to passenger rail security in the U.S. have been discussed in CRS (Congressional Research Services) Report (2006).

The Department for Transport, UK (Dft Research Report, 2005), commissioned a research study in October and November 2005 to look at how Londoners and users of the London Underground railway responded to the attacks on the London public transport network in July 2005, and their attitudes to the potential introduction of higher security measures on the transport network. The results showed that a majority of respondents were not worried about travelling in London, generally since the attacks, and that respondents agreed that the introduction of additional security measures on the London underground would greatly reduce the threat of a terrorist attack. Responses showed that respondents were generally positive about accepting some level of delay to allow for additional security. Several other research studies looked at the related aspects of this issue (Dft LUNR Research Report, 2005; Dft Report, 2006a, 2006b, 2006c).

Gao Xukuo and Wang Qiong (2013) have made a comparative study of different modes of transport using Analytic Hierarchy Process (AHP), with criteria being “five factors of the cost, speed, security, punctuality and transportation.” They have found rail transportation to be advantageous and
suggested certain measures to remove the existing bottlenecks for further improvements.

2.7 Security Systems

Since 9/11, the security systems have undergone several fundamental shifts (Airport Security Report 2002). One is the adoption of digital networking technologies which automate systems, and thus reduce manpower requirements. Second, the growing complexity of security systems requires more sophisticated integration skills. Security systems to protect critical infrastructure now rely on a range of products (such as cameras, detection equipment and servers), communication platforms (fiber, wireless, IP, etc.), and system features (including remote access and real-time analytics).

Koch (2004) reports development of a 3D computer tool to assist the US Federal Aviation Administration security group in evaluating new equipment and procedures to improve airport checkpoint security. Haering and Shafique (2007) discuss development of automatic visual systems for transportation security. The developed system, Object Video, is an intelligent video surveillance system designed to work in diverse environments, such as subway tunnels, railroad crossings, air and seaports. Hallowell and Jankowski (2005) review the mission and function of the Transportation Security Laboratory (TSL) within the Department of Homeland Security, USA.
2.8 Legislative and Coordination Systems

Several studies conducted in the U.S. allude to the lack of a comprehensive rail legislation to improve safety of railways. Plant and Young (2007) make the following recommendations: (i) Congress needs to pass comprehensive rail security legislation and allocate adequate financial and administrative resources to enhance current security efforts, (ii) Coordination between law enforcement and railroad police needs to be improved, (iii) Legislation directed at specific modes of transportation should take into account the intermodal nature of contemporary transportation, factoring in logistics chains and intermodal connections, and (iv) The lessons learned from efforts to protect other modes of transportation should be examined for their potential to enhance rail security. Similarly, a GAO study (2003d) recommends that strong federal action is needed to address security challenges in the transportation sector. Several subsequent studies by GAO follow the common theme that while some work has been done to address security concerns, significant challenges still remain (GAO 2004, 2007, 2008).

2.9 Systems Approach to Problem Solving

2.9.1 Systems Theory

Systems concepts and methodologies are developed as a response to the ever increasing complexity of the socio-technical and managerial systems. Many techniques and approaches based on systems philosophy have been
developed, which help in analyzing various problem situations in multiple ways (Sushil, 1993a). In a seminal paper, Satsangi and Ellis (1971) describe the physical system theoretic construction developed to model the Canadian economy. The authors identify national economy as a collection of interconnected components. The approach adopted that of component-to-system construction. The framework developed is general enough to embrace many “input-output” models in economic literature.

Bertalanfy (1972) has reported extensive developments in the field of General Systems Theory and discussed the trends in System Science, Mathematical Systems Theory, Systems Technology, and Systems Philosophy. General Systems Theory structured sciences and systems and provided answers for a variety of systems such as material systems, informational systems, and conceptual systems (Boulding, 1956). The systems movement has been reviewed by Checkland (1981 a, b). He concludes that the development had been more on the hard systems thinking and recommended that the newer developments should be more on soft systems thinking with a “learning” paradigm. An intriguing review by Troncale (1988) puts the developments in systems sciences together by defining the domains of systems sciences such as General Theory of Systems, Systems Theory, System Analysis, and Systems Applications. ISM has been successfully used to provide significant inputs for policy making in many complex human systems. Warfield (1990a) mentions that the ISM process, since its inception in the early 1970’s, has been used in
different fields like forestry, fishery, corporate planning, administration, etc., in the settings of various countries, including Brazil, India, Japan, U.K., and USA. The hub of methodological development activity in this area has been the Center of Interactive Management, first at University of Virginia, and later at George Mason University, USA.

A set of consensus methodologies was suggested by Warfield (1990) while presenting a science of generic design. A subsequent concept of “Total System Intervention” was proposed by Flood and Jackson (1991). ISM has been a part of methodology base of the company, Tata Consultancy Services (TCS). Warfield (1990b) lists major governmental application of ISM in Doordarshan, the T.V. Broadcasting organisation of Govt. of India. However, ISM was academically introduced in India in 1998, especially at IIT Delhi (Gaur, 1996).

Satsangi and Gautam (1983) have presented a comprehensive account of soft systems methodology for studying large scale human systems. They provide an overall perspective of the proceedings of the National Workshop on Select Dimensions of Rural Energy Systems held in Delhi in 1981. Apart from covering all relevant aspects of rural energy management like examining the potential of renewable energy, rural transportation, rural cooking appliances, etc., they give a scholarly account of systems science methods like NGT, Delphi Technique, Harva Scenario Building approach and the like.

Angnihotri and Satsangi (1993 a, b) discuss the development of a systems
engineering framework for policy design for the Government of India for the Handloom sector of Indian textile industry. In developing this policy, they specifically used the ISM as a tool along with other consensus methodologies such as Brain Writing, Nominal Group Technique, Option Field and Option Profile Methodologies, and Fuzzy Set Evaluation Procedures. Similarly, Gaur, Mishra and Satsangi (1995) have used ISM to arrive at alternatives of integrated policy designs for Indian industries.

More recently, several innovative applications of the systems approach are beginning to emerge in the areas of literary and spiritual systems (Satsangi 2008; Dayal and Satsangi 2008; Dayal and Srivastava 2008; Satsangi and Sahni 2008), information risk management in supply chains (Faisal, Banwet and Shankar, 2007), creation of flexible and lean value chain using outsourcing (Mohammed, Shankar and Banwet, 2008), cement industry (Saxena et al., 2006), etc. Shahabadkar et al. (2012) provide a taxonomical overview of the literature on the use of ISM in supply chain management. Although the above-mentioned examples are only a representative subset of the application of the ISM in various contexts, they are sufficient to indicate the potent use of this technique in diverse settings and applications.

Green, Armstrong, and Graefe (2007) conducted an extensive survey and found that Delphi technique can be highly advantageous as compared to traditional group meetings, if the former is utilised well. Prediction markets may
have certain advantages over Delphi technique for short term forecasting but Delphi Technique, which appears to be under-utilised so far, can pay rich dividends as far as prediction involving experts ventilating their honest opinions for long term scenarios are concerned.

2.9.2 System Dynamic Modeling

Forrester (1961) and Sterman (2000) have authored pioneering books in the field of system dynamics. Useful reference texts in this area have been authored by Sushil (1993b) and Mohapatra et al. (1994). Bora et al. (1990) present a system dynamics study to design price stabilization and growth policies in Indian tea industry. Using system dynamics methodology, Jain, Satsangi, and Kothari (1993) examine the effects of urbanization and industrialization on energy-related problems such as high energy demand, air pollution and traffic congestion at urban centers. Impacts of investment in the industrial sector are compared with those due to investment in other sectors and population growth over a period of 20 years. Satsangi et al. (2003) develop a system dynamics simulation model to analyse system behaviour representing city problems in the context of an integrated urban system.

Ge et al. (2004) presents a system dynamics approach for the analysis of the demand amplification problem, also known as the bull whip effect, which has been studied fairly extensively in the supply chain management literature. The construction of the model is reported using a part of a supermarket chain
system in the UK as an example. Sachan et al. (2005) used system dynamics approach to model the Indian grain supply chain involving the dynamic interaction of cost variables that influence the total supply chain cost. The objective is to minimize the total cost of the supply chain. Saini, Swami and Bhushan (2008) use system dynamics approach to model the technology diffusion process in the Indian foundry sector.

2.9.3 Flexible Systems Approach

Deriving inspiration from the developments in systems methodology in terms of schemes of systems techniques, and a wide applicability of integrated systems in computer based management, Sushil (1993) generalizes the philosophy of integration of techniques over the whole spectrum of system techniques in the framework of Flexible Systems Methodology (Sushil, 1993). A specific application of this framework has been recently used in policy and strategy formulation (Saxena, et al., 2006). This approach proposes that a flexible policy framework is needed to strategically meet the dynamics of the new era. Flexibility paradigm in this context implies creating more “policy options” in order to have a broader policy choice, thus building “change mechanisms” in policy framework, and providing “freedom of choice” to all the stakeholders (Sushil, 2000).