CHAPTER-II
SURVEY OF LITERATURE

“It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change.”

Charles Darwin
CHAPTER II
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A study on the Ants organization and collective behavior and its application in modern organizational teams is taken up for research investigation. Elaborate survey has been taken up by perusing the literature available on the subject. Literature in the form of books, articles, reports, journals, dissertation and websites have been referred for acquiring insight on the subject. The survey of literature has been grouped into four categories. They are:

A. Survey of literature related to ants.
B. Survey of literature related to organizational team building
C. Survey of literature related to application of ants based techniques in organisations.
D. Identification of research gap

2.1 Survey of literature related to ants

John H. Sudd and Nigel R. Franks (1987)\textsuperscript{1} discusses about the eusociality or truly social nature of ants society, where individuals of the same colony cooperate in caring for the brood, more or less non-reproductive individuals work for the colony and also exists overlapping of adult generations. The trait of sterility in the case of non-reproductive workers in the ant colonies has been reasoned through the propositions of kin selection and parental manipulation.

Kin selection hypothesis states that, by reducing personal survival and reproduction workers nevertheless increases the survival and reproduction of genes they share with other members of the colony by common descent. Individuals suffer but the colony flourishes. The theory of Parental manipulation explains that in ants, the queen is able to neuter (sterilize) and control some of their offspring so as to produce a larger total number of
offspring. The parents’ personal fitness is raised even though that of some of the offspring is lowered.

Ajay Narendra and Sunil Kumar M (2006)\(^2\) points out that the origin of ants goes back in time somewhere between 140-168 million years ago. The life cycle of an ant colony is elucidated. It consists of three stages-the founding stage, growing and the reproductive stages. The method of communication by touch and using chemical substances called pheromones, and navigation techniques like landmark cues, panoramic cues behind the goal and along the foraging route, path integration are elaborated.

Edward O. Wilson (1972)\(^3\) observes that the competencies of ants and other social insects in respect of cohesion, caste specialization which is equivalent to distinctive roles, and individual altruism— is nonpareil. The author elaborates on truly social or eusocial nature of ants and other social insects. The author details about the classification of social stages based on the possibility for the eusociality traits to occur independently of one another. They are:

- Solitary – showing none of the traits of eusociality.
- Subsocial – The adults care for their own nymphs or larvae for some period of time.
- Communal – members of the same generation use the same nest without cooperating in brood care.
- Quasisocial – members of the same generation use the same composite nest and also cooperate in brood care.
- Semisocial – as in quasisocial, but there is also reproductive division of labor, that is, a worker caste cares for the young of the reproductive caste.
- Eusociality – Individuals of same species cooperate in caring for the young; there is reproductive division of labour, with more or less sterile individuals working on behalf of fecund individuals; and there is an overlap of at least two generations in life stages capable of contributing to colony labor, so that offspring assist parents during some period of their life.
The kind of castes or roles that exists in ants is elucidated. The existence of three basic female castes is highlighted — the worker, the soldier, and the queen. These are referred to as basic because they exist usually. The males constitute an additional caste.

The subject of determination of female caste, genetically, that is, each caste arise as a response to a particular set of genes, or phenotype controlled by a single set of genes occurring in the brood stage is dealt with. Based on the evidences it has been pointed out that female castes are determined by environmental factors rather than genetic factors.

**Bert Holldobler and Edward O. Wilson (1990)** it is a comprehensive book that covers in great detail about the Ants — the colony life cycle, altruism and the origin of worker caste, kin recognition, division of labor, communication, symbioses among ant species and plants, and foraging strategies.

Cites the key advantages of organized colonies of the kind made possible by eusociality that is under most circumstances groups of workers are better able to forage for food and defend the nest, because they can switch from individual response to group response and back again swiftly and according to need. Another aspect of equal importance is that the execution of multiple-step task is accomplished in a series-parallel sequence instead of parallel-series sequence where individual ant specializes on particular step.

The single most important feature of social insect behavior is the existence of non-reproductive worker caste. The altruistic action of this caste integrates the colony tightly and makes possible advanced forms of labor specialization.

It has been pointed out that complex social behavior of ants appears to be mediated in greatly by chemoreceptors. Ants secrete substances called pheromones, which are chemical messages detected by other ants through sense organs or the antennae. This process is called chemoreception. In general the typical ant colony operates with somewhere between 10 and 20 kind of
signals, and most of these are chemical in nature. There are other forms of communication like tactile, acoustic and visual. The modes of communication are divers and evoke various responses from recognition to recruitment and alarm.

W. M. Wheeler (1965) details the habits of ants in general. Ants pursue the three-fold aim – aim of securing food, perpetuating their species, and protecting themselves and their offspring. The source of nutrition includes other insects, excretions of plants, seeds of plants, and fruits, and fungus. No single species of ant is able to draw on all of these sources of nutrition. The protective habits include the care of the young, their personal care, and that of another, their methods of defending themselves against enemies, of keeping their nest clean, of preserving the colony free from other species.

John H Sudd (1967) according to the author, the way the animal’s behavior is locked into its life and environment depend on what sort of sense organs and nervous system it has. The way of self-grooming, use of mandibles and sting for defense, details of hairs in the cuticular part which makes the organ sensitive to particular class of stimulus like acting as sense organs of touch, air-currents, airborne sound vibrations. Other hairs acts as organs of chemical sense, corresponding to taste and smell in man. Ants use antennae to investigate food, other ants, ground over which they walk and all objects they meet. Ants eyes can detect the plane of polarization of the light. Ants are sensitive to lights of different wavelengths. They perceive information about the outside world through the signal made up of physical sounds and movements, and chemical. Ants use their sense organs like antennal chemical sense and vision to navigate. They also use scent trails and gravity for navigation. Different types of nest constructions based on the species are explained.

The variation in behavior which is referred to as polyethism and its types based on caste and age have been brought out. The integration of work in single task begins through formation of cluster and followed by imitation. Cooperation in
group work and coordination in ants through the stigmergy that is the arrangement where the results of the work give the stimuli to guide further work and the learning in ants is outlined.

Ken Thompson (2008)\textsuperscript{7} observes that pheromone-based communication system is the oldest and most evolved form of biological signaling, using chemicals for messaging, and elaborates on the characteristics of pheromone signaling.

Carl Anderson & Elizabeth McMillan (2003)\textsuperscript{8} discusses on the principle and attributes of self-organization found in social insect teams like ants and its advantages. Self-organized societies are not run through command and control system but through a flat, decentralized organized structure in which individuals make their own simple decisions using information generated from the local environment and through interaction among individuals.

Oster and Wilson (1978)\textsuperscript{9} highlights the important distinction of ants is its capacity to conduct all of its operations concurrently instead of sequentially. The system is efficient and reliable as the specialized caste status of each colony member tends to match the contingency to which it responds.

Hugh Newman (1967)\textsuperscript{10} brings out that the ants have developed a caste system and their community contains three distinct types of castes – males, queens, and workers. The workers make up the most of the community. Many ant communities produce a special type of worker known as a soldier and are distinguished by abnormally large heads and powerful jaws. The time of development from egg to adult differs according to the species and the time of the year. The sex of an ant is determined when the egg is laid. The queen can lay either fertilized or unfertilized eggs. The feeding of the larvae plays an important part in the development of the adult ant. In order to produce queens the larvae must be especially well fed, but queens production also dependent on the mothers state of nutrition.
Sigmund A. Lavine (1960) states the reason for the great for number of ants are their abilities to adjust themselves to almost any environmental conditions like temperature and nesting materials and to eat a wide variety of food. The ants live in communities where each individual does a definite task, working for the common goal. Ants find their way handily by means of their sense of touch and smell which are located in their antennae. When they tap food with their antennae, they actually taste it, for ants not only recognize air-borne smells, but also sense of chemicals, by touch just as human taste buds. Ants recognize both nest mates and intruders. Each species has its own odor.

W M Wheeler (1923) observes that the social living beings work together to insure to one another for development and survival. Such mutualism and cooperation affect their structure and behavior. They also show the extent to which social organization can be developed and integrated on a purely physiological and instinctive basis. The social plasticity of ants is described in the nature of nesting and feeding habits. The author says that it is egoistic appetite and not altruistic maternal anxiety for the welfare of the young constitutes the potent drive that initiates and sustains intimate relations of the adult ant to the brood. It is just as the mutual regurgitation of food initiates and sustains the mutual relations among the adult workers.

Brain Vesey and FitzGerald (1969) says the ants owe their social and industrial superiority to their habitat. Ants have its building material close at hand and its architecture may be varied as these materials. Thus, it is inferred that ants owe their social and industrial superiority to their habitat.

Walter M Blaney (1976) points out that the nest building occurs in all true social insects and the occurrence of division of labor is nearly accompanied by the occurrence of physically distinct castes or groups. Just as the task of reproduction, foraging and defense are part of the basic behavioral repertoire so
the bodily form of the individuals which specializes in particular tasks results from the enhanced development of particular physical attributes.

R B Freeman (1959) view the trophallaxis or the exchange of food between the adult ant and the brood was of fundamental importance in the social evolution of social behavior. The trophallaxis also occurs between the adults themselves and is essential to the maintenance of the unity of ant colony. The origin of caste differentiation depends on the both the quality and quantity of food given to the brood may determine which caste they eventually develop into. It is stated that in the presence of queen in the colony, a social hormone or queen substance which inhibits and controls the production from workers and have an overriding control of caste or group differentiation.

R W Matthews and J R Matthews (1978) discusses about the advantages of group behavior and development of altruistic behavior and pre-adaptation in ants. Worker ants show more intense digging behavior when confined in groups than do isolated individuals given the same conditions. Others include food detection and/or utilization may also be more efficient, modification of the environment, group living changes the predator-prey relationship. For a trait to be a selective advantage, the living entity must be already equipped to use it in advance of its occurrence. Previously existing behavior patterns, physiological processes, and morphological structures that are already functional in some other context become as stepping stones to new adaptations of eusociality. Defines the term behavior as the ways in which an organism adjusts to and interacts with its environment. The meaning of term social is pointed out as the indication of adaptively significant and usually cooperative interactions between two or more individuals.

Derek Wragge Morley (1954) points out that the ant is dependent on its senses especially its sense of smell to possess a constant mental awareness of the presence or absence of other nest mates and recognition. The antennae is used as mobile nose and as well as organs of touch.
W M Wheeler (1928)\textsuperscript{18} says the specific structure and behavior of the individuals belonging to the different castes are definitively fixed on their emergence from the pupae. The life of ant colony containing only a single fertilized queen, will survive till the queen’s life. In some of the species queen is known to live at least fifteen years. But when fertilized daughters of the queen are adopted from year to year by the colony, the colony lives much longer to an age of forty or fifty years or perhaps more.

Otto T. Solbrig and Dorothy J. Solbrig (1979)\textsuperscript{19} explains that the behavior is subject to natural selection. The definition of natural selection given is any characteristics that will increase the probability of survival of an individual and its offspring will become increasingly more abundant until all individuals in the group possess it. The behavioral characteristics of a living being are limited by its morphology and physiology.

Walter Linsenmaier (1972)\textsuperscript{20} discuss the importance of care of the brood and nest mother queen in the colony. The brood care and division of labor are more highly organized and the society is much more adaptable.

Jean George (1979)\textsuperscript{21} gives a brief account of several kinds of ants like harvester, carpenter, acrobat, parasol, kidnapper and others and their core function, especially of parasol (leaf-cutting) ants.

M V Brain (1965)\textsuperscript{22} says that the natural selection is able to effect socialization of relatives, as mutual protection and co-operation enhance the survival of gene replicas they carry (kin selection). The haplodiploid method of sex-determination is particularly favorable to social evolution. This also provides plausible explanations of why males are not socialized. The social insects are organized in different forms, some into distinct colonies which are closed to others of the same and different species, some into colonies that are diffuse and only closed to members of other species and there are all forms of intermediaries.
P Passarind’Entreves and M Zunino (1976)\textsuperscript{23} describes about the formation of colony and functions of members belonging to different castes. It mentions of ants navigation using features of the landscape and the position of the sun.

G.K. Veeresh et al. (1987)\textsuperscript{24} outlines on the general nesting habits, feeding habits, foraging strategies and the breeding habits of specific species. Each species has its own plan of construction modified to adapt to special local conditions. Nesting types for a specific species consists of – permanent nests under the foundation of building, temporary nests under composite farm-waste or at the base of a tree, seasonal nests under small stones and bricks and in bare soil without any vegetation. Based on feeding habits ants are divided into three major groups – Sub families of Formicinae and Dolichoderinae are largely associated with homopterans, the myrmicinae ants have equal preference to honeydew and insects as food and the ponerines prefer insects and other arthropods as their food. A brief description of the study of ecology and foraging behavior of a particular species is highlighted.

Vinayak Bhat (2007)\textsuperscript{25} depict the weatherproof nest among leaves using the silk produced from the larvae of weaver ants, and are capable of building huge colonies spread across several trees.

Raghavendra Gadagkar (2011)\textsuperscript{26} states in some species of insects such as ants and other social insects organize themselves into colonies /very sophisticated societies that are parallel and sometimes surpass human societies in their social organization, in their social integration, in communication, in division of labor and most importantly in the way in which they tread a balance between conflict and cooperation in the colony. Some of his findings include that the presence of queen will suppress the worker reproduction, and worker themselves regulate each other’s work in a decentralized, self-organized manner, irrespective of whether the queen is present or not.

Eric Bonabeau and Christopher Meyer (2001)\textsuperscript{27} observes that social insects have been so successful because of three characteristics: flexibility – the colony
can adapt to a challenging environment; robustness – even when one individual fail, the group can still perform its tasks; and self-organization – activities are neither centrally controlled nor local supervised. And, to a large extent, flexibility and robustness result from self-organization.

Jeffrey Kluger (2009)\textsuperscript{28} cites from the studies of that the worker ants in colonies with a queen are physically attacked by their peers if they try to reproduce. The studies of Jurgen Liebeg and Adrian Smith have shown that the synthetic hydrocarbon compound applied to few of them was attacked by other ants in the presence of queen. The deceitful ants were bitten and pulled by their peers. But this was not the same in colonies without a queen, where ants were free to reproduce. This “reproducing policy” plays an important role in maintaining harmony in the ant world.

Peter Miller (2007)\textsuperscript{29} outlines that ant colonies can solve problems collectively such as finding the shortest path to the food source, allocating workers to different tasks, or defending a territory from neighbors. As individuals, ants might be tiny dummies, but as colonies they respond quickly and effectively to their environment. They do it with something called swarm intelligence. It is the collective group behavior consisting of features of decentralized control, response to local cues, simple rules of thumb – add up to a strategy to cope with complexity.

Mark W. Moffett (1999)\textsuperscript{30} depicts the discovery of first known ant species, a Sphecomyrmafreyi worker, from the Cretaceous period about 90 million years ago. Yet Sphecomyrma was apparently already social, as are today’s ants, with a queen atop the pyramid of a highly organized colony.

Meredith Belbin (1998)\textsuperscript{31} states the behavior of the eusocial insects like ants has been explained by postulating a ‘selfish gene’. It is shorthand for saying that the whole genetic complex of an individual creates a body and drives its behavior with the ultimate purpose of protecting and propagating its own
genetic complex. The theory holds that the life of an individual is devoted to the perpetuation of his/her genes if necessary at the expense of his/her life.

Tony White (2005)\textsuperscript{32} discusses the definition and meaning of stigmergy and its importance. Stigmergy, as originally described by Grassé in 1959, embraces the principle that the environment plays a crucial role in coordinating the activities of individuals. A stigmergic system is one in which coordination of activity is achieved by individual agents leaving signals in the environment and other agents sensing them and using them to drive their own behavior. A Stigmergic system solves problems in a bottom-up way – they self-organize – with no central leader. Stigmergic system is pervasive and is widely observed in social insect systems.

Michael D Atkins (1980)\textsuperscript{33} explains under the normal circumstances basic inherited components of behavior serve a vital purpose and consequently persist as a characteristic of each species. This preprogrammed pattern of response is called innate behavior or instinct. Innate behavior is distinguished from learned behavior on the basis that it can be performed with no prior experience. There are drawbacks at least for the individual. To behavior that is entirely preprogrammed, since there is no opportunity to develop beneficial alternative strategies in recurring situations. Learning permits the development of behavioral alternatives that in some situations more beneficial than the basic innate response. Learning implies that some beneficial adaptive change in behavior as a result of experience or it is also implies some storage and retrieval of information (memory) that has a subsequent effect on an individual’s behavior. Different methods of learning in insects are discussed like conditioning, instrumental learning, shock avoidance learning, olfactory learning, habituation, latent learning, imprinting and insight learning.

Donald J Borror and Dwight M Delong (1954)\textsuperscript{34} gives an overview of different caste or groups in ants and the lifecycle of an ant colony. It also covers the classification of orders in insects and subfamilies of formicidae.
Robert W Matthews and Janice R Matthews (1978)\textsuperscript{35} states behavior as what animals do and it is the way in which an organism adjusts to and interacts with its environment. It covers a wide range of activities and are classified into maintenance activities and communicatory activities. The widely accepted scheme to classify communication is based on the receptor involved. In terms of transmission and reception channels involved communication may be visual, acoustical, chemical or tactile. The function of chemical communication in recruitment, alarm and others are elucidated. The advantages of group behavior like increased reproductive efficiency, defense, predator-prey relationship, and increased productive activity at work such as worker ants show more intense digging behavior when confined in groups and social facilitation.

Katja Bargum (2007)\textsuperscript{36} explain the reasons for grouping and factors that promote and maintain social polymorphism in ants and its cost and benefits to the colony. The author highlights Hamilton’s kin selection theory to explain cooperation in animal groups, from collaborating microbes to the evolution of eusociality – costly behavior such as helping can spread when the benefits to the recipient weighted by the relatedness outweighs the cost. Some cost and benefits to the workers and queens associated with polyandry and polygyny colony are elucidated. In some colony queens are multiply mated (Polyandry), or the colony encompasses multiple queens (polygyny). Polyandry and polygyny entail several costs and benefits for the workers and queens, whereby individuals gain directly from cooperating like in many cooperatively breeding species, larger group size results in higher survival and the case of foraging success for all members. Thus individuals help to rear offspring other than their own in order to increase group size. The author highlights Hamilton’s kin selection theory to explain cooperation in animal groups, from collaborating microbes to the evolution of eusociality – costly behavior such as helping can spread when the benefits to the recipient weighted by the relatedness outweighs the cost.
John Bartholdi and Don Eisenstein (2004)\textsuperscript{37} describes the manner of seed transportation by the specific species of ant into their nest having inherent benefits. The seed would be picked by up by the smallest and slowest ant, carried back, passed over to a larger and faster ant, who speeds it up back toward the nest, where it is taken by a bigger and faster ant, until the biggest and the fastest ant of all races back to the nest. The slowest ant goes back to get another one.

Markus Waibel et al (2006)\textsuperscript{38} outlines the efficiency of social insect colonies critically depends on their ability to allocate to the various tasks which need to be performed. A model based on the genetic architecture is used to compare the performances of three genetic architectures underlying within colony variation in response thresholds of workers to given tasks. The three genetic architecture were deterministic mapping, probabilistic mapping and dynamic mapping systems. In the deterministic mapping system, the threshold of individuals for each of the given tasks is strictly genetically determined. In probabilistic mapping system, the genes only influence the probability of engaging in one of the tasks. In the dynamic mapping system, the tendency of the workers to engage in one of the given tasks depends not only on their own genotype, but also on the behavioral phenotypes of other colony members. Overall, the type of mapping and individual behavior greatly influences the dynamics of task specialization.

Bill Hughes (2008)\textsuperscript{39} examine and put forwards an evidence that the Hamilton’s theory of kin selection explains the evolution of social insects and high relatedness among the social insects like ants has seen as essential for the evolution of highly social behavior.

Smith (2008)\textsuperscript{40} portrays that in many social insects queens enjoy nearly complete control over production and workers have diversified in form and function to increase their efficiency at performing different labors. The factors that determines which individuals becoming queens or different type of
workers from developing larvae has been outlined. Larvae become different caste small worker, large worker, or queen based largely on the nutrition they receive. Those fed more insects than seeds are more likely to become larger individuals (queen, large worker, small worker). Even once caste is determined, nutritional, social (colony size), and genetic factors all contribute how big individual grows.

**Tanja Schwander et al (2008)**\(^41\) says it was supposed that daughter’s caste, either worker or queen, was determined by a developmental switch during the larval stage controlled by nutritional and other environmental factors, meaning that eggs laid by females had the capacity to go either way. Their study on the role of queen indicated that the new queens are produced only from eggs laid by queens exposed to cold, and there was a strong age effect, with development into queens occurring only in eggs laid by queens that were at least two years old. It was also given that eggs further revealed hormonal differences that developed into queens versus workers.

**Richard Gill and Robert Hammond (2010)**\(^42\) explains ants have some of the most integrated and complex societies found in nature and cooperation is highly important to their success and mechanism that resolve such arguments should have evolved. Based on their study about how a conflict over who reproduces in a specific species of ant colonies containing multiple queens it has been found that workers indeed hold the power – the workers eliminate all but one queen who they preferentially groom and who ends up reproducing.

**John Whitfield (2001)**\(^43\) highlights collaboration activities of ants with examples like ants carrying a lump of food too big for single ant to transport, an unusually large worker ant takes the front, and an small one, the back. Two such ants can a carry a load heavier than the sum of their abilities. A lot of ants hold the intruder down, and a big one comes along and attack.
Vance Packard (1950)\textsuperscript{44} explains that there are three different types of intelligence revealed in animal behavior. These are instinctive actions, learned actions and reasoned actions. It is cited that the ants have learned mazes with more blind alleys, which had been explained that the ant is aided by its very acute senses and the ease and quickness with which it can move around.

Lord Avebury (2003)\textsuperscript{45} states that when the habits of ants, their social organization, their large communities and elaborate habitations, their roadways and their possession of domestic animals are considered it makes them have a fair claim to rank next to man in the scale of intelligence. It has pointed out that the very young ants devote themselves at first to the care of broods, and that they take no share in the defense of the nest or other work outside the nest. A possible explanation provided is that for young it would be undesirable to for them to take rough work or run into danger until their armour had time to harden.

R Mathur et al (2008)\textsuperscript{46} states that all behavior patterns are either learned or genetic. The lower animals like insects rely more on genetics as compared to higher animals like human beings. Further, social organization of a group depends on the total number of individuals, age, sex ratio, these in turn depends on other factors like abundance and dispersion of food, predation, habitat and such other factors. The characteristics of social groups are highlighted, they are actively come together, social behavior depends on the length of time or part of the life cycle that remain together, physical proximity to each other and energy actually spent in social behavior.

Hoshang S Gundevia and Hare Govind Singh (2008)\textsuperscript{47} outlines the display of specific behavior pattern of an organism is dependent on its genetic makeup and the environment in which it habitats. Broadly behavior has been classified into two types namely, Stereotyped and Acquired. In the case of stereotyped behavior the organism is to a large extent stimulus bound, it is known as innate or inborn or inherent behavior. The acquired behavior becomes more variable and modifiable through experience. In lower organism,
what may be acquired is fairly simple and is still stimulus bound. But with the complexity of nervous system as in human beings, new behavior pattern originate.

2.2 Survey of literature related to organizational team building

John Adair (1999)\(^4\) elicits the important stages in team building. The stages are selection of team members, team building exercises, reviewing and role of consultant. The process of selection of member involves consideration of technical or professional competence and ability to work as a team member. The selection process discover and reject those who are non-motivated, non-workers and disruptive. Subsequent to selection of group of people, a crucial event in the movement from being a group to becoming a team can be through significant or relevant team building exercises. They should also be seen as introductory to tasks which closely resemble the actual tasks which the group will be called upon to tackle together. The reviewing phase helps the group to think critically about its performance of day’s work or task together. Reviewing is an essential part of the process of being a high-performance team. The right consultant plays a significant part as a catalyst. The consultant role as an outsider is complimentary to the leader’s role. A consultant can help a group see possibilities of at least a degree of teamwork in what seems to be mere assemblage of individual tasks or contributions.

Bradley J. Sugars (2007)\(^5\) describes the steps that are essential in the creation of team - selecting compatible team members, ensuring fundamental and controllable team building elements in Place and right environment. To ensure that team members are compatible with other members their personality profile is studied and matched using DISC Personality Profile: D – Dominant, I – Influential, S – Steady, and C – Compliant. The DISC personality Profile is used to predict the behavior of individuals when they work on their own and with others. The DISC test highlights a person’s relative strength in each of the four areas – Outgoing or Reserved, and Task Oriented or People Oriented. Equally important is to put fundamental & controllable team building elements
in place like leadership, common goal, rules of the game, action plan, support risk taking and members involvement and commitment.

Mike Pegg (2008) illustrate the ‘8S framework’ of team building elements: The first element is spirit – Setting up the team to succeed. Great teams are made up of people who have similarity of spirit and diversity of strengths. Selection of right person is done by knowing or discovering the following three things - the person’s desire to join the team, skills and potential contribution the person can make contribution to the team or perform effectively and deliver success. The other elements are strength – knowing team members top talents; specific goals – fixing teams specific goals; strategy – leaders clearly set the strategies the team can follow to give itself the greatest chance of success; star performances – ensuring the team delivers star performances – There are two performance aspects that are discussed, one related to the leader work and the other to team members work. First, leaders work is to keep peoples eye on vision and team goal. They often follow the stage model. They recognize that the strategic, tactical, administrative, grunt (daily tasks) and emotional parts of the job must be done. Some focus their own efforts on the strategic and emotional aspects; support – provide the team members with support – encouragement, enterprise and excellence are the keys to creating a stimulating environment; solutions – crises can make or break a team. Forming group and each group chooses one particular topic to tackle; success – leaders will have to encourage team to follow good habits, work hard and reach the destination by the deadline.

Jon R. Katzenbach and Douglas K. Smith (2003) the author discusses eight best practices approach in team-building. These are to establish urgency and direction, selecting members based on skills (technical and functional, problem-solving and interpersonal); Paying particular attention to first meetings and actions; Setting some clear rules of behavior; set and seize upon a few immediate performance-oriented tasks and goals; challenge the group
regularly with fresh facts and information; spending lots of time together; exploiting the power of positive feedback, recognition, and reward which helps to shape behaviors critical to team performance and gives positive reinforcement that encourages continued contributions and commitment.

Sandy Pokras (2007) explains about different stages in team development and discusses about the way to become a high-performance team. Every new group goes through stages like forming, storming, norming and performing during team development. In the forming stage team members will be cautious, quiet, and uncertain. In the storming stage members learn to work through the differences (consensus and compromises), tensions and conflict as they begin to open up and feel some ownership for what they are trying to accomplish. In the norming stage members learn to incorporate others input and concentrate on solving problems and making team activities work more smoothly. In the last stage of team development, that is performing stage, members cooperate and work together and become more effective and productive.

Further, author points out that to accelerate growth at these stages and to become a high-performance team quickly there must be clear mission and road map, complete membership, and competent leadership are essential. Also, It is required to be defined what is expected of from the team and to what extent the team will be empowered.

Robert B Maddux (2002) details essential things required for team building like: leaders must assign high priority to team building and know clearly the advantages that can accrue from team effort; selecting members who can meet the job requirements and work well with others; ensure transparency and effective communication; setting clear goals; willingness to replace members who do not perform in order to build a strong and performing team; establish guidelines to coordinate activities, ensure feedback as the work progresses; building a motivated climate based on the understanding of people needs; providing training and supervisory assistance necessary for each employee to
achieve mutually established objective; providing the resources, guiding and encouraging personal development; recognizing and rewarding good team performance and correcting poor performance; establishing control system to ensure goal achievement; shaping management style to make members focus and committed to organizational goals; involvement of members in goal setting and problem solving helps in developing a sense of ownership.

**Alison Hardingham and Jenny Royal (2007)** highlights the functioning of a team from the stage when a group of people come together to achieve an objective they will go through a series of stages like Forming, Storming, Norming and Performing, and Mourning. The measure of team competence and commitment, and a way to appraise the team swiftly using a model called PERFORM (which stands for Productivity, Empathy, Roles & Goals, Flexibility, Openness, Recognition, and Morale) are discussed.

**John A Woods (2004)** discusses the stages a team goes through as it evolves into a high-performing team. The four stages of team development are forming, storming, norming and Performing. The forming is the beginning stage of a team where members start to feel and know one another out and this is the dependency stage. In the storming stage members begin to understand their tasks and roles are being figure out. In the norming stage, members begin to reconcile differences among themselves and begin to work together. The last stage, the team starts to get a lot of work done. There is real synergy at work. The teams that have a set of values in place that supports teamwork are likely to become high-performing team.

**Rupert Eales and White (2007)** describes the components of team building process. They are: collecting information about task and team; sharing the information, including team strength and implications of skill mix; developing team vision; developing task definition; agreeing objectives and interim milestones; brainstorming technical requirements, actions and timing; completing a resource audit – budget, roles clarity according to strengths;
implementing first agreed phase, having agreed support, feedback and review mechanism.

**Donald H Weiss (2007)**\(^{57}\) depicts the following phases of team development: Introducing—coming together as a group; Stage setting—laying the ground rules and creating the climate; Probing/Testing—getting to know one another, establishing positions within the group, developing trust and candor; Creating—Identifying objectives, solving problems, designing methods for doing business/dealing within a team; Producing—executing the team’s functions and; Maintaining—taking care of continuation needs.

**Ken Blanchard (2010)**\(^{58}\) outline that all teams go through stages in their development. These stages are called as Orientation, Dissatisfaction, Integration and Production stages. The characteristics of orientation stage are members are eager about purpose, norms, roles, goals, structure and dependent on the need for direction and support. Some issues are personal well-being, well-being and trust. The characteristics of dissatisfaction stage are discrepancy and confusion between expectation and reality about roles and goals, dissatisfaction with dependence on authority, feelings of incompetence and competition for authority and attention. Some issues in this stage are low trust, power, control and conflict. The characteristics of integration stage are increased clarity and commitment on roles, goals tasks and structure. There is growing trust and cohesion. The issues in this stage are sharing of control and avoidance of conflict. The optimal productivity, clear purpose, values, roles, goals, and relationships and trust are built on trust, mutual respect and openness. The issues in this stage are new challenges and continued growth and learning.

**Robert Heller (1998)**\(^{59}\) says that establishing a team is the leader’s prime task. The steps involved are setting goals, considering the aims of individual team members when setting targets, not to let failure of one part of a project
jeopardize its overall success and to provide support for a team setting up links with management. Also, the leader has to ensure team has a clear purpose and sufficient resources to achieve it. And the leader has to be open and to be impartial in treatment to team members.

**Deborah Ancona and Henrik Bresman (2007)**\(^{60}\) explains the approach to create a team and facilitate a team’s ability to engage in distributed leadership pulling together the various resources inside and outside the organization, and up and down the organizational hierarchy. There are four core steps for the team to engage – Select the members and set the stage; Begin exploration; Engage in exploitation; Follow through with exportation. The team’s composition can make enormous difference in its ability to carry out ambassadorship, scouting, task coordination, execution and the social networks or ties of potential team members. In the exploration stage, team members explore task, environment, the customer, the technology, and the competition. The goal of exploitation stage is to narrow the focus of the team’s project through scouting, ambassadorship, task coordination and execution. In the last stage, which follows through exportation, the focus is primarily external. The goal of exportation is to transfer the team’s knowledge to others in organization who will take on the next phase of team’s work. This stage is also meant for the team to reflect on what it has done and learned so that it can pass on this information to others.

**Michael West (2004)**\(^{61}\) describes the five natural stages of team development - forming, storming, norming, performing and adjourning. In the forming stage team members are anxious about the task roles and goals. The team leader needs to set the overall direction and clear objectives. The storming stage occurs after the team has first formed and before roles are clearly worked out. Team members may compete for tasks that offer status or chance to learn new skills. Roles are established based on skills and experience. Leader seeks to establish norms of openness, empathy, courteous within the team. In the
norming phase, implicit and explicit norms are established. Rules are established by members observing what behavior is accepted. In the longest phase, of performing, team members are getting on with the job and progress towards the goal.

**Jon R Katzenbach and Douglas K Smith (2005)** discuss the four elements – common commitment and purpose, performance goals, complementary skills, and mutual accountability – that make teams function. Also, some of the common approaches of successful teams are highlighted like selecting members for skill and skill potential, not personality, to pay attention to first meetings and actions, as initial impressions mean a great deal, to set some clear rules of behavior, to set and seize upon a few immediate performance oriented tasks and goals, providing the teams with challenging facts and information, spending time together, and exploiting the power of feedback, recognition and reward.

**Rob Young (2000)** outlines the approach for creating a team based on five stage approach (Forming, Storming, Norming, Performing, Mourning) and making a team work. The author highlights six things that matter in making a team work – to define the issue, brainstorming ideas, evaluating options, gathering information, agreeing action or involving the team in decision making, and measuring results.

**Michael A. West (2004)** elucidates five types of team building interventions. They are: Team start-up – this type of building is specific to a team that is just beginning its work and that requires clarification of its objectives, strategies, processes, and roles; Regular formal reviews – regular reviews of functioning leads to greater awareness, problem areas, maintain and promote effective functioning; Addressing known task-related problems – the team must take up and define specific known problems and has to develop alternative solutions and action plans for implementing the selected way forward; Identifying what the problems are – to diagnose what the problems are
when the team is functioning ineffectively through group discussions or team climate inventory; Social process interventions – focuses on interpersonal relationships, social support, team climate, support for growth and development of team members and conflict resolution.

T V Rao (2010)\textsuperscript{65} says that one of the basic building blocks of organization development is team building. The more integrative the manager, the more collaboration needs to be encouraged from the micro to macro level. Collaboration depends upon the extent to which people in teams have shared goals, values, perceptions and cooperative attitudes. The author highlights the important characteristics of teamwork: Listening to each other; communicating transparently and freely; Willingness to share; Building on each others’ ideas; Seeking and giving feedback; Focusing on maintaining group morale and motivation; Supportive attitudes of each other; Committing to larger goals.

Mike Woodcock (1989)\textsuperscript{66} explains the four stage model of team development. These are: Underdeveloped Team, Experimenting Team, Consolidating Team, and Mature Team. The Underdeveloped team are abound wherever people have to come together to complete a task with little or no consideration how the team must operate One characteristics of this stage is that the feelings are not dealt with. The Experimenting team begins when the team decides that it wants seriously to review its operating methods and undertake activities which will improve its performance. The Consolidated team works to resolve the interpersonal issues and begin to have the confidence, open approach and trust to examine the operating methods systematically. In the Mature team, the flexibility become the keynote, with different procedures being adopted to meet different needs. Leadership is decided by the situation and not by the protocol.

Patrick Lencioni (2006)\textsuperscript{68} states the true measure of a team is that it accomplishes the results that it sets out to achieve. To do that on a consistent, ongoing basis, a team must overcome the five dysfunctions – absence of trust, fear of conflict, lack of commitment, avoidance of accountability and
inattention to results. The author also provides a framework for building the team using the tools and exercises to overcome dysfunctions.

**Paul F Levy (2001)** explains the causes for hardworking, uncomplaining, dedicated, and well intentioned good team to go wrong and produce perverse results – what is called as the nut island effect. The nut island effect begins with a homogeneous, deeply committed team working in isolation that can be physical, psychological or both. The team’s supervisors are usually separated by from the team by several layers of management. Largely due to senior management inattention, ignorance, indifference, and taking the team’s self-sufficiency for granted breeds resentment in the team, reinforces its isolation. The isolation leads to conflict and both the team and management form distorted picture of reality that are difficult to correct. This leads to deterioration of the teams working environment and deficiencies in the performance.

**Steven L McShane (2011)** illustrates the model of team effectiveness. A team is said to be effective when it benefits the organization, its members, and its own survival. Team exists to serve some organizational purpose hence effectiveness is partly measured by the achievement of those objectives. Also, team effectiveness relies on the satisfaction and well-being of the members, and its ability to maintain the commitment to the organizational objectives. The model integrates the main components of team effectiveness – Organizational and Team Environment (rewards, communication, structure, leadership, spatial), Team Design (task characteristics, size, composition), Team Processes( team development, team norms, cohesion, trust) and Team Effectiveness (task accomplishment, satisfy member needs, maintain team survival).

**Ramesh Budani (2011)** state that teams are used for high performance results. All teams must function effectively to contribute positively. Team
building consists of two tasks – to create a team carefully, and to make team operate effectively. Enhancing team effectiveness involves four approaches: Team building, Collaboration, Team leadership and Understanding cultural values. Team building demands right members and right type of efforts and establishes a sense of partnership and emotionally intelligent.

Team building – It consists of six steps: Team Skills Workshop, Data Collection, Data Confrontation, Overcoming barriers and Intergroup Building. Collaboration – It consists of developing team spirit or intimacy to work effectively. Collaboration is closely related to group efforts, cooperation and partnership, and involves improving interpersonal interactions in group setting. Team Leadership and understanding cultural values plays pivotal role in improving the team effectiveness. Acceptable leadership is precondition to make the team effective. Culture remains a key factor in determining the pattern or relationship in teams.

**Terri D. Farrar (2009)**\(^7\) opines that team building as an ongoing process throughout team’s existence rather than a one-time cure all. To build a successful team is to build a successful relationship, and for this the elements of cohesiveness, leadership, trust and self-esteem must be nurtured. Team building activities are often divided into two categories; task activities and social activities. Task team building activities may be described as those activities in which the team members communicate and clarify the expectations they have of themselves, their teammates, and their coaches. The team building activities in this category tend to focus on aspects of goal setting, role clarification, and personal and team commitment. The social team building activities are often used to promote friendships and relationships among team members. Social activities may include team dinners, team outings, and challenge courses.

**Jesse G Mendoza (2001)**\(^7\) examines the effect of traditional and experiential team building methods that have on the team’s trust. It is pointed that
traditionally management training has focused on the cognitive aspects (policies, procedures, operations, etc. with minimal interactions) of teams and not the affective elements (feelings, emotions, purposes, etc. with high participant interactions). It is pointed out that most of the group formation models are based on Tuckman’s five stages of group development: forming (orientation), storming (conflict), norming (cohesion), performing (task performance), and adjourning (dissolution). It is highlighted that the experiential methods are most effective in developing trust.

**Charles Larry Garner (1998)** the literature contains many views about how teams develop. An early stage is the linear model is the Schultz group development model – this model described the three stages where the interpersonal needs of inclusion, control, and affection area addressed within the group context, by the process of receiving from and giving these three needs areas.

Charles described a five step process or ladder group development. These rungs were politeness, goal setting, bid for power, cooperation, and esprit de corps. The classic stage of group model is Tuckman’s four stages of small group development – forming, storming, norming, and performing. The Gibson model depicts the following stages in the group development process – mutual acceptance, communication & decision making, motivation & productivity, and control & recognition.

Mink’s model of group development is patterned on the lines of linear process – First is the development of trust. This enables the development of norm of acceptance of individual differences. This enables the development of norm of giving feedback. This enables the development of norm of problem solving. This enables the development of norm of letting go.

**Roger Thorson (2005)** provides insights into the realm of effective team building. If an individual is unconscious of their own actions and typical
responses to different facets of their life, they are not being as effective in a team setting as they could be; and if individuals are unaware, do not appreciate, or do not understand where the diverse strengths are within the working group, personnel simply do not work optimally as a group. The author explores the connection between individual and group awareness of how an individual deals with situations and how this will connect to improve team building within an organization using Myers-Briggs Type Indicator tool (MBTI).

The MBTI has been used to assess an individual and team functioning. a) how an individual prefer to respond to circumstances of gathering information (b) one’s attitude towards the outer world (c) personal values, subjectivity, logic and objectivity and (d) whether an individual is predisposed to pay more attention to the outer world of people and activities or inner world of ideas and feelings.

**Marilyn Sawyer Wesner (1995)** the study identified three distinct periods in the history of team building. In the 1900-1950 period the origins and the antecedents appeared as a result of changing perception of the behavior and contributions of the group versus the individual worker. The second period, the decades of 1950ds and 1960s, saw the initial version of team building as an OD efforts focusing on developing managers’ interpersonal relationship s to improve group functioning. During the third period, 1970, through 1989 team building matured into standalone educational intervention for all levels of employees focused on improving specific performance problems in the work place.

Scientific management was the impetus for the emergence of the development of groups and their impact in the workplace. In the early 1900s, Fredrick Taylor began experimentation that resulted in an individualized approach to the performance of work, with each worker having a singular contribution to the total effort. An organized approach to training was another change that
resulting from the scientific management. When the scientific management broke the work into small tasks, management assumed responsibility for the control of production of the whole product, and the likewise, the training of worker to perform those tasks. Foremen became instructors as well as overseers.

The experimentation in the work place that began with the practice of Taylorism led to the well Hawthorne Works studies during the period 1922 to 1932. From these studies, Elton Mayo and Frits Roethlisberger confirmed that work organizations consisted of both formal and informal groups with many interrelationships. Small groups of workers were found to have informal agreements of on acceptable behaviors. Rather than a number of individuals working independently on separate tasks, work now included the ways in which workers and managers related to each other to get the job done.

Another Hawthorne studies was that the positive relationships among supervisors and workers were identified as the key to worker satisfaction. Known as human relations, the focus of management training shifted to incorporate these ideas. Following the Hawthorne studies, research on group behaviors by Kurt Lewin resulted in the development of group development theory. The discovery that groups modified the individual members behavior was an important finding. From the findings, the idea arose to create small groups to identify with the goals of management. And management through dynamics of the group could enlist workers to pursue the goals of the management.

The discovery of training laboratory or T-group was another major outcome of by Lewin’s work. The predecessor of team building, this experienced based process for group learning had a far reaching impact for adult education both inside and outside workplace. The rudiment of participative management ideology was evident during this period as well.
In the 1950-1969 period, organizations were harnessing the power of groups for improving the working relationships and performance. Organizational Development emerged as a process for planned organizational change using the knowledge of human relations and group dynamics. OD also created many opportunities for learning. Many of them like team building were experiential in nature instead of classroom training. Different models of team building arose during this period and many of them were based on social interactions of group members. Douglas McGregor’s work in 1964 one of the earliest examples of team building. The management team using eight character of an effective team like willingness to listen, free expression and non-dominating leadership, which McGregor identified were rated against the ideal. Using their own rating, team members determined what actions are needed to be taken to improve their own functioning. Towards the end of 1960s, the issue of productivity improvement arose as an important component of the content of team building. The managerial grid, created by Robert Blake and Jane Mouton in 1964, was the first major attempt to link and measure manager’s concern for people, or interpersonal concern with concern for productivity.

During 1970s and 1980s, the evolution of team building continued and saw team building become a standalone educational with a consistent purpose, improving performance, a consistent process, problem solving, and new teams of frontline workers. There was huge growth in the number of teams, QCC, QWL teams became commonplace. And, for the first time rank and file workers were included in team building sessions. The new format of team building appeared in response to the needs of the organizations Quality circles and QWL teams differed from earlier teams because of their focus on improving workplace quality and productivity. Team building now incorporated processes to build skills used to improve quality and productivity problems and problem solving. They also learned make changes to improve, logical process for problem identification, evaluation and resolution and assess through experience and feedback what actually worked. Although the
interpersonal relationship were not the focus but the later teams spent time learning about effective ways to work together through their experiences in the group and the planned material content.

Ziad A Zennie (1991) outlines that team building becomes an act of working together, a problem solving process and a vehicle for culture change. Team building empowers individuals as well as the team. Team building as an act of working together primarily serves to develop the self-skills of the individual at interpersonal levels. As a problem solving process aims at enhancing the interpersonal skills of problem solving, trust, communication, and respect. Team building as a vehicle of culture change is targeted at organizational level. The study mentions different team building models of Beckhard, Harrison, Beer and Dyer.

Beckhard model (1969) includes the following components — a statement, discussion, clarification of the mission of group; discussion of the concerns and hopes of the group; A presentation and explanation of the group leader’s plan to organize the work; A sharing and discussion of the major areas of the responsibility and authority of each member; The development of mechanism for communication; Planning for the training and induction of the rest of the organization; and arrangements for the follow-up planning.

Harrison Role Negotiation Approach (1973) assumes people in organization prefer a fair negotiated settlement to a state of unresolved conflict, people have truly and sometimes opposed interests and that the effective alternative to competition and mistrust is a where differences are resolved by making changes in working relationships — duties, responsibilities, authority, and accountability of persons in roles.

Beer’s classification of role models falls into four integrated models (1976) — the goal setting or problem solving model suggests the setting of objectives by the members and the identification of problems that interfere with the accomplishment of these goals; the interpersonal model is based on the
assumption that people who are competent in their interpersonal skills can function more effectively as a team; the role model views a group as a set of interacting roles and assumes that group effectiveness can be increased by a better understanding of the roles of the members in that group and; the managerial grid model overlaps with and integrates the other models.

Dyer’s team building program (1977) follows a problem solving cycle which begins with the identification of problems, gathering data as to the causes behind the problems, action planning to solve these problems, and the implementation and evaluations of these actions.

**Gareth R Jones and Jennifer M George (2009)** highlights the importance of team learning, that is, learning that takes place in a team or group than individual learning in increasing organizational learning. The importance of building a shared vision and its use to frame opportunities or problems among the team is emphasized.

**Barrie G Dale et al (2009)** points out that teamwork is a key element in getting people involved in improving organizational performance. There are different teams like Quality Circle, Project team, Yield improvement teams and others. Each type of team has its advantages and differ with characteristics in terms of membership, autonomy, scope of activity, problem selection and others.

**P SubbaRao (2006)** says that the most of the organization shifted to teamwork and team analysis. The team analysis includes team description and team specification. The author explains that Team description is an organized, factual statement of the duties and responsibilities of a complete team. The team specification pertains to minimum acceptable human qualities and relationship necessary to perform team activities.

**Wayne F Cascio and Ranjeet Nambudiri (2010)** discusses about the increasing emphasis on team performance and systematic approach to team training. The training broadly consists of team training need analysis to identify interdependencies and skill requirement for coordination among the team members and knowledge and skills required to interact as a team. Also training
to include task-work skills like adaptability, performance monitoring, feedback, shared awareness of situations decision making skills and others. Also teamwork skills like mutual trust, team goals and shared vision.

**Patrick Lencioni (2006)** describes the five dysfunction of a team namely, absence of trust, fear of conflict, lack of commitment, avoidance of accountability and inattention to results. Team building road map is explained and it covers initial off-site activities before the team begins to work together on-site. The off-site activities include review of team dysfunctions, behavioral profile assessment of members, member affirming commitments, learning team conflict management and undergoing team effectiveness exercise. Also, the team should constantly address areas of deficiency.

**Ramnath Narayanswamy (2009)** says teamwork is about galvanizing a group of people towards a common objective while simultaneously addressing the head yet appealing to the heart. It is about bringing the best out of each individual in the pursuit of a collective goal deemed worthy of being realized. The key to teamwork lies in overcoming ego to facilitate the accomplishment of objectives and outcomes that are infinitely larger than individual goals. It is also essential that a balance between a robust process-driven system and individual competence and talent in a way where both merge to break new grounds. It is also recommended that experiential learning in empathy, bonding, communication, collaboration, nurturing mutual respect and providing mutual support can be very effective in building a team.

**Herminia Ibarra and Morten T. Hansen (2011)** explains the importance of collaborative leadership and teams based on collaborations over hierarchical leadership and matrix or small group. Defines the Collaborative leadership is the capacity to engage people and groups outside one’s formal control and inspire them to work toward common goals-despite differences in convictions, cultural values, and operating norms. It is emphasized that although organization talk about team building but most organization pay too much
attention to individual achievement. The solution proposed is to move from command and control leadership to collaborative leadership. It is suggested to make global connections that help to spot opportunities and engage diverse talent from everywhere to produce results.

**Yochai Benkler (2011)** explains that the research findings indicate people are more cooperative and less selfish than people believe. These findings suggest that instead of using controls and carrots and sticks to motivate people, organizations or leaders should use systems that rely on engagement and a sense of common purpose. Several levers can help build cooperative system: encouraging communications, ensuring authentic framing, fostering empathy and solidarity, guaranteeing fairness and morality, using rewards and punishments that appeal to intrinsic motivations, relying on reputation and reciprocity, and ensuring flexibility.

**Nitin Nohria et al (2008)** states that getting people do their best work is important in the team. The author suggests that people are guided by four basic emotional needs that are the product of common evolutionary heritage. These are drive to acquire, drive to bond, drive to comprehend and drive to defend. It is suggested that each need or drive is best met by a distinct lever at the organizational level. These are, the reward system for drive to acquire, culture of the mutual reliance and friendship for drive to bond, design jobs that have distinct and important roles for drive to comprehend, and improving transparency in appraisals, resources and recognition for drive to defend.

**Martin Reeves and Mike Deimler (2011)** observes that in a world of constant change, the spoils go to the nimble. The organization that succeeds is those with the ability to experiment with ideas where forecast and deducing not possible, ability to mobilize the adaption through flexible structure and empowerment for increasing adaptability. Adaptive organization needs simple and generative rules to facilitate interaction and clearly empowered set of boundaries. Also, identification of core behaviors and skills in its employees:
judgment, communication, innovation, passion, honesty, selflessness and others only to increase employee freedom rather than limit it, to continue to attract and nourish innovative people, so to have long-term chance of success.

**John Maxwell (2001)** discuss about important imperatives of effective teamwork. These are: more can be done working together than alone; members must be willing to subordinate his personal goals to the good of the team and look at the big picture; putting the right people in right place; it takes an experienced team to deal with challenges; Every member in the team must be effective like the law of chain; members to act like catalyst to make things happen as it is in winning teams; work towards a shared vision and values; and effective communication increases coordination and cooperation. The lists of imperatives are termed as irrefutable laws of teamwork.

**Bill Butterworth (2006)** explains three important needs, barriers and traits of effective teams. The three needs of team members discussed are a sense of belonging, a sense of worth and a sense of competence. Four team barriers have been presented namely, personal insecurity of members, unhealthy competition among the team members, no proper communication among the members and resistance to change by the team. Also, the important traits of effective teams referred to are development of mutual respect, sacrifice for the team, creative and work with unity.

**Frank Ostroff (1990)** underline that structure is critical to designing an efficient organization and organizational teams. The inherent shortcomings of vertical hierarchy are discussed which are like focus on internal goals rather that delivering value and winning customers, ineffective communication in the hierarchy, fragmentation of performance objectives due to multitude of distinct levels and goals and stifling of creativity at lower levels. To overcome shortcomings and move towards competitive advantage in the future the structure proposed is called Horizontal organization.
Some of the fundamental principles of such horizontal organization system are:
to organize around cross-functional processes and not tasks or functions; to
make teams the cornerstone of organizational design and performance; promote
multi-skilling, the ability to create and respond flexibly to new challenges that
arise in the work team; and build a corporate culture of openness, cooperation,
empowerment, continuous performance improvement and values, and well
being.

**Umesh U (2011)**\(^9\) explores the significance of emotional intelligence in the
workplace. The emotional intelligence is described as the capacity of
recognizing one’s own feelings and those of others. It is an array of personal
management and social skills that allows one to succeed in the workplace and
work teams. Emotional Quotient is a measure of Emotional Intelligent. The
emotional quotient is measured using four dimensions namely, self-awareness,
self-management, social awareness and social skills. Higher emotional
quotient leads to increase productivity, improved responsiveness and
relationships which help in accomplishing team and organizational goals.

**D Gopalakrishna (2003)**\(^9\) explores the application of Buddhist vipassana
meditation technique in modern management. The study reveals that vipassana
meditation is an effective tool which transforms the people through reduction
of negative thoughts and help in development of positive thoughts and
attitudes. The other benefits are it enhances the personal effectiveness,
interpersonal effectiveness and professional effectiveness. The study
recommends that the technique can be used as tool to train and develop team
members to increase the effectiveness of members and work teams.

**Harvey Robbins and Michael Finley (2000)**\(^9\) mainly discuss about team
intelligence, team benefits and causes for team failures. Team intelligence is
defined as the intelligence about working together. The author explains how to
maintain the highest level of team intelligence with required skills, attitudes
and emotional flexibility needed to overcome team’s inherent differences.
2.3 Survey of literature related to application of ants based techniques in organisations.

This section explores the application of Ants based techniques in the management. These are discussed below:

Peter A. Gloor (2006)\textsuperscript{94} explains the application of self-organization properties of ants in innovation through Collaborative Innovation Network (COIN) by its members across the world. The members working together in a COIN have not been ordered to do so, but because they want the innovation to succeed and spread, just like the ant queen is not served because she orders her sterile daughters to do so, but because evolution has taught the insects that protection of the queen means protection of their gene pool for survival. The COIN members openly share ideas, work, findings and results and it is entirely based on self-organizing and self-selecting. Roles and responsibilities of each member are very clear. There is no leader in COIN with tens of thousands of members engaged in innovation. An ideal example is Wikipedia (the online encyclopedia) and Linux (open source Operating System Software) which are created by members through online collaboration with no leader controlling the creative output.

Ants exhibit many interesting complex behaviors, such as emergent properties from local interactions. The emergent collective behavior is the outcome of a process of self-organization, in which ants are engaged through repeated actions and interactions with their evolving environment. The emergence is the fact that a structure appears at the higher level. With no central command, a complex collective behavior raises then from simple local individual interactions.

Self-organization is a process in which activities are neither centrally controlled nor locally supervised, or a process in which pattern at the global level of a system emerges solely from numerous interactions among the lower-level components of the system. Moreover, the rules specifying interactions among
the system’s components are executed using only local information, without reference to the global pattern.

**Rick Whiting (2001)** highlights the precept of complexity theory and compares it to the ant’s rule of collective behavior, along with its application in the supply chain. The principle of complexity theory state that most system is made up of interactive components and by changing the behavior of one component, the behavior of the entire system gets changed, and complexity science is about understanding those interactions. The author cites an example of Procter & Gamble Co. experimentation of new supply-chain practices that incorporates the lesson from the world of social insects.

**Stephen Olariu and Albert Y. Zomaya (2006)** provides an insight on Swarm Intelligence (SI) principles and its applications like ant colony optimization to control of large group of cooperating autonomous agents. Ant colony optimization algorithm based on foraging behavior of real ants has been applied successfully to large number of optimization problems like travelling salesman, scheduling, vehicle routing, networks and others. An Ant algorithm is a multi-agent system, where agents solve required tasks through local interaction, cooperation and combined efforts of agents using emergent property of the ants.

**Ivars Peterson (2000)** discusses the insight of collective behavior of ants in finding the shortest path to a food source, or combining forces to move a large, unwieldy object, and performing other functions crucial to an ant colony’s well-being, and its applications. Certain ant species send out foragers along more or less random paths to explore a nest’s surroundings. Each scout lays down a trail of scent molecules called as pheromones. When one of them finds a food, it returns to the colony for others to follow. An ant taking a shorter path to a particular food source returns sooner than a second one following a longer trail. Other ants start on the shorter path, reinforcing the odor cue, before the
second ant returns from the lengthier route. The stronger the scent, the more ants choose a given path. Hence the longer route gets lesser traffic, and its scent slowly fades away as the pheromone fads away. As a result teamwork emerges from a large number of unsupervised individuals following a few simple rules of following the trail with more concentration. This sort of self-organizing behavior among Ants have been applied for developing algorithms for governing how robots operating independently would work together especially in unpredictable environments.

The author discusses the work of Laurent Keller of the University of Lausanne, Switzerland, the application of data on the division of labor among real ants to simulate the behavior of swarm of small robots. It is detailed that in some of the robotic experiments based on ant-inspired system, one robot could enlist another if it happened to identify a resource-rich area. The results show that ant-inspired system of task allocation provides a simple, robust, and efficient way to regulate activity within team of robots. This has important implications in robotics, particularly in situations where the risk of system of failure must be avoided, for example in critical military and space missions.

Ken Thompson (2008)\textsuperscript{98} discusses the applications of nature’s bioteam precepts in the cases illustrated below:

(i) Small companies operating in the Environmental Technologies Sector in Ireland decided to form Virtual Enterprise Network (VEN) to compete on a global scale collectively through joint R&D, joint marketing, joint purchasing, joint tendering and other such collaboration among them whilst retaining the agility and cost advantage of small businesses. Fifteen core member companies constituted the group. A joint collaborative effort based on the following technique were used:

Develop and follow a set of key rules among the members and consider as a primary responsibility. The team to put a system in place to allow each member of the network to reach instantly, as and when required.
That is, to provide instant “in-situ” message hotlines for all team members. Members of the virtual network to be open enough to let good members to come in, but closed to keep bad members out. This ground rule was translated into agreement where “every member is a recruiter,” but with the proviso that the team had to formally agree to any new member joining.

Being the member of ETC has allowed the members to develop mutually beneficial partnerships with companies previously seen as competitors. It also provided new business opportunities providing collaborative efforts whilst still allowing individual gain.

(ii) The author explains the application of pheromone based messaging or communication in Healthcare management (by Daisyhill Hospital Mobile Intermediate Care Team- Ireland) to improve multi-disciplinary communication and collaboration by instant access to all members of team despite location and resolution of health and safety issues in relation to calls to team members.

The characteristics of pheromone messaging used for the purpose are group broadcast, and Quick & Slow responses. Group broadcast predominantly are broadcasts to many within a trusted group and enables the group members continuously connected – Always On system. Quick and Slow responses, ensures that urgent messages are communicated immediately to all group members on their preferred device. This is similar to two kinds of pheromone messages used by Ants – Release messages that release an immediate effect in the receiver and Prime message that prime the member to commence a long-term response in the case of unimportant messages.

(iii) A team consisting of a number of stakeholders from telecom software industry in Ireland was formed to determine the level of industry support for an all-island Convergent Telecom Software Laboratory, provide support and aimed at increasing the level of competitive performance of
companies in the wireless sector and other areas of the Convergent Telecommunication sector. It was identified that a critical success factor in planning the execution of the assignment is to build viable consensus and engage effectively with the stakeholders. The Bioteaming techniques applied in this case are highlighted below:

Metabolism Questions – To determine what member’s want and what they will contribute to get it.

Cell Division Technique – To create viable sub-groups to develop required work plans.

Stop Controlling – Communicate information and not orders, through one-way broadcast or two-way communications. Teams like CTSL could perform well based on the agreed objectives, swarm or group rules and with required resources.

Self-Organizing Networks – Bioteaming approaches the results to be achieved through transformations in the members engaged with. It focuses on pre-conditions for success like to understanding the members motivation drivers, defining a common collective goal and using collective leadership techniques.

(iv) Dynamic Knowledge, a leading Performance and Consulting Company in London, applied the Bioteaming techniques in the organization of workshops to achieve the objectives of attracting a potential delegate through effective ways, minimizing no shows and enable and encourage delegate participation at the event. The techniques applied are highlighted below:

Symbiosis – Treating all stakeholders, internal and external, as part of the team and considered as trusted partners. This thinking of one team becomes the foundation for the other bioteaming principles.

Cluster & Team Ties – Use natural relationships of the whole team or collective network as the way to engage with the rest of community, particularly external parties. To make this work, the key external
relationship needed for team’s success are identified and used as engines to attract or market to the potential delegates.

Always-On—Means that providing instant message hotlines for all team members, includes external parties, using group messaging tool. This concept is used to provide messages to the delegates and remainders of the event. Also, for enabling the delegates to actively interact during the event in real-time mode with the speakers.

(v) The author discusses the application of Bioteam technique in LANCELOT, a training center and a job portal for live online language trainers. In the training center, language trainers meet their language students in virtual classrooms to conduct highly interactive lessons using Internet Communication Technologies.

A virtual team of live online language trainers present courses via a single portal. The competition between the language teachers created low participation and commitment.

The technique of Metabolism was applied to the team members to identify what the members wanted out of the collaboration and what members can contribute to the network. The technique helped to identify major leadership and team member gaps in a number of activities or areas that had to be addressed before the network could move forward.

(vi) Kharma45, an exciting UK based music team used a different approach to fan management using Bioteaming model and swarm teams. The goal was to enhance existing social network strategies. The technique used are outlined as below:

Symbiosis – Bioteams treat all parties as trusted partners of the team. As a result fans become part of the team. This enables to take the benefit of fans network of relationships. Using Swarm teams, a group messaging tool, key messages were sent to Swram of top fans. The strategy is to
make these VIP fans would forward these messages to their own network.

Cluster – Use natural relationships of the whole team or collective network as the way to engage with the rest of community, particularly external parties. To make this work, the members identified the key connectors, the Aplha fans, for word-of-mouth marketing to the fans.

Always-On – Means that providing instant message hotlines for all team members, includes external parties, using group messaging tool. This concept was used to provide messages to the fans using group messaging tools.

**Giovanna Di MarzoSerugendo et al. (2007)** discusses about some applications based on self-organizing and stigmergy mechanism followed by ants for task performance in the areas of network routing. Self-organizing systems functions without central control, and through contextual local interactions. In this system, components achieve a simple task individually, but a complex collective behavior emerges from their mutual interactions. Such a system modifies its structure and functionality to adapt to requirements and to the environment.

One of the applications based on self-organizing system is an artificial ant based network where periodically each node launches an digital ant to find the route to a given destination. By simply smelling the strength of the pheromone along the neighborhood paths of the node, the digital ant generates the map that shows the fastest route to any end point. This method has outperformed all other popular routing algorithms in terms of speed to avoid the network congestion.

Further, the author depicts the application of self-organization and swarm rules of ants society to businesses in the area of marketing and management. One such model from the marketing domain is the one-to-one variable pricing model which provide individual offering to customer. This involves self-
organization of marketing policies by changing prices quoted and customers targeted based on market dynamics, customer characteristics and the business goals. Companies like FedEx, eBay, use this type of marketing approach based on self-organization model of social insects. Each customer is offered variable pricing depending on a variety of parameters. FedEx allows customers to access the computer systems via the web site to monitor the status of their packages. For corporate customers FedEx provide software tools that enable the organization to automate shipping and tracking packages using their own computing resources. Each customer is offered different prices depending on a variety of parameters.

Another application is from the area of management is the theory of activity. The view of a company is that it consists of networks of working groups that can change their structure, links and behavior in response to business requirements. The aim is to capture the self-organization decision that need to be taken during the business operations both by managers and by employees’ interactions with emphasis to solving potential conflicts of interest.

Nosh Contractor and Feniosky Pena-Mora (2005) in their study on disaster management are looking to nature, specifically, to social insects for ways to improve human collaboration during relief efforts. One of the ways researchers hope to advance understanding of the dynamics of communication and knowledge networks is by learning basic principles on how social insects are able to effectively self-organize based on local information and a set of rules governing the behavior. Such a strategy helps the first responders who could rely more on local information. Such a strategy also helps in developing strategies that will coordinate knowledge sharing in chaotic social settings and decision-making.

Bartholdi and Don Eisenstien (2004) depicts the technique of “Bucket Brigades” observed in seed harvester ants, and discusses its application in high volume distribution warehouse. The Bucket Brigades are a way of organizing
workers on a flow line so that the line balances itself. In a particular species of ant, seed are carried from the source to the nest. The seed would be picked up by the smallest and slowest ant, carried back, passed over to a larger and faster ant, who speeds it back, passed over to a larger and faster ant, who speeds it back towards the nest, where it is taken by a bigger and faster, until the biggest and fastest ant all races back to the nest. The slowest ant goes back to fetch another seed.

The same method is applied in large warehouse for executing the product orders. The product on a flow line is progressively moved from upstream towards completion line. Each worker carries a product towards completion. When the last worker finishes his product he sends it off and then walks back upstream to take over the work of his predecessor and so on, until after relinquishing his work, the first worker walks back to the start to begin work on new product. In addition, workers are sequenced from slowest to fastest. It is a way of organizing workers on a flow line so that the line balances itself, and had the properties to self-organize. The benefits highlighted are; there is reduced need for centralized planning and management as bucket brigades make the flow line self-balancing, increased throughput, and flexible and agile.

Marie-Annick Montalan and Robert Descargues (2004) presents a solution based on collective behavior of social insects to improve the performance of a network of small and medium-sized companies working on a common shared project for a big company in the case of aircraft industry. These networks of small and medium sized companies work mostly on shared projects decided and controlled by an international company. The networking of such companies brings up the problems of distribution according to tasks and skills required to achieve the shared project. It discusses the problems in the information system and network management of this grouping of organizations, business impact on some of the companies within this network as a result of failure of the system, and the solution to the problems. The study proposes the solution based on biological models based on the self-organization
and swarm intelligence to improve the business performance of network organizations. The main characteristics of the model relies upon collective intelligence and not hierarchical by mapping the skills of each members and connecting all group members, use of stigmergy technique to communicate in a indirect way through the environment and to use in an efficient way physical data, and using network communication instead of hierarchical communication.

**Eric Bonabeau and Christopher Meyer (2001)**\(^{103}\) illustrates an application of Ants foraging technique to find efficient routes to food source using pheromones. This technique has been successfully used in the following organizations –

- Southwest Airlines improved freight transfer rates by as much as 80%, decrease the workload of the people who move the cargo by as much as 20%, and reduced the number of overnight transfers. It also reduced the cargo storage facilities and minimizes wage costs and fewer planes are running full.

- Unilever, a consumer goods multinational, used the technique to develop more efficient way to schedule factory equipments in one of its production facilities. The company was having trouble in developing a fast, automatic and efficient way to deploy equipments to carry out a set of jobs. The traditional optimization method could not handle the intricacies of a complex-liquid manufacturing facility. Based on the foraging technique an algorithm was developed to determine a shortest time to perform a set of given jobs given various constraints production line. Through the use of digital pheromones, the software Ants finds the fastest schedule, one that allocates jobs to resources while satisfying all the constraints and making sure that every job is performed. The technique copes easily with the changing conditions like when a piece of machinery breaks or demand changes suddenly the algorithm schedules quickly under the new conditions.
Hewlett-Packard laboratories in England have developed a computer program based on ant-foraging principles that routes telecom calls effectively. In the program, ants like software agents roam through the telecom network and leave trails of digital pheromones to reinforce paths through uncongested areas. Phone calls follow the trails left by the agents. When the route becomes congested, agents that follow it are delayed, and the agents find alternative paths for the calls. The evaporation mechanism of pheromone ensures that as the congested paths become free the agents reinforce the trail for routing new calls.

France Telecom, British Telecom, and MCII World Com have taken an early lead in designing such ant-based telecom routing methods.

Université Libre de Bruxelles applied ant-based routing to handle Internet traffic and found this technique outperformed all the existing routing methods, and given maximum throughput and reduced delays.

Istituto DalleMolle di Studisull’IntelligenzaArtificiale (IDSIA) has developed an ant-based program that PinaPetroli organization uses to direct its fleet of vehicles in distributing heating oil to its customers in Switzerland overcoming various factors that interplay in scheduling task like trucks size, changes in customers orders, and others.

University of Chicago has applied the ants “bucket-brigade” technique to order pickers in a large distribution center of a major retail chain. Work allocation model of Seed-harvester ants carrying food from back to their nest has been used.

Initially the warehouse used a zone approach in which each worker was responsible for a particular part of the order, and the next person could not begin until the first person completed that task. The problem in the zone approach is the variation in the speed at which different employees work. Simple rules followed in this application based on Ants are: “Continue picking out products to fill the order until the person downstream from
you takes over your work; then head upstream to take over the next person’s work.” Also to maximize productivity, based on computer simulations it was showed that the optimum sequence of workers is from slowest to fastest.

- By implementing the technique, the productivity of the workers improved as compared with earlier zone approach, and bucket brigade approach displays the following advantages – It allows a work line to balance itself, and flexible and robust as it adjusts to any unexpected changes. Variations of bucket brigade approach are being used in distribution centers like McGraw-Hill, DELL and others.

- Capital One, the credit card business company applied the Ants Swarm Rules techniques to manage its the rapidly growing IT group size in the company – from small to becoming untenable. Inspired by the Ants model, the company came up with four basic guidelines to ensure that everyone in the organization is working towards same goals – (i) Always align IT activities with the business (ii) Use good economic judgment (iii) Be flexible and use lateral thinking and (iv) Have empathy for others in the organization.

- To reinforce the rules, the company distributed chips in four different colors. Each of the employee was instructed to give chips to people in the IT group whenever they followed any of the four guidelines. If any employee did something that embodied all four rules, a manager could nominate that person for special chip which would be presented by the manager himself. Over a period of time, the rules became so ingrained that they formed the norms, unified the group, and empowered the employees to make decision on their own with lesser managerial control. The benefit to the company as a result of implementation of right swarm rules is lower attrition rate than the industry average and unity in the group.
Use of swarm rules in allocation of labor, that is, carryout or to specialize in a particular activity unless an important need to perform another function arises. This technique has been devised for painting trucks that can automatically adapt to changing requirements.

Don Miner (2007) discusses the application of emergent behavior properties of Ants in development and controlling large-scale homogeneous multi-robot system along with some examples of swarm robotics projects like iRobot, S-bots and others. The algorithms are based on the idea that complex macro-level behaviors can emerge from simple local interactions between agents. This paradigm is inspired from observations of social insects such as Ants, and do not have a centralized control. They are not very intelligent on an individual level but are still able to perform complex colony-level behaviors such as building bridges of ants, foraging for food, migrating, nest building and others. Swarm robotics is focused on creating a system of simple modules from which complex behaviors emerge.

A variety of algorithms have been implemented to be run on swarm of robots. Some provide basic functionality, such as dispersion based on color, distance, etc, while others form complex teamwork such as chain formation. While algorithm produce different emergent behavior, they all have some common feature based on presents an overview of swarm robotics algorithms and its functions such as Scalable, decentralized and usage of local interactions. Swarm robotics algorithms are designed so that they work for any number of robots.

The robots in swarm are autonomous and do not follow any exterior commands. Although a member of a swarm can be directly and predictably influenced by the behavior of another the choice is under its own accord. Local interactions are used over broadcasting messages in these applications. Even broadcasts are implemented as message – hopping protocol and is a major factor in the scalability of the systems. Some of the selected algorithms
discussed are: Dispersion in Indoor Environment, Distributed localization and mapping, Mobile formations, Cooperative hole avoidance, Chain based path formation and Group transport. These concepts in particular have tremendous potential in the defense applications.

Tony White (2005) highlights the role of stigmergy (indirect communication) as a problem solving technique. A survey of several applications using stigmergy is covered below:

Ant Colony Optimization (ACO) is an algorithm developed based on the behavior of colonies of real ants. One of the main ideas behind this approach is that the ants can communicate with one another through indirect means stigmergy by making modifications to the concentrations of highly volatile chemicals called pheromones in the immediate environment. ACO algorithms have been successfully applied to solving problems like Traveling Salesman Problem (TSP) of finding the shortest circuit of a set of cities starting from one city, visiting each other city exactly once, and returning to the start city again.

Ant inspired routing algorithms is used for routing in the communication networks. In a routing task, a message is sent from a source to a destination node in a given network. Two nodes normally communicate via other nodes in a multi-hop fashion. Routing paths are found dynamically using routing algorithms based on the concept of pheromone based foraging of cooperative ants. Several routing algorithms have been developed and tested for different application system. One such example is an ant inspired algorithms were developed and tested by British Telecom and NTT for both fixed and cellular networks with superior results.

Collective or swarm-based robotics that exhibit complex distributed collective problem solving strategies is based on biologically inspired approach, with ants as inspiration. Areas of application include distributed exploration and collaboration based on cooperative transport of ants; NASA’s autonomous
nanotechnology swarms (ANTS) that will be deployed in space for the study of asteroids; Swarm Bots, consisting of a number of simpler insect-like robots (s-bots), capable of self-assembling and self-organizing to adapt to its environment, has the future potential to use in search and rescue operations.

Explore the potential applications of swarm behavior in military organizations and in the areas of logistical optimizations — allocation and distribution of individuals to achieve a particular goal, how teams can be dynamically formed, based on ACO; construction of military structures on the principles of nest building; securing information based on sorting and clustering; emergence of specialization in battlefield management using division of labor and task allocation based upon response thresholds allows the stigmergic system to overcome real time failures and robust; and swarm bots due to its capabilities, have significant value from a military perspective.

**Vitorino Ramos and Ajith Abraham (2004)**

Presents a new evolutionary approach based on stigmergic and self-organized model found in social insects like ants for Data Mining application management. Data mining is the exploration and analysis of large quantities of data from a database in order to discover valid, novel, useful and understandable patterns in data. A number of algorithms models have been developed around the way ants sort and cluster, like, forming piles of corpses and brood sorting. The author cites the work of Deneubourg et al research in this field, where a population of ant-like agents randomly moving onto a 2D grid is allowed to move basic objects in order to cluster. This method was further improvised by Lumer and Faiete applying it to the exploratory data analysis. They presented a method to measure the similarity between the two data objects and designed an algorithm for data sorting and clustering. The model developed based on self-organized mechanism underlying corpse clustering and brood sorting has been used in different applications. One such application is in interactive exploratory database analysis, like, database containing the profiles of bank customers.
Attributes of the customers included marital status, gender, residential status, age, a list of banking services used by the customer, etc. containing both qualitative and quantitative attributes.

**Pixel (2007)**

explores the application of swarm intelligence in areas like people management, business, and research and development. Discuss on people in organizations with different roles like drones, leaders and developers can work more efficiently under a set of group or swarm rules to carryout tasks in an organization. The application of swarm rules in delivery or transport oriented business based on pheromones left by an ant, the more likely it is that another ant will follow the same route because that path is more likely to be the quickest and most efficient one. The airlines have been processing flights by using ‘virtual pheromone’ in which planes remembers the faster departure gates based on the information fed to them by the computer. Also the applications of ant behavior as a way to remodel wireless communication to develop mobile routers (tiny computer chips holding mathematical algorithms) for processing information in communication networks connecting to nodes having several systems.

**S Ananthanarayanan (2003)**

explores the application of ant behavior in Internet management. Using the ants foraging techniques based on pheromones for selection of path, in which if there were two paths to the source, the more efficient path would attract more followers. As the path gets crowded and speed come down, the quantity of pheromone deposited will also reduce. The less crowded path, or a newly discovered path or source, would soon have pheromone and adherents would switch. The same technique in internet when the destination is found the message retraces the steps More than one path is established and computers switch from me path to another if the best gets congested. The evaporation of pheromone is implemented or built in using ‘time to live’, to ensure that the queries get dropped if they do not reach destination within a set number of hops.
2.4 Identification of research gap

The survey revealed that not much work was done on the application of ants based system in Human Resource Management specifically in the area of team building in the modern organization. The survey of the literature reveals the gaps which are indicated below:

1. In depth research work has not been done to explore the application of ants behavior and social organization in the area of team building and organizational teams.
2. No empirical study has been conducted to know how an organizational work team based on ants organization and teamwork techniques will improve the work team performance in modern organizations.
3. A generic comparative study related to ants and human based organizational team is scanty and very limited.
4. No studies have been done to model organizational work teams based on ants behavior and their social organization.
5. Some ants based techniques like foraging, collective behavior, communication, division of labor and swarm rules have been applied in few organizations mainly in the areas of engineering, logistics and operations.
6. There is also a vast scope to build new innovative models of team building with the changing times.

The present study attempts to fill some of these gaps related to work teams in Human Resource Management. The major task is to get an insight on Ants team building behavior and their organization structure and apply the techniques and insights in the work teams in the selected organization to determine empirically its impact in improving the synergy and effectiveness of work teams.