Transportation Networks		
Disruption type	**Pathways to resilience**	**Social insect example**
Traffic congestion	***Resist*** traffic congestions by building traffic-resistant topology or through behaviours such as lane formation	Leaf cutter ants, *Atta colombica*, form lanes which follow priority rules as congestion increases. Returning laden ants are prioritised, followed closely by returning unladen ants. Ants do not attempt to overtake those in front. This decreases head on collisions and increases information transfer [24]. Despite a forced decrease in speed, the foraging efficiency increases (up to 6 times pre-congestion conditions), potentially due to the increased communication [118]. *Atta cephalotes* clear trunk trails to maintain a width that maximizes traffic flow [119].
	Redirect traffic to alternate routes of existing network	*Lasius niger* ants respond to increases in traffic by redirecting to additional trails, thus preventing congestion [103]. They are also capable of down regulating pheromone deposition in response to crowded conditions to discourage further congestion [120].
	Alleviate traffic congestion by building new routes ***(Reconstruction)***	
Obstructions	***Resist*** obstruction by building robust transportation network	Meat ants build networks that balance cost and robustness [21, 22].
	Redirect flows around obstruction	Individually foraging desert ants, *Cataglyphis fortis*, update the bearing of their journey to accurately navigate home when they are forced to follow a detour. Desert ants do not use pheromone trails, so each individual is capable of navigating around an obstruction to return to the nest [104].
	Reconstruct network by removing obstruction	Leaf-cutting ants, *Atta columbica*, will remove obstacles, such as small litter items from their established trunk trails [105]. Meat ants (*Iridomyrmex purpureus*) clear obstructive vegetation from their trails [106].
Destruction of roads/paths/trails	***Resist*** destruction by building protected routes	Blind termites, *Hospitalitermes sharpi*, protect foraging routes by lining the trail with large and small soldiers from the colony [23]. Several ant species build walled trenches (eg. *Dorylus wilverthi, Dorylus nigicans, Labidus praedator, Pheidologeton diversus* [107]).

		Formica lugubris build extra, redundant trails in their internest network. This allows the colony to resist disruptions that would otherwise isolate nests in the colony network. It also allows for redirection along other edges if a disturbance occurs [21].
	Redirect flows along existing routes	Same as for traffic redirection [above; 21, 103].
	Reconstruct damage by rebuilding lost trail infrastructure	
Natural degradation/ senescence of road/path/trail	***Resist*** degradation through regular maintenance	Colonies of *A. columbica* regularly maintain and construct trail networks by removing litter items from important trails [105]. Workers of *Eciton burchelli* use their bodies to plug holes along the trail [108]. Pharoh's ants (*Monomorium pharonis*) use U-turns to increase pheromone deposition thereby reinforcing trails [109].
	Redirect flows along better maintained routes; redirect around damaged or suboptimal stretches	
	Reconstruct by investing in rebuilding after failure has occurred	
Communication networks		
Disruption type	**Pathways to resilience**	**Social insect example**
Loss or degradation of signal	***Resist*** by using multi-component signals, or multiple signal modalities	Honey bees (*Apis* sp) use a 'waggle dance' to communicate information about food source location and quality via auditory, vibrational, tactile, olfactory and gustatory cues; *Aphanogaster* workers use combination of pheromone and stridulation (auditory) to recruit nest mates to foods [110]. Giant hornets (*Vespa mandarina*) use multi-component alarm pheromone [111].
	Redirect by seeking signal elsewhere (example, ants choosing new route if pheromone trail doesn't	*Laisus niger* workers turn back (u-turn) if trail deviates from their preferred direction of travel [104].

	lead to resource)	
	Reconstruct by repairing communications infrastructure (example: reapplying pheromone)	Argentine ants (*Linepithima humile*) constantly lay new pheromone trail as they walk, thus allowing them to repair pheromone trails [112].
Loss of signaling units	***Resist*** by having extra units on hand (redundancy) or having homogeneous network topology	Several social insect species have inactive workers that can potentially undertake signaling tasks when individuals are lost [54, 71-73]. Small colonies of the wasp *Ropalidia marginata* have a homogeneous network structure that is resistant to the loss of individuals [4].
	Redirect signal to remaining units	
	Reconstruct by rebuilding lost section of communication infrastructure (example, individuals recruited from a different task)	
	Supply chain	
Disruption type	**Pathways to resilience**	**Social insect example**
Loss of resource supplier/ increase in demand for a resource	***Resist*** by having multiple backup suppliers (duel or multiple sourcing); by ensuring adequate stockpiles (warehousing), and adequate forecasting	Many ant species forage independently, leading to multiple 'suppliers'. On average, meat ant colonies monopolize 2.7 (range 0-6) 'food trees'(containing colonies of sap sucking hemipterans) which the ants are dependent upon for carbohydrates [113]. Honey bees, bumble bees and stingless bees store nectar and pollen; Mexican honey wasps store nectar; several ant species have 'repletes' which function as resource warehouses [57, 58, 60]. Some ants use 'outstations' to store food [58]
	Redirect to backup supplier; to alternative supply (warehouses or backup suppliers)	Honey bees are able to redirect foraging efforts to profitable nectar sources as they change over time. [114]. Ant colonies can redirect to better food sources if food sources change in quality [33].
	Reconstruct by sourcing additional suppliers and building additional	Honey bees build additional storage cells after an influx of pollen or nectar (56)

	warehouse space	
Loss of distributors/work force	***Resist*** by maintaining backup workforce, or redundant workers	Honey bees and ants appear to maintain a large reserve workforce of inactive or redundant individuals that become activated when the colony is attacked or a high value resource is discovered [54, 71-73].
	Redirect to backup workers	In bumblebees(*Bombus sp*), experimental decreases in colony resources (which could naturally occur with the loss of work force), resulted in task switching behavior among foragers and within-nest workers Conversely, some ants, such as *Pogonomyrmex badius*, do not reallocate workers from other castes to fill labour gaps [115].
	Reconstruct by increasing backup workforce, or redundant workers	Honey bees, *A. mellifera*, will hasten maturation of brood and the individuals will begin foraging earlier in life after disturbances, such as the loss of work force. [67, 99].
Surge in supply of a product	***Resist*** by proactively building extra warehouse/storage facilities, having additional transporters	Workers can be enlisted from other tasks, or from the inactive workforce to aid in product transportation [for examples see, 61, 116, 71-73]. Harvester ants, *Pogonomyrmex barbatus*, are solitary foragers but increase foraging activity based on interactions with other foragers and the numbers of returning and outgoing foragers in the nest [121]. Argentine ants recruit individuals to a new food source from a trunk trail. This allows for rapid exploitation when a resource increases in quality [122].
	Redirect oversupply to existing warehouse/storage facilities; re-assign workers to act as transporters. Alternatively, reallocate workers to new roles of products in demand.	*Eciton burchelli* split the central trail of their foraging column into lateral trails to cover a larger foraging area during times of high food densities [117]. *Pogonomyrmex* sp increases activity during times of greater food abundance, with more foragers and more time searching for available food [118]. Italian honey bees, *Apis mellifera ligustica*, that forage for pollen will switch to nectar foraging when pollen stores are full, or cease activity and stay within the hive [61].
	Reconstruct by building new warehouse/ storage facilities; build additional	

	transportation infrastructure	
Destruction of warehouse/storage	***Resist*** by having multiple, spatially distinct warehouses	*Crematogaster torosa* maintains multiple spatially distinct outstations [61]. Replete ants are spread between spatially isolated galleries [58].
	Redirect to undamaged warehouses or directly to suppliers	The ant, *Leptothorax albipennis*, and honeybee, *Apis mellifera*, utilise scouts to identify suitable undamaged nest sites that the colony can move to, in the event that their nest is destroyed [123].
	Reconstruct warehouses	