PART-4: SUMMARY OF THE ENTIRE RESEARCH STUDY
Manual material handling of heavy has been considered to be quite a primitive mode of load carrying, yet it is very much contemporary even in today's technological advancement. In almost every spheres of our lives, be it in the working arena or in the home-front, MMH is inevitable. Thus the significance of MMH and its direct implications on those regularly engaged in MMH cannot be ignored. The study that constitutes the thesis primarily revolves around the workers who perform MMH jobs in different industries belonging to both organized and unorganized sectors. A comprehensive study involving a thorough questionnaire analysis, the daily work schedule, the physical, the physiological, work behaviour, as well as the work environment and some other factors that contribute to the development of work related injuries and accidents, the postures and the location of center of gravity that are being adopted frequently during work and the conditions of the overall work organization have been taken into consideration. All these factors either directly or indirectly lead to the development of accidents and injuries.

The entire study has been represented in this thesis in broadly three different parts. These are Part 1 to Part 3 followed by the summary of the study, which is this part itself and the next part entailing the conclusion of the study. The thesis has been culminated with the last two parts involving bibliography, list of publications and appendices.
The first part of the thesis deals with the unorganized sector and the units where this study was conducted has been described. The units that are studied under unorganized sector include central market area, brick kilns, railway porters (only licensed porters) and hand cart pullers. Four chapters under this part have been respectively assigned to the two units and the general pattern of work with special emphasis on MMH in those units has been elaborately discussed.

The second part deals with the organized sector and the industries where this study was conducted has been described. Four types of industries under organized sector have been studied, viz., heavy engineering industries, steel mills, jute mills and construction industry. Four chapters under this part have been respectively assigned to the four types of industries and the general pattern of work with special emphasis on manual heavy load handling in those industries have been elaborately discussed.

In the first part of the thesis the individual description about the each unit has been given. Which contains a brief description about the unorganized sector with their definition, description, distribution and their present scenario in the economic context has been discussed.

Successively each and every unit of unorganized sectors has been discussed thoroughly in separate chapter. In the subsequent part (Part-1) the main study has been arranged. After the introduction of about the unorganized sectors (chapter 1), next four chapters represented about each units of the unorganized sector with their work process, life style and other information about their MMH tasks. This part, the chapter five constitute the methodology adopted in the study on different units of the unorganized sectors. The successive two chapters (chapter-6 and chapter-7) deal with the results obtained respectively in the unorganized sector and followed by another chapter respectively providing the general discussions on these sectors.
The final chapter under Part 1 involves the general discussion on the units under unorganized sector. These units hardly pay notice to the laid down restrictions of MMH and there is no upper limit to the duration, amount and frequency of load handling. Since more load handling means more monetary returns, the poor workers indulge in performing such strenuous tasks for prolong periods. The result is the occurrence of different types of occupational injuries and accidents affecting specific regions of the body. The workers in the unorganized sector perform their load handling activities throughout the week. The MMH workers of the central market area work 12 hours regularly and do not even have a specific work schedule. The workers of the brick kilns work 10 hours each day whereas the workers of railway porters work 10-12 hours a day and the hand cart pullers work 8-12 hours a day. Workers of all these groups have no weekly off but only the brick kiln workers hardly get a day off in a week. Moreover the workers of the unorganized sector are not privileged with any kind of leave benefits and to them absenteeism from work means no financial returns.

It has been observed that the workers of different unorganized sectors are mostly middle-aged ranging from 35–40 years, whereas most of them have a work experience of above 10 years in their individual occupation.

An intriguing data is that although the MMH workers of the central market area are least aged but are most experienced, being associated with their jobs from a tender age of even below 20 years. All the manual load handling workers of central market area and brick kilns, railway porters and hand cart pullers are constantly engaged in chewing tobacco and smoking beedis. A crucial finding has also emerged that most of these load handling workers (more than 50%) consume alcohol regularly. According to them alcohol gives them somewhat relief for a certain interval of time from the physical and mental agony of their strenuous tasks and erratic work schedule. Due to their erratic work schedule, the central market area workers do not even have any specific time for their meals. Since the workers of the central market area, brick kilns, railway porters and hand cart pullers mostly stay away from their families, so they try earnestly to expend as
minimum to enhance their monthly savings. This is because the more they will be able to save, the more money they can send to their home.

The manual material handling tasks are quite strenuous and the MMH workers of the central market area perform enormous load handling jobs throughout the day. Every one of them bears a load of almost 100 kg overhead and the frequency of lifting is 19 times on an average each day. The influx of more vegetables in the market throughout the day enhances the frequency of heavy load lifting in those workers. They carry these loads after unloading them from the trucks and travel a distance of 26.4 m through the market and place them to a specific storage site. Most of the time these MMH workers (88%) use to take help from their fellow workers in load lifting task, as all of them (100%) follow a same lifting mode overhead at the time of load handling. In most of the time walking surface is slippery to say the least, with debris of rotten vegetables scattered all over the floor of the market place. Furthermore the place is extremely congested with insufficient illumination and noisy, so the workers have to remain cautious while handling such huge loads to avoid injuries and accidents. As a result they have to handle these heavy loads in some erroneous postures. Ultimately all these factors shove them towards the injuries and accidents. Thus the load handling tasks in the central market area are quite unsafe from the occupational health and safety point of view.

Although the brick kiln workers lift a mere 9.36 kg load every time but the frequency of lifting is astoundingly high, 367 times per day. To aggravate the condition further, the distance covered with load each time is found to be 44.2 m, which is very high. Thus they have to walk vast distances with load at such amazing frequency every day. This work pattern is bound to magnify their misery to an immense extent, as a result accidents occurs regularly. On the other hand the railway licensed porters have to lift average 63.65 kg load each time with a high frequency of 32.2 times/day. Most of the time they have to travel an average distance of 116.2 m, here also they have practiced 50% overhead load lifting behaviour. Lastly the hand cart pullers are involved in manual handling of heavy load have to lift an average 83.11 kg load with a frequency of 42.3 times per day and have to travel an average distance 128.6 m each day. In both the cases
workers have to take assistance of their fellow colleagues at the time of load lifting. Most of the time railway station area are crowded and congested enough, at the same time the walking surface rough and slippery one as a result accidents occurs recurrently. Hand cart pullers engaged in MMH activity through a more crowded work place with heavy load experience almost same trouble every day.

On analyzing accidents from questionnaire response it was revealed that MMH workers of all the units of unorganized sector experienced different kind of injuries and accidents. It was found that 80% of the central market area porters, 74% of the brick kiln workers, 84% of the railway porters and 88% of the hand cart pullers experienced some sort of accidents in one year. On further analysis it was observed that a majority of accidents occurred at the time of load carrying, lifting loading and unloading in all the units of unorganized sector. Accidents also occurred in other activity also.

On analyzing the nature of injury it was found that cut, laceration, abrasion and fracture are common nature of injuries among MMH workers of different units of unorganized sectors. It was found that among workers of unorganized sectors predominant type of accidents are found to be struck by object and slip and fall types of accidents.

On the other hand it was observed that the vertebral column and lower back region are the most affected body parts in case of central market area workers. Due to faulty load handling behaviour different types of injuries results and different accidents encountered by the workers. As a matter of fact other parts of the body also injured badly. Brick kiln workers working in the brick field suffered mostly from head injury, low back and feet injuries. Railway porters predominantly affected in the vertebral column, neck and hand region; whereas hand cart pullers are involve in MMH activity frequently affected in feet, leg and low back region.

A seasonal variation in the occurrence of accidents was noted after the questionnaire analysis and it was observed that maximum accidents occurred in rainy
season in all units of unorganized sector. A good percentage of accidents also observed in summer and winter season. As the MMH workers are constantly exposed in the inside and outside of their workplace and specially in the rainy season the workload also very high make the work much more hazardous. At the same time the walking surfaces become more slippery in the rainy season.

Workers of all units of unorganized sector reported about the dust hazards. The thermal condition of each of the work place was found to hot and humid. Other environmental factors like noise level revealed a high value as the workers constantly entering and leaving their respective workplace and these work places are mostly situated very nearby roadside as a result they are exposed to the a highly noise area. There existed not much variations in the noise level in different seasons. However, the level of illumination was found to be low in the respective workplaces of different units of unorganized sectors.

There is no such record keeping system in the unorganized sector for accident and incident documentation and the workers have a general trend of negligence in reporting their injuries and accidents because they do not any leave benefit or worker compensation system and in most of the cases they are daily payment based workers and no work means no pay to them. Only in severe cases of accidents they have to visit to the hospital nearer to their workplace. In the hospital all these type of accidents are recorded in the indoor police case record books. Therefore the only way of their accident analysis was found to be the analysis of accident records of the hospital nearer to the respective workplaces. For this purpose IPC records for a period of 10 years (1996-2005) were recorded and analyzed. It was found that only 0.38% of MMH accidents recorded in this period. On further analysis it was found that vertebral column was the most affected body part. Low back, hand, neck and leg are the other body parts affected due to accidents. It was also noted that the cervical region (82.72%) of the vertebral column was worst affected.
A similar result of questionnaire was found where most accidents occurred at the time of load carrying (44.44%), unloading (24.65%) and at the time of load lifting (16.32%) during MMH activity. Fracture and sprain were predominant nature of injuries found in MMH accidents. Struck by object, struck by falling object and slip and fall were the predominant type of accidents. These findings were also similar to the questionnaire responses, this suggests that MMH activities in the unorganized sector are quite similar and dreadful in nature. The situation further deteriorates in rainy season.

The arduousness of the manual load handling jobs in the unorganized sector is manifested from the measured heart rates. In case of the central market area workers, a sharp increment in mean heart rate (134 beats/minute) measured just after completion of one work cycle from that measured before the work (86 beats/minute) is observed. The probable reason behind this result is that these workers, handling colossal load overhead, require a much greater effort to complete the job. In the matter of brick kiln workers, the enhanced heart rate after work (120 beats/minute) exemplifies the grueling nature of the job they perform. On the other hand the heart rate of railway porters increases from 84 beats/minute to 130 beats/minute. In case of the hand cart pullers the awful MMH tasks demand great physiological efforts, as a result the heart rates increase up to 116 beats/minute, indicating the severity and intensity of their job. However in spite of the massive alterations in heart rates, the systolic and diastolic blood pressures measured just before work and after the completion of a single work cycle show some variations in all cases.

On analyzing the work postures of central market area workers, it is revealed that most of the postures are awkward and are repeated several times in a day depending upon the frequency of load handling. Therefore such faulty postures, the stupendous load overhead that is always much greater than the body weight of the person carrying it, the high frequency, the extensive distance traversed throughout the congested market place together with the never-ending commotion - all these issues make their tasks substantially hectic. As a consequence almost all of them suffered from different types of injuries and accidents involving various body regions, which has been already established from the
questionnaire analysis. In case of brick kiln workers most of the frequently adopted postures are faulty. Apart from that they have to cover vast distances with load at a very high frequency every day. This traumatic work schedule together with flawed postures causes in the occurrence of injuries and accidents. Postures of the railway porters adopted at the time of MMH activity are not correct and by adopting such postures they have to travel a large distance as a result injury and accident occurs. On the other hand like other work units of the unorganized sector hand cart pullers also adopt some awkward postures which create a great pressure on musculoskeletal systems as a result injuries and accidents occurs.

After the analysis of working postures, the center of gravity was calculated for each hazardous posture adopted by the workers of different unorganized sectors. It was revealed that in workers of central market area, all the postures at the time of load handling showing a higher value. In all of the cases the percent location of the whole body center of gravity exceeds 50%, which means all these postures are totally incorrect. As we know that the location of the center of gravity should be closure to the body and load should be handled nearer to the body, but the workers of unorganized sector practice a faulty work mode, work behaviour which contributes considerably in the occurrence of accidents.

It has been observed from the general discussion on organized sector that although in India the industries under organized sector follow the rules regarding manual lifting tasks with the amount of load to be handled each time maintained at or within 50-60 kg., yet the workers associated with load handling jobs for prolonged periods suffer different injuries and accidents affecting different regions of the body. The probable reasons behind these injuries and accidents have been intricately assessed in this part. It has been observed that age of these workers range from 30-40 years, whereas most of them have a work experience of 5-10 years in their individual occupation with the workers of the heavy engineering industries most of them have a experience more than 10 years, followed by the workers of the jute mills, construction industry and steel mills respectively.
On further performance of questionnaire it has been seen that these workers are addicted to a great degree either to tobacco chewing or to smoking. Irrespective of all units of it is evident that, workers consume alcohol occasionally.

While analyzing the lifting behaviour of these workers, a distinct variation in their work pattern is observed. In the heavy engineering industry, a single worker lifts around 55 kg load about 23 times each day and cover a distance of 23.6 m on an average each time with load. In the steel mill, the workers carry hand ladle filled with red-hot molten iron from the furnace area to the site of deposition in the core box at a distance of 38.2 m. The weight of the ladle filled with molten iron is 40 kg and they carry out this job almost 40 times every day. Not only they have to carry the filled up ladle but also after deposition they have to return to the furnace site with the empty ladle that weighs almost 25 kg. So ultimately the frequency of load handling as well as the distance covered gets almost doubled. The workers of the jute mills have to handle around 60 kg load each time with a frequency of 31 times a day. In the construction industry the workers are engaged in lifting and carrying 103 cement bags (weight of each bag is around 50 kg.) each day and the total amount of load lifted and carried increases drastically. Moreover they have to cover a considerable distance (48.2 m.) throughout the day with the load overhead for bringing the cement bags from the storeroom to the machine where the content of those bags are to be poured and also have to climb a height of 1.9 m each time with the load overhead from the ground to the pouring level, which make their work process even more strenuous and awful. Performing such hazardous MMH tasks they feel pain and even pain felt during sleep at night.

On analyzing accidents from questionnaire response it was revealed that MMH workers of all the units of organized sector experienced different kind of injuries and accidents every day. It was found that 70% of the heavy engineering industry workers, 96% of the steel mill workers, 84% of the jute mill workers and 92% of the construction industry workers experienced some sort of accidents in one year. On further analysis it was observed that a majority of accidents occurred at the time of load carrying, lifting
loading and unloading in all the units of organized sector. Accidents also occurred in other activity also but they are less frequent.

Afterward on analyzing the nature of injury it was found that cut, laceration, abrasion and fracture are common nature of injuries among MMH workers of different units of unorganized sectors. It was found that among workers of unorganized sectors predominant type of accidents are found to be struck by object and slip and fall types of accidents.

On the other hand it was observed that the vertebral column and lower back region are the most affected body parts in case of central market area workers. Due to faulty load handling behaviour different types of injuries result and different accidents encountered by the workers. As a matter of fact other parts of the body also injured badly. Brick kiln workers working in the brick field suffered mostly from head injury, low back and feet injuries. Railway porters are predominantly affected in the vertebral column, neck and hand region; whereas hand cart pullers are frequently affected in feet, leg and low back region.

A seasonal variation in the occurrence of accidents was noted after the questionnaire analysis and it was observed that maximum accidents occurred in rainy season in all units of organized sector. A good percentage of accidents also observed in summer and winter season. As the MMH workers are constantly exposed in the inside and outside of their workplace and specially in the rainy season the workload also very high make the work much more hazardous. At the same time the walking surfaces become more slippery in the rainy season.

Workers of all units of organized sector reported about the dust hazards. The thermal condition of each of the workplace was found to be hot and humid. Other environmental factors like noise level revealed a high value as the workers constantly entering and leaving their respective workplace and these work places are mostly situated very nearby roadside as a result they are exposed to the a highly noisy area. There exist
not much variations in the noise level in different seasons. However, the level of illumination was found to be low in the respective workplaces of different units of organized sectors.

The workers perform extremely rigorous activities as documented by their heart rates. Among them, the construction industry workers seem to be under more severe physiological stress. In their case, the mean heart rate measured just before work was $78.0^{\text{beats/minute}}$, which escalated alarmingly to $160^{\text{beats/minute}}$ after the completion of a single work cycle. Among the MMH workers of the steel mills and heavy engineering industries an enormous rise in the mean heart rate is observed. Just before work it was $78.6^{\text{beats/minute}}$ and $77.7^{\text{beats/minute}}$, respectively in those industries and accelerated to $91.6^{\text{beats/minute}}$ and $84.9^{\text{beats/minute}}$ respectively after the completion of a single work cycle. However irrespective of the abysmal alterations in heart rates, the systolic as well as the diastolic blood pressures measured just before work and after the completion of a single work cycle seem to vary not by much in all cases.
After the analysis of working postures, the center of gravity was calculated for each hazardous posture adopted by the workers of different organized sectors. It was revealed that in workers of central market area, all the postures at the time of load handling showing a higher value. In all of the cases the percent location of the whole body center of gravity exceeds 50%, which means all these postures are totally incorrect. As we know that the location of the center of gravity should be closer to the body and load should be handled nearer to the body, but the workers of organized sector practice a faulty work mode, work behaviour which contributes considerably in the occurrence of accidents.