Summary

In today's society, human conveyors such as, lifts, escalators or moving walks play an important role for the transportation of people inside and outside buildings. They can perform vertical, inclined and horizontal transport. As we all use them to increase our comfort during short-distance traveling, most of us don't know the systems behind the movement of the car of a lift, the steps of an escalator or the pallets of a moving walk. In order to provide insights into the world of these machines a research has been performed with the aim to give an overview of the working principles of human conveyors, types available, market position – according to the number of installations – and safety components associated with the equipment.

There are many types of human conveyors, but not all designs are used as often, here the most important types have been classified. Lifts can be classified according to their drive, where traction and hydraulic lifts are the main types and screw, drum, linear induction motor drive, rack and pinion, pneumatic and chain driven lifts can be considered as an exception. Within escalators and moving walks many designs have been introduced. Of these designs, only one is used regularly today and is basically identical for escalators and moving walks.

Traction lifts are suspended by cables. The ends of the cables are attached to the car and counterweight and run over a grooved sheave. The friction generated by the cables being pulled in the drive sheave grooves, provides the traction force needed to drive the car.
The cables are either single or double wrapped around the drive sheave, where the double wrap provides more traction for high-speed lifts. Different roping systems can be used, these lower the load on the cables and therefore lower the required drive torque and increases required motor speed and length of the cables.

Within the traction lift type, distinction can be made between the driving mechanism used; geared or gearless. As well as the location of the driving mechanism; in a separate machine room on top of the hoistway or – like machine room-less lifts – inside the hoistway. Geared lifts use a reduction gear to reduce the motor speed and to increase the torque, this means smaller motors can be used, but losses in the gearbox reduce the system efficiency. Gearless lifts are directly driven, bigger motors are used and higher speeds can be obtained, making gearless driving systems more suited for higher buildings. Machine room-less lifts use compact driving equipment, which is installed in the hoistway together with the control unit, making machine room-less lifts more space efficient.

Hydraulic lifts are driven by a hydraulic cylinder. Inside the cylinder a plunger – or piston – fits tightly, its end supports the car. Pumping hydraulic fluid inside the cylinder and under the plunger raises the plunger and thus the car attached to the end. The distance the plunger can travel inside the cylinder limits the traveling height of the car.

Hydraulic lifts can be subdivided by the type of plunger used and plunger usage. The plunger can either be single or telescopic, where the telescopic type has multiple plungers that extend out of each other. The plunger can be used directly, where it is connected to the bottom of the car and the cylinder extends into the ground. Another encountered design is the holeless lift that uses one or two cylinders that are located at the sides of the car and the plunger is connected to the top of the car. Lastly, roped hydraulic lifts use a rope that is attached to the side mounted cylinder and the car. This rope runs over a pulley that is attached to the plunger, in this way the car travel twice the length of the plunger.

The design of escalators is very similar to that of moving walks. It consists of a truss that supports the structure. The steps that are chain driven have rollers attached. The rollers run in tracks which are connected to the truss, the positions of the tracks determine the orientation of the tread. The handrail is driven by a pulley; its drive is located inside the truss as well as the drive for the steps. Instead of steps, moving walks are equipped with either a belt or pallets.

Escalators can be straight or curved. The curved type requires less space for installation, but the design is more complex. Straight escalators can be arranged crisscross or parallel. With the crisscross arrangement, the escalators connecting two floors face in opposite direction, this arrangement is mostly used for multiple floors. The parallel arrangement – here the escalators face in the same direction – is mostly used where only two levels are connected.

Moving walks can be used either horizontally (<6°) or inclined (≤12°). The horizontal type can be subdivided in; constant speed (max. 0.75 m/s) and accelerating moving walks, where the speed can be increased from normal speed up to 15 km/h. Inclined moving walks are mainly used to move passengers with carts vertically, also they are easier to use for small children, elderly and handicapped compared to escalators.

In Europe there are about 4.8 million lifts and 75 thousand escalators and moving walks installed. About 80% of the lifts are installed in residential and office buildings, on the other hand about 80% of the escalators and moving walks are installed in commercial buildings.

On all lifts safety components have to be installed to increase the safety level. According to the European Lift Directive (a legal act with minimum health and safety requirements in the EU), every lift has to be equipped with minimum the following 6 categories of safety components.

1) Devices for locking landing doors to prevent the opening of landing doors while the car is moving and prevent the car from moving while the landing doors are open.
2) Devices to prevent the car from falling or unchecked upward movement.
3) Overspeed limiting devices.
4) Shock absorbers.
5) Safety devices fitted to jacks of hydraulic power circuits used as devices to prevent falls.
6) Electric safety devices in the form of, safety switches containing electrical components.

In addition to these safety components, lifts, escalators and moving walks have to be built according to European standards to ensure the safety of users, maintenance and inspection personnel, as well as persons adjacent to the equipment. All new human conveyors installed in the EU have to be constructed according the harmonized standards (a standard common throughout the EU in support of one or more European Directives to prove the performance of important requirements) in force.

This overview of human conveyors has shown the working principles of lifts, escalators and moving walks, types available, market position and the safety requirements for human conveyors. In this way insights into the world of human conveyors have been provided.