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CONSTRUCTION OF ROBUST SUPPLY CHAIN NETWORK FOR SUSTAINABLE MARS  
HABITATION

**Abstract**

Manned space exploration is still difficult. In case of Moon, high reliability was needed. In addition, in case of ISS, high flexibility was needed for sustainable space stay. For future human space exploration of Mars, there are many difficulty of transportation between Earth and Mars, such as long transportation time, high delta-V and periodic change of relative position. So, robustness become very important in addition to reliability and flexibility for safety of astronauts.

Redundant and spare materials have been used for safety of astronauts ever. But because of long transportation time and low frequency transportation between Earth and Mars, additional material of sustainable Mars habitation become much heavier than the manned missions ever. Furthermore, because of high delta-V, IMLEO (Initial Mass in LEO) increase drastically as the additional materials increase. So, it is difficult to keep survivability of astronauts by using of traditional transportation system. So, we have to make new transportation system for sustainable Mars habitation. New system should have the point of view of sustainability and robustness. We suggest to construct the SCN (Supply Chain Network) for transportation between Earth and Mars by using of multiple spacecraft. Using this network we save IMLEO and advance survivability of astronauts.

Transportation system between Earth and Mars need high delta-V. But, transportation time should be short as possible. So, Many plans of manned Mars exploration suggest to use solid core NTR (Nuclear Thermal Rocket). In addition, in case of space exploration like JIMO (Jupiter Icy Moons Orbiter) suppose to use NEP (Nuclear Electric Propulsion). In this research we suppose to use these new transportation system too. But, by using these new technology, we construct SCN that is not the only extension of traditional transportation system. In this research, SCN is consists of transportation using cycler orbit and direct transportation between Earth and Mars. These transportation system can cover the week point each other. For example, in case of emergency transportation to Mars, over 500days are needed from Earth when relative position of two planets is bad. But, using cycler emergency transportation can be done in about 180days in all time. By combine and optimize these transportation system, robust and sustainable SCN is constructed in this research.